USABILITY OF DIGITAL LIBRARIES DURING INFORMATION RETRIEVAL BY PERSONS WITH VISUAL IMPAIRMENT IN SELECTED PUBLIC UNIVERSITIES IN KENYA

FRIDAH GATWIRI KIAMBATI

E83/31664/2015

A RESEARCH THESIS SUBMITTED IN PARTIAL FULFILMENT FOR THE AWARD OF THE DEGREE OF DOCTOR OF PHILOSOPHY (INFORMATION SCIENCE) IN THE SCHOOL OF EDUCATION, KENYATTA UNIVERSITY

DECEMBER, 2021

DECLARATION

I confirm that this research thesis is my original work and has not been presented in any other university for certification. The thesis has been complemented by referenced works dully acknowledged. Where text, data, graphics, pictures, or tables have been borrowed from other works- including the internet, the sources are specifically accredited through referencing in accordance with anti-plagiarism regulations.

Signature ……. Date …….

Fridah G. Kiambati
Reg. No.: E83/31664/2015
Department of Library and Information Science
Kenyatta University

Supervisors' declaration

We confirm that the work reported in this thesis was carried out by the candidate under our supervision as university supervisors.

Signature ……. Date …….

Dr. Caroline Mutwiri
Department of Library and Information Science
Kenyatta University

Signature ……. Date …….

Dr. Rose Njoroge
Department of Library and Information Science
Kenyatta University

DEDICATION

I dedicate this study to my Parents Lawrence and Evangeline for nurturing my education journey; my siblings for their unending encouragements and to my son Darrel for brightening my study days.

ACKNOWLEDGEMENTS

I acknowledge God almighty for His providence, good health and for making it possible to achieve my goals to this level. My sincere gratitude goes to the Kenya Institute of Special Education (KISE) for financing my studies.

I offer special thanks to my supervisors, Dr. Caroline Mutwiri and Dr. Rose Njoroge for their expert input and professional guidance, throughout the process of conducting this research study.

I acknowledge the department of Library and Information Science at Kenyatta University for the practical skills in research and for the many opportunities to participate in research-based seminars. Further acknowledgements go to all departmental lecturers and staff for their encouragements and unlimited support. Special thanks go to Dr. Philothere, Dr. J.R. Njuguna for their rich advice and to Mr. Juma for insightful support.

I sincerely thank the Kiambati family for their unlimited support and inspiration towards achieving my career goals and for consistently ensuring that I am on course towards successful completion of my studies.

I acknowledge the research department at KISE for continuous capacity building in research through hands on experiences in diverse national research activities which has greatly influenced the quality of this study.

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ABBREVIATIONS AND ACRONYMS

AMOS	Analysis of a Moment Structures
AT	Assistive Technology
CAPI	Computer Assisted Personal Interview
DL	Digital Library
FGD	Focus Group Discussion
GoK	Government of Kenya
ICT	Information and Communication Technology
IR	Information Retrieval
ISO	International Standards Organization
KISE	Kenya Institute of Special Education
KNBS	Kenya National Bureau of Statistics
KU	Kenyatta University
NACOSTI	National Commission for Science, Technology & Innovation
NCPWD	National Council for Persons with Disabilities
SDG	Sustainable Development Goals
SEM	Structured Equation Modelling
SPSS	Statistical Package for the Social Sciences
SR	Screen Reader
UoN	University of Nairobi
UTAUT	Unified Theory of Acceptance and Use of Technology
UX	User Experience
VI	Visual Impairment
W3C	World Wide Web Consortium
WHO	World Health Organisation

ABSTRACT

Usability studies play a key role in advancing best practices in the design of usable digital libraries. Users with visual impairment have been excluded in design of digital libraries due to unintentional biasness towards the sighted majority. As a result, these users experience difficulties when using the digital libraries to retrieve information. The purpose of this study was to evaluate five usability attributes of digital libraries from the perspective of a user with visual impairment regarding information retrieval. The study sought to determine the level of user friendliness, efficiency, user satisfaction, learnability, and the level of accessibility of digital libraries by persons with visual impairment when retrieving information. Unified Theory of Acceptance and Use of Technology was adopted for the study. The study used a cross-sectional survey design in which 126 students with visual impairment and 12 special needs librarians were targeted. Complete enumeration technique was used to select all for the study. Questionnaire, interview guide and focus group discussion guide were used to collect data from the students and special needs librarians. A pilot study was conducted at the University of Nairobi to improve the reliability and validity of the data collection instruments and enhance data collection logistics. A mixed method approach to data analysis was used, where descriptive and inferential statistical methods were used in the analysis and presentation of quantitative data while thematic approach was used to analyse qualitative data. The study findings revealed that digital libraries were not friendly to use by students with visual impairment. On efficiency of digital libraries, slightly more than half of students with visual impairment reported that digital libraries are efficient. On user satisfaction with digital libraries, it was found that a bigger percentage of students with visual impairment were dissatisfied. The findings further revealed that user's level of satisfaction was independent of their gender and age. Research findings also established that majority of students with visual impairment found the digital libraries not easy to learn. Further, the study findings revealed that digital libraries were not accessible to persons with visual impairment and that some of them lacked the basic accessibility requirements for the visually impaired as guided by the World Wide Web Consortium standards. This study established that there is a close interrelation among four of usability attributes; friendliness, efficiency, learnability, and accessibility as they all correlated positively to user satisfaction. The study concludes that prior training of students with visual impairments in assistive technology improves overall user experience with digital libraries. Thus, the study recommends institutionalization of assistive technology training as a strategy to enhance the use of digital library resources among users with visual impairment. The study also recommends involvement of persons with visual impairment in usability testing of information retrieval (IR) systems such as digital library to facilitate design of friendly, efficient, easy to use, easy to learn and accessible systems.

CHAPTER ONE

INTRODUCTION AND BACKGROUND TO THE STUDY

1.1 Introduction

This chapter introduces the contextual background of the study and statement of the problem. The chapter also presents the purpose of the study, objectives, research questions and significance of the study. Further, the assumptions, limitations and delimitations, theoretical framework and conceptual framework of the study are also discussed. The chapter ends with operational definition of terms.

1.2 Background to the Study

The use of digital libraries (DL) is increasingly gaining prominence in providing access to learning information resources (Li, Jiao, Zhang, & Xu, 2019). Digital libraries have become the recent gateway to modern knowledge and information and therefore influence how information is gathered worldwide. The role of digital library in advancing research and academic excellence cannot be underestimated in line with the Sustainable Development Goals (SDGs). The SDG 4 that aims at ensuring inclusive and equitable quality education and lifelong learning opportunities echoes the need for accessible digital libraries so that everyone regardless of their disability can access and retrieve useful information.

Digital Libraries (DL) may be defined in a variety of ways depending on specific contexts in which the term is used. As such, there may not be a precise and

universally acceptable definition of this term. This study adopted the definition of digital library contained in the IFLA/UNESCO manifesto for digital libraries developed by the International Federation of Library Associations and Institutions (IFLA) and endorsed by the 36th session of the general conference of UNESCO in 2011. In this regard, digital library is defined in this study as "an online collection of digital objects, of assured quality, that are created or collected and managed according to internationally accepted principles for collection development and made accessible in a coherent and sustainable manner supported by services necessary to allow users to retrieve and exploit the resources."

Presence of digital libraries (DLs) and digital collections indicate that there is a significant growth of the traditional library (Dickson, 2008; Li et al., 2019). According to Dickson, Digital library technologies have kept on being improved to offer better services and improved access to the collections they host. The author however notes that a check on usability of digital libraries has not matched the required level to have the users satisfied with their use. In addition, the study by Li et al above also observed that most of the digital libraries in developing countries fall short if International Organization for Standardization [ISO] (2015) quality standards on functionality and accessibility.

To advance the discourse on inclusive system design and better user experience (UX) with digital libraries for all users, there is need for more usability studies with focus on UX to be given on usability testing as well as incorporating the needs of all digital library users including persons with disabilities such as visual

impairments at the design stage. A person with visual impairment as used in this study refers to someone who is either totally blind and cannot see at all or one who has low vision (Vinter, Bonin & Morgan, 2018). This category of digital information users interacts with digital content using assistive technologies such as screen magnification software for those with low vision or screen-reader (SR) software for those who are totally blind. The screen-reader (SR) software identifies and interprets text content on a system interface and presents it in audio form through a synthetic voice. Persons with visual impairment comprise a vulnerable user group that interacts with digital libraries (DLs), in different ways from the sighted users, through use of assistive technologies.

Persons with disabilities such as those with visual impairments are vulnerable in many situations and deliberate effort ought to be made to mitigate such vulnerabilities. According to Xie, Babu, Castillo and Han (2019), a vulnerable person is one who is at risk of being ignored, excluded, hurt, or marginalised by others. Earlier, Andreas Kleynhans and Fourie (2014) came up with the social model to disability which serve as a reminder that keeping an inclusive perspective in the design of our technologies is not an option but a requirement for a progressive society. The social model to disability replaced the medial model to disability whose propositions would give the impression that persons with disabilities were in essence ‘sick’ and needed cure (Evans, 2004). As a result of the paradigm shift from medical to social model to disability, the design of human technologies and information systems such as digital libraries need to

be done in such a way that it is inclusive in its applications and contains usable interfaces, thus the concept of the universal design.

Universal Design is a concept that emerged from the architectural industry in 1961 when the American National Standards Institute (ANSI) published its first standard on accessible design of public buildings. This concept has grown beyond the physical architectural industry into many other disciplines including information science and education. The concept describes a system design which accounts all the needs of any potential user regardless of their ability, including disabilities. When considering universal design and usability in the context of the design of digital libraries, it may be important to check social context, environmental barriers as well as technological barriers that may present difficulties to a user as opposed to viewing the impairment as the source of the difficulty. Universal design is about creating services and products that are usable by the widest range of users (Kopeva, Ivanova, & Zaitseva, 2018). To actualize the power of digital experience and information age in higher education, creation of usable digital libraries is inevitable. This is possible if and only if universal design principles are used in the attempt to minimise barriers of accessibility and functionality.

Currently, different education stakeholders have concerns about the utilization of digital libraries by students with visual impairments. For instance, scholars such as Jaeger, Bertot and Franklin, (2010) have argued that while the goal of embracing digital libraries in higher education institutions is to provide a gateway of universal access to information, this goal is yet to be achieved for the

marginalized group of users like persons with visual impairments. Xie, Babu, Castillo and Han, (2018) contends that current designs of digital libraries (DL) have usability pitfalls as evidenced by their inadequacies in meeting the needs of persons disabilities such as those with visual impairment.

Babu and Xie, (2017) concur that information seeking behaviour of persons with visual impairment is characterised by difficulties in searching for relevant digital content. A digital library (DL) designer needs to support the widest range of users, especially those with visual impairments to effectively search for information through implementation of a series of help and accessibility features, which can enhance the usability of the DL. Universal design approach can be applied by digital library system developers to include help and accessibility features that can be used by persons with visual impairment to overcome difficulties they experience during their interaction with digital libraries. While the recommendations to leverage universal design is less contentions, there is limited empirical research on how students who are blind and those with low vision interact with digital library interfaces during information retrieval which is a critical aspect establishing the usability of digital libraries.

Information retrieval from digital libraries is a key variable in this study. It is hypothesised that informational retrieval from digital libraries by persons with visual impairments is influenced by usability attributes including but not limited to friendliness, efficiency, satisfaction, learnability, and accessibility of digital library interface. Bevan, Carter, Earthy, Geis and Harker (2016) defines usability

as the extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use. Information retrieval is arguably the ultimate demonstration of successful utilization of a digital system (Bevan et al., 2016; Babu and Xie, 2017; Kopeva et al., 2018).

Globally, various scholars have conducted research on usability of digital systems including digital libraries. A study by Asian scholars perceives Usability knowledge as very important in establishment of both effective and efficient as well as safe and learnable design of the ever changing information technologies (Lei, Xu, Meng, Zhang, & Gong, 2014). In another study conducted on North America, the need for usability testing was emphasised. The author noted that to improve the way users interact with the interfaces of digital libraries, Librarians need to employ the use of usability testing techniques. The same techniques have been used to improve the usability of library websites (Dulock, 2015).

Most studies conducted across the world may not have adequately addressed the usability requirements of digital libraries for persons with visual impairments. For instance, a study in Bangladesh by Ronny (2017) explores the experiences of persons with visual impairment on use of information and Communication Technology (ICT) in learning. On the other hand, a study in China by Wang and Yu (2017) described use of digital Technologies for persons with visual impairment as a small world using Chatman's theory, while Al-Harrasi and Taha

(2017) focused his study on provision of e-resources to learners with visual Impairment in United Arab Emirates (Muscat).

There were few studies across the globe that studied usability of digital libraries by persons with visual impairment. However, most of them focussed on one or two of the usability attributes. For instance, a study by Dodamani and Dodamani (2009) focussed on friendliness of digital libraries by persons with visual impairment while a Swedish study by Muhammad and Mohammad (2009) and Malaysian study by Bodaghi and Zainab (2017) focussed on efficiency of digital libraries.

Various studies have been conducted in Africa continent on utilization of digital libraries by persons with visual impairments, but without special focus on usability. For instance, a study in South Africa by Lourens and Swartz (2016) explored the experiences of users with visual impairment in higher education and library usage with a focus on inclusion in learning. Another study by Olapa (2017), carried out in Nigeria focused on factors affecting utilization of digital information resources such as literacy skills and availability of alternative format for students with visual impairment. Very few African studies touched on usability of digital libraries by persons with visual impairment. On record is a study by Eligi and Mwantimwa (2017) that focussed on ICT accessibility and efficiency in a library setting in Tanzania.

Kenyan based studies also focused more on service provision of persons with visual impairment in a library setting and less on usability of digital libraries.

For instance, a study by Odini, Chege & Mbugua (2018) and that by Kiruki (2018), focused on provision of information services to persons with visual impairment.

In Kenya, Universities have embraced the use of digital information systems as evidenced by some innovative ideas such as development of digital schools, digital libraries, digital institutional repositories, and subscription to e-resource databases through the Kenya Libraries and Information Services Consortium (KLISC). Classic examples of these innovations are evidenced by a lot of investments in universities' e-learning platforms, and student portals. While these innovations come with tremendous advantages for the sighted users, scanty empirical research has been done in Kenya on usability of these technologies by persons with visual impairments.

Theoretically, perceived ease of use and perceived usefulness of a system are thought to be factors influencing the acceptance and use of an information technology ((Venkatesh, Michael & Gordon, 2003). Domesticating this concept in the Kenyan context where technology has been embraced in the education sector including the new competence-based curriculum by incorporating digital literacy component as a core competence, usability becomes a new driver to harnessing the full potential of technology.

Usability studies across the globe seem not to have adequately addressed how persons with visual impairments (VI) interact with digital libraries, nor the typical problems encountered during interactions. Persons with visual

impairments (VI) are vulnerable in digital information environments, particularly the digital library (DL) environment mainly because of limitations in the design of a digital library that prevent them from interacting with its features, its interface, and the content that it contains in an effective way. Failure to address limitations in the DL design through evidence based empirical research focusing on varied usability attributes, may continually exclude persons with VI from participating in lifelong learning.

According to World Health Organization report (WHO, 2018), the population of persons with visual impairment across the globe exceeds 0.65 billion people, 78 million living in Sub-Saharan Africa. In Kenya, prevalence of visual impairment (VI) seems to be among the highest disabilities in the general population. For instance, a survey conducted by Kenya Institute of Special Education (KISE, 2018) on children (between 3 and 21 years) with disabilities and special needs in education found that prevalence of VI was highest at 3.1%. This indicates that there are many children with visual impairments within the basic education systems that need to access learning resources in digital format, who will ultimately transit to tertiary education. Recently, the Kenya National Population and Housing Census report (KNBS, 2019) found that visual impairment is the second most prevalent disability after physical disability. Clearly, failure to address the issue of usability challenges facing persons with VI in interacting with digital libraries would mean excluding a significant population from lifelong learning.

This research therefore focussed on the study of five usability attributes of digital libraries (DLs) from the perspective of a user with visual impairment with the aim of providing empirical evidence that contributes towards a holistic and universal design of digital libraries in Kenyan universities, and across the globe.

1.3 Statement of the Problem

Creation of digital libraries is intended to provide universal and remote access to information, round the clock availability and multiple access (Xie, Joo & Matusiak, 2018). In most cases, digital libraries (DLs), tend to be designed predominantly based on experiences of sighted digital information users. As a result, users with visual impairments may experience difficulties using those digital libraries.

Having digital libraries designed predominantly based on the experiences of sighted users may pose usability challenges to users with visual impairment when retrieving information in the venture to meet their information need. If the situation highlighted here-in continues to prevail, the intended purpose of digital libraries which is to increase information access and retrieval to all its clientele may not be actualized. In addition, library users with visual impairment may continue aspiring without necessarily actualising the use of digital information resources in such times when most information resources and services are digital based due to the increasing advancements in technology and use of the internet.

Difficulties experienced by persons with visual impairment in searching and retrieving digital information resources, made the researcher question usability

of digital libraries by the widest possible range of users including those with disabilities. To answer this question, a usability study targeting digital library users with visual impairment was conducted. The study sought to find out whether digital libraries in Kenyan universities are friendly, efficient, satisfying, easy to learn and accessible to persons with visual impairment during information retrieval.

1.4 Purpose of the Study

The purpose of the study was to evaluate usability of digital libraries (DLs) by persons with visual impairment during information retrieval so as to provide empirical evidence towards an inclusive design of digital libraries in Kenyan universities and across the globe.

1.5 Objectives of the Study

The study objectives were as follows:

1. To determine the level of friendliness of digital libraries during information retrieval by persons with visual impairment.
2. To assess the level of efficiency of digital libraries during information retrieval by persons with visual impairment.
3. To determine the level of user satisfaction in using digital libraries during information retrieval by persons with visual impairment.
4. To establish the level of learnability of digital libraries during information retrieval by persons with visual impairment.
5. To establish the level of accessibility of digital libraries during information retrieval by persons with visual impairment

6. To determine the association between usability of digital libraries and information retrieval by persons with visual impairment.

1.6 Research Questions

The research was guided by the following questions:

1. How friendly are digital libraries during information retrieval by persons with visual impairment?
2. How efficient are digital libraries during information retrieval by persons with visual impairment?
3. How satisfying are digital libraries during information retrieval by persons with visual impairment?
4. How easy to learn are digital libraries during information retrieval by persons with visual impairment?
5. How accessible are digital libraries during information retrieval by persons with visual impairment?
6. What is the association between usability of digital libraries and information retrieval by persons with visual impairment?

1.7 Assumptions of the Study

In conducting this study, the following assumptions were made:

1. Usability of a digital library affect information retrieval by persons with visual impairment.
2. Users with visual impairment in the selected universities have access to digital libraries through available assistive technologies.

3. Digital libraries used in the selected universities are useful in addressing information needs of users.

1.8 Limitations of the study

The sample used in this study has a significant level of heterogeneity. This is reflected in their varying levels of prior training on use of the system, duration of interaction with the digital library, the level of expertise of the user in assistive technology, enabling digital infrastructure, technical support, and user attitude. Other than Usability, the independent variable under study, these factors could also affect how persons with visual impairment interact with digital libraries during information retrieval. This limitation could be overcome in future research by sampling participants with similar characteristics to increase the level of homogeneity in the sample.

The findings of this study may not be generalizable to the entire population of digital library users in all universities in Kenya which include users who are sighted since the sample was limited to users with visual impairment. This may be overcome by conducting a study that targets digital library users who do not have any visual disability, herein referred to as the sighted.

1.9 Delimitations of the study

The study evaluated the usability of digital libraries that were hosted on DSPACE library information system. There are other information management systems available over the counter or open access systems that did not form part of this study.

The study population was limited to users with visual impairment. The sighted population who significantly use the digital library content and who form the larger population of digital library users did not form part of this study.

In Kenya today, there are many public and private universities where digital libraries have been established. However, this study only focused on three public Universities.

1.10 Significance of the Study

Informed by article 35 of the constitution of Kenya, 2010 on right to information access, the findings of this study may form a basis of ensuring that digital information is easy to retrieve by all intended users by creating digital libraries and digital information retrieval systems that are usable by all categories of users including those with visual impairment.

The study findings may therefore be useful to:

i) Users with visual impairment as they will be the future beneficiaries of digital libraries and other information retrieval systems that are friendly, efficient, user satisfying, easy to learn and that which meets the accessibility requirements. This will be because of the awareness created through the findings of this study on the need to involve persons with visual impairment on usability testing of information retrieval systems.

ii) The digital library managers as the study findings may guide them in planning for and ensuring that they have usable digital libraries which facilitate easy access to digital information.

iii) The university management since the study findings and recommendations may inform creation of an inclusive digital information access policy of the university thus bridge the gap towards achievement of Sustainable Development Goal (SDG) 4.

iv) The system designers as the study findings may inform the need to involve persons with visual impairment as well as other categories of persons with disabilities in usability testing of any developed system since each of the category interact with the system differently and may have an array of varied needs as far as the interaction with the system is concerned.

v) National governments, as the study may inform policy at national level. With the realization that technology will continue advancing, the arms of government at their various levels may take into consideration inclusion of persons with visual impairment in every information related matter especially that which pertains access to and retrieval of digital information.

vi) The national and international information sector managers as the findings of this study may ground their knowledge on the usability issues of digital information retrieval systems by persons with visual impairment thus informing their recommendations on adoption of digital information platforms that are usable by not only the sighted majority but also by persons with visual impairment.

vii) National and international organizations working for persons with disabilities, since the study findings may inform policy at their level on ways

of making digital libraries and other information retrieval systems usable by persons with visual impairment.

viii) The future researchers since the study findings may inform further research in digital library usability by other special categories of users. For instance, the gifted and talented, those with mild mental disabilities, autism, hearing impairment to name but a few as well as categories of users by age like the elderly and children.

1.11 The Theoretical Framework

Unified Theory of Acceptance and Use of Technology (UTAUT) was used as a basis for this study (Venkatesh Viswanath , Michael G. Morris & Gordon B. Davis, 2003). The theory lays out four constructs that influence the use of an information technology or system such as a digital library by an individual. The four constructs are performance expectancy, effort expectancy, social influence and facilitating conditions. The theory also points out four factors that moderate the effect of the key constructs, that is age, experience, gender, and voluntariness of use (Venkatesh et al, 2003).

The proponents of the theory highlight four main constructs of the theory as follows:

Performance expectancy is the belief by an individual that the information system will help him or her to achieve their intended task.

Effort expectancy is the degree of ease that is associated with the system.

Social influence refers to the degree to which an individual perceives that there are other important persons who believe that he or she should use the system.

Facilitating conditions are defined as the belief by an individual that both organisational and technical infrastructure exist to support the use of the system (Venkatesh et al, 2003).

Application of the Theory to the Study

This study evaluates user perspectives of persons with visual impairment on friendliness, efficiency, satisfaction, learnability, and accessibility (independent variables) of digital libraries (system) to the process of accessing information (Dependent variable). On the other hand, the Unified Theory of Acceptance and use of Technology (UTAUT) explains the relationship that exists between performance expectancy, effort expectancy, social influence and facilitating conditions (Independent variable) to the usage (dependent variable) of an information system or a technology (system) in the presence of moderating factors.

The application of the theory constructs in the study is as follows:

The theory explains performance expectancy as the degree to which an individual believes that the system will help him or her to achieve their intended task. Likewise, persons with visual impairment may consider that using technology will help them to satisfy their information need. It is on this basis that the study assumed that digital libraries are useful to persons with visual impairment.

Effort expectancy is explained in the theory as the degree of ease that is associated with the system. Ease of use is considered in this study as the overall

usability construct that the study sought to check of the digital library. This was done through an evaluation of whether the digital library was friendly, efficient, satisfying, easy to learn and accessible to persons with visual impairment in the process of information retrieval.

Social influence is described in the theory as the degree in which an individual perceives that there are other important persons who believe that he or she should use the digital system. In this study, there were various bodies described in the significance of this study that support digital information access and retrieval by persons with visual impairment. These include the universities seeking to provide digital information resources to persons with visual impairment as well as other governmental, non-governmental and international agencies that encourage persons with visual impairment to use digital platforms to access and retrieve information as a way of promoting their independence.

Facilitating conditions are explained in the theory as the belief by an individual that both organisational and technical infrastructure exist to support the use of the system. It is necessary for persons with visual impairment to acquire assistive technology skills such as use of screen readers and screen magnifiers for those who are blind and low vision respectively. In addition, they need to be provided with the required assistive technologies (both hardware and software) such as screen magnifiers and screen readers to facilitate utilization of digital library and subsequent retrieval of the required information resources to meet an information need. The UTAUT theory therefore forms a basis of this study and explains the findings achieved from the study.

1.12 The Conceptual Framework

As brought out in this study, the digital library usability attributes are independent variables that influences how the user interacts and experiences a digital system. Specific contexts in which usability attributes influences information retrieval is however determined by interplays of prior training to assistive technology, period of exposure to digital libraries, individual attitude and technical support. Figure 1.1 shows the relationship between the independent and dependent variables in the study.

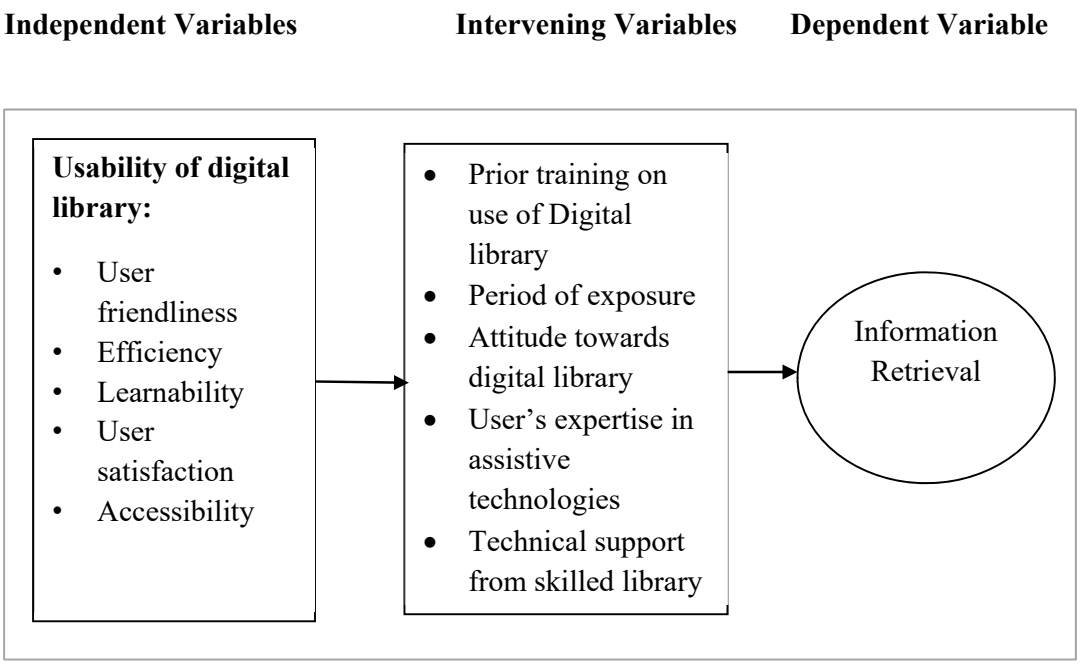

Figure 1.1: Conceptual Framework

Source: Researcher, 2020

From the conceptual framework above, user friendliness, efficiency, user satisfaction, learnability and accessibility are considered key usability attributes of special interest in this study. These five usability attributes were therefore investigated to establish their implications on information retrieval. They are

presented as the independent variables. On the other hand, information retrieval is presented as the dependent variable of the study. It is to be noted that there are other factors that could affect information retrieval (dependent variable) apart from usability of the digital library. These have been presented as intervening variables in the conceptual framework. They include prior training on use of the digital library, period of exposure or interaction with the digital library, expertise on use of assistive technology, user attitude towards the digital library and technical support from skilled library staff. This study was aimed at establishing whether digital libraries are usable by persons with visual impairment during information retrieval. The conceptual framework therefore presents the intent of the study diagrammatically by highlighting the key variables and showing the direction and flow of their relationship.

1.13 Operational Definition of Terms

Accessibility: A property of the digital library that makes persons with visual impairment be able to navigate through using assistive technologies such as screen readers and screen magnifiers.

Digital Information: Information hosted in digital libraries such as electronic journals and e-books.

Digital Library: A collection of resources which are in digital format hosted by DSPACE information management system.

Information Retrieval: The process of obtaining or achieving the desired digital content from a digital library.

Learnability: a quality of the system that makes it easy to learn during the process of interacting with it without necessarily going through some formal training.

Special Needs Librarian: library staff who offer services to persons with disabilities and or special needs who require specialised services like sign language interpretation and use of assistive technologies among others in their information retrieval venture.

Usability: The degree to which a digital library can be used by all persons including those with visual impairment to retrieve digital information efficiently, with satisfaction and through a learnable, accessible, and user-friendly platform.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Introduction

This chapter presents the review of literature related to the variables under investigation in this study. Specifically, the chapter lays out the views of renowned scholars and researchers on usability of digital libraries. It reviews literature on five digital library usability attributes. These are user friendliness, efficiency, learnability, user satisfaction and accessibility. Literature on these attributes is reviewed in relation to information retrieval which is the dependent variable under study. The chapter ends with a summary indicating the gap in the existing literature on the topic under investigation.

2.2 Usability of Digital Libraries

Digital library technologies have kept on being improved to offer better services and improved access to the collections they host. However, a check on usability of digital libraries has not matched the required level to have the users satisfied with their use (Dickson, 2008). This study evaluates usability of digital libraries regarding information retrieval.

The construct usability has been defined by various authors even though no single conceptualization has been reached. For instance, Matusiak (2012) sees it as a multidimensional construct that attracts different meaning to different people. Matusiak defines usability as user friendliness and effectiveness of the user interface. On the other hand, but following a close link, Chowdhury,

Landoni, and Gibb (2006) define usability of a digital library as the efficient and effective access to information.

Nielsen (2007) lays out five usability attributes: efficiency, learnability, memorability, rate of errors and satisfaction. A more contextualised, user specific and goal-oriented view of usability is given by Bevan, Carter, Earthy, Geis and Harker (2016) who define usability as the extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use.

This study adopts the definition by Nielson as well as the one by the International Standards Organisation and adapts it further to incorporate accessibility attribute which is very key in digital technologies use for persons with disabilities. In this study, usability is used to refer to the extent to which digital library is user friendly, efficient, easy to learn and satisfying as well as the degree to which it meets the accessibility standards for users with disabilities.

2.3 Friendliness of digital libraries during information retrieval by persons with visual impairment

User-friendliness as an attribute of digital library usability refers to the degree to which the interface minimizes the efforts that the users employ and at the same time maximizing the results these users get from the digital library in relation to expected results (Matusiak, 2012). According to Muhammad and Muhammad (2009), digital library users are not experts in using the computers and the internet. Therefore, developers of the digital library interface should make it easy

to understand for every user, i.e., whether novice or expert users of the digital library interface. Highlighting the importance of user-friendliness in usability studies, Matusiak (2012) emphasizes that user satisfaction cannot be achieved if the digital library interface is not user-friendly, i.e., if it is not easy to use, does not have a well-organized information, clear labelling, attractive visual appearance, and appropriate content.

Different aspect of digital library usability has been emphasized in different usability studies globally. Interface friendliness was one of the aspects investigated in the study conducted by Muhammad and Muhammad (2009) to evaluate the usability of Blekinge Tekniska Högskolan (Blekinge Institute of Technology) digital library in Sweden. The study used usability test, questionnaires, and interview techniques to evaluate different usability aspects. The findings of this study revealed that Blekinge Tekniska Högskolan (BTH) digital library was not user-friendly since most of the respondents stated that the links were not written in such a way that users could quickly get what they were looking for.

Dodamani and Dodamani (2019) conducted a usability study in India to get the users experiences on use of Assistive Technology for Students with Visual Impairment in University libraries. The study was more focussed on friendliness of digital libraries for students with visual impairments since India as a country has advanced information technology applications in the university libraries aimed at providing innovative library services. The findings showed that out of the population that uses the library 22.7% reported that library technologies were

friendly to use when accessing information. Students' reasons for library technology unfriendliness were that they needed guidance every time they wanted to use the digital library which denied them a chance for privacy and confidentiality. The study recommended improvements in the design of digital libraries to include possible inclusions metrics that enhance universal information access and overall satisfaction (Dodamani & Dodamani, 2019). The researcher recognises the fact that friendliness of digital libraries has not been adequately addressed in previous studies as an established usability attribute. A large body of existing research considers friendliness of a digital library system as a perception construct.

Findings from a Malaysian research conducted by Bodaghi and Zainab (2017) regarding user friendliness as a key component of overall experience in the usability of digital library revealed that persons with visual impairments enjoyed studying and learning when technology is usable and friendly to them. The study focused on perceptions and experiences of students with visual impairments with study library computers located in the university library carrels. As a result of enhanced user experiences resulting from friendliness of digital technologies in the library, participants considered their carrels as second homes where they felt safe, comfortable, and accepted. The friendly library technologies gave students with visual impairments a sense of belonging to the learning community due to increased independence in information seeking without much reliance on external support (Bodaghi & Zainab, 2017).

In Pakistan, research has shown that students with visual impairments have keen interest to learn using digital information through digital libraries (Zia & Fatima, 2016). This is because they recognize the importance and usefulness of digital information in their education. However, evidence from the same study shows that eminent struggles facing students with visual impairments in learning and making library technologies useful originates from system unfriendliness. It was found that students with visual impairments could not use computer and internet without the support from others, yet assistive technology software could be used instead. Zia and Fatima (2016) recommended that more design improvement needed to be done in the library technologies to make them more friendly for use by students with visual impairment who were slowly being excluded from the system not because they lacked interest but due to poor and unfriendly system designs.

A study was conducted by Rathi, Shiri, and Lucky (2012) to examine different features used and implemented in two national and two public digital libraries from Canada, United States, Britain, and Australia. The study aimed at identifying new features and functionalities that would improve access and retrieval of information as well as enhance users' interactive experience with the digital library user interface. Using a grounded theory approach, the study revealed that all the four digital libraries' interfaces were not sufficiently user-friendly as not all attributes of the metadata were available for browsing, searching or query refinement. The study also established that the incorporation of social media tools in the visual interface of the digital libraries affected users'

experience negatively in searching, retrieving, and browsing the collection, thus further lowering the overall user-friendliness of the digital library interface.

A similar study was conducted by Ronny (2017) in Bangladesh to investigate experiences of students who are blind and their teachers in Information Communication Technology as a tool for inclusive information access. The findings showed that blind students use of ICT as support tools to access digital information in their learning process, was highly correlated with ease of use, which suggests friendliness of a technology.

A study was conducted in South Africa by Lourens and Swartz (2016) on the experiences of students with visual impairment in higher education concerning Library usage and their perspectives on friendliness of systems in enhancing inclusion in learning. The study revealed that students with visual impairments who perceived computer technology to be friendly were free and confident with the use of digital library in their search for information. On the other hand, students who perceived technology as unfriendly were less likely to use digital libraries in information seeking. This evidence suggests that friendliness of a system influences its usage. The research recommended establishment of inclusive digital libraries in all learning institutions that are more user friendly as a way of encouraging persons with disabilities to embrace use of technology as a tool for lifelong learning.

Based on all these findings from literature, the researcher sought to pay attention to friendliness of a digital library a new focal paradigm from perception-oriented

to formally defined usability attribute with user experience (UX) as a core indicator.

In Nigeria, Olaopa (2017) investigated factors affecting digital information resources utilization such as information literacy skills and availability of alternative format by students with visual impairments. The study findings showed that information literacy skills in using digital library by users with visual impairment was lower due to system unfriendly interfaces and complexity.

In Kenya, Odini, Chege, and Mbugua (2018) conducted a study on provision of information services to the visually impaired students. The study was informed by the Moore's Model of Social Needs and Wilson's Model of Information Behaviour. The study found out that whilst the education stakeholders in Kenya have vastly improved teaching techniques and facilities, it is still persistent that students with visual impairment experience difficulties accessing the ordinary curriculum and has been worsened through use of emerging technologies such as digital libraries (Odini, et al., 2018). The study established that provision of information to visually impaired students require improvement and thus recommended improved design of the existing digital information services, system, and channels to make them more friendly to persons with visual impairments.

Although adequate literature is available on friendliness, it is to be noted that majority of these studies have not adequately covered friendliness as a usability attribute, a gap that the current study sought to address. The focus of most studies

is diverse with majority focusing on friendliness of digital Information and Communication technologies (Bodaghi and Zainab, 2017; Zia and Fatima, 2016; Ronny, 2017; Laurens and Swartz, 2016). Odini, Chege and Mbugua, (2018) focused on friendliness of library services to persons with visual impairment while Olaopa (2017) investigated the factors affecting utilization of digital information by persons with visual impairment. Out of the studies reviewed, only one conducted by Rathi, Shiri and Lucky (2012) seemed to focus on friendliness as a usability attribute of digital library. The current study therefore sought to provide a deeper evaluation of friendliness of digital libraries as perceived by students with visual impairment.

Information access, retrieval and utilization plays key roles in the contemporary information age and society and are drivers towards knowledge-based economy (Mallik & Bera, 2021). Digital libraries become crucial in obtaining and utilization of information for academic, research, social and economic purposes among others (Babu & Xie, 2017; Moorthy et al., 2019). This provides evidence that for one to be abreast with the fast-paced contemporary academic lifestyle, one need to be quick at retrieving and utilizing information from available digital platforms. Whilst information retrieval is core to all in this era, persons with visual impairment are susceptible to exclusion from full utilization of digital content due to the limiting interfaces of information retrieval systems (Xie et al., 2020). This paper sought to explore determinants of friendliness of digital library interfaces for students with visual impairments in selected public universities in Kenya. The study was delimited to students with visual impairments who access the digital content by means of screen readers and screen magnifiers.

A significant amount of research demonstrate that the blind and visually impaired (BVI) students experience vulnerabilities in accessing digital library (DL) platforms (Arif & Kanwal, 2009; Matusiak, 2012; Xie et al., 2020). Latest research suggest that such difficulties are largely attributable to limitations in DL's design that prevent BVI from effectively interacting with features and subsequently the content (Xu & Du, 2019; Xie et al., 2020). However, most of this evidence are drawn from outside Sub-Saharan African countries. In this regard, there is need to integrate drivers of friendly digital interface platforms in the African context. One of the reasons why such a research initiative is core is the fact that measurement of visual impairment varies across different regions and countries of the world (Papadopoulou et al., 2020). Despite adoption of the Washington Group of Tools by different countries in measuring disabilities such as visual impairments, there still exists discrepancy in the consistency of disability statistics within and between countries. This situation poses a challenge to domesticate research evidence from other parts of the world in the Kenyan situation.

A Digital Library (DL) that does not allow effective access to information and subsequent retrieval by a person with visual impairment can be described as one with an unfriendly user interface. In this study, we describe a friendly digital interface as one that increases access to the content, improves navigability through the system and consequently makes information retrieval successful (Rodriguez & Carver, 2019). When the needs of all users regardless of their disability are met in the design of an information retrieval system such as a digital library, significant steps are achieved towards an inclusive information

society in which access to information, its retrieval and use are key. Universal design of digital library interface accounts for all individual differences in the access to content and navigation.

Friendliness is an important attribute of usability. As such friendliness of a digital library interface refers to the degree to which the interface minimizes the efforts employed by the user and at the same time maximizing the results these users get from the digital library in relation to expected results (Matusiak, 2012). According to Arif and Kanwal (2009), digital library users are not experts in using the computers and internet. Therefore, developers of the digital library interface should make it easy to understand for every user, i.e., whether novice or expert users of the digital library interface. Matusiak, (2012) describes a friendly interface as one that is easy to use, one that has well-organized information, clear labelling, attractive visual appearance, and appropriate content.

Persons with visual impairment form part of the digital library users in the quest to meet their information needs. Their inclusion, therefore in the design of user-friendly digital library interfaces is critical. Various studies have been conducted globally emphasizing on the need for user-friendly interface for successful information retrieval venture. Dodamani and Dodamani (2019) conducted a usability study in India that focussed on the friendliness of digital libraries for students with visual impairments. Out of the 20 students who participated in the study only 22.7% perceived the digital library as being friendly. The key

indicator of unfriendliness was the fact that they needed guidance every time they wanted to use the digital library.

Persons with visual impairments enjoy studying and learning when technology is usable and friendly to them. This is according to Malaysian research conducted by Bodaghi and Zainab, (2017) regarding user friendliness of digital library. The study focused on perceptions and experiences of students with visual impairments in accessing digital libraries while using computers located in the university library carrels. It was found out that, the friendly library technologies gave students with visual impairments a sense of belonging to the learning community due to increased independence in information seeking without much reliance on external support (Bodaghi & Zainab, 2017; Li & Liu, 2019).

2.4 Efficiency of digital libraries during information retrieval by persons with visual impairment

As noted earlier, Matusiak (2012) highlighted that usability of a digital library is a construct that is multidimensional in nature and can be examined from various perspectives. Further, efficiency of a digital library system is often defined by the quality of its usability attributes. In earlier usability studies by Matusiak, the term efficiency was referred to as "the degree to which users can quickly perform tasks in a digital library" (Nielsen, 2007).

Other scholars such as Dicks (2002) states that efficiency of a web-based system is concerned with the completion of the task in relation to the productivity of the user, in a specified time. To this end, there is consensus among system evaluation scholars and practitioners that although some other external factors such as the

speed of internet connectivity can adversely affect the time taken to perform a task or open a web page, the time taken to complete a task still remain a good usability measure of a web-based system such as digital libraries. Evidence from previous usability studies globally suggest that it is difficult to conduct a usability study in a comprehensive manner without making explicit or implicit reference to or examining their efficiency as a key attribute (Dicks, 2002; Nielsen, 2007; Matusiak, 2012).

Bhardwaj (2018) conducted a study in India on information access mechanism for students with visual impairment in higher learning educational institutions. The study was conducted in the University of Delhi. The study findings revealed that the facilities for students with visual impairments in higher educational institutions are very basic, some are obsolete, inefficient and it is difficult for students with visual impairment to conduct study and research with existing ICT infrastructure (Bhardwaj, 2018). This finding implied that higher educational institutions in Delhi do not have the infrastructure suited to the current information needs of students with visual impairment to facilitate efficient information seeking. The study further established that library and information science professionals face challenges in providing quality services to students with visual impairments due to inefficient hardware equipment, obsolete assistive software(s) and devices which are time-consuming (thus inefficient) and general lack of awareness among students with visual impairment on efficient utilization of available library resources and services (Bhardwaj, 2018).

Pradhan and Sahu (2019) examined the Information Services in digital libraries for Students with visual impairment in India. The study findings revealed that a negligible percent of the population of students with visual impairment were satisfied with the information service of the library, which they viewed as efficient, while more than half of students with visual impairment indicated that they used the digital library occasionally since it did not fully solve their research issues (Pradhan & Sahu, 2019). These findings were combined and concluded that the digital library is less efficient in providing information to students with visual impairment. The research made the following recommendations: that more relevant information resources should be added in libraries to minimise cases of delay in searching and retrieving information resources, well-trained personnel/librarians be employed in public and private libraries to cater for needs of persons who are blind to enhance efficiency in use of technology in accessing information (Pradhan & Sahu, 2019).

A similar but more recent research in Iran by Khasseh, Yamchi, Azimi, Ghazizadeh & Alipour (2020) was carried out to examine library services to the visually impaired learners. A researcher-made questionnaire, inspired by the American Library Association checklist and the library access checklist by the International Federation of Library Associations (IFLA) was adapted and used for data collection. In this study, several factors such as insufficient funding (51.6%) and were identified as drivers of inefficient provision of education services for persons with disabilities. Notably, however, inefficient technologies in public university libraries and databases were identified to be contributing

more significantly to denying persons with visual impairment access to critical academic and general information (Khasseh et al., 2020). Based on the evidence brought out by this study, inefficient design of digital information systems contributes more to exclusion of persons with visual impairment than lack of awareness by library staff.

In China Wang and Yu (2017) conducted research to investigate the level of efficiency of Digital libraries information service to learners with visual impairments. Chatman's small world theory was applied in the study. The study found that broadcast media, people and networked source satisfied most of their needs. Most persons with visual impairments tended to have a small and unconnected social network (small world) due to inefficient navigation around these technologies. It was then concluded that information access centres were less efficient to the non-sighted users. Evidence from such studies point to a potential challenge in digital library design that impede efficiency particularly for users with visual impairment.

Al-Harrasi and Taha (2019) conducted a study to examine Electronic Libraries efficiency in provision of electronic information resources to learners with visual impairment in United Arab Emirates (Muscat). The researchers used a semi-structured interview survey to gather the survey data from university students drawn from the Special Needs Services (SNS) Unit at the UAE University. The interview was concerned with the use of library e-resources and online services in doing their assignments, easy-to-use facilities to access the e-resources and main challenges facing them in communicating with the library staff. Evidence

from the study reveals that students with visual impairment considered that the university library does not meet their needs when getting access to digital content and using online services adequately (Al-Harrasi & Taha, 2019). It was concluded then that the digital library, as a way of accessing academic information is not efficient for persons with visual impairment unless serious usability designs are incorporated to break accessibility barriers that currently exist.

Another similar study on Library Information Services for students with visual impairment in public universities was conducted in South Africa by Cassells & Weber (2018). The purpose of the study was to determine the best practices and guiding principles for making academic reading material available to students with visual impairments at the University of Pretoria (UP) easily and efficiently. A semi-structured interview with a staff member from the Disability Unit at the UP as well as a focus group consisting of students with visual impairments who make use of the unit were used to obtain responses to the research questions. The overarching theme from the study by Cassells and Weber (2018) is that of appreciating integration of technology in education but with a strong recommendation to making the same technology available to persons with visual impairment in a more efficient way.

In Zimbabwe, Jagero, Nhendo, Sithole, Chisita, and Guvava, (2014) conducted usability research to evaluate the usability of the African University Digital Library, Jokomo/Yamada Library, in Mutare. The study used researcher made questionnaire, interviews, and indirect observations to gather necessary

information from the library users. The key indicators used to measure the efficiency of the Jokomo/Yamada library were the time taken to complete a task in relation to response time, error or delay and the number of steps required to complete a task. The findings revealed that the digital library system was not efficient as most respondents showed a great concern about the response time as well as its errors and delays when it is used to locate information.

Chaputula and Mapulanga (2016) conducted a study in Malawi to investigate the provision of library services to people with visual impairment in Malawi. Evidence presented from this Malawian study suggest that technologies in information centres (library) are not efficient to learners with visual impairment. The study revealed a lack of equipment to support persons with visual impairments in accessing digital information content from the digital library (Chaputula & Mapulanga, 2016). The study recommended that libraries should take further steps to either introduce or enhance services that cater for digital information needs of students with visual impairment.

A similar study was carried out in Nigeria where Tom, Mpekoa and Swart (2018) explored the efficiency and factors that affect the provision of digital information to students with visual impairment in higher education. It was found that in universities where the management had invested in customizing library information platforms, an overwhelming majority of students with visual impairment reported that digital libraries were efficient. On the other hand, in universities that had invested in standard library technologies, many students

with visual impairment preferred use of books over digital libraries citing frustrations caused by inefficiency of the system (Tom, et al., 2018).

In Ghana, Appiah (2019) carried out research to investigate the provision of library services to students who were visually - challenged at Akropong School for the Blind in the Eastern Region of Ghana. The study revealed that libraries were not well done (not as efficient as users would have preferred) since there was lack of policy in providing digital information services to students with visual impairments, lack of enough assistive technology devices and inadequate library resources to meet the varied information needs of users. The study recommended that assistive technology devices such as voice recognition software, screen magnifier and computer with JAWS are needed by students with visual impairments to facilitate efficient use of standard library technologies such as digital libraries and that libraries should also enhance services delivery tailored for students with visual impairments (Appiah, 2019).

A study was done in Tanzania by Eligi and Mwantimwa (2017) on ICT accessibility and efficiency to support the learning of visually impaired students. Visually impaired learner was identified in the University of Dar es lam and questionnaires were given targeting to address the learner's perception on the efficiency of library services in general. The findings from the study revealed that the use of digital libraries was limited and inefficient to a large extent (Eligi & Mwantimwa, 2017). The two scholars made a conclusion that the services provided by the digital libraries in Tanzania were not efficient as those with disabilities were completely excluded from using the digital content. The study

recommended that libraries should be equipped with information systems that are responsive to the needs of all students regardless of their disabilities.

Kiruki (2018) conducted a study in Kenya to investigate the information service provision to the people with visual and physical impairments in public university libraries in Kenya. The study was underpinned by the International Federation of Libraries Associations and Institutions (IFLA) Access to Libraries for Persons with Disabilities Checklist, and the Social Model of disability. The findings of the study revealed that university students with visual impairment found the digital library less efficient in providing them with information. The study recommended more improvements to be done in the digital library to ensure that every user is satisfied with the service.

Out of the studies reviewed, a varied trend was identified in terms of the nature of efficiency studied. Some of the studies pursued efficiency of digital technologies (Bhardwaj 2018; Eligi and Mwantimwa, 2017), while the majority of studies focussed on efficiency of services offered to library users with visual impairment in a digital environment (Pradhan and Sahu, 2019; Khasseh et al., 2020; Wang and Yu, 2017; chaputula and Mapulanga, 2016; appiah, 2019 and Kiruki, 2018). Only few studies reviewed had their focus on efficiency as a usability aspect of digital libraries (Jageroet al., 2014 and Al-harasi ad Taha, 2019).

From this review, efficiency as a usability attribute of digital libraries has not been given prominence in existing literature. The current study therefore sought

to bridge the existing gap by examining efficiency of digital libraries in information retrieval by persons with visual impairment.

2.5 Satisfaction in using digital libraries by persons with visual impairment during information retrieval

User satisfaction is another important component of the usability of any digital library. According to Rogers (2009), user satisfaction is concerned with the attitudes and perception of users about how the digital library is enjoyable to use. User satisfaction involves areas such as ease of use, organization of information, clear labelling, visual appearance, contents, and error corrections (Matusiak, 2012). Nielsen (2007) combined these two definitions and came up with the summarized definition that refers to user satisfaction as the degree to which the design of a digital library is pleasant to use. Hence, any usability study should consider user satisfaction.

Menzi-Cetin, et al. (2017) conducted a study in the United States of America to evaluate user satisfaction of a university website by students with visual impairment (VI). Respondents with VI were asked to think aloud while performing 11 tasks involving their university's web pages, including the main page and then accomplish these tasks. The study established that, identifying final exam dates on the calendar posed major difficulties to about half of students with visual impairment, while accessing the course schedule web page was the task that required the most time for the same category of users. It was established that students who retrieved information with ease were satisfied with using

university web while those who experienced difficulties were dissatisfied and would opt to use Braille or large print materials.

Satisfaction with digital library has previously been viewed from the perspective of attitude. However, the current trend derived from the International Organizations Standardization (ISO) (2015) which puts focus on the customer tend to mainstream satisfaction as a core in determining the quality standards of any system, service, or product. In this context therefore, research on usability ought to put in focus the new ideal of studying satisfaction as being independent of individual attitude and become an explicitly defined usability attribute that can be considered in the universal design of digital libraries.

Another usability study by Grove (2020) in the United States of America (USA) was conducted in the University of Phoenix to explore experiences of blind and visually impaired students enrolled in or graduated from post-secondary institutions in the United States. Results from the study indicated that persons with visual impairment continues to encounter numerous obstacles in the higher education environment as majority of those sampled for the study were not satisfied with the use of the information technologies despite the fact that they were current technologies. Evidence from Grove's study suggested that lack of access to reasonable accommodations was at the forefront of the many challenges confronting students with visual impairments daily. Other areas of concern included difficulties in learning to navigate the campus and locate classrooms; disability and library support services; faculty attitudes; socialization; and the incompatibility of institutional software systems with

screen readers for the blind and visually impaired. Participants expressed moderate to high levels of frustration surrounding these obstacles which often led to anxiety and avoidance behaviours (Grove, 2020).

In Malaysia, Masrek and Gaskin (2016) conducted a study to examine the determinants of user satisfaction in the context of academic web digital library (DL) for persons with visual impairment. A model based on the re-specified information system success model was developed and tested using the structural equation modelling (SEM) technique (Masrek & Gaskin, 2016). The study employed a survey research methodology with a self-administered questionnaire as a data collection instrument. The target population of the study was students enrolled for the bachelor's degree in the Faculty of Information Management. Descriptive analysis and inferential analysis which included Structured Equation Modelling (SEM) were executed using SPSS and Analysis of a Moment Structures (AMOS) statistical software. The findings indicated that information quality, systems quality, service quality, perceived usefulness, perceived ease of use and cognitive absorption are significant predictor of users' satisfaction with the web digital library (Masrek & Gaskin, 2016).

A study conducted in Nigeria by Osadebe, Onuigbo, and Ewa (2019) on Library services for students with visual impairment in Nigerian universities. The purpose of the study was to examine the level of satisfaction by users with visual impairments in the library. The findings showed that library policy, technical and personnel factors affect library services delivery to students with visual impairment. Students were not satisfied with the service to their level of

expectation. The study recommended amongst others that university libraries should conduct user-satisfaction studies regularly to ensure that their services meet clients' expectations (Osadebe et al., 2019).

Still in Nigeria, Nkiko et al. (2018) conducted a study in the library setting on satisfaction of Visually Impaired learners. The study adopted a survey research design of the ex-post facto to select 470 personnel as respondents. A questionnaire titled Information Technology Use Scale (α=0.74), and Interview Schedule (α=0.75), were used. Data were analysed using descriptive statistics and Pearson Product Moment Correlation. The findings indicated that information technology in transcription was low and had a significant positive relationship between the application of information technology and transcription of information materials (r=0.62: $p<0.05$). Students with visual impairments were not satisfied with the library services in general, as their response indicated that they were highly dependent on the help of others for any service which denied them privacy (Nkiko et al., 2018). The research further recommended that Library services need to be improved in a way that each student is given time to research and only helped when in need.

Phukubje and Ngoepe (2017) conducted research in South Africa on the student's satisfaction on the service offered by the Library for the VI. The study used quantitative data collection through questionnaires directed students with disabilities registered for the 2013 academic year, and an interview was done with the librarian responsible for the disabled students. Observation was made using the IFLA checklist for access to libraries for disabled people to evaluate

the convenience and accessibility of library services for students with disabilities at the University of Limpopo (Phukubje & Ngoepe, 2017). Even though the study established that a purpose-built library service unit for students with disabilities that complies with international best practice was in place, students with visual impairments were not adequately satisfied with the library services they received as very few library materials had been transcribed into accessible formats (Phukubje & Ngoepe, 2017). It was found that only a few users were satisfied with the services produced by the library. The study recommended that the university should hire more librarians to assist students with visual impairment in the library (Phukubje & Ngoepe, 2017).

Digital Library (DL) satisfaction relates to the ways and to what extent users are satisfied with DLs (Joo & Lee, 2011). Satisfaction is considered to be a main criterion for usability and is a top measurement for evaluating users' DL perceptions (Alberton, 2015; Chowdhury et al., 2006; Jabeen, Qinjian, Yihan, Jabeen & Imran, 2017; Khoo, Kusunoki & MacDonald, 2012; Liu & Luo, 2011; Masrek & Khan, 2015; Nasreen & Alawi, 2011; Xie & Matusiak, 2016). Researchers have investigated user satisfaction related to ease of use, information organization, labelling, visual appearance, and error correction (Nasreen & Alawi, 2011). Jabeen et al. (2017) employed a mixed-method approach for a usability study at a university library and found user satisfaction increased with the availability to access information and usability of the DL interface for resources. Liu and Lio (2011) applied survey questionnaires to collect data related to undergraduate and graduate students' satisfaction levels

and pointed out that expectations, emphases, and frequency of use contributed to differences between the two groups in satisfaction levels. At the same time, Joo (2010) investigated efficiency, effectiveness, and satisfaction of a Younsei University DL with graduate students in South Korea and identified correlations among these usability elements. Nasreen and Alawi (2011) investigated University of California Berkeley undergraduate students' satisfaction when using both the university DL and internet technology and concluded that design of the DL primarily affected user interactions and user satisfaction.

Several studies have investigated the usability of a DL by testing the incorporation of new interfaces or new features. DLs with new interfaces or features have been tested to assess how these features enhance DL usability (Suprapto, Ferdiana & Hartanto, 2016; Wu & Chen, 2016; Wu, Tang & Tsai, 2014). Wu and Chen (2016) studied children's search performance related to 2D or 3D navigation of a children's DL interface and found that 3D navigation interfaces provide better performance for children. Wu et al. (2014) investigated children's information search efficiency and memory of category features between a text-based and graphic-based DL and discovered that graphical interfaces improve children's search speed and overall success. After developing a new DL interface with a simple search for elementary school students, Suprapto et al. (2016) noted that the new interface reduced difficulties related to system use. Besides DL usability, some studies tested the usability between desktop and mobile platforms and between text and graphic-based systems (Ho, Bendrissou, Azman & Lau, 2017; Wentz & Lazar, 2011).

Coetzee (2016) conducted a study in South Africa to investigate the everyday life information-seeking behaviour of visually impaired students at Stellenbosch University. The study framed by Pamela McKenzie model focused (Jabeen et al., 2017) on how the visually impaired students obtain their information and the role of the Stellenbosch University library (Coetzee, 2016). The study was motivated by the vital need to seek out, listen to and act upon the voices of students with disabilities to make higher education more inclusive to students with some form of disability or challenge. Students with visual impairment from various faculties of Stellenbosch University completed a questionnaire. The study finding revealed that Students with visual impairments at Stellenbosch University would consult friends, family members and lecturers for information (Coetzee, 2016). The Internet was the major resource of information used by all students, however those with visual impairment relied on support of others to access information from the internet. The main reasons for not using the Stellenbosch University library were attributed to the inability to use printed resources, lack of facilities for visually impaired students, difficulty in navigating the physical library and lack of training in exploiting the digital library and its services (Coetzee, 2016). All students with visual impairment made use of assistive technology and relied heavily on the support and services of the Braille Office for additional academic information (Coetzee, 2016).

In Kenya, Kiruki (2018) conducted a study on the Information service provision for the people with visual and physical impairments in public university libraries. The study was underpinned by the International Federation of Libraries

Associations and Institutions (IFLA) Access to Libraries for Persons with Disabilities Checklist, and the Social Model of disability. The study findings established that most students who use the library are not fully satisfied according to their expectations. Many students were not free to service produced with their reasons (Kiruki, 2018).

The current study appreciates the foundation laid by previous researchers in their efforts to address satisfaction of persons with visual impairment on information services. A glaring gap was established on user satisfaction of persons with visual impairment on digital library usage. As such, most of the literature reviewed, did not adequately address user satisfaction on use of a system from a usability perspective. For instance, studies by Grove (2020) studied the experiences of persons with visual impairment in higher education environment while (Nkiko, et al., 2018; Phukubje and goepe, 2017; Osadebe, Onuibo and Ewa, 2019 and Kiruki, 2018) focused on user satisfaction of users with visual impairment on and library services.

Out of the studies reviewed only two seemed to address user satisfaction by persons with visual impairment of an information retrieval system (Masrek and Gaskin, 2016; Menzi-Cetin, et al., 2017). In these two studies, Masrek and Gaskin focused digital library while Menzi-Cetin and fellow researchers evaluated the university website. The current study will focus on user satisfaction as a usability attribute in the use of digital libraries by persons with visual impairment in an effort to bridge the gap that exist in the utilization of

digital content from information retrieval systems and particularly the digital library that hosts scholarly content in a learning environment.

2.6 Learnability of digital libraries during information retrieval by persons with visual impairment

Learnability is one of the five attributes of usability of any digital system (According to Nielsen, 2007). Nielsen further explains that learnability is the most important component of usability to consider when developing a digital library system because learning how to use the system is the first user experience with the system. This perspective is perhaps the reason why most usability studies seem to put emphasis on learnability as a critical attribute in evaluation of system usability.

The construct of learnability encompasses the ability of the system to support users in accomplishing basic tasks the first time they use the system. It is also the capability of a system to enable users to feel that they can productively use the system in the right way and quickly learn new functions. Previous studies that have been conducted globally to evaluate the usability of digital library systems have consistently put in focus importance of learnability of digital libraries.

A study was conducted by Bhowmick and Hazarika (2017) in India on the technology for the visually impaired and blind people in a research field, and the level of learnability by users. They collected data by having a random interview on the librarians, students and teachers in the institution interviewed. There was

a face to face conversation between the interviewers and the selected team of respondents. The activity involved questioning them about the entire setting of the library, accessibility, and the ability to learn when using the library (Bhowmick & Hazarika, 2017). Response from each were combined and analysis were done. It was found that many leaners can learn and get information when using the library only that most of them would occasionally take longer.

A study in Germany by Gaona, Martin and Montenegro (2017) on evaluating the extent to which learners with visual impairment get information via the digital library. The study also targeted to explore factors affecting learning in the research environment. The information included in this study was collected based on a systematic literature review approach. The main information sources were explored in several digital libraries, including Science Direct, Scopus, ACM, and IEEE, and include journal articles, conference proceedings, books, European project reports and deliverables and PhD theses published in an electronic format. A total of 142 studies comprised the review. The research revealed that most learners who are visually impaired can learn when using the Library. The researcher appreciates the findings of this study which clears the way for the current study. In deed it responds to the assumption made earlier that digital libraries are useful. The current study explores learning not an end result but as part of the process. That is, ability of a person with visual impairment to learn to use the digital library itself during information retrieval.

Research that was carried in Brazil by (Fernandes, Costa, Filipe, Paredes & Barroso (2019) on the assistive technology employed in Digital Libraries to meet

the needs of learners with visual impairment. The study purposed to examine how learners get informed when using the library. Questionnaires were distributed to the selected respondents who were using the digital library. It was established that only part of students who used the library were able to learn. The research recommended that a more advanced technology should be initiated and that librarians need to be trained to meet the needs of all users (Fernandes et al., 2019).

The researcher observes that Learning as a result of using the digital and learning how to use the digital library are two different scenarios. While previous studies focused on learning as a result of using digital libraries, the current study lays more emphasis on learning to use the Digital library which is a prerequisite skill in ensuring smooth retrieval of information.

Another study in India by (Xie, Babu, Lee, Castillo, You & Hanlon, 2020) on Enhancing the usability of digital libraries: They realised that Blind and visually impaired (BVI) users experience vulnerabilities in digital library (DL) environments largely due to limitations in Digital library design that prevent them from effectively interacting with DL content and features. Multiple data collection methods including pre-questionnaires, think-aloud protocols, transaction logs, and pre and post search interviews, were employed in an experimental design. Forty subjects were divided into two groups with similar demographic data based on data generated from pre-questionnaires. The findings of this study showed that users were able to learn. It was supported by the

experimental group that they encountered a fewer number of help-seeking situations than the control group when using the library to access information.

According to the study carried in Nigeria by Aghauche and Udem, (2018) on utilization of library and information resources by visually impaired primary school pupils in special education centres in South-East Nigeria for learning. The result of the study showed that primary school pupils with visual impairment were not making use of available resources to a high extent and only a few pupils showed that they learn new concepts when using the library. This was because of the non-availability of resources in alternative formats.

Cassells & Weber (2018) conducted a study in South Africa about Learnability of Visually Impaired Learners when using Digital Library. The study also aimed at establishing the best practice guidelines for making academic reading materials available to students with visual impairment at the University of Pretoria (UP) easily and efficiently. A basic literature review of relevant research data was done to help create further context for this study. A semi-structured interview with a staff member from the Disability Unit at the UP as well as a focus group consisting of students with visual impairment who make use of the unit were used to obtain responses to the research questions. The students with visual impairment felt that local publishers and UP staff needed further insight on the academic needs of students with visual impairment so as to make acquisition of their resources run smoothly and more efficiently.

Phukubje and Ngoepe, (2017) conducted a study in South Africa to examine the convenience, learnability and accessibility of library services to students with disabilities of sight at the University of Limpopo in South Africa. The study utilised quantitative data collected through questionnaires from students with sight disabilities. Interviews were conducted with the librarian responsible for the disabled student's unit. In addition, observations were done using the IFLA checklist for access to libraries for persons with disabilities to evaluate the convenience and accessibility of library services for students with disabilities at the University of Limpopo in South Africa. Even though the study established that a purpose-built library service unit for students with disabilities that complies with international best practice was in place, students with disabilities were not adequately satisfied with the library services they received as very few library materials had been transcribed into accessible formats. Student's level of learnability was low. The situation was compounded by the fact that only one librarian was assigned to manage and run the library services for the disabled. The study recommended that the university should hire more librarians to assist students with disabilities in the audio-braille library.

Agabirwe and Kiyingi (2020) conducted a study in Uganda on the Utilization of Assistive Technologies among Visually Impaired Students in University Libraries in Uganda. Qualitative approach was employed and data was obtained from twenty students with visual impairment in-depth open-ended interviews. The findings revealed exclusion in the provision and utilization of assistive technologies in the libraries studied. Skills, competency and capacity constraints

by both staff and visually impaired students on the use of assistive technologies, coupled with insufficient assistive technologies impacted on the gainful utilization of digital information resources for academic undertaking. The study concluded that Visually Impaired Learners in Uganda can benefit when using digital Library and therefore these digital libraries need to be made easy to learn and interact with using assistive technologies.

Oira (2016) conducted a research study in Kenya to examine the use of modern assistive technology and its effects on the educational achievement of students with visual impairment at Kibos special secondary school in Kisumu County, Kenya. The research also targeted to explore the level at which learners learn when using technology in their Libraries to access information. The study employed a case study research design where both quantitative and qualitative data of one special school were collected and analysed. The study revealed that in Kenya students with visual impairment use analogue technology which include manual Braillers, slate and stylus, abacus, Taylor Frame, cubes, and Cuberithm Boards which are slower, inefficient, and not matching digital age. The study also established that use of modern assistive technology has an enormous contribution on curriculum coverage and early completion of classwork and assignments. Assistive technology was only in use at the computer laboratory where computer lessons were being conducted. Braille machines were the most frequently used type of assistive technology, followed by computers, i-pads and tablets. The study recommended that the Ministry of Education should recognize the potential of assistive technology in supporting

education for students with VI, schools for VI should be equipped with modern assistive technology which is less bulky, quick, easier efficient, motivating and that encourage independent study/learning. Skills in assistive technology and availability of such technologies in a digital library is a key aspect in this study. This is because these skills would influence how fast a person with visual impairment learns to use the digital library.

Chikati, Wachira, & Mwinzi (2019) conducted a study in Kenya to examine the government role in the development of education for the Visually Impaired (VI) persons in Kenya from the time such education was established to the present. Data was evaluated through external and internal criticisms. The historical inquiry was done by a collection of archival data through archival research, collection of data through interviews and research into secondary materials in libraries. Data collected was analysed qualitatively through triangulation and deduction of themes. The research findings in the paper provide an overview of the state of education for the VI learners in Kenya. The research findings reveal that learners can learn when using the digital information resources although, the government may not have done much towards supporting education for the VI, the government still played a significant role that has led to the current improved access to education for the VI learners in Kenya.

A study conducted to evaluate the usability of the Africa University Digital Library, Jokomo / Yamada Library, in Mutare, Zimbabwe, Jagero, Nhendo, Chisita, Sithole, and Guvava (2014) considered learnability as an important aspect to investigate. In that study, understandability of steps required to

complete tasks, time required to know how to begin searching, helpfulness of search instructions, and memorability of the user interface were considered as the indicators of learnability. Using questionnaire, interviews and direct observation to measure learnability of the Jokomo/Yamada Library, the researchers found that the library was not sufficiently learnable. The findings revealed that although users understood steps required to complete tasks and the interface was memorable, it was difficult for users to learn how to begin and accomplish tasks and use the search instructions. For them, lack of adequate user instruction from the librarians constituted an obstacle to individual learning on how to use the digital library.

The reviewed literature on learnability of digital libraries by persons with visual impairment forms a strong basis for this study. Learnability has been adequately addressed in previous literature. However, most of the studies looked at learnability of digital libraries as a product and not as a design aspect. For instance, (Bhowmic and Hazarika, 2017; Gaona, Martin and Montenegro, 2017; Fernandes et al., 2019) all concluded that persons with visual impairment can learn when using the digital library. While this is true from an end product perspective, a gap still exists in literature on whether or not learners with visual impairment are able to learn to use the digital library itself, a gap that this study seeks to fill.

2.7 Accessibility of digital libraries during information retrieval by persons with visual impairment

Accessibility is essential for designers and organizations that want to create high-quality information retrieval systems, and not exclude some groups of users from their products and services. Web accessibility means that websites, tools, and technologies are designed and developed so that people with disabilities can use them with ease. The World Wide Web Consortium's (W3C) Web Accessibility Initiative defines the practice of web accessibility as making websites such that people with disabilities can perceive, understand, navigate, and interact with the web.

Creation of systems that meet accessibility standards benefits all disabilities including auditory, cognitive, neurological, physical, speech and visual. Creating accessible information retrieval systems can benefit other people without disabilities, including older people with changing abilities due to ageing, people with "temporary disabilities" such as a broken arm or lost glasses and people with "situational limitations" such as in bright sunlight or in an environment where they cannot listen to audio (Parcu, 2020).

When digital libraries are properly designed and coded, people with disabilities can use them. However, currently many information-based systems are developed with accessibility barriers that make them difficult or impossible for some people to use (World Wide Web Consortium -W3C standards). Across the globe, researchers have previously explored accessibility as a key attribute of usability of digital systems.

Khowaja and Fatima (2019) conducted a study on knowledge resources for persons with visual impairment in India. The study employed a qualitative research approach interviewing 20 students with visual impairment who attended higher education institutions and were present at a workshop organised for blind and partially sighted individuals between 19 and 45 years. Data was collected using unstructured open-ended questions exploring their perceptions of information access as well as inclusion. The interviews were transcribed verbatim and a thematic analysis conducted using Nvivo (version 12). The four main themes that emerged included: Access to lecture notes, access to published books and print materials, having a sense of inclusion, and access to digitalised learning materials (Khowaja & Fatima (2019). Evidence from the study showed that the participants generally felt that strategies and interventions to enhance access to and retrieval of information was not carefully considered furthering a negative cycle of exclusion.

A similar study was carried out in the United States of America (USA) by Vanderheiden and Jordan (2016) to evaluate the accessibility of the digital library by students with visual impairments at the University of North Carolina at Chapel Hill. Users with visual impairments answered questions about the use of the library website and the use of assistive technologies in a questionnaire and following-up with a usability test. The usability test involved having participants complete tasks that were guided by a research question. Throughout the test, they navigated a database access page, a subject guide, and two databases to find research articles that related to the question. The resulting data indicated that

users preferred the organized layout of the database access page, but overall participants were frustrated with navigating the interfaces of databases, which varied in their design and delivery of accessible PDFs (Vanderheiden & Jordan, 2016), perhaps giving a general perception on inaccessible digital libraries that accommodate all users with their varied needs.

An exploratory study conducted in Pakistan by Bano and Qureshi (2017) on the use of ICT among students with visual impairment aimed at exploring the actual role of ICT in imparting information to students with visual impairment. The data was collected from 41 students with visual impairment using android mobiles, computer/laptop or using internet facilities at libraries of their academic institutions (Bano & Qureshi, 2017). It involved quantitative data gathering techniques following snowball sampling procedure. The study found that female students were using information communication technologies more effectively for their digital literacy compared to male students with visual impairment. The effort made by Bano and Qureshi (2017) in their study was a clarion call and awareness creation among the stakeholders to enhance the provision of more computer labs with internet browsing services to enhance digital literacy among students with visual impairment.

Research by Pant (2016) was done in India on the perception of undergraduate students who have visual impairment about the digital environment (library) in their institutions to develop an online information system suiting their requirements. The study targeted undergraduate students enrolled in ten colleges of the University of Delhi. The study found that majority of (35.8 per cent)

respondents' access online electronic resources daily. Major constraints facing students with visual impairment included inaccessibility of the college notice board, lack of accessibility to existing facilities and resources, lack of assistive technology facilities and unavailability of readers and writers (Pant, 2016). More than half of respondents indicated that it is cumbersome to access the college website because they are not designed according to the accessibility standards developed for persons with visual impairments (Pant, 2016).

A study was conducted by Diyaolu and Ologunde (2019) in Nigeria to investigate the information needs and library service delivery to students with visual impairment in Oyo State. The study focussed on assessing the influence of library services; information needs; media formats availability and accessibility on library use among students with visual impairment in Oyo State, Nigeria. The study established that print Books/Magazines, Braille Books and Braille-in-Print were prominent among the few media-formats available for the students while the dearth of media-formats was found to be inadequate in meeting the information needs of students with visual impairment. Lack of ease of accessing the library resources, facilities as well as library staff whenever they need help, poor policy on borrowing privileges, lack of path sounders to guide their movement around the library among others were major accessibility issues confronting the students in enjoying quality library services (Diyaolu & Ologunde, 2019). The study recommended the need to address the provision of basic facilities that are critical to effective library service delivery to the visually impaired students.

In South Africa, Majinge and Mutula (2018) conducted a study on the access to electronic and print information resources by people with visual impairments in university libraries. The study was focussed on examining the extent to which electronic and print information resources in university libraries are accessible to people with visual impairments (Majinge & Mutula, 2018). An interview schedules was used to collect data from the selected group of students with visual impairments. Evidence brought out from the study suggest that with appropriate customization, persons with visual impairments can find it easy to access digital content.

Ojok (2018) conducted a study in Uganda on the accessibility and Utilization of Information and Communication Technology by Students with Visual Impairment in Uganda's Public Universities. A quantitative study was conducted with students with visual impairment enrolled in two public universities in Uganda to explore the extent to which they accessed and utilized ICT. The study found that more than half of the students with visual impairments (60%) knew that their university had an e-learning platform, but most of the students had never uploaded/downloaded any learning materials from their universities' websites (Ojok, 2018). Less than half of the students (46%) were confident to produce text using a word processing program but only a few could use PowerPoint (12%) and excel (8.6%) applications. To improve students with disabilities' access and use of ICTs, multiple actions are required, including equipping departments with computers, ensuring the computers are in accessible

locations, giving the students opportunity to practice, and purchasing licensed adapted software applications (Ojok, 2018).

A study in Kenya by Odini, Chege and Mbugua (2018) on the provision of information services in learning and instructional process in schools including those of the visually impaired students. The study was conducted using a case research and mainly used qualitatively and quantitatively approaches. Data was collected using interview schedules, the focus group guide and documentary review. It was revealed that a small percentage of library users can access information from the library. It established that provision of information to visually impaired students required improvement. The study concluded that authority and information providers in this area take recognition of visually information needs and channels of accessing information (Odini, et al., 2018). The study recommended improvement of the existing information services, system, and channel of disseminating information to visually impaired to serve them without discrimination through systemic exclusion (Odini, et al., 2018).

Previous studies have been able to study accessibility with regard to digital information utilization. However, the focus of this accessibility leans more towards the availability of information services and technologies for use by persons with visual impairment and not on accessibility as a system usability aspect. For instance, studies by (Khowaja and Fatima, 2019; Bano and Qureshi, 2017; Pant, 2016; Majinge and Mutula, 2018; & Odini, Chege ad Mbugua, 2018) seemed to lean toward access to information services, access to information resources and enabling technologies by persons with visual impairment.

Out of the reviewed literature only two studies seemed to have a bias towards accessibility of digital library (Vanderheiden and Jordan, 2016; Ojok, 2018). However, their focus would still veer towards access to digital infrastructure and technologies and deviate from accessibility as a design aspect of the digital library itself, a gap that this study sought to address.

2.8 Summary of Exiting Literature and Gap

The internet has become a crucial part of life because it is used in government, health care, education, finance, and other essential areas of human life. Access to educational information has increasingly become internet-based with innovations which soon may eliminate the necessity for physical library. This may come to pass as more education institutions embrace digital libraries for its perceived effective usability such as enhanced storing and retrieval of information. As digital libraries gain prominence as main repository of mankind's knowledge, their interfaces need to be made user friendly, for optimal utilization and management of digital library content.

Previous usability studies have contributed significantly toward the current wave of inclusion in information access and retrieval across the globe. Survey of contemporary literature about usability of digital information retrieval systems reveal a trend in terms of areas of focus, guiding principles, theories, and methodologies. For instance, almost all usability studies previously conducted have addressed at least one of the usability attributes; user friendliness, effectiveness, efficiency, learnability, error tolerance, memorability and user satisfaction (Matusiak, 2012; Bhardwaj, 2018; Fernandes et al., 2019).

A survey of literature on friendliness of digital information retrieval systems reveals that previous research in this area have focussed on how assistive technology fosters satisfaction when using digital libraries. One such perspective is provided by Dodamani and Dodamani (2019). Other studies (Bodaghi & Zainab, 2017; Lourens & Swartz, 2016) have focused on the concept of friendliness of a digital system as a perception issue rather than a design issue. Zia and Fatima (2016) examined the concept of friendliness of digital system from the viewpoint of external factors such as internet and computer hardware. To these ends, few studies (Rathi, et al., 2012; Olaopa, 2017) seem to have examined the construct of friendliness of an information retrieval system such as digital library in the context of its features and consequently system design that ultimately dictate its friendliness to some categories of persons such as those with visual impairments; a gap that this study sought to fill.

Regarding efficiency of digital information retrieval systems, current literature seems to suggest that only proficient users of a system regard it as efficient. Additionally, most usability studies focusing on efficiency of digital learning platforms have a component of comparing the user experience with other media such as Braille and print materials (Bhardwaj, 2018; Pradhan & Sahu, 2019). As such, evaluation of efficiency of digital systems have been previously based on comparison with older modes of information access as opposed to user experience in the use of the digital library itself.

This study found evidence of limited empirical researchers focusing on learnability of digital libraries. Available evidence such as the study by

Fernandes et al. (2019) and Aghauche and Udem (2018) examines the construct of learnability of digital library as the product rather than the process. In these studies, there was evidence that competence and influence of the librarians and other sighted students respectively was given much focus as opposed to the way persons with visual impairment learn to use digital libraries. The current study mainly focused on the perspectives of users with visual impairment with regard to learning to use the digital library. In addition, the study focussed on learnability of the digital library as a design aspect and not an end product as perceived in many studies reviewed.

Regarding satisfaction of digital information retrieval systems, literature suggests a possibility of skewed viewpoint of this construct. Most of the usability studies (Menzi-Cetin, et al., 2017; Osadebe, et al., 2019; Grove, 2020) discuss the concept of user satisfaction as a function of the rest of usability attributes rather than a user experience in information retrieval process.

Previous usability studies focusing on accessibility of digital platforms focussed on infrastructure such as availability of computers (Vanderheiden & Jordan, 2016; Majinge & Mutula, 2018; Ojok, 2018). In fact, researchers like Ojok (2018) focussed on accessibility of Microsoft packages such as word, excel, and PowerPoint by users with visual impairment, and recommended equipping university libraries with more computers. The current study introduced accessibility as a key usability attribute for users with visual impairment, a component that seem to have been excluded in most of the earlier studies.

While the current study acknowledged significant contribution by earlier scholars and practitioners globally, regionally, and nationally in usability of digital libraries, there were focus issues that needed to be addressed with more robust methodologies due to the changing education landscape in Kenya resulting into new perspective on usability of digital platforms. The current study introduced a simultaneous approach in examining all usability attributes at the same time as opposed to previous studies that focused on one attribute at a time. Regarding target population, the current study introduced a comparative analysis approach in which perceptions with regard to usability of digital libraries by users with blindness and those with low vision were compared. Comparative analysis has been used in previous studies to compare users with visual impairments (combining low vision and the blind) and the sighted users. Methodologically, most previous usability studies were case studies of isolated institutions. The current study adopted a cross-sectional approach where data from three different institutions was collected and analysed before drawing its conclusions. It is hoped that the evidence presented in this study will stimulate discourse among policymakers to include students with disabilities in information access and collection development policies. The findings of this study may ignite the urge in designers of digital libraries to consider universal designs of systems that may not exclude any users regardless of their disabilities.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter describes and justifies the research design and methodology used in the study. In particular, the chapter presents the research design, research variables, location of the study, target population, sampling techniques and sample size, research instruments, pilot study, validity and reliability of the instruments, data collection techniques, data analysis, and finally logistical and ethical considerations.

3.2 Research Philosophy

This research is based on Pragmatism research philosophy (Shields, 1998). Pragmatism research philosophy seeks to improve practice by the application of concepts (Kaushik & Walsh, 2019). It accepts relevance of concept only when they are in support of action (Martela, 2015). Pragmatics hold that there are different ways of conducting research. They recognise that there is no single point of view that can give the entire picture of the situation under study since there are multiple realities in every situation (Morgan, 2014).

Pragmatism research philosophy was chosen for this study since it provides an opportunity to integrate more than one research approach and research strategies. For instance, use of both the deductive and inductive approaches through mixed methods to achieve both quantitative and qualitative data sets.

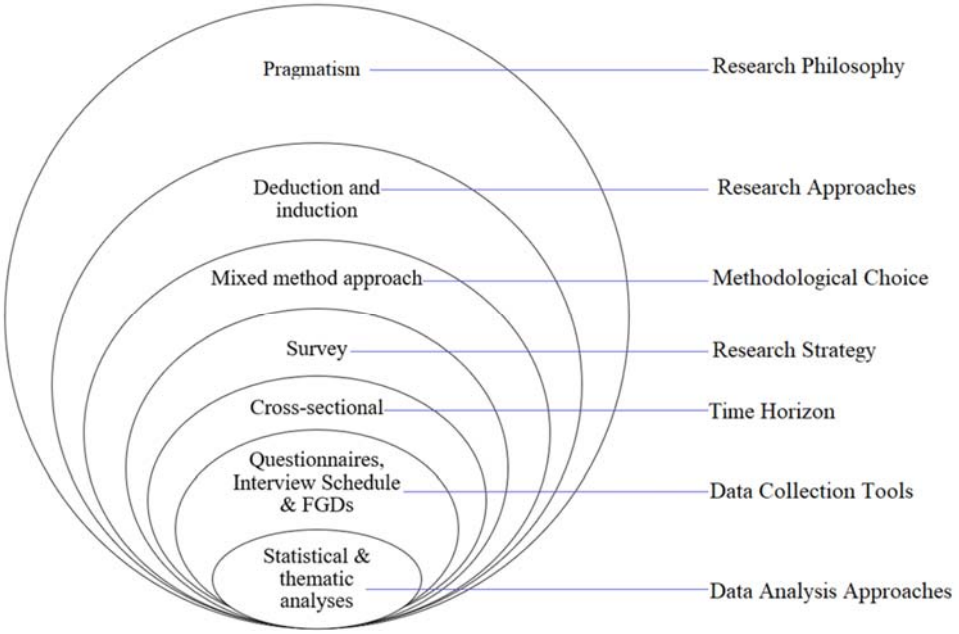

Figure 3.1: The pragmatic research Onion
Source: Developed from Saunders et al. (2019)

3.3 Research Design

According to Kumar (2005), a research design is a plan, structure and strategy of investigation conceived to obtain answers to research questions or problems. This study used the descriptive type of cross-sectional survey research design. Cross-sectional survey design was appropriate for this study since data was collected from the study population at one point in their information retrieval venture without manipulating any variables. The suitability using a cross-sectional survey design was based on the need for prescriptive and inferential approaches in responding to the research questions of the study. Additionally, descriptive type of cross-sectional study design is suitable in user experience (XU) research, in which the aim is to establish how user interact with and experience the system, product or service (Lewis & Sauro, 2021). Saunders,

Lewis, and Thornhill (2009) describe a cross-sectional survey design as one which deals with portraying the existing conditions, practices, structures, processes, or opinions held. The aim of cross-sectional survey design is to describe the characteristics of a population or situation (Amin, 2005). A cross-sectional survey research design was suitable for this study because the study aimed at getting the opinions of users with visual impairment concerning usability of digital libraries at a point in time and without manipulation of variables. The study gave a description of usability of digital libraries through evaluation of various usability attributes.

3.4 Research Variables

The dependent and independent variables in this study were as follows:

a) Dependent variable

Giunchiglia, Maratea, and Tacchella (2002) define a dependent variable as the factor being measured and tested in a scientific experiment. The dependent variable in this study was information retrieval. Retrieval of digital information was the dependent variable in this study influenced by usability attributes defined in the conceptual framework of the study such as friendliness, efficiency, satisfaction, learnability, and accessibility of digital library when being used by a person with visual impairment. The dependent variable was measured on the study questionnaire by a set of self-reported questions items on the ease of accessing data files and relevant pieces of information from the DL without explicit help. As such, the level of information retrieval for every individual was captured directly from the questionnaire.

b) Independent variables

Giunchiglia, et al. (2002) define an independent variable as a factor that is controlled in a scientific experiment with the aim of observing its influence on the dependent variable. This study considers the five usability attributes as independent variables in this study. Specifically, friendliness, efficiency, user satisfaction, learnability and accessibility of the digital library were studied, and their influence checked on the dependent variable which was retrieval of digital information.

Friendliness of a digital library as used in this study describes user's self-reported experience of how friendly they find a digital library interface. This variable is a usability attribute used to as a proxy description of user experience of Digital library accessibility and functionality.

Efficiency of a digital library describes the ability to accomplish tasks without wasting time, or energy as it would have been the case when not using the digital library.

Satisfaction with digital library describes the attitude of a user with visual impairment to the digital library one employs in the context of their academic and research activities in education.

Learnability of a digital library describes a quality of the system that makes it easy to learn during the process of interacting with it without necessarily going through some formal training.

Accessibility of a digital library describes a property of the digital library that makes persons with visual impairment be able to navigate through using assistive technologies such as screen readers and screen magnifiers.

c) Intervening Variables

In this study, intervening variables included prior training to assistive technology, period of exposure to digital libraries, individual attitude, and technical support. These are variables that plays an intermediary role between usability attributes and the information retrieval.

3.5 Location of the Study

The study was conducted at Kenyatta University, Moi University and Maseno University with specific focus on their digital libraries. Public universities were selected because they are obliged to admit all learners on merit including those with disabilities (GoK, 2018). The three universities have been selected because they are inclusive universities and have a bigger number of library users with visual impairment compared to the other universities in Kenya.

3.6 Target Population

The target population comprised of university students with visual impairment who used digital libraries. Students with visual impairment were selected as the target population for this study because they are at a greater risk of being excluded from usability testing for digital libraries (Odini, et al., 2018), since they interact with information technologies differently using assistive technologies.

The target population for this study was therefore 138 persons. Out of this, 126 consisted of students with visual impairment in the three Universities and 12

special needs librarians. Table 3.1 gives an account of the target population for this study:

Table 3.1: Target Population

University	**Students with VI**			**Special needs Librarians**			**Grand Total**
	Male	**Female**	**Total**	**Male**	**Female**	**Total**	
Kenyatta	34	46	**80**	2	4	**6**	**86**
Moi	10	14	**24**	1	2	**3**	**27**
Maseno	10	12	**22**	1	2	**3**	**25**
Total	**54**	**72**	**126**	**4**	**8**	**12**	**138**

Source: University database, 2019

3.7 Sampling Techniques and Sample Size

Students with visual impairments and special needs librarians were sampled as respondents in this study. Sub-sections 3.5.1 and 3.5.2 below discusses the sampling techniques used to sample these participants and the sample sizes for each of these respondents, respectively.

3.7.1 Sampling Techniques

a) Sampling of Students

Complete enumeration technique was used in the sampling of students with visual impairment from the selected universities. Complete enumeration involves including every member of the target population into the study. This sampling technique is often used when target population is known to be

sufficiently small to an extent that every member of the population can be investigated without causing financial or logistical strain on the researcher (Ravitch & Carl, 2016). Thus, all the 126 students with visual impairment were selected for data collection using questionnaire.

The target sample of students with visual impairments for interview schedule and Focus Group Discussion (FGD) was determined by the Krejcie and Morgan (1970) formula. According to this approach (*As detailed in Appendix VIII*), the sample size for interview schedule and FGDs was 92. However, only 54 (43%) students with visual impairments gave consent to participant in follow-up in-depth interviews and 42 (33%) gave consent to participate in FGDs.

b) Sampling of Special Needs Librarians

Like students, the population of special needs librarians in the selected public universities is small and thus complete enumeration otherwise known as census was used. Thus, all the twelve (12) special education needs librarians were sampled to participate in this study.

3.7.2 Sample size

Chuan and Penyelidikan (2006) on sample size estimation using Krejcie and Morgan (*See Appendix VIII*) and Cohen statistical power analysis concludes that the purpose of sampling is to overcome the challenge posed by inability to access the entire target population. Some of the barriers to accessing entire target population include high cost, and time consumed to cover a large population or due to the difficulty to get the cooperation from the entire population to participate in the study. Given the small target groups for the students with visual

impairments and special needs librarians in public universities, complete enumeration method was used, where every member in the target population was included in the study. Thus, the sample size and the target population were equal. Table 3.2 presents a summary of sample size used in this study.

Table 3.2: Sample Size Matrix

Category of Respondent	Target Sample Size	Attained Sample size	Percent
Students with Visual Impairment	126	117	93%
Special Needs Education Librarians	12	9	75%
Total	138	126	91%

Source: Research Data (2020)

3.8 Data Collection Instruments

This study used three data collection instruments; questionnaire, interviews, and focus group discussion.

3.8.1 Questionnaire

A Semi-structured questionnaire constituting both open and closed ended questions was used in this study. The questionnaire was used to collect data from university students with visual impairment. The tool was aimed at responding to all the five objectives in this study. The questionnaire was adapted from the system usability measurement inventory (SUMI) by Kirakowski and Corbett (1993) and from System usability scale (SUS) by John Brooke (1986) which are standard usability tools. These tools were used because they are easy to administer and can be used on a small sample size with reliable results. The tools were then customized to suit the current study objectives. Open and closed ended

questions were used because of their ability to collect detailed and reliable data, both qualitative and quantitative data sets. The questionnaire had six sections. Section A about general and demographic information, sections B, C, D, E, and F about information on the study objectives. A five-point Likert Scale was used to capture responses of individual items regarding friendliness, efficiency, satisfaction, learnability, and accessibility of digital libraries.

Each of these usability attributes was measured on a uniform Likert scale where **SA**=Strongly Agree, **A**=Agree, **U**=Undecided, **D**=Disagree, **SD**=Strongly Disagree. Respondents were expected to select one response for each of the items listed under each of the usability attributes. Information retrieval was captured using a 10-point self-reporting scale where 1 indicated that one found it difficult to retrieve information while 10 indicated that one found it very easy to retrieve information from DL. The tool was then loaded in kobo collect application to facilitate efficiency in the process of data collection considering that the respondents were persons with visual impairment.

3.8.2 Interview Guide

Two semi structured interview guides were used to collect data. One guide collected data from students with VI while the other guide was used to collect data from special need librarians. Interview guide was used to triangulate the data collected using the questionnaire. The items in the interview guides adequately covered all the five objective areas.

3.8.3 Focus group Discussion Guide

A students' focus group discussion (FGD) consisting of open-ended questions was conducted. The tool had five sections representing the five objectives of the study. Each objective addressing an independent usability attribute: user friendliness, efficiency, user satisfaction, learnability, and accessibility. Five FGDs consisting of between 7 and 9 students with visual impairments were held; 3 FGDs were held at Kenyatta University, 1 FGD in Moi and another FGD in Maseno. Kenyatta University had more FGDs conducted considering the bigger number of students with visual impairment in the university compared to Moi and Maseno universities. Each FGD took a duration of between 42 and 51 minutes. A voice recorder was used to take audio notes which was later transcribed in verbatim before data was analysed.

3.9 Pilot Study

The instruments for this study were successfully pre-tested in Nairobi University. The University of Nairobi was selected since it had similar characteristics with the main study locale in terms of availability of a digital library hosted on DSPACE software and population of students with visual impairment. According to Orodho (2013) participants in the pilot study ought to be at least 10% of the main study sample. However, it was found that individuals with similar characteristics to the target population in the University of Nairobi were less than 13 (10% of the target sample of 126). Therefore, the researcher collected data from four students with visual impairment using a questionnaire loaded Kobo Collect toolbox, an application that is accessible

through android phones. Personal interviews were conducted with four students with visual impairment and two special needs librarians. The focus group discussion guide was also tested using a group of four students. The purpose of this pilot study was to be able to identify ambiguous and vague questions, rephrase sentences, make wording clear, provide enough space for answers, and revise the layout of instruments where need be. During the pilot study, it was noted that some students referred to digital library as the mere search of digital information through Google or other common search engines. To ensure that the respondents referred to the same digital library as the one under study, the scope of the digital library was clearly defined on the introductory part of every tool for clarity and to ensure that the right data was collected. In addition, the findings of the pilot study informed review of question items to remove ambiguity and enhance clarity.

3.9.1 Validity

According to Amin (2005), the term validity refers to how appropriate an instrument is in measuring what it is intended to measure. It is the degree to which results obtained from the analysis of the data represent the phenomenon under study (Mohajan, 2017). Content validity and construct validity were addressed in this study. Content validity is the extent to which the items on a test are representative of the entire domain that the test seeks to measure (Yusoff, 2019). The content domain in this study consisted on the five usability attributes; Friendliness, Efficiency, Satisfaction, Learnability and Accessibility. To achieve content validity, the data collection tools were subdivided into sections

to ensure adequate items were developed under each of the five domain areas. In addition, pre-testing of the data collection instruments was done and items that generated similar responses revised so as to measure what they were intended to measure towards achieving the purpose of the study.

Construct validity is the extent to which a test adequately measures the phenomenon that it is intended to measure (Nájera & Gordon, 2020). In this study, construct validity was achieved by asking a series of related questions that covered different aspects of every usability attribute under study. In addition, triangulation strategy was employed, such that data from the questionnaire was triangulated with data from the interview schedule and focus group discussion to ensure the results of data analysis was a representation of the phenomenon under study.

3.9.2 Reliability

The Reliability of instruments in research refers to the degree to which an instrument consistently measures whatever it is measuring (Amin, 2005). Amin further defines stability reliability as the degree to which the results of a similar test done by a similar group of individuals are consistent over time. Cronbach's alpha was used to assess the internal consistency of different sets of items measuring each of the usability attribute. Cronbach's alpha of at least (α =0.7) suggest that the given set of test items are reliable in measuring the construct under investigation (Creswell, 2013). The questionnaire was divided into 5 major sections where each section was dedicated to measuring a single usability

component. Thus, the reliability statistics for each of the 5 sections was conducted independently and Cronbach's alpha reported as shown in Table 3.3.

Table 3.3: Reliability Statistics Cronbach's Alpha

Questionnaire Section	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
Friendliness of Digital Libraries	0.7974	0.7912	11
Efficiency of Digital Libraries	0.8540	0.8429	8
Satisfaction with Digital Libraries	0.8629	0.8131	8
Learnability of Digital Libraries	0.7889	0.7730	13
Accessibility of Digital Libraries	0.8373	0.8343	6

Source: Research Data (2020)

The first section on friendliness of digital libraries had 11 items (α=0.79), the second section on efficiency of digital libraries had 8 items (α=0.84), the third section on satisfaction with digital libraries had 8 items (α=0.81), the fourth section on learnability of digital libraries had 13 items (α=0.77) and the fifth section on accessibility of digital libraries had 6 items (α=0.83) as presented in Table 3.3. Based on these observations, the test items under each of these usability attributes suggested a high internal consistency in measuring the construct based on the pilot sample of students with visual impairment.

3.10 Data collection techniques

There were 138 targeted participants in this study: 126 students with visual impairments and 12 special needs librarians. Questionnaires, interview schedule and focus group discussion were used to collect data from students with visual impairments. During data collection exercise, 117 students responded to the questionnaires while 54 students participated in interviews and 42 students

participated in focus group discussion. Data from special needs librarians was collected using interviews.

To collect data using questionnaire from students with visual impairment, the researcher used computer assisted personal interview (CAPI) method. An accessible, user-friendly application known as Kobo Collect toolbox that allows data collection both offline and online was used. The questionnaire was loaded in the application and was accessible through android phones while the submissions were hosted in a safe and personal online server. The researcher and two well-trained research assistants were used to collect data from the respondents using Kobo Collect toolbox. For students at Kenyatta University, the tool was administered at the Post-Modern library since students with visual impairment were considered frequent users of the library according to patron's record at the special needs section (2019). The staff on duty at the section supported the researcher in preparing and ushering in the students at the reading carrels at the section where the tool was administered. For students at Moi University, the researcher met the students through support from the braille transcription services office under dean of students' office. At Maseno University, the researcher was linked with the students from the dean's office. The researcher then arranged with the students on the best time to conduct the interview within the campus. The tool administration was done by the researcher and research assistants through a one-on-one question and answer session with the respondents. The researcher and research assistants then keyed in the responses on the tool loaded in the kobo collect application, which was opened

through mobile phones or tablets. At the end of every administration, the questionnaire with the responses was then submitted online and were received in real time at the researcher's Kobo Collect server. This method was effective, time saving and friendly for respondents with visual impairment. In addition, the researcher was assured that data was received from the right respondents.

To collect data from using interviews from students with VI, Individual arrangements were made with the sampled students from every university and interviews were undertaken face-to-face within the universities. To collect data from special needs librarians, prior arrangements were made to identify a convenient time at which interviews were conducted.

To collect data using Focus Group Discussions (FGDs), a convenient time for the FDGs was identified for each university when most of the participants were available. In addition, an appropriate meeting venue was pre-arranged within the university for the FGD, away from noise to facilitate recording and smooth running of the discussion. FGDs comprised of a minimum of 7 and a maximum of 9 participants.

3.11 Data Analysis

Descriptive and inferential statistical methods were used in the analysis and presentation of quantitative data emanating from closed ended Likert Scale questionnaire items. Descriptive statistics used in this study included frequency tables, percentages, mean and variances while inferential statistics used included chi-square tests of association, correlation, and linear regression. Chi-square

tests statistic was used to ascertain association between usability attributes and respondents' demographic indicators while correlation and regression analysis was used to analyse the nature of relation between usability attributes and information retrieval.

Qualitative data was analysed using thematic approach, achieved through a systematic coding system. Most of the qualitative data was gathered from students with visual impairment through Focus Group Discussions (FGDs) and interview schedules, and qualitative interviews with special needs librarians. Both the interview schedules and FGDs for students with visual impairments had clearly labelled sections conforming to the five usability attributes under study. The data was captured in audio and written format using voice recorders and a notebook respectively.

Coding of the qualitative dataset adopted an inductive approach where codes were derived from the data. In this case, codes were derived to suit specific objectives of the study. Coding of qualitative data from FGD and interview data from students was conducted independent of qualitative interview data from Special Needs librarians. There were two coding cycles. The first cycle was to identify initial categories, then these categories were uploaded in the excel spread sheet and more codes were added in the process of coding. The second coding cycle was to combine the codes generated in the first cycle to identify categories. According to Tracy (2013), the first cycle is to describe the data and the second cycle is to organize the codes into categories.

Constant comparison method described by Memon, Umrani and Pathan, (2017) was adopted in reporting the findings emerging from qualitative data. Using this approach, themes emanating from qualitative data are mapped to corresponding incidences brought out by statistics and reported in support of each other (Memon et al., 2017). This reporting methodology mirror the grounded theory approach in which qualitative and quantitative datasets are continuously triangulated and reported as one.

3.12 Logistical and Ethical Considerations

Before data collection, the researcher ensured that all data collection instruments were valid and reliable. The researcher also sought for clearance from the Graduate School of Kenyatta University. After getting this clearance, the researcher proceeded to obtain a research permit from the National Commission for Science, Technology, and Innovation (NACOSTI) and then from the authorities of the selected universities. In addition, research assistants were trained to make them familiar with the research and data collection tools.

During data collection, the researcher sought for informed consent from every respondent through an informed consent form prepared as per the guidelines of the Kenyatta University ethics review board. The consent form was attached to the questionnaire as the first part before the question items such that the respondent would give informed consent before embarking on the other question items of the digital questionnaire. The researcher respected the principle of anonymity of the respondents by not asking a question that would identify them

by name on the questionnaires. Strict confidentiality was followed by ensuring that all the information obtained was only used for the purpose of the study. Finally, the researcher avoided any form of plagiarism by acknowledging all authorities quoted.

CHAPTER FOUR
DATA PRESENTATION, ANALYSIS, AND INTERPRETATION

4.1 Introduction

The general objective of this study was to explore usability of digital libraries with special focus on information retrieval by persons with visual impairment. This chapter begins with a presentation of general and demographic information of study participants and then follows the findings of the study on the extent to which digital libraries are user friendly, efficient, user satisfying, easy to learn and accessible to persons with visual impairment during information retrieval from digital libraries.

4.2 General and Demographic Information

This section presents general information about participants in the study from the target population and the sample selected.

4.2.1 Response Rate

This is the response rate of the successfully completed number of data collection instruments from study respondents, usually expressed as a percentage of the target sample. Generally, a low response rate is undesirable as it has negative impact on the overall quality of the data and conclusions that may be drawn from the study. However, there is no consensus about the minimum threshold that is universally acceptable for a response rate because different data collection approaches result into varying response rates. Different scholars have proposed different response rates they consider adequate for highly rigorous academic

and/or scientific research. Lynn, Beerten, Laiho and Martin (2001) reported different response rates according to the mode of the survey as follows; in person 80-85%, phone 80%, direct mail 50-70%, email 40- 60%. Further, Mugenda and Mugenda (2012) proposed that response rate should be more than 70% for meaningful generalization to be made from a survey study. There were two categories of respondents in this study: 126 students with visual impairments and 12 librarians. The response rate for the students with visual impairment was 117 (92.9%) while the response rate for Special needs librarians was 9(75%). Based on observations and recommendations by (Lynn et al., 2001; Mugenda & Mugenda, 2012), the response rate in this study may be considered adequate.

4.2.2 Demographic Information of Respondents

This section presents demographic information of students with visual impairment who participated in the study. The key demographic information presented herein are gender, age, nature of visual impairment, year of study for undergraduate students and level of study for post graduate students.

a) Gender of Respondents

Figure 4.1 shows gender of special needs education (SNE) librarian and students with visual impairments (VI) who were the respondents in this study. Figure 4.1 shows that 66(56.4%) of the students with VI and 4(44.4%) of SNE librarians were male while 51(43.6%) of students with VI and 5(55.6%) of SNE librarians were female.

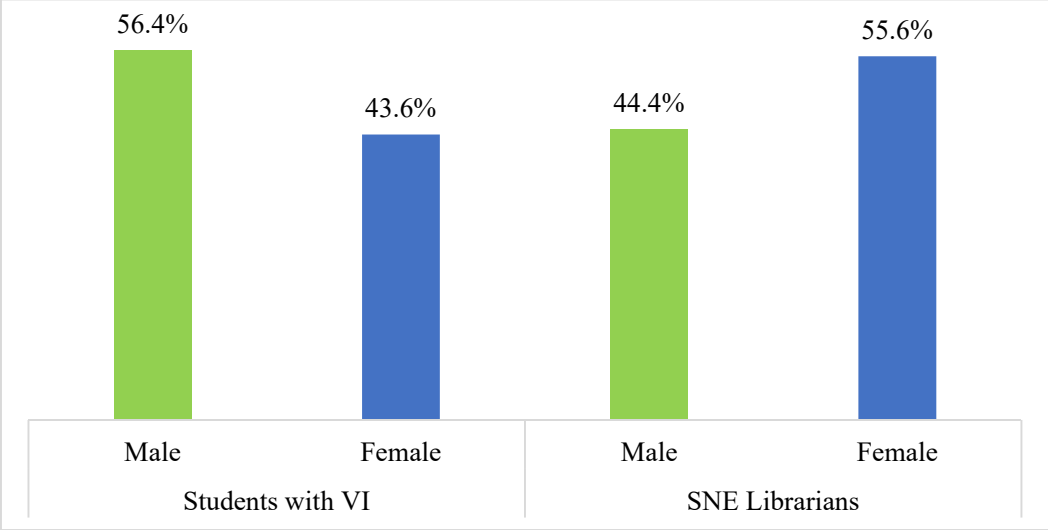

Figure 4.1: Gender of SNE Librarians and Students with VI

Source: Research Data (2020)

Gender is one of the parameters of inclusion alongside disability. In this study, it was important to ensure gender parity issues. As shown in Figure 4.1 above, both students and staff of both genders were represented. Hence, the findings of the study accounts for perspectives of male and female users with visual impairments.

b) Age of Respondents

Figure 4.2 shows age distribution of students with visual impairments (VI) who were respondents in this study. It is evident that majority of students at 95 (81.2%) were aged between 18-25 years, 15 (12.8%) were aged between 26-35 years, 5 (4.3%) were aged between 36 – 45 years and 2(1.7%) were aged above 45 years.

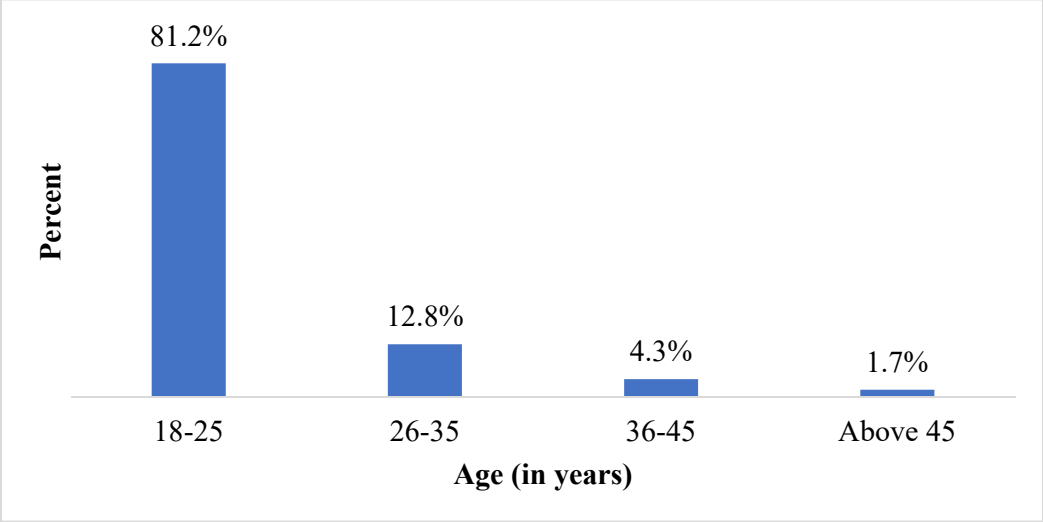

Figure 4.2: Age Distribution of Students with VI

Source: Research Data (2020)

Traditionally, it was assumed that younger people tend to embrace technology more compared to their older counterparts. Whist this may be a misguided assumption, this study accounted for usability experience of digital library users with different age brackets from below 20 years to over 45 years who are at the university. As such, cross-tabulation of information retrieval with age was conducted as an important aspect.

Similarly, Figure 4.3 shows age distribution of SNE librarians who were respondents in this study. It was found (as shown) that 3 (33%) were aged between 26 – 35 years, 4(44%) aged between 36 – 45 years and 2(22%) aged above 45 years. Whist the age of SNE librarian was not at the core of this study, the results provide an interesting insight such that over 80% of staff are 45 years and below. Such results may give the impression that younger persons embraces technology and that could be the reason why they are deployed as SNE librarians to support users with visual impairments.

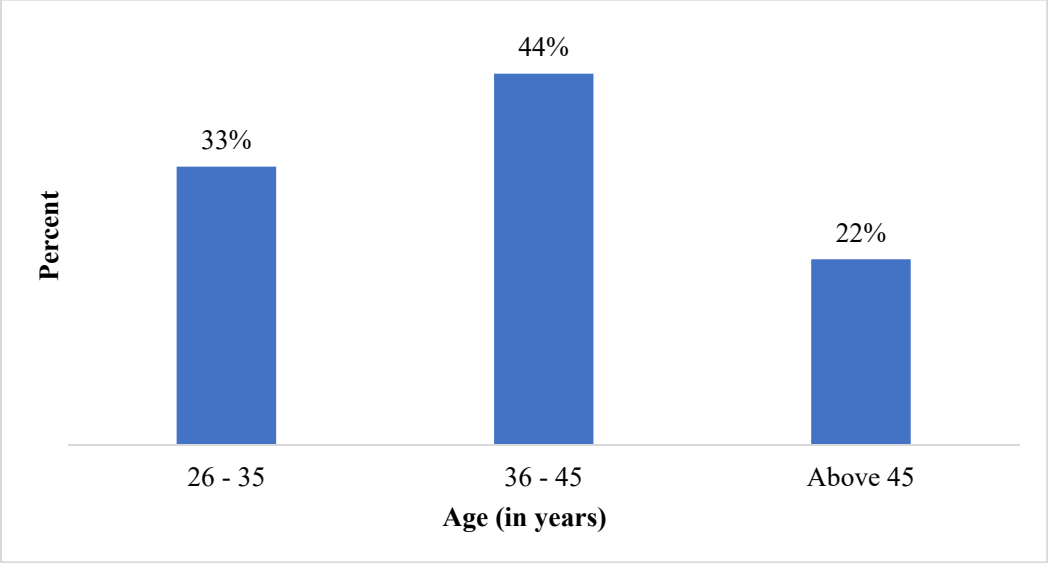

Figure 4.3 Age Distribution of SNE Librarians

Source: Research Data (2020)

c) Nature of visual impairment of Students with Visual Impairment

Figure 4.4 shows percent of students who are blind or low vision who participated in this study. It was found (as shown), that 93 (79.5%) of students with visual impairment were with low vision and 24 (20.5%) were students with blindness. Whist persons with visual impairments require universally designed digital libraries that enhance their accessibility and functionality, it is important to note that the experience is not the same. In this study, attention is paid on how the blind interact and experience digital library interface in relation to their counterparts with low vision.

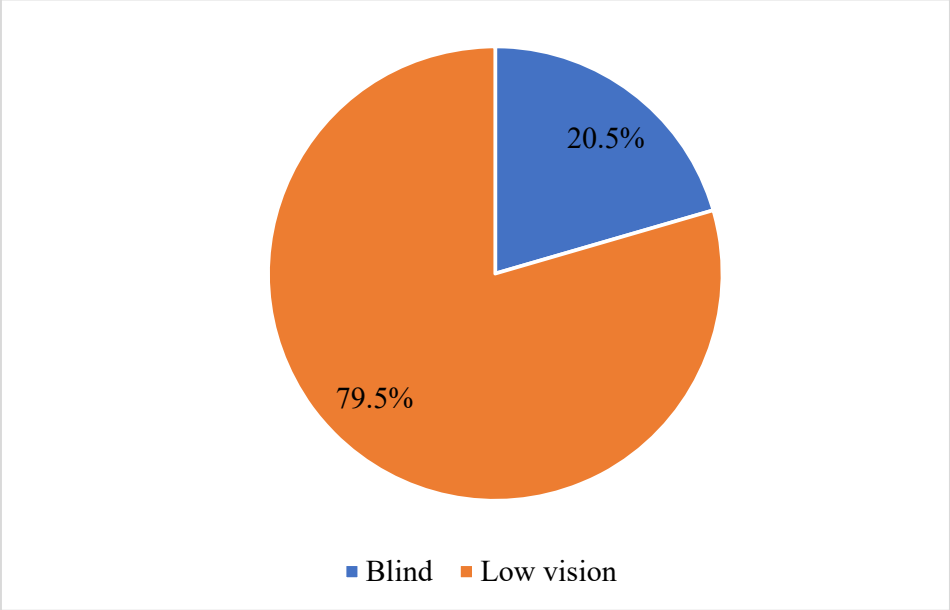

Figure 4.4: Percentage of Students who are blind or low vision

Source: Research Data (2020)

d) Undergraduate students with Visual Impairment

In this study, 117 students with visual impairment participated out of which 110 (94%) were undergraduate. As shown in Figure 4.5, 24(20.5%) were first years, 44 (37.6%) were second years, 26 (22.2%) were third years and 16 (13.7%) were fourth years. Further 7 of students with visual impairment interviewed were postgraduate students. As presented in Figure 4.5, 5(4.3%) were enrolled in master's program while 2(1.7%) were enrolled in PhD programs. The year of study was used in this study as a proxy variable to the period of exposure to digital library. This stems from the study assumptions that our target population encountered digital library at the university. Hence, the year in which they are at school is directly proportional to the exposure period.

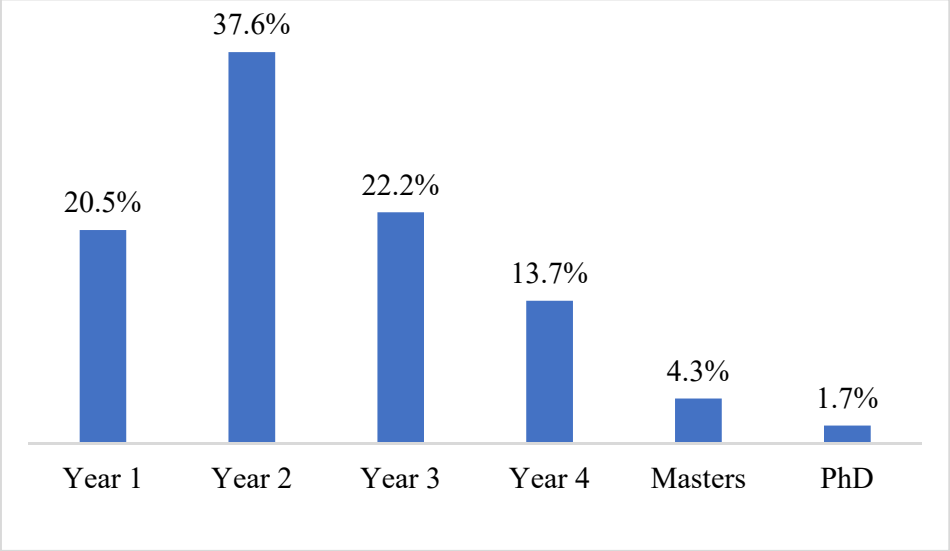

Figure 4.5: Distribution of Students According to Level of Study

Source: Research Data (2020)

4.3 User Friendliness of digital libraries during information retrieval

The first objective of this study was to determine the level of user friendliness of digital libraries in information retrieval by persons with visual impairment. Review of user friendliness was based on four key drivers of functionality and operational ease of use of the General User Interface (GUI) such as; navigation within the digital library, proficiency in the use of relevant functions within the digital library and design, presentation, and layout of the digital library, and perceived impact on the use of the digital library. Matusiak (2012) contends that digital libraries represent emergent and complex forms of digital information organization and design, consisting of multiple layers and building blocks, in various stages of development. As such ease of navigation, aptitude in the use of functions, design, presentation, and layout of DL are important consideration in determining the level of system friendliness.

4.3.1 Ease of Navigation

Navigation within the system has been identified as an important factor influencing system friendliness by the end user (Matusiak, 2012). Basic navigation in a digital library includes one's ability to log in and out of the digital library and ease of movement from one part of the task to another. In this study, students with visual impairment were asked to rate their user experience when they login and logout of the digital library and when navigating from one part of the digital library interface to another. Table 4.1 presents result of ability of students with VI to navigate digital libraries.

Table 4.1:Ease of Navigation in Digital Libraries

	Variable	Nature of VI		Overall Percent	Sub-total (n)
		Blind	Low vision		
I am able to log in and out of the digital library	Strongly agree	8%	92%	11%	13
	Agree	14%	86%	6%	7
	Undecided	44%	56%	8%	9
	Disagree	19%	81%	45%	53
	Strongly disagree	23%	77%	30%	35
I find easy to move from one part of a task to another in the digital library	Strongly agree	15%	85%	23%	27
	Agree	23%	77%	41%	48
	Undecided	17%	83%	5%	6
	Disagree	19%	81%	18%	21
	Strongly disagree	27%	73%	13%	15

Source: Research Data (2020)

The findings presented in Table 4.1 indicate that three quarters of students with visual impairment are not able to log and out of digital libraries. This translates to75% (30% plus 45%) compared to only 17% (11% plus 6%) who can log in and out of the digital libraries. However, it appears that once a student with visual impairment has managed to log into the system, most of them 64% (23% plus 41%) find it easy to move from one part of the task to the other compared

to 31% (13% plus 18%) who said they find it difficult to navigate through the digital library. Focus group discussions with students with visual impairment revealed that ease of navigation in the digital library is facilitated by audio sound. Whenever the digital library system is not compatible with screen reading software 'no audio sound', students with visual impairment find it difficult to access content.

Interviews with students with visual impairment revealed that those who used digital library more than three times a week also reported that they found it easy to navigate from one part of the task to another. This was further confirmed by special needs librarians, who reported that students who appeared in the library more frequently required little physical support to accomplish their tasks compared to those who rarely used the digital Library. These findings concur with the recommendation made by Xie, et al. (2019) that for effective exploration, retrieval and management of the digital libraries, frequent use of the system is important.

4.3.2 Aptitude in the use of Functions

The friendliness of an information retrieval system such as a digital library is dependent on the user's level of mastery of important functions that perform various tasks. In this study, students with visual impairment were asked about their level of confidence in the use of key functions and ability to explore new functions within the digital library that would help them perform tasks better. The summary of findings is presented in

Table **4.2**.

Table 4.2: Aptitude in the use of Functions in DLs

	Variable	Nature of VI		Percent	Total (n)
		Blind	Low vision		
I sometimes wonder if I am using, the right function	Strongly agree	37%	63%	16.2%	19
	Agree	9%	91%	28.2%	33
	Undecided	26%	74%	19.7%	23
	Disagree	23%	77%	18.8%	22
	Strongly disagree	15%	85%	17.1%	20
I prefer to stick to the functions that I know best	Strongly agree	24%	76%	21.4%	25
	Agree	25%	75%	45.3%	53
	Undecided	14%	86%	17.9%	21
	Disagree	18%	82%	9.4%	11
	Strongly disagree	0%	100%	6.0%	7

Source: Research Data (2020)

The findings from

Table **4.2** indicate that on the statement 'I sometimes wonder if I am using, the right function' 16.2% agreed strongly, 28.2% agreed, 19.7% were undecided, 18.8% disagreed while 17.1% disagreed strongly. Interview with special needs librarians revealed that digital library (DL) resources are often underutilized by students with visual impairments due to lack of assistive ICT literacy skills. According to librarians, some students with visual impairments, especially those with low vision have difficulties reading on screens and locating buttons on computer keyboards. Indeed, it was found that students with low vision experienced severe difficulties trying out new functions, rather preferred using what they were already comfortable with.

4.3.3 Design, Presentation and Layout

In this study, students with visual impairment were asked to state how design, presentation, and layout of digital library pages impacted on their overall interaction with the information within the digital library. While the digital libraries may be hosted by the same system, DSPACE, customization of user interfaces may be done to improve its aesthetic view, interior design, and content layout. These adjustments may improve or worsen user friendliness of the digital library to persons with visual impairment.

In this study, students with visual impairment were presented with question items focusing on design, presentation of information and layout of digital libraries in a five-point Likert scale. Their responses were as presented in Table 4.3

Table 4.3: Design, Presentation and Layout of DLs

	Variable	**Nature of VI**		**Overall Percent**	**Sub-total (n)**
		Blind	Low vision		
The way information is presented is clear and understandable	Strongly agree	19%	81%	18.8%	22
	Agree	17%	83%	36.8%	43
	Undecided	29%	71%	15.4%	18
	Disagree	15%	85%	17.9%	21
	Strongly disagree	24%	76%	11.1%	13
I do understand the information as presented in the digital library pages	Strongly agree	16%	84%	17.9%	21
	Agree	19%	81%	37.6%	44
	Undecided	35%	65%	13.7%	16
	Disagree	8%	92%	19.7%	23
	Strongly disagree	30%	70%	11.1%	13
The organization of the menus seem quite logical to me	Strongly agree	18%	82%	23.1%	27
	Agree	30%	70%	29.1%	34
	Undecided	11%	89%	23.1%	27
	Disagree	0%	100%	15.4%	18
	Strongly disagree	21%	79%	9.4%	11

Source: Research Data (2020)

From Table 4.3, between 18.8% and 36.8% of students with visual impairment reported that information presented in DLs is clear, understandable and organization of the menus is logical. This may support the claim made by Calvo, Seyedarabi, and Savva (2016) in their study on beyond web content accessibility guidelines that when websites and web tools are properly designed and coded, people with disabilities can use them.

During Focus Group Discussions (FGDs) with students with visual impairment, some of students with low vision complained of poor colour contrast as one of the key accessibility barriers that influenced user friendliness of DLs. Further, interviews with special needs librarians showed that while design and layout are key in improving accessibility, universities may have focused on some dimensions and left others, probably without knowing.

4.3.4 Perceived Effect of use

The user friendliness of an online system is a function of the overall effect it creates on the user. In this study, students with visual impairment reported the impact of using digital library on the way they would ordinarily arrange their work, perform tasks, access files and the feeling of being in command of the system. Summary of results is presented in **Table 4.4.**

Table 4.4: Perceived Effect of using DLs

	Variable	Nature of VI		Overall Percent	Sub-total (n)
		Blind	Low vision		
When using the digital library, I get disrupted the way I normally like to arrange my work	Strongly agree	16%	84%	27.4%	32
	Agree	28%	72%	27.4%	32
	Undecided	38%	63%	13.7%	16
	Disagree	9%	91%	19.7%	23
	Strongly disagree	14%	86%	12.0%	14
I feel in command of the digital library when I am using it	Strongly agree	20%	80%	25.6%	30
	Agree	13%	87%	26.5%	31
	Undecided	27%	73%	22.2%	26
	Disagree	27%	73%	12.8%	15
	Strongly disagree	20%	80%	12.8%	15
I can perform tasks in a straightforward manner using the digital library	Strongly agree	15%	85%	22.2%	26
	Agree	20%	80%	34.2%	40
	Undecided	6%	94%	13.7%	16
	Disagree	24%	76%	21.4%	25
	Strongly disagree	50%	50%	8.5%	10
I find it difficult to get data files in and out of the digital library	Strongly agree	24%	76%	31.6%	37
	Agree	30%	70%	25.6%	30
	Undecided	10%	90%	17.9%	21
	Disagree	7%	93%	12.8%	15
	Strongly disagree	21%	79%	12.0%	14

Source: Research Data (2020)

The results presented in **Table 4.4** show that about half of students with visual impairments agree that when using the digital library, they get disrupted the way they normally like to arrange their work. This result implies that most students with visual impairments find it difficult using digital libraries. Paradoxically, more than half agreed that they feel in command of the digital library when they are using it. Similarly, about half also reported that they could perform tasks in a straightforward manner using the digital library. More than half of the students interviewed also reported that they find it difficult to get data files in and out of the digital library. To this end, it is demonstrated that while a significant number

of students with visual impairments reported to be proficient in using digital libraries, there remains a challenge in accessing or retrieving useful information from Digital Libraries. One of the main reasons why such students may still experience significant challenges in information retrieval despite reporting of successful use is the persistence challenges in accessibility and functionality of the digital library interfaces.

4.3.5 Overall Level of User Friendliness of Digital Libraries for persons with Visual Impairment

The overall level of user friendliness of digital libraries under this study was measured by summing up all the 11 items whose descriptive statistics are shown in Table 4.1, **Table 4.2**, Table 4.3 and **Table 4.4**. A description of how the overall level of friendliness was measured is here in presented, followed by the figure on friendliness of digital libraries as perceived by users with visual impairment.

Measuring the level of user friendliness of digital libraries

Friendliness of digital library was measured using eleven (11) questionnaire items scored on a 5-point Likert scale where **SA**=Strongly Agree, **A**=Agree, **U**=Undecided, **D**=Disagree, **SD**=Strongly Disagree. For positively constructed items, a response of 'Strongly Agree' brings an impression of a more friendly digital library and thus assigned a numerical value of 5. For negatively constructed items, a response of 'Strongly Agree' brings an impression of a less friendly digital library and thus assigned a numerical value of 1.

The sum of the 11 questionnaire items on friendliness of digital libraries was then obtained. The maximum total score was 55 (where each item was scored 5) while the minimum total score was 11 (where each item was scored 1). Based on the sum, respondents with the highest scores based on the sum were those who perceived digital libraries as friendly. On the other hand, respondents with the lowest scores based on the sum were those who perceived digital libraries as unfriendly. The difference between the maximum and minimum scores obtained by addition was 44. This range was classified into three to classes of size 14 (44/3=14.6). Based on this classification, scores of between 11-25 indicated a perception of 'Unfriendly Digital Libraries', scores of between 26 – 40 indicated a neutral perception 'Not Sure' while scores between 41 – 55 indicated a perception 'Friendly Digital Libraries'. The overall findings on friendliness of digital libraries is as presented in Figure 4.6.

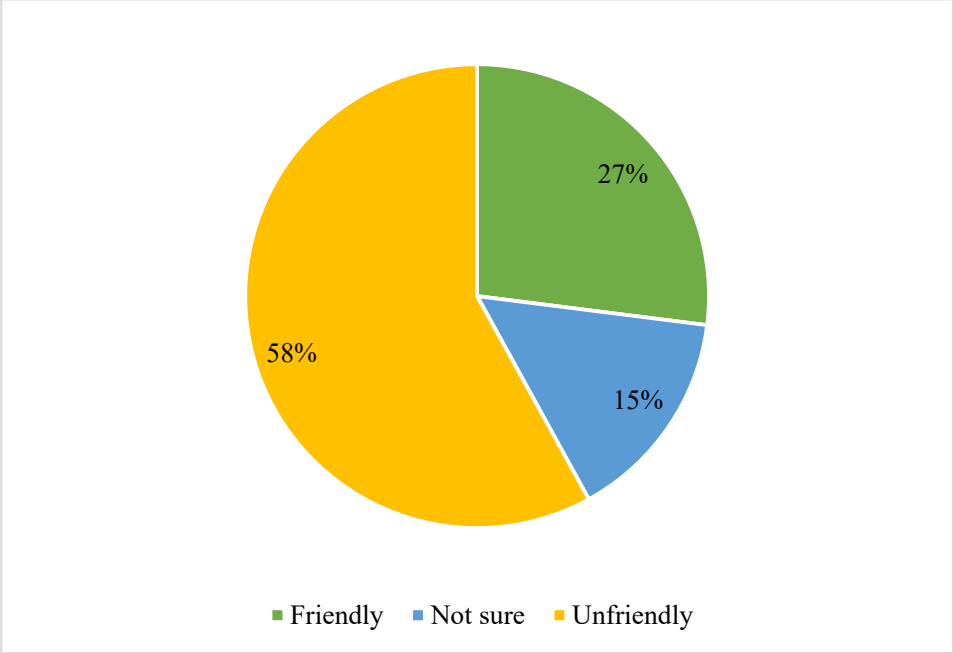

Figure 4.6: Level of User Friendliness of DLs for Learners with VI

Source: Research Data (2020)

From Figure 4.6, Majority of students with visual impairment, comprising of 58% indicated that digital library was not friendly, 27% of students perceived digital library as friendly, while 15% remained undecided. The findings in this study regarding friendliness of digital library as perceived by students with visual impairments concur with previous researchers such as Rathi, et al. (2012) and Dodamani and Dodamani (2019). Despite these studies being carried out in different geographical locations of the globe and applying different methodologies, they all suggest similar findings regarding friendliness of digital systems for persons with visual impairments. However, another study in Malaysia by Bodaghi and Zainab (2017) found a contrary result where a higher percentage of students with visual impairment reported that digital library was friendly. While this may be true in developed countries such as Malaysia, it is

also possible that the methodological design applied by Bodaghi and Zainab (2017) that compares digital library and other media such as Braille could have influenced the findings.

It was found from interviews and focus group discussions that students with visual impairment gave their responses based on the amount of support they are given by library assistants while using the digital library. The study revealed that students who were given support to access, navigate and find educational resources tend to believe that digital library is friendly as opposed to those who expressed frustration about the support given by the library staff. The study further revealed that students with low vision who reported that the digital library is very unfriendly had the lowest frequency of using the digital library while those who used the digital library more frequently reported that digital library was very friendly.

To further explore the perception of friendliness of a digital library, a cross-tabulation with selected demographic variable was conducted. The Pearson's p-value associated with the chi-square test was included on the cross-tabulation result to show the significance of the observed distribution with respect to each of the selected demographic information. Chi-square test for independence was used to determine the level of friendliness for users with different demographic characteristics; type of visual impairment, Level of study, year or level of study, age, and gender and shown in Table 4.5.

Table 4.5: Cross-Tabulation of user Friendliness and Key Demographic Characteristics

Characteristics	Response	Friendly	Not sure	Unfriendly	P-value
Type of Visual Impairment	Blind	8.3	12.5	79.2	0.06
	Low Vision	31.1	15.1	53.8	
Level of study	Undergraduate	17.5	23.3	59.2	0.001
	Postgraduate	28.6	-	71.4	
Year of Study	Year 1	8.0	52.0	40.0	0.005
	Year 2	23.2	7.0	69.8	
	Year 3	42.4	3.8	53.8	
	Year 4	37.5	-	62.5	
	Masters	-	-	100.0	
	PhD	100.0	-	-	
Age of students with VI	18-25	24.5	12.8	62.8	0.118
	26-35	40.0	33.3	26.7	
	36-45	33.3	-	66.7	
	Above 45	-	-	100.0	
Gender of students	Male	28.8	10.6	60.6	0.37
	Female	23.5	19.6	56.9	

Source: Research Data (2020)

From Table 4.5, user friendliness is independent of type of visual impairment ($p=0.06>0.05$), age ($p=0.11>0.05$) and gender ($p=0.37>0.05$). This means that to experience a digital library as either friendly or unfriendly does not depend on the type of visual impairment, age, and gender. The findings of our study concur with a recent study conducted by Stecz et al (2021) to determine the characteristics of the variables associated with gaming for adolescents with visual impairments. The study found that whilst there are many sociodemographic variables that are important in predicting gaming prevalence, gender was not found to be a strong predictor of gaming behaviour among students with visual impairments. On the other hand, experience of a digital library as either friendly or unfriendly is dependent on individual's level of study

($p=0.00<0.05$) and year of study ($p=0.00<0.05$). similarly, our results concur with a recent study by Moon et al (2020) that sought to investigate factors influencing adoption of mobile applications by persons with visual impairments. The study found that accessibility and functionality are the most significant factors influencing adoption of mobile apps by persons with visual impairments compared to age and other demographic factors.

It was observed that 17.5% of students who were pursing undergraduate degrees courses reported that the digital libraries were friendly compared to 28.6% of postgraduate students comprising of master's and PhD. Similarly, only 8% of first year and 23% second year students reported that digital libraries were friendly compared to 42.3% of third year and 37.5% of fourth year students. Students in first- and second-year students in undergraduate have spent relatively less time with digital libraries at the university compared to third- and fourth-year students who have spent relatively longer time with digital libraries.

The results did not find any significant association between student's year of study and their style of reporting on friendliness of DL interface. A plausible reason for this kind of results could be that given diverse backgrounds of students, it is not necessarily true that the more time an individual spends in school the more they become they find systems friendly. Whilst it may be possible that the longer one stays in schools the more proficient, they become in using technology, the system design difficulties may persist over time.

These findings are similar to a previous study (Matusiak, 2012) on perceptions of usability and usefulness of digital libraries which concluded that Library systems are not viewed as user-friendly, which in turn discourages students from using DLs provided by academic libraries. Matusiak (2012) also observed that individual characteristics such as gender and age do not affect perception of usefulness of DLs, but availability of relevant support, prior training in the use of DLs and time taken practicing the skill affect individual perceptions of usefulness and relevance of DLs among undergraduate students.

4.4 Efficiency of digital libraries in accessing information

The second objective of this study was to assess the efficiency of digital libraries in information retrieval by persons with visual impairment. Efficiency of an online information system such as digital library is a function of system's processing speed, stability, and flexibility.

4.4.1 Digital Library's Processing Speed

One of the efficiency's measures of a digital library is increased speed in information retrieval compared to the physical library. As such when a user notices that a digital library helps them to retrieve information faster than they would in a physical library, they are likely to rate the digital library as being more efficient.

In this study, learners with visual impairments were asked about how digital library respond to input commands and the corresponding speed in achieving the desired results. The summary of findings is presented in Table 4.6.

Table 4.6: Digital Library's Processing Speed

	Variable	Nature of VI		Overall Percent	Sub-total (n)
		Blind	Low vision		
I find the digital library responding slowly to the inputs	Strongly agree	29%	71%	17.9%	21
	Agree	18%	82%	18.8%	22
	Undecided	29%	71%	14.5%	17
	Disagree	19%	81%	27.4%	32
	Strongly disagree	12%	88%	21.4%	25
The speed of achieving such results with the digital library is fast enough	Strongly agree	23%	77%	22.2%	26
	Agree	16%	84%	26.5%	31
	Undecided	0%	100%	8.5%	10
	Disagree	25%	75%	23.9%	28
	Strongly disagree	27%	73%	18.8%	22

Source: Research Data (2020)

The distribution of students who reported that the find DL responding slowly ranged between 17.9% and 27.4% most of who disagreed. It can be concluded from the results that while there was a significant number of students with visual impairment who regard DL as being slow, a slightly bigger proportion perceive DL as fast enough. When asked about the speed of achieving results with digital library, 22.2% agreed strongly that the DL speed is fast enough compared to 18.8% who disagreed strongly that the speed is fast enough.

4.4.2 Digital Library's Stability

Stability of an online system depends on user experience on the system's performance. User's perception of digital library's stability was evaluated based on consistent performance and possible system challenges which would sometimes cause system failure and unexpected closures. The summary of findings on the stability of the digital library is presented in Table 4.7.

Table 4.7: Digital Library's Stability

	Variable	Nature of VI		Overall Percent	Sub-total (n)
		Blind	Low vision		
The digital library has at sometimes closed unexpectedly	Strongly agree	26%	74%	16.2%	19
	Agree	18%	82%	23.9%	28
	Undecided	20%	80%	12.8%	15
	Disagree	14%	86%	29.9%	35
	Strongly disagree	30%	70%	17.1%	20
I think the digital library is inconsistent	Strongly agree	18%	82%	18.8%	22
	Agree	16%	84%	21.4%	25
	Undecided	27%	73%	12.8%	15
	Disagree	26%	74%	29.9%	35
	Strongly disagree	15%	85%	17.1%	20

Source: Research Data (2020)

The results show that 16.2% agree strongly and 23.9% agree that digital library has at sometimes closed unexpectedly. These numbers are fairly comparable with 17.1% who disagreed strongly and 29.9% who disagreed with the same statement. Regarding the inconsistencies of DL, 18.8% agreed strongly and 21.4% agreed that they thought digital library is inconsistent compared to 17.1% who disagreed strongly and 29.9% who disagreed with the same statement.

4.4.3 Digital Library's Flexibility

Flexibility of a digital library is a function of provisions within the interface that allows the user to manipulate or achieve similar results using varying approaches. Flexibility as a component of system efficiency is related to the complexity of steps or stages involved to achieve significant results. In this study, students with visual impairment were asked to rate the flexibility level of the digital library based on the ease of making the system do exactly what one

wishes to achieve, and minimum number of steps required to accomplish a certain task. The results are as presented in Table 4.8

Table 4.8: Digital Library's Flexibility

	Variable	Nature of VI		Overall Percent	Sub-total (n)
		Blind	Low vision		
It is easy to make the digital library do what exactly I want	Strongly agree	29%	71%	17.9%	21
	Agree	22%	78%	30.8%	36
	Undecided	14%	86%	12.0%	14
	Disagree	20%	80%	21.4%	25
	Strongly disagree	14%	86%	17.9%	21
There are too many steps required to get something to work when using the digital library	Strongly agree	26%	74%	19.7%	23
	Agree	18%	82%	33.3%	39
	Undecided	38%	63%	6.8%	8
	Disagree	7%	93%	23.9%	28
	Strongly disagree	32%	68%	16.2%	19

Source: Research Data (2020)

Majority of students with VI agreed that DL is flexible. As shown in the Table 4.8, 48.7% agreed (17.9% agreed strongly, 30.8% agreed) that it is easy to make the digital library do what exactly they want while 39.2% disagreed (17.9% disagreed strongly, 21.4% disagreed). On the statement that there are too many steps required to get something to work when using the digital library, 19.7% agreed strongly, 33.3% agreed while 16.2% disagreed strongly and 23.9% disagreed.

4.4.4 Overall Level of Efficiency of Digital Libraries by Students with Visual Impairment

The overall level of efficiency of digital libraries was assessed by aggregating the processing speed of information retrieval, system stability, variety of

information, and flexibility of the digital library. The approach to measuring the level of efficiency of digital library based is detailed in the subsection that follow, after which the overall study findings on efficiency of digital libraries are presented.

Measuring the level of efficiency of digital libraries

Efficiency of digital library was measured using eight (8) questionnaire items scored on a 5-point Likert scale where **SA**=Strongly Agree, **A**=Agree, **U**=Undecided, **D**=Disagree, **SD**=Strongly Disagree. For positively constructed items, a response of 'Strongly Agree' was interpreted to mean, the digital library was more efficient and thus assigned a numerical value of 5. For negatively constructed items, a response of 'Strongly Agree' brings an impression of a less efficient digital library and thus assigned a numerical value of 1.

The sum of the 6 questionnaire items on efficiency of digital libraries was then obtained. The maximum total score was 30 (where each item was scored 5) while the minimum total score was 6 (where each item was scored 1). Based on the sum, respondents with the highest scores based on the sum were those who perceived digital libraries as efficient. On the other hand, respondents with the lowest scores based on the sum were those who perceived digital libraries as inefficient. The difference between the maximum and minimum scores obtained by addition was 24. This range was classified into three to classes of size 10 (24/3=8). Based on this classification, scores of between 6-14 indicated a perception of 'Inefficient Digital Libraries', scores of between 15 – 23 indicated

a neutral perception 'Not Sure' while scores between 24 – 30 indicated a perception 'Efficient Digital Libraries'

Figure 4.8 shows the overall level of efficiency of digital libraries in retrieving information by persons with visual impairment.

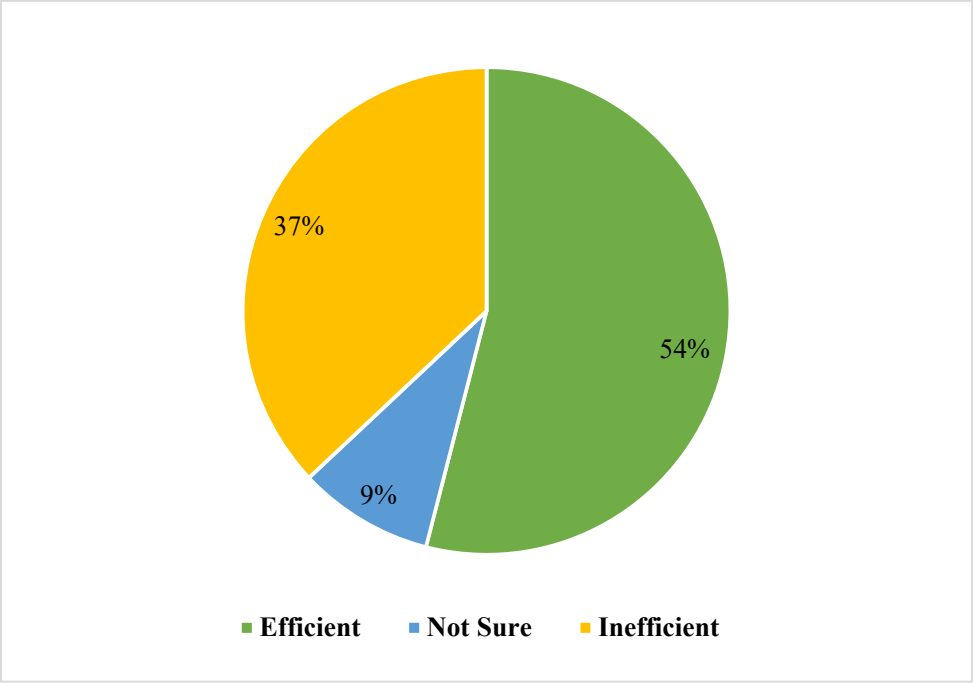

Figure 4.7: Level of Efficiency of DLs among Students with VI

Source: Research Data (2020)

From Figure 4.7, More than half of students with visual impairment, constituting of 54%, reported that digital libraries are efficient. On the other hand, 37% of students with visual impairment participating in the study reported that digital library is not efficient while 9% remained undecided regarding efficiency of digital libraries. Intuitively, there are students with visual impairment who still believe digital library is an efficient information retrieval platform despite being unfriendly. Similar conclusions were made by Pradhan and Sahu (2019) where

despite students with visual impairment reporting that digital library had delays, they still regarded the digital library as efficient.

Interviews with special needs librarians revealed that most students who said that DLs were not efficient is simply because most of them could not accomplish simple and basic tasks unless supported. Most special needs librarians said that unless a student with visual impairment has prior training in assistive technology, they cannot make use of DLs for anything meaningful. Clearly, there is a clear disconnect between self-reported efficiency by students with VI and observed efficiency by special needs librarians. These differences may have been explained by Xie, Joo, and Matusiak (2018) who concludes that there are two perceptions to a system; one based on technical, cognitive, social, and design orientation while another is based on content and organizational orientation.

To further explore the construct of efficiency of digital libraries, a cross-tabulation with selected demographic variables was conducted. The p-value based on the Pearson's Chi-square test was included in the cross tabulation to indicate the significance of the observed distribution with respect to each of the selected demographic variables. Chi-square test for independence was used to determine the efficiency of DLs by users with different demographic characteristics; type of visual impairment, Level of study, year or level of study, age, and gender as shown in **Table 4.9.**

Table 4.9: Cross-Tabulation of Efficiency of DLs and Key Demographic Characteristics

Characteristics	Response	Efficient	Not Sure	Inefficient	P-value
Type of Visual Impairment	Blind	58.3	12.5	29.2	0.583
	Low Vision	53.8	7.5	38.7	
Level of study	Undergraduate	53.4	8.8	37.8	0.015
	Postgraduate	100.0	-	-	
Year of Study	Year 1	44.0	32.0	24.0	0.009
	Year 2	44.1	4.7	51.2	
	Year 3	73.1	-	26.9	
	Year 4	50.0	-	50.0	
	Masters	100.0	-	-	
	PhD	100.0	-	-	
Age of students	18-25	44.7	9.6	45.7	0.032
	26-35	93.3	6.7	-	
	36-45	100.0	-	-	
	Above 45	100.0	-	-	
Gender of students	Male	57.6	7.6	34.8	0.761
	Female	51.0	9.8	39.2	

Source: Research Data (2020)

From **Table 4.9**, efficiency of DLs does not depend on individual's type of visual impairment ($p=0.58>0.05$) and gender ($p=0.76>0.05$). This was deduced from 58.3% of students who are blind and 53.8% of students who have low vision reporting that DLs are efficient for their academic work. Additionally, 57.6% of male students and 51% of female students reported that DLs are efficient. These variations are not statistically different and thus, DLs efficiency is not affected by the type of visual impairment and/or gender of an individual.

On the other hand, individual view of efficiency of DLs was found to be closely associated with one's level of study ($p=0.01<0.05$), year of study ($p=0.00<0.05$) and age ($p=0.03<0.05$). It was observed that all students in postgraduate (Masters and PhD) reported that DLs are efficient compared to 53.4% of students in undergraduate. Further still, the number of students who reported that DLs are

efficient increased from 44% in first year, 44.2% in second year, 73% in third year. Similar trend was observed for the age of students with fewer students who younger students were reporting that DLs are efficient compared to older students. This may be the case since there is high correlation between age and year of study; younger students are in their early years (mostly first and second years) and third years to postgraduate students are older.

4.5 User Satisfaction of Digital Libraries in Accessing Information

The third objective of this study was to establish the level of user satisfaction of digital libraries in information retrieval by persons with visual impairment. User satisfaction varies significantly from one person to another depending on one's expectations. In this study, user experiences and fruitful information search was used as key indicators of user satisfaction in using the digital library. The findings are as presented in sub-sections 4.5.1 and 4.5.2.

4.5.1 User Experience

Through expression of user's level of contentment, fulfilment, approval, and gratification of a digital library, the user experience and subsequently the satisfaction is established. In this study, students with visual impairment were asked to describe both their pleasant and unpleasant experience with the digital libraries. Table 4.10 presents a summary of findings of user experience (fulfilment and contentment in using the digital library respectively) while Table 4.10 presents a summary of user experiences (unfulfilling experiences).

Table 4.10: User Experience with DLs

	Variable	Nature of VI		Overall Percent	Sub-total (n)
		Blind	Low vision		
Using the digital library is mentally stimulating	Strongly agree	19%	81%	27.4%	32
	Agree	29%	71%	29.1%	34
	Undecided	25%	75%	6.8%	8
	Disagree	11%	89%	15.4%	18
	Strongly disagree	16%	84%	21.4%	25
The digital library has always done what I was expecting	Strongly agree	21%	79%	29.1%	34
	Agree	25%	75%	30.8%	36
	Undecided	29%	71%	6.0%	7
	Disagree	17%	83%	20.5%	24
	Strongly disagree	13%	88%	13.7%	16
The digital library presents itself in a very attractive way	Strongly agree	21%	79%	36.8%	43
	Agree	17%	83%	19.7%	23
	Undecided	17%	83%	10.3%	12
	Disagree	21%	79%	16.2%	19
	Strongly disagree	25%	75%	17.1%	20

Source: Research Data (2020)

Concerning the statement that using the digital library is mentally stimulating, 27.4% agreed strongly, 29.1% agreed, 21.4% disagreed strongly while 15.4% disagreed. Regarding the statement that the digital library has always done what I was expecting, 29.1% agreed strongly, 30.8% agreed, 13.7% disagreed strongly while 20.5% disagreed. On the statement that the digital library presents itself in a very attractive way, 36.8% agreed strongly, 19.7% agreed, 17.1% disagreed strongly while 16.2% disagreed.

Table 4.11: Unfulfilling Experiences with DLs by Students with VI

	Variable	Nature of VI		Overall Percent	Sub-total (n)
		Blind	Low vision		
I would not like to use the digital library every day	Strongly agree	11%	89%	15.4%	18
	Agree	13%	87%	19.7%	23
	Undecided	25%	75%	6.8%	8
	Disagree	20%	80%	29.9%	35
	Strongly disagree	30%	70%	28.2%	33
Using the digital library is frustrating for me	Strongly agree	17%	83%	20.5%	24
	Agree	26%	74%	16.2%	19
	Undecided	0%	100%	10.3%	12
	Disagree	22%	78%	27.4%	32
	Strongly disagree	27%	73%	25.6%	30
There have been times in using the digital library when I have felt quite tense	Strongly agree	20%	80%	21.4%	25
	Agree	5%	95%	16.2%	19
	Undecided	50%	50%	5.1%	6
	Disagree	21%	79%	29.1%	34
	Strongly disagree	24%	76%	28.2%	33
I think the digital library has sometimes given me a headache	Strongly agree	13%	88%	13.7%	16
	Agree	13%	87%	19.7%	23
	Undecided	14%	86%	6.0%	7
	Disagree	26%	74%	32.5%	38
	Strongly disagree	24%	76%	28.2%	33

Source: Research Data (2020)

From the summary presented in table 4.11, the study identified that the percentage of students with visual impairment who have had negative experience while using digital libraries is slightly less than those who had a fair experience with digital libraries. For instance, between 15.4% and 19.7% reported that they would not like to use digital library, due to frustrating experiences, feeling of tension when using digital library while some said using digital libraries gave them headache. It was noted that majority of the students who frequently

experienced frustrations were students with low vision. As shown in Table 4.11, between 16.2% and 20.5% of students reported that using digital library is frustrating. This was evidenced through a feeling of tension during its usage.

4.5.2 Fruitful Information Search in Digital Libraries

User satisfaction of a digital library is in most instances judged based on the user's fruitful search of information. In this study, students with visual impairment were asked to cite their experience when using digital library for information search and their corresponding level of satisfaction with the search process. The summary of findings is presented in Table 4.12.

Table 4.12: Fruitful Information Search in DLs

Variable		Nature of VI		Overall Percent	Sub-total (n)
		Blind	Low vision		
I enjoy the time I spend using the digital library	Strongly agree	26%	74%	16.2%	19
	Agree	18%	82%	23.9%	28
	Undecided	20%	80%	12.8%	15
	Disagree	14%	86%	29.9%	35
	Strongly disagree	30%	70%	17.1%	20
Doing information searches within digital library is satisfying	Strongly agree	26%	74%	16.2%	19
	Agree	13%	87%	33.3%	39
	Undecided	13%	88%	13.7%	16
	Disagree	28%	72%	24.8%	29
	Strongly disagree	29%	71%	12.0%	14

Source: Research Data (2020)

Between 16.2% and 23.9% of students with visual impairments said they enjoy the time spend using digital library while between 16.2% and 33.3% said information searching within digital library is satisfying.

Similar findings were established from focus group discussions (FGDs) with students with visual impairment. For instance, when asked about their overall experience when working with digital libraries, one male student with blindness in third year had this to say;

> *ST 3 [Male]: "I can use screen reader to search to information without looking for a guide or assistance"*

Other students reported;

> *ST 5 [Female]: "It saves time because it is possible to search for a particular topic within a big book or encyclopaedia"*
>
> *ST 15 [Male]: "It's not time consuming like physical library. Eg looking for the physical resource for me is time consuming"*

4.5.3 Overall Level of User Satisfaction with Digital Libraries

The overall level of user satisfaction in using digital libraries was based on user experiences, fruitful information search and quality of services offered. Descriptive statistics of questionnaire items are as shown in Table 4.10, Table 4.11 and Table 4.12.

This section presents a description of how the overall level of satisfaction was measured, followed by a presentation of overall perception of users with visual impairment on the level of satisfaction in using digital libraries.

Measuring the level of user satisfaction with digital libraries

Satisfaction of digital library was measured using eight (8) questionnaire items scored on a 5-point Likert scale where **SA**=Strongly Agree, **A**=Agree, **U**=Undecided, **D**=Disagree, **SD**=Strongly Disagree. For positively constructed items, a response of 'Strongly Agree' was interpreted to mean, the user is more satisfied with the digital library and thus assigned a numerical value of 5. For negatively constructed items, a response of 'Strongly Agree' brings an impression that the user is less satisfied with the digital library and thus assigned a numerical value of 1.

The sum of the 8 questionnaire items on satisfaction with digital libraries was then obtained. The maximum total score was 40 (where each item was scored 5) while the minimum total score was 8 (where each item was scored 1). Based on the sum, respondents with the highest scores based on the sum were those who were more satisfied with digital libraries. On the other hand, respondents with the lowest scores based on the sum were those who were dissatisfied with digital libraries. The difference between the maximum and minimum scores obtained by addition was 32. This range was classified into three to classes of size 10 (32/3=10). Based on this classification, score of between 8-18 indicated a perception of 'Dissatisfied with Digital Libraries', scores of between 19 – 29 indicated a neutral perception 'Not Sure' while scores between 30 – 40 indicated a perception 'Satisfied with Digital Libraries'.

Figure 4.8 shows the overall level of user satisfaction in using digital libraries by persons with visual impairment.

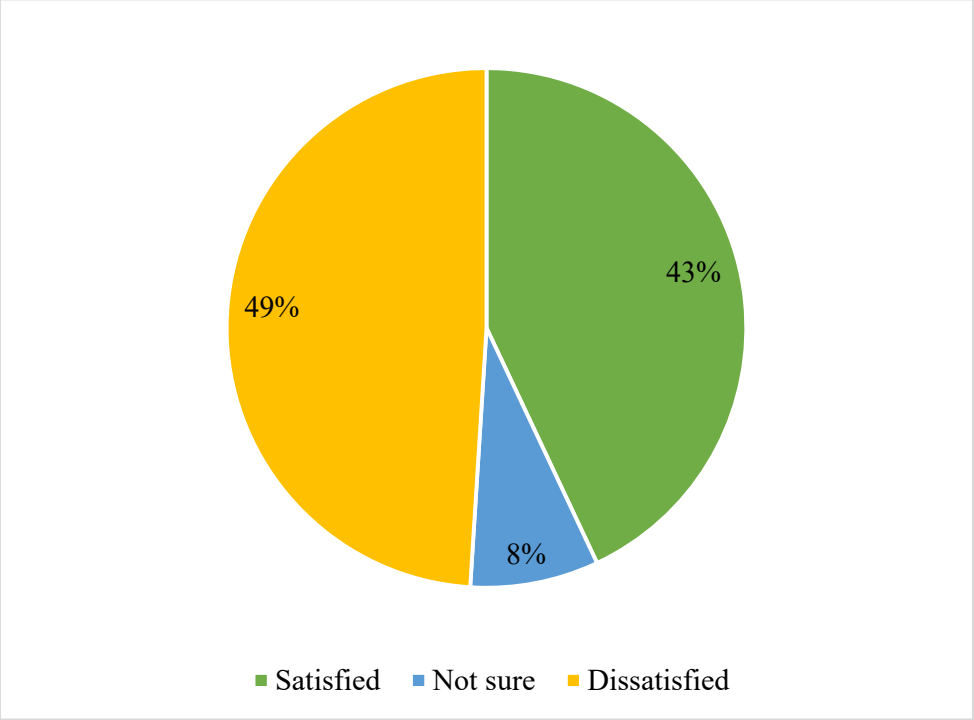

Figure 4.8: Level of User Satisfaction with DLs

Source: Research Data (2020)

Results from Figure 4.8 show that 43% of students with visual impairment were satisfied with the use of digital libraries, 49% were not satisfied while 8% remained undecided. This shows that there was a higher percentage of students with visual impairment who were not satisfied with using digital libraries. This evidence supports findings from earlier researchers such as Rogers (2009) and Grove (2020) who observed that user satisfaction is concerned with the attitudes and perception on digital library usage. Perhaps, descriptive evidence presented in Table 4.10, Table 4.11, and Table 4.12 in this section point to plausible reasons why there is a higher percentage of students with visual impairment who were dissatisfied with digital libraries.

To further explore the concept of user satisfaction, a cross tabulation with selected demographic variables was conducted and Chi-square test option included. Chi-square test for independence was used to determine the level of user satisfaction by users with different demographic characteristics; type of visual impairment, Level of study, year or level of study, age, and gender as shown in **Table 4.13**. The p-value based on Pearson's chi-square was included to show the significance between level user satisfaction and each of the selected demographic variable.

Table 4.13 shows that 42.7% of students with visual impairment reported that they are satisfied with DLs, 48.8% said they were dissatisfied with DLs while 8.5% were unsure. The table below gives a detailed cross-tabulation of levels of satisfaction with DLs and type of visual impairment, level of study, and years of study, age, and gender of respondents (students with visual impairment).

Table 4.13: Cross-Tabulation of user Satisfaction and Key Demographic Characteristics

Characteristic	Response	Satisfied	Not Sure	Dissatisfied	P-value
Type of Visual Impairment	Blind	20.8	12.5	66.7	0.042
	Low Vision	48.4	7.5	44.1	
Level of study	Undergraduate	26.7	12.1	61.2	0.033
	Postgraduate	85.7	-	14.3	
Year of Study	Year 1	24.0	16.0	60.0	0.011
	Year 2	34.9	7.0	58.1	
	Year 3	76.9	-	23.1	
	Year 4	18.8	18.8	62.5	
	Masters	80.0	-	20.0	
	PhD	100.0	-	-	
Age of the student with VI	18-25	39.4	7.5	53.2	0.08
	26-35	53.3	20.0	26.7	
	36-45	83.3	-	16.7	
	Above 45	-	-	100.0	
Gender of students	Male	40.9	6.1	53.0	0.414
	Female	45.1	11.8	43.1	

Source: Research Data (2020)

Table 4.13 shows user satisfaction of DLs does not depend on neither age ($p=0.08>0.05$) nor gender ($p=0.41>0.05$). This means that reporting on level of satisfaction with DLs did not vary significantly across different age sets and/or gender of the student. On the other hand, type of visual impairment, level of study, and years or level of study influences the level of user satisfaction.

Type of visual impairment ($p=0.04<0.05$) influences level of user satisfaction. This is evidenced by 66% students who are blind and 44% of students who have low vision were dissatisfied with DLs compared to 20% of students who are blind and 48% of students with low vision who reported that they satisfied. Further level of study ($p=0.03<0.05$) also influences the level of user satisfaction with digital library. This is evidenced more postgraduate students (85.7%) who were satisfied with DL compared to only 26.7% of undergraduate students.

Similar trend is observed in years of study ($p=0.01<0.5$) in which the level of satisfaction increases with years of study, which was a proxy for the exposure period in using digital libraries (DLs). From **Table 4.13**, those who reported that they were satisfied with DLs increased steadily from 24% in first years to over 80% at master's level and above.

4.6 Learnability of digital libraries in accessing information

The fourth objective of this study was to evaluate the extent to which digital libraries are easy to learn in information retrieval by persons with visual impairment. Optimal utilization of information technology is dependent on the ease to learn and accept to use the new technology. Other key indicators of learnability of digital libraries used in this study were level of difficulty in using DL, complexity of DL functions, user support mechanisms within the DL and general comprehension of digital library. Students with visual impairments commented on the learnability of the digital library regarding these indicators and the results are presented in sub-sections 4.6.1 to 4.6.4.

4.6.1 The Learning Curve

This is a concept describing the difficulty or ease with which a user gets to understand and use a system based on their consistent experience. In this study, students with visual impairment reported their experience of learning to use the digital library at initial stages up to a level where they can perform basic tasks in the DL. The summary of findings is presented in Table 4.14.

Table 4.14: The Learning Curve in DLs for Students with VI

	Variable	Nature of VI		Overall Percent	Sub-total (n)
		Blind	Low vision		
Learning to operate the digital library initially is full of problems	Strongly agree	7%	93%	23.1%	27
	Agree	26%	74%	33.3%	39
	Undecided	50%	50%	6.8%	8
	Disagree	21%	79%	23.9%	28
	Strongly disagree	13%	87%	12.8%	15
It takes long to learn the digital library functions	Strongly agree	17%	83%	19.7%	23
	Agree	18%	83%	34.2%	40
	Undecided	18%	82%	9.4%	11
	Disagree	28%	72%	24.8%	29
	Strongly disagree	21%	79%	12.0%	14
Learning how to use new functions in the digital library is difficult	Strongly agree	20%	80%	21.4%	25
	Agree	31%	69%	33.3%	39
	Undecided	17%	83%	10.3%	12
	Disagree	12%	88%	21.4%	25
	Strongly disagree	13%	88%	13.7%	16

Source: Research Data (2020)

Concerning the statement that Learning to operate the digital library initially is full of problems, 23.1% agreed strongly, 33.3% agreed, 12.8% disagreed strongly while 23.9% disagreed. On the statement that it takes long to learn the digital library functions, the results show 19.7% agreed strongly, 34.2% agreed, 12% disagreed strongly, while 24.8% disagreed. Regarding the statement that learning how to use new functions in the digital library is difficult, 21.4% strongly agreed, 33.3% agreed, 13.7% disagreed strongly, 21.4% disagreed.

4.6.2 Complexity of Digital Library Functions

The overall interface of the digital library coupled with the required functions for basic operations determines the complexity or simplicity of the digital

library, which consequently affect the learnability of the platform. The summary of findings is shown in Table 4.15.

Table 4.15: Complexity of Digital Library Functions

Statement	Variable	Nature of VI		Overall Percent	Sub-total (n)
		Blind	Low vision		
If I log out of the library, it is not easy to log in again	Strongly agree	22%	78%	23.1%	27
	Agree	28%	72%	21.4%	25
	Undecided	21%	79%	12.0%	14
	Disagree	16%	84%	31.6%	37
	Strongly disagree	14%	86%	12.0%	14
It is easy to forget how to perform tasks in the digital library	Strongly agree	14%	86%	18.8%	22
	Agree	15%	85%	34.2%	40
	Undecided	17%	83%	5.1%	6
	Disagree	29%	71%	29.1%	34
	Strongly disagree	27%	73%	12.8%	15
The digital library occasionally behaves in a way which cannot be understood	Strongly agree	21%	79%	28.2%	33
	Agree	18%	82%	29.1%	34
	Undecided	11%	89%	7.7%	9
	Disagree	24%	76%	24.8%	29
	Strongly disagree	25%	75%	10.3%	12

Source: Research Data (2020)

The results show that on the statement 'If I log out of the library, it is not easy to log in again', 23.1% agreed strongly, 21.4% agreed, 12% were undecided, 31.6% disagreed while 12% disagreed strongly. On the statement 'It is easy to forget how to perform tasks in the digital library', 18.8% agreed strongly, 34.2% agreed, 5.1% were undecided, 29.1% disagreed while 12.8% disagreed strongly. These findings suggest that a significant majority of students with VI agree that its easy to forget how to perform tasks in DL. Lastly, on the statement 'the digital library occasionally behaves in a way which cannot be understood', 28.2%

agreed strongly, 29.1% agreed, 7.7% were undecided, 24.8% disagreed while 10.3% disagreed strongly. Based on these findings, it can be deduced yet one again that a significant majority of students with VI agree that occasionally, the DL behaves in a way they cannot understand.

4.6.3 User Support Mechanisms

Support mechanisms such as help buttons, documentations, and instructions and prompts have an effect of learnability variance especially for persons with visual impairment. Table 4.16 shows how students with visual impaired rated instructions and prompts in the digital libraries, informative nature of library documentation, and the possibility of using digital libraries to overcome learning barriers associated with it.

Table 4.16: User Support Mechanisms in DLs

Statement	Variable	Nature of VI		Overall Percent	Sub-total (n)
		Blind	Low vision		
The instructions and prompt in the digital library are helpful	Strongly agree	0%	100%	7.7%	9
	Agree	40%	60%	12.8%	15
	Undecided	29%	71%	6.0%	7
	Disagree	12%	88%	42.7%	50
	Strongly disagree	28%	72%	30.8%	36
The digital library documentation is very informative	Strongly agree	36%	64%	9.4%	11
	Agree	20%	80%	21.4%	25
	Undecided	10%	90%	17.1%	20
	Disagree	25%	75%	34.2%	40
	Strongly disagree	14%	86%	17.9%	21
The digital library has helped me overcome any problem I have had in using it	Strongly agree	15%	85%	17.1%	20
	Agree	13%	88%	13.7%	16
	Undecided	27%	73%	9.4%	11
	Disagree	27%	73%	37.6%	44
	Strongly disagree	15%	85%	22.2%	26

Source: Research Data (2020)

The results show that on the statement 'The instructions and prompt in the digital library are helpful' 7.7% agreed strongly, 12.8% agreed, 6% were undecided, 42.7% disagreed while 30.8% disagreed strongly. This suggest that majority of students with VI do not find the instructions and prompts in the DL helpful. On the statement 'The digital library documentation is very informative', 9.4% agreed strongly, 21.4% agreed, 17.1% were undecided, 34.2% disagreed while 17.9% disagreed strongly. In the same way, these findings suggest a significant majority of students with VI do not find DL documents very informative. Lastly, on the statement 'The digital library has helped me overcome any problem I have had in using it', it was found that 17.1% agreed strongly, 13.7% agreed, 9.4% were undecided, 37.6% disagreed while 22.2% disagreed strongly. Yet again, it can be observed that a significant majority of students with VI do not think that DL system by itself has features that may be of help to them to overcome the challenges they face during information retrieval.

4.6.4 Mastery and General Comprehension of Digital Libraries

Mastery and general comprehension of digital libraries was assessed based on general navigation in the digital library by a student with visual impairment, frequency of making reference to the guideline while using digital libraries and overarching attitude of the ease to master the working of digital libraries. **Table 4.17** shows a summary of findings:

Table 4.17: Mastery and General Comprehension of Digital Libraries

Statement	Variable	Nature of VI		Overall Percent	Sub-total (n)
		Blind	Low vision		
I sometimes don't know what to do next in the digital library	Strongly agree	9%	91%	18.8%	22
	Agree	21%	79%	36.8%	43
	Undecided	27%	73%	12.8%	15
	Disagree	27%	73%	22.2%	26
	Strongly disagree	18%	82%	9.4%	11
I keep having to go back to look at the guides when using the digital library	Strongly agree	30%	70%	19.7%	23
	Agree	15%	85%	33.3%	39
	Undecided	9%	91%	9.4%	11
	Disagree	23%	77%	25.6%	30
	Strongly disagree	21%	79%	12.0%	14
I will never learn to use what is offered in the digital library	Strongly agree	8%	92%	21.4%	25
	Agree	25%	75%	27.4%	32
	Undecided	43%	57%	12.0%	14
	Disagree	17%	83%	25.6%	30
	Strongly disagree	19%	81%	13.7%	16

Source: Research Data (2020)

The results show that on the statement 'I sometimes don't know what to do next in the digital library' 18.8% agreed strongly, 36.8% agreed, 12.8% were undecided, 22.2% disagreed while 9.4% disagreed strongly. On the statement 'I keep having to go back to look at the guides when using the digital library' 19.7% agreed strongly, 33.3% agreed, 9.4% were undecided, 25.6% disagreed while 12.0% disagreed strongly. Finally, on the statement that 'I will never learn to use what is offered in the digital library' 21.4% agreed strongly, 27.4% agreed, 12.0% were undecided, 25.6% disagreed while 13.7% disagreed strongly.

4.6.5 Overall Extent of Learnability of Digital Libraries by Students with Visual Impairment

The extent of learnability of digital library was an aggregate of the learning curve, complexity of digital library functions, user support mechanisms and mastery and general comprehension of the digital library components. The measurement of learnability based on these indicators and the overall summary on learnability are as presented here in.

a) Measuring the extent of ease of learning digital libraries

Learnability of digital library was measured using thirteen (13) questionnaire items scored on a 5-point Likert scale where **SA**=Strongly Agree, **A**=Agree, **U**=Undecided, **D**=Disagree, **SD**=Strongly Disagree. For positively constructed items, a response of 'Strongly Agree' was interpreted to mean, it is easy to learn using digital library and thus assigned a numerical value of 5. For negatively constructed items, a response of 'Strongly Agree' brings an impression of it is not easy to learn using digital library and thus assigned a numerical value of 1.

The sum of the 13 questionnaire items on learnability of digital libraries was then obtained. The maximum total score was 65 (where each item was scored 5) while the minimum total score was 13 (where each item was scored 1). Based on the sum, respondents with the highest scores based on the sum were those who perceived digital libraries as easy to learn. On the other hand, respondents with the lowest scores based on the sum were those who perceived digital libraries as not easy to learn. The difference between the maximum and minimum scores obtained by addition was 52. This range was classified into three to classes of

size 17 (52/3=17.3). Based on this classification, scored of between 13 - 30 indicated a perception of 'Not Easy to Learn Digital Library', scores of between 31 - 48 indicated a neutral perception 'Not Sure' while scores between 49 - 65 indicated a perception 'Easy to Learn Digital Library'. Figure 4.9 shows a summary of learnability of digital library.

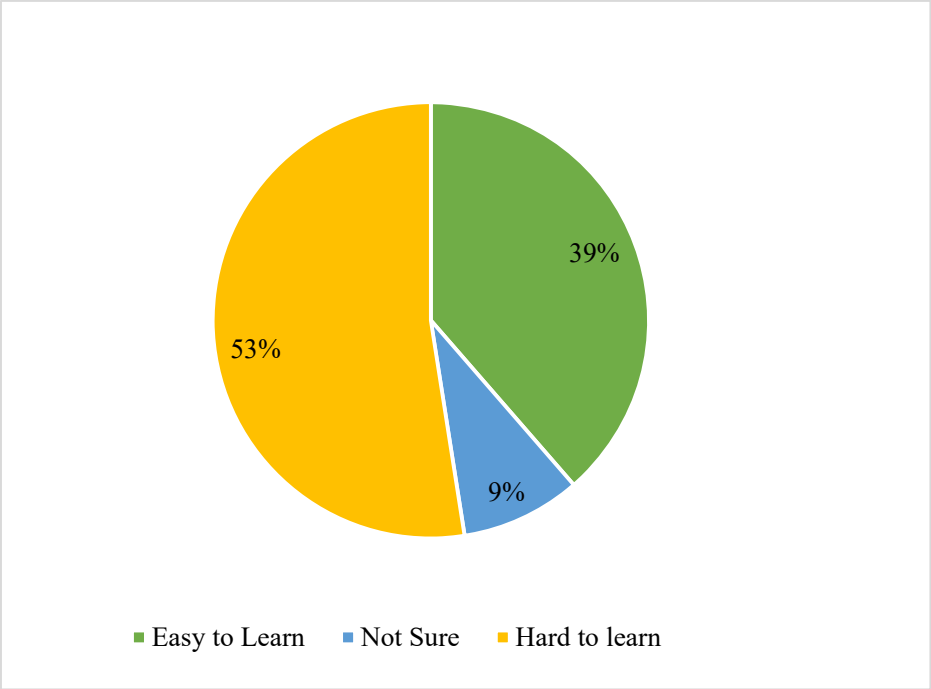

Figure 4.9: Extent of Learnability of DLs by Students with VI

Source: Research Data (2020)

It was found that fewer students with visual impairment reported that it is easy to learn how to use DLs. Results from Figure 4.9 confirms this by indicating that 39% of students with visual impairments reported the digital library as easy to learn, 53% perceived digital library as difficult to learn while 9% remained undecided regarding learnability of digital libraries.

To further explore the construct of learnability of digital libraries as reported by students with visual impairment, a cross-tabulation with selected demographic variables was conducted. A p-value based on Pearson's chi-square test was included on the cross-tabulation to indicate the significance of the observed distribution. Chi-square test for independence was used to determine the extent of DLs learnability by users with different demographic characteristics; type of visual impairment, Level of study, year or level of study, age, and gender as shown in Table 4.18.

Table 4.18: Cross-Tabulation of Learnability of DLs and Key Demographic Characteristics

Characteristic	Response	Easy to Learn	Not sure	Not Easy to Learn	P-value
Type of Visual Impairment	Blind	20.8	12.5	66.7	0.143
	Low Vision	43.0	8.6	48.4	
Level of study	Undergraduate	24.1	11.0	64.9	0.142
	Postgraduate	28.6	14.3	57.1	
Year of Study	Year 1	20.0	20.0	60.0	0.001
	Year 2	30.2	11.6	58.1	
	Year 3	76.9	-	23.1	
	Year 4	31.3	-	68.8	
	Masters	20.0	20.0	60.0	
	PhD	50.0	-	50.0	
Age of the student with VI	18-25	39.4	10.6	50.0	0.53
	26-35	46.7	-	53.3	
	36-45	16.7	16.7	66.7	
	Above 45	-	-	100.0	
Gender of students	Male	42.4	9.1	48.5	0.601
	Female	33.3	9.8	56.9	

Source: Research Data (2020)

Results from Table 4.18 show that learnability of digital libraries is independent of most demographic characteristics; type of visual impairment ($p=0.14>0.05$), level of study ($p=0.14>0.05$), age ($p=0.53>0.05$), and gender ($p=0.60>0.05$).

This implies that learnability of DLs is a challenge to most students regardless of the type of visual impairment, level of study, age, and gender. Table 4.18 shows that learnability is related to the year of study ($p=0.00<0.05$). However, a close examination of the distribution of responses indicates a potential outlier, where 76.9% of third year students reported that it is easy to learn using DLs.

Evidence from focus group discussions (FGDs) with students with visual impairment and interviews with special needs librarians revealed that indeed learning to use DLs is challenge for most students with visual impairment. Most students expressed frustrations about the complexity of functions required to master DLs. Some also complained that it takes a long time to learn how to use DL productively. This was further confirmed by sentiments made by special needs librarians who reported that student become independent in their later life in collage. One of the reasons for this kind of observation was that students with visual impairment are slow in learning and mastering basic functionalities.

4.7 Accessibility of digital libraries in accessing information

The fifth objective of this study was to examine the accessibility of digital libraries in information retrieval by persons with visual impairment. The accessibility of the digital library was assessed by looking at several aspects which enhances independence of using the system such as; ease of navigation, frequency of seeking for help, and the extent to which needs of a VI person have been taken into consideration.

4.7.1 Ease of Navigation

Students with visual impairment were asked to comment about the ease to navigate from one part of the DL to another and the results were presented in Figure 4.10.

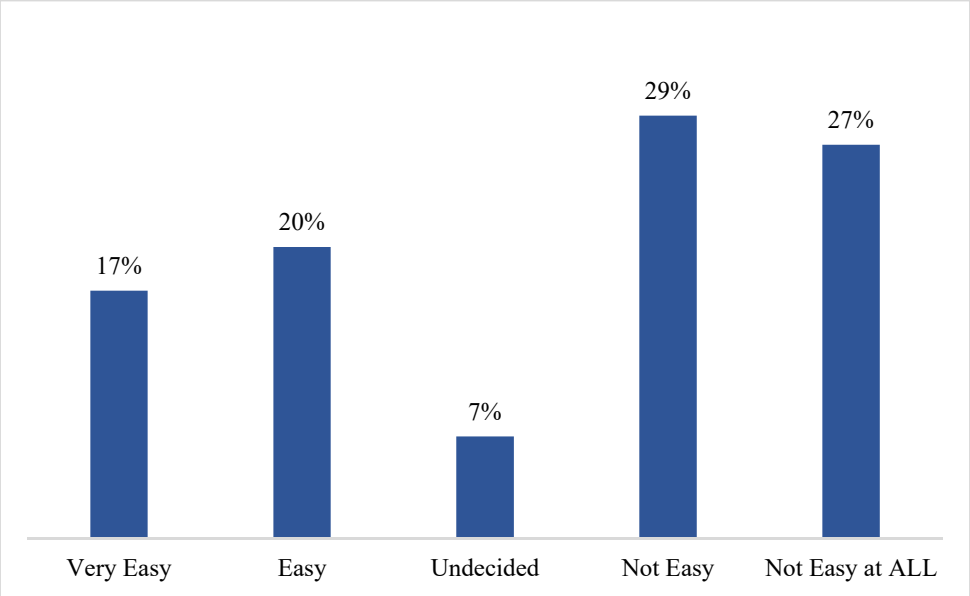

Figure 4.10: Ease of Navigation in DLs

Source: Research Data (2020)

From the findings presented in Figure 4.10, it was found out that students who said it was not easy to navigate (29% plus 27%) were more than those who said it was not easy to navigate (17 % plus 20%). From FGDs, it was clear that most students who reported that it is not easy to navigate were in most cases first and second years while third, fourth and postgraduate students reported that it was easy to navigate. This can be used to deduce that ease of navigation was positively associated with the number of years spent in using the digital library.

4.7.2 Frequency of seeking Assistance

Students with visual impairments who use digital libraries for their academic work were asked to state how often they sought for help from library staff or their guide when using DLs. The results were as presented in Figure 4.11.

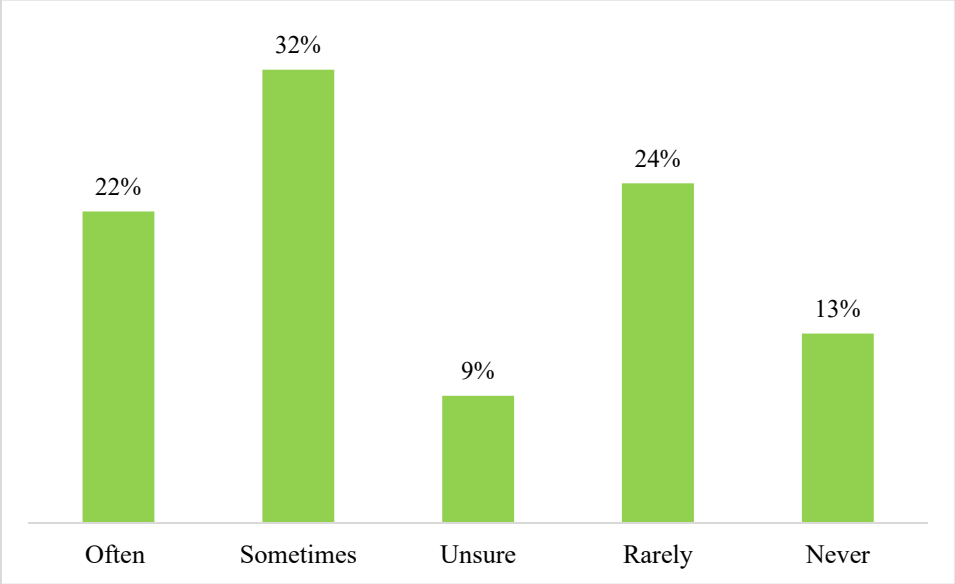

Figure 4.11: Frequency of seeking Assistance in DLs
Source: Research Data (2020)

The results presented in Figure 4.11 show that majority of students with visual impairment (22% plus 32%) seek for help more frequently compared to 13% who never seek for assistance and 24% who rarely do. The study further probed to find out why some of these students do not seek assistance. It was found that some had already given up seeking help from staff due to what they described as 'they will ignore my request' attitude from library staff. While there were a few of these students who reported that they do not seek help because they are comfortable, many of them chose to suffer in silence due to perceived lack of support from library staff. The perceived lack of technical support on use of

digital library as reported by students could be attributed to inadequate technical skills on use of assistive technology for persons with visual impairment. From the interview with special needs librarians, most of them cited that they lacked adequate skills on assistive technology to fully support students who are using the digital library. One of them had this to say:

> "I would like to really support these students but sometimes I do not know how to operate those software that read for them when they are using a computer."

4.7.3 Extent of Considering VI needs

During interviews, special needs librarians were asked to rate the extent to which they believed the university was responsive to the needs of students who have visual impairment regarding information retrieval. The findings are as presented in Figure 4.12.

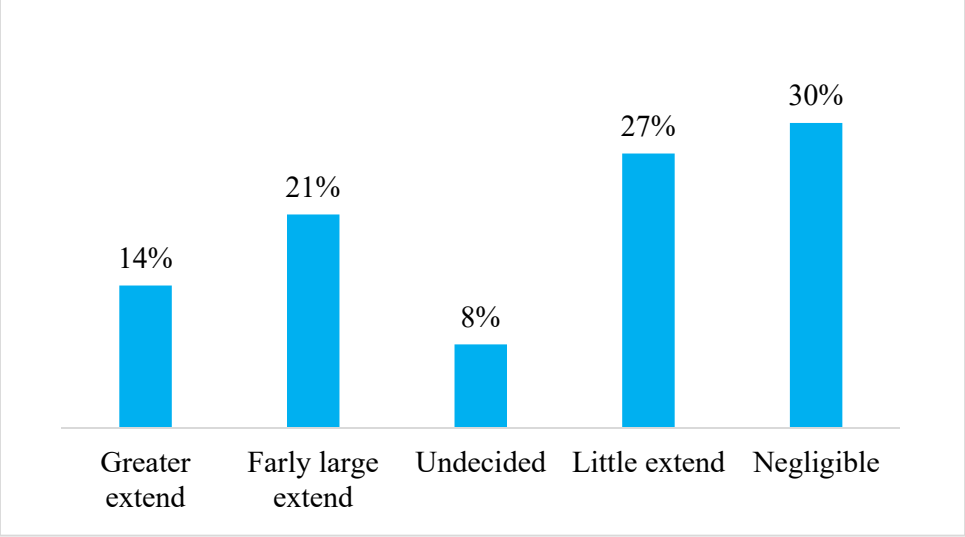

Figure 4.12: Extent of Considering VI needs

Source: Research Data (2020)

The findings from Figure 4.12 reveal that 57% of special needs librarians reported that universities are responsive to digital information needs of persons with visual impairment to a very small extent. Only 35% of librarians reported that universities were responsive to the needs of persons with visual impairment to a large extent.

4.7.4 Overall Extent of Accessibility of Digital Libraries

Overall accessibility of digital libraries was based on the three aspects previously presented in Figure 4.10, Figure 4.11 and Figure 4.12 . This section describes the measurement of the descriptive indicators of accessibility and then presents the final score on accessibility of digital libraries as perceived by students with visual impairment and special needs librarians.

b) Measuring the accessibility of digital libraries

Accessibility of digital library was measured using six (6) questionnaire items scored on a 5-point Likert scale where **SA**=Strongly Agree, **A**=Agree, **U**=Undecided, **D**=Disagree, **SD**=Strongly Disagree. For positively constructed items, a response of 'Strongly Agree' was interpreted to mean, the digital library was more friendly and thus assigned a numerical value of 5. For negatively constructed items, a response of 'Strongly Agree' brings an impression of a less friendly digital library and thus assigned a numerical value of 1.

The sum of the 6 questionnaire items on accessibility of digital libraries was then obtained. The maximum total score was 30 (where each item was scored 5) while the minimum total score was 6 (where each item was scored 1). Based on the

sum, respondents with the highest scores based on the sum were those who perceived digital libraries as accessible. On the other hand, respondents with the lowest scores based on the sum were those who perceived digital libraries as inaccessible. The difference between the maximum and minimum scores obtained by addition was 24. This range was classified into three to classes of size 8 (24/3=8). Based on this classification, scored of between 6 - 13 indicated a perception of 'Inaccessible Digital Libraries', scores of between 14 – 22 indicated a neutral perception 'Not Sure' while scores between 23 – 30 indicated a perception 'Accessible Digital Libraries'. Figure 4.11 presents an overall accessibility score of the digital libraries.

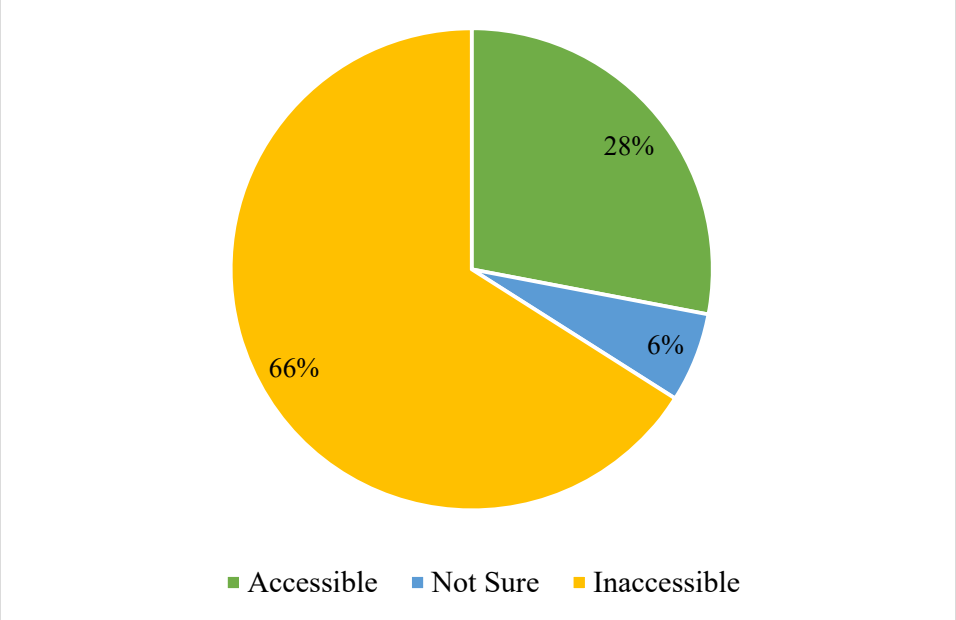

Figure 4.13: Extent of Accessibility of Digital Libraries

Source: Research Data (2020)

The study found that 28% of students with visual impairment indicated that digital library is accessible, 66% reported that digital library is inaccessible while

6% remained undecided regarding accessibility of digital library. Further, one female student, reported in an FGD.

"Accessibility can be a problem because there are commands that do not give audio sounds to the blind"

To further explore the construct of accessibility of digital libraries, a cross-tabulation with selected demographic indicators was indicated. A p-value based on Pearson's chi-square test was included on the cross-tabulation to indicate the significance of the observed distribution. Chi-square test for independence was used to determine the extent of DLs accessibility by users with different demographic characteristics; type of visual impairment, Level of study, year or level of study, age, and gender as shown in **Table 4.19**. As such, it was found that 28.2% reported that DL is accessible, 65.8% said it is not accessible while 6% were unsure.

Table 4.19: Cross-Tabulation of Accessibility of DLs and Key Demographic Characteristics

Characteristic	Response	Accessible	Not Sure	Inaccessible	P-value
Type of Visual Impairment	Blind	25.0	20.8	54.2	0.040
	Low Vision	41.9	7.6	50.5	
Level of study	Undergraduate	40.2	14.1	45.6	0.012
	Postgraduate	42.9	-	57.1	
Year of Study	Year 1	32.0	20.0	48.0	0.001
	Year 2	20.9	11.6	67.5	
	Year 3	76.9	-	23.1	
	Year 4	31.2	12.5	56.3	
	Masters	40.0	-	60.0	
	PhD	50.0	-	50.0	
Age of the student with VI	18-25	36.1	9.6	54.3	0.161
	26-35	60.0	20.0	20.0	
	36-45	33.3	-	66.7	
	Above 45	-	-	100.0	
Gender of students	Male	36.4	13.6	50.0	0.39
	Female	41.2	5.9	52.9	

Source: Research Data (2020)

From **Table 4.19**, accessibility of DLs is not significantly influenced by age ($p=0.16>0.05$) and gender ($p=0.39>0.05$). This means that the percentage of students who reported that digital libraries are accessible or inaccessible remained relatively the same across different age or gender of respondents. However, accessibility of DL was influenced by nature of visual impairment ($p=0.04<0.05$), level of study ($p=0.01<0.05$) and year of study ($p=0.00<0.05$).

Further, a cross tabulation was done to establish the relationship between prior training in assistive technology and accessibility of digital libraries. The results are as presented in **Table 4.20**.

Table 4.20: Cross-Tabulation of Prior Training in Assistive Technology and Accessibility of DLs

PRIOR TRAINING IN AT	Accessible	Not Sure	Inaccessible
Trained in Assistive Technology	80%	4%	16%
Not Trained in Assistive Technology	14%	7%	79%

Source: Research Data (2020)

The results from **Table 4.20** show that majority (80%) of students with VI who had prior training in AT perceived DLs to be accessible compared to 14% of those who did not have any training in AT but perceived DL as accessible. Conversely, 79% of students with visual impairment who did not have prior training in assistive technology reported that DLs were not accessible compared to only 16% of those who had prior training but perceived the DL as inaccessible.

This study therefore established a significant positive relationship between prior training in assistive technology (AT) and accessibility of digital libraries. Students with visual impairment who had prior training in assistive technology found DLs more accessible compared to their counterparts who had not had any prior training in assistive technology.

4.8 The Association between usability of digital libraries and information retrieval

The sixth objective of this study was to determine the association between usability attributes of digital libraries described in previous section with information retrieval. As discussed in the preceding sections of this chapter, the usability attributes include friendliness, efficiency, satisfaction, learnability, and

accessibility of digital library. This section presents the correlation analysis between the usability attributes and regression analysis examining how usability of DL influence extent of information retrieval by students with visual impairments.

4.8.1 Correlation Analysis

Correlation analysis was used to determine the strength and direction of relationship/association between different usability attributes and information retrieval and results presented in Table 4.21.

Table 4.21 Correlation between Usability and Information retrieval

	Variables	1	2	3	4	5
1	Friendliness	1.00				
2	Efficiency	0.11	1.00			
3	Satisfaction	0.00	0.10	1.00		
4	Learnability	0.07	0.27	0.20	1.00	
5	Accessibility	-0.03	0.29	-0.03	0.29	1.00
6	Information Retrieval	-0.01	0.45	0.11	0.56	0.42

Source: Research Data (2020)

As presented in Table 4.21, there is significant positive correlation between information retrieval and efficiency of DL (r=0.45), learnability of DL (r=0.56), and accessibility of DL system (r=0.42). There is a fair positive correlation between informational retrieval and satisfaction (r=0.11). There is no significant association between friendliness of a DL and information retrieval (r=-0.01). Based on these results, it can be deduced that improving efficiency, learnability and accessibility of DL for persons with visual impairment has the potential to significantly improve their experience during information retrieval.

Further, it was evident from the results in Table 4.21 that some of the usability attributes are not independent of each other for instance, there is fairly positive correlation between learnability and efficiency (r=0.27), accessibility and efficiency (r=0.29), accessibility and learnability, and satisfaction and learnability (r=0.20). As a result of the presence of correlation between some independent variables, the data was tested for normality, linearity, and multicollinearity assumptions before conducting linear regression analysis.

a) Test for Normality Assumption

The normality assumption of the linear regression model assumes that variables in the models follow a normal distribution. Normal probability plot (Q-Q plot) was used to determine the distribution of the data on information and results presented in Figure 4.14.

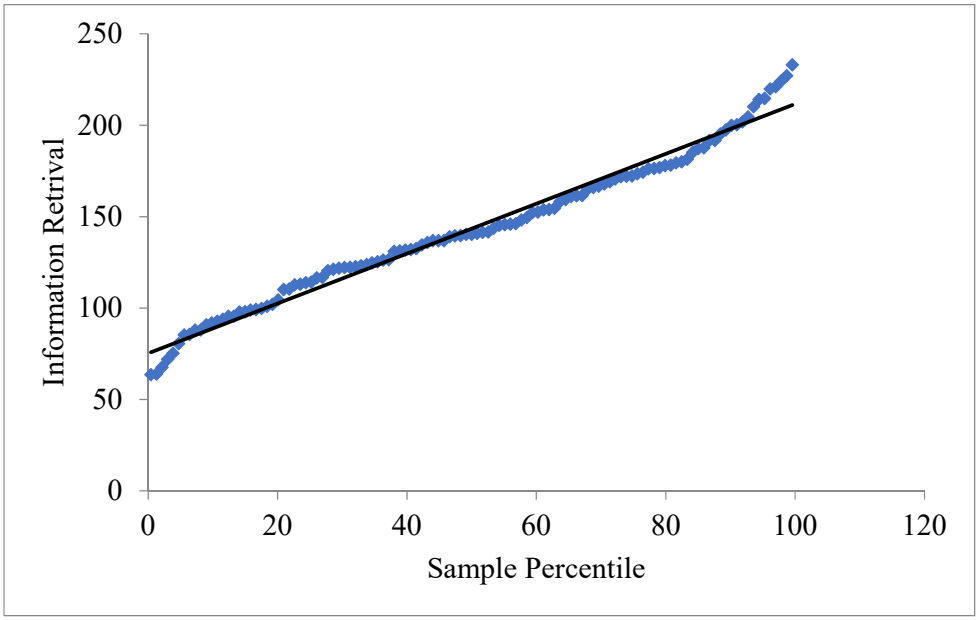

Figure 4.14: Probability Distribution of Information Retrieval (Q-Q Plot)

Source: Research Data (2020)

As presented in Figure 4.14, most of observed values lay in the range of the expected values in a normal distribution which indicate that data is approximately normal for the information retrieval.

b) Test for Linearity Assumption

The linearity assumption of the linear model assumes that the dependent variables can be expressed as a linear combination of the set of independent variables. To perform a linear regression analysis, it is desirable that the linearity assumption is not violated, otherwise the conclusions drawn from the analysis would be invalid (Steyerberg, 2019). In this study therefore, we assume that information retrieval can be expressed as a linear combination of the five usability attributes discussed in this study; friendliness, efficiency, satisfaction, learnability, and accessibility of digital library. Deviation from linearity test was used to check the linearity assumption and results presented in Table 4.22.

Table 4.22: Test for Linearity between Usability and Information Retrieval

			Sum of Squares	df	Mean Square	F	Sig.
Usability *Information retrieval	Between Groups	(Combined)	225.56	4	1.27	1.74	0.08
		Linearity	37.51	1	6.96	9.56	0.00
		Deviation from Linearity	188.05	24	1.09	2.71	0.98
	Within Groups		341.31	87	0.73		
	Total		1437.92	116			

Source: Research Data (2020)

The results suggest that there is a linear relationship between usability attributes and information retrieval of students with visual impairments F (4,116) =2.71, p=0.98>0.05.

c) Test for Multicollinearity

Multicollinearity is a statistical property whose presence give an indication of significant correlation between independent variable, which is undesirable in linear regression analysis. Thus, to perform linear regression analysis, there should be no multicollinearity in the data. To check the multicollinearity assumption in the set of usability attributes, the variance inflation factor (VIF) values was used and results presented in Table 4.23.

Table 4.23: Test for Multicollinearity for Usability attributes

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	2.40	1.03		7.54	0.00		
	Friendliness Efficiency Satisfaction Learnability Accessibility	0.89	0.78	0.87	5.50	0.00	1	4

Source: Research Data (2020)

According to Steyerberg (2019), the VIF value greater than 10 indicates a heavy presence of multicollinearity. From Table 4.23, the VIF for the independent variables was 4, which is less than 10, the researcher thus concludes that there were no statistically significant multicollinearity challenges in the data, thus linear regression analysis can be performed.

4.8.2 Linear Regression Analysis

Multiple linear regression analysis was conducted to evaluate the influence of each usability attribute on information retrieval. The results of the multiple linear

regression analysis are presented in three distinct tables as follows: Model summary, Analysis of Variance, and regression coefficient.

a) Linear Regression Model Summary

Based on the adjusted R Square (R^2=0.435) presented in Table 4.24, this study found that 43.5% of variation in information retrieval is explained by the five usability attributes.

Table 4.24: Linear Regression Model Summary

R	R Square	Adjusted R Square	Std. Error of the Estimate
.677[a]	.459	.435	30.051

a. Predictors: (Constant), Accessibility, Satisfaction, Friendliness, Efficiency, Learnability

Source: Research Data (2020)

b) The analysis of variance (ANOVA)

The analysis of variance (ANOVA) breaks down information retrieval into two components; regression (variation in information retrieval due to influenced by usability attributes) and residual (variation in information retrieval which are not explained by the five usability attributes). As shown in Table 4.25, there was a statistically significant linear relationship between usability attributes and information retrieval, $F_{(5,111)}$ =18.83, p=0.00<.05). Usability attributes as regressors explains most of the variations in information retrieval for students with visual impairments.

Table 4.25: Analysis of Variance (ANOVA)

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	85,037.24	5	17,007.45	18.83	.00
Residual	100,243.05	111	903.09		
Total	185,280.29	116			

Source: Research Data (2020)

c) Regression Coefficient

Adjusted R-squared and ANOVA give overall performance of the fitted regression model, however, they do not provide insight into which among the usability attributes is a better determinant of information retrieval for persons with visual impairments. To further understand the relationship between usability attributes and information retrieval, regression coefficients on each of the usability attributes was examined and results presented in Table 4.26.

Table 4.26: Regression Model Coefficients for Information retrieval

	Unstandardized Coefficients		Standardized Coefficients	t	p-value	95.0% Conf. for B	
	B	Std. Error	Beta				
(Constant)	47.90	11.64		4.11	0.00	24.83	70.97
Friendliness	-0.18	0.19	`-0.07	-0.97	0.33	-0.55	0.19
Efficiency	5.30	1.40	0.29	3.79	0.00	2.53	8.07
Satisfaction	0.01	0.25	0.00	0.03	0.98	-0.48	0.50
Learnability	5.00	0.88	0.43	5.67	0.00	3.25	6.74
Accessibility	1.45	0.53	0.21	2.71	0.01	0.39	2.51

a Dependent Variable: **Information Retrieval**
Source: Research Data (2020)

The results presented in Table 4.26 shows that efficiency ($p=0.00<0.05$), learnability ($p=0.00<0.05$) and accessibility ($p=0.01$) of digital library significantly influence students' level of information retrieval compared to system friendliness or satisfaction. These results can be used to deduce that efficiency, learnability, and accessibility are linearly related information retrieval. On the other hand, friendliness of DL and user satisfaction have a non-linear relationship with information retrieval.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents a summary of findings of each objective of the study, conclusion and recommendations are made based on the empirical results and literature review of the study.

5.2 Summary of findings

The purpose of this study was to evaluate usability of digital libraries (DLs) by persons with visual impairment during information retrieval to provide empirical evidence towards an inclusive design of digital libraries in Kenyan universities and across the globe. The concept of usability of digital libraries was based on five attributes: friendliness, efficiency, satisfaction, learnability, and accessibility.

The first objective of the study was to determine the level of user friendliness of digital libraries in information retrieval by persons with visual impairment. Friendliness of digital libraries was assessed based on four indicators: ease of navigation; aptitude in the use of functions; design, presentation, and layout of the digital library; and perceived effect of the use of the digital library. The study findings revealed that majority of students with visual impairment perceived the digital library as unfriendly compared to those who viewed it as friendly. Further, the study indicated that the nature of visual impairment, age and gender of DL user are not related to the level of user friendliness of digital libraries. As

such rating of DLs level of friendliness did not vary significantly with respect to student's type of visual impairment, age, and gender. The time of exposure to the use of digital library was found to be significantly associated with user friendliness of a DL. This was observed in different areas. In addition, the frequency of use of digital library affected user friendliness; students who used digital libraries more than three times a week reported that DLs were friendly while those who rarely used DLs reported that they were unfriendly.

The second objective of this study was to assess the efficiency of digital libraries in information retrieval by persons with visual impairment. Assessment of DLs efficiency was based on three main aspects of the system: processing speed, stability, and flexibility. The study findings revealed that more than half of students with visual impairment perceived the digital library as being efficient. Based on this, one may conclude that most students with visual impairment find DLs to be efficient. However, interview with different special needs librarians led to a contrasting conclusion since most of them believed that students with visual impairment are not efficient in the use of DLs especially when they have no physical assistance from library staff or their sighted guides. This study established that while these two conclusions may be true depending on the context, there were two perspectives of assessing system efficiency. Student perspective of DLs efficiency was based on content and organizational efficiency.

Further, it was found that reporting on efficiency of DLs was independent of student's type of visual impairment and gender. On the other hand, the study

revealed that reporting a system as efficient is closely associated with prior training in assistive technology, age and level of study which was a proxy variable to exposure time. Put differently, students with visual impairment who either had prior training in assistive technology and/or have used DLs libraries for longer period reported that DLs are efficient compared to those who did not have prior training in assistive technology or had used digital library for relatively shorter period.

The third objective of this study was to establish the level of user satisfaction of digital libraries in information retrieval by persons with visual impairment. User satisfaction was based on evaluation of user expectations against what the DLs really gives, general appearance, and any possible frustrations users may have had when using DLs. Specifically, User experience and fruitful information search were used in this study as indicators of user satisfaction in using the digital library. The study findings established that slightly more students with visual impairment found the digital library dissatisfying compared those who perceived the digital library as satisfying to use in retrieving information resources. On the other hand, it was established that level of satisfaction with DLs increased with one's year of study, level of study, and exposure in the time of use of DLs and prior training in assistive technology. The study showed that level of satisfaction increased significantly among master's levels.

The fourth objective of this study was to evaluate the extent to which digital libraries are easy to learn in information retrieval by persons with visual impairment. Learnability was evaluated based on self-reported learning curve,

complexity, or ease of key functions of DLs, system support mechanisms, and mastery of general usage of digital libraries. It was found from this study that majority of students with visual impairment reported the digital libraries as not easy to learn. Further, learnability of DLs was found to be independent of any demographic characteristic such as type of visual impairment, level of study, and year of study, age, and gender of the student. This is perhaps related to the fact that most students who do not have prior training in assistive technology experience difficulties in learning to use DLs regardless of their age, gender, year of study or level of study.

The fifth objective of this study was to examine the accessibility level of digital libraries in information retrieval by persons with visual impairment. Accessibility in this study was based on ease of navigation, frequency of seeking assistance, and system support though customized prompts and library staff. From the study, majority of students with visual impairment found the digital libraries inaccessible compared to those who perceived digital libraries to be accessible while 6% were undecided. The study also established that accessibility of DLs is not significantly influenced by age or gender of the user, but it is influenced by nature of visual impairment, level of study and year of study. This means that the percentage of students who reported that digital libraries are accessible or inaccessible remained relatively the same across different age or gender of respondents but varied between the totally blind and Low vision students as well as across various levels and years study. This study further established a significant positive relationship between prior training in

assistive technology (AT) and accessibility of digital libraries. Students with visual impairment who had prior training in assistive technology found DLs more accessible compared to their counterparts who had not had any prior training in assistive technology.

5.3 Conclusions

Based on the findings of this study, four main conclusions have been made regarding usability of digital libraries by persons with visual impairments as follows:

First, although several usability studies done in the past have proved that perceived ease of use and perceived usefulness of a technology influences its usability, individual usability attributes are highly inter-correlated to the extent that they appear not to be entirely related to perception but to design of the system as well. As presented in this study, the concept of friendliness of a digital library appears to be inseparable from the concept of learnability. The study therefore concludes that a user's ability to learn to effectively utilize a digital library, is closely associated with their perception of a digital library as a friendly system.

Secondly, this study concludes that while accessibility of information system is a critical element of system usability, it does not solve the challenge of usability of a system by itself. As earlier discussed in this study, usability of an information retrieval system is a multifaceted construct that include among others system accessibility, learnability, friendliness, efficiency, and satisfaction from the end user perspective. This study thus concludes that a holistic way of

addressing the challenges of usability of a system is to examine all the usability attributes with the perspective of user experience in the appropriate context.

Thirdly, this study concludes that user satisfaction with digital library and indeed with any information retrieval (IR) system is largely dependent on their perception of system efficiency. When the system is efficient to the expectation of the user, then satisfaction follows as a natural intuition.

Finally, the study concludes that prior training in assistive technology is a requisite to meaningful utilization of digital libraries and other information retrieval systems. Since persons with visual impairment interact with the system in different ways such as by use of screen magnifiers or screen reading software, then it is critical to first equip them with these basic skills which are key in navigation and utilization of any digital system including digital libraries.

5.4 Recommendations

Based on the findings, two types of recommendations are made; policy recommendations, and recommendations for further research as expounded in sections 5.4.1 and 5.4.2.

5.4.1 Policy Recommendations

i. Based on the evidence that training in assistive technology is a critical requisite in the utilization of digital library resources, the study recommends substantive inclusion of Assistive Technology Component (ATC) within the digital literacy core competency of the national

Competency Based Curriculum (CBC) by Kenya Institute of Curriculum Development (KICD).

ii. Key findings in this study revealed that digital libraries used in universities are not friendly, user satisfying, easy to learn or accessible to persons with visual impairment. This could have been attributed to their exclusion in usability testing. The study therefore recommends involvement of persons with visual impairment in usability testing of any digital information retrieval systems. In case of any customization done by individual universities on an information retrieval system such as a digital library, the study recommends consideration of the user needs of persons with visual impairment who interact with the system non visually using screen readers or visually through use of screen magnification and combination of other accessibility features such as varying the colour contrast. These inclusion usability strategies in the design and customization of digital systems should be well laid out in the system design and customization policies of individual institutions.

iii. Considering that assistive technologies and related skills is considered as a 'can't do without' aspect for persons with visual impairment to interact with digital information through digital libraries and other information retrieval systems, the study recommends establishment of Assistive Technology Training Centres (ATTCs) across the country under Ministry of Education (MOE) targeting persons with visual impairment who have completed the basic education to equip them with the required

skills to harness technology for information access and retrieval purposes.

iv. The study also recommends development of a National Assistive Technology Curriculum (NATC) by Kenya Institute of Curriculum Development (KICD) for persons with visual impairment and other disabilities. This will act as a structured guide with training resources to standardize the scope of AT training, thus improving quality and relevance of training in assistive technology for the 21st century student.

v. From the findings of this study, majority of students with visual impairment pointed out that digital libraries were not accessible to them and that some of them lacked the basic accessibility tools as per the W3C requirements. The study therefore recommends that universities and other academic institutions of higher learning to consider accessibility of digital platforms as a critical item in their information access policies. In addition, they should include 'design of accessible digital platforms' as an integral item in their ICT policy. The proposed digital provisions would ensure adequate digital inclusion of students with various disabilities.

vi. Universities to strengthen staff development policies to include disability mainstreaming and technical skills in certain areas such as assistive technology to adequately offer support to students with various disabilities like visual impairment when interacting with digital systems and retrieving the information hosted therein. This study revealed that

many students who were dissatisfied with digital libraries (DLs) would often refer to lack of support from library staff as opposed to the DLs itself.

5.4.2 Recommendations for Further Research

i. This study found a positive association between frequency of visiting the library and user friendliness of a digital library. However, based on this study one may not clearly identify the cause and effect of this association. As such, further research is recommended to determine frequency of library visit is what influences one's perception on friendliness of a digital library or it is the appreciation of digital library friendliness that influences frequency to the library.

ii. This study evaluated usability of digital libraries used in universities. However, most universities in Kenya, and indeed across the globe are rapidly investing in other digital systems like e-learning platforms and online students and staff portals. The use of these portals seems to be at the centre of almost all university operations. The study therefore recommends an in-depth usability study focussing on the inclusiveness of these portal systems, to mitigate a possibility of future exclusions of persons with disabilities and other vulnerable groups of the population.

iii. This study was conducted using a one-time survey of sampled public universities in Kenya. However, satisfaction as a product of system usability is a dynamic and subjective issue. This study therefore recommends a longitudinal study which may provide more insights on

the changes in users' satisfaction over years of study from first year to final year to make customized intervention for optimal utilization digital library resources.

iv. This study focused on usability of digital libraries by persons with visual impairment. However, there are many other special categories of persons who may experience exclusion in design of usable digital systems. The study strongly recommends further research in digital library usability by other special categories of users. For instance, the gifted and talented, those with mild mental disabilities, those with autism spectrum disorder and those with hearing impairment to name but a few as well as categories of users by age like the elderly and children.

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APPENDICES

APPENDIX A: LETTER OF INTRODUCTION

Dear participant,

Re: Request to participate in data collection for PhD Thesis

I am a PhD student at Kenyatta University conducting a study on 'Usability of Digital Libraries During Information Retrieval by Persons with Visual Impairment in Selected Public Universities in Kenya'. I have chosen you to participate in my study as one of the respondents in data collection since you are the best suited candidates for this nature of study. I will appreciate if you assist in achieving the intended goal by providing the best responses to the questionnaire items. The structure of the questionnaire makes it very easy to compete within a short period of time. The information you provide is only for the purpose of this study, in which confidentiality shall be upheld. Please note that the information you provide electronically is kept completely confidential, and no information will be stored on computer media that could identify you as a person.

Thank you for your time and cooperation.

Fridah Gatwiri Kiambati

0720 088 439

APPENDIX B: QUESTIONNAIRE FOR STUDENTS WITH VISUAL IMPAIRMENT

Section A: General Information

Please tick appropriately.

1. Gender: Male ☐
   Female ☐
2. Age: Below 18 years ☐
   18 - 25 years ☐
   26 – 35 years ☐
   36 - 45years ☐
   Above 45 years ☐
3. Nature of Visual impairment:
   Blind ☐
   Low vision ☐
4. Please indicate the course being undertaken:

   ……
5. (i) If an undergraduate student, please indicate your year of study:

   Year 1 ☐ Year 4 ☐
   Year 2 ☐ Year 5 ☐
   Year 3 ☐ Year 6 ☐

   (ii) If a postgraduate, indicate your level:

   Masters ☐ PhD ☐

Section B: User friendliness of Digital Library

Please tick in the appropriate box if you strongly Agree (**SA**), Agree (**A**), Undecided (**U**), Disagree (D) or Strongly Disagree (**SD**) with the following statements.

Statements	**SA**	**A**	**U**	**D**	**SD**
I am able to log in and out of the digital library					
I sometimes wonder if I am using the right function.					
The way information is presented is clear and understandable.					
When using the digital library, I get disrupted in the way I normally like to arrange my work					
I feel in command of the digital library when I am using it.					
I prefer to stick to the functions that I know best					
I do understand the information as presented in the digital library pages					
I can perform tasks in a straight forward manner using the digital library.					
The organization of the menus seem quite logical to me					
I find it easy to move from one part of a task to another in the digital library					
I find it difficult to get data files in and out of the digital library					

Section C: Efficiency of Digital Library

Please tick in the appropriate box if you strongly Agree (**SA**), Agree (**A**), Undecided (**U**), Disagree (D) or Strongly Disagree (**SD**) with the following statements.

Statements	**SA**	**A**	**U**	**D**	**SD**
I find the digital library responding too slowly to inputs					
The digital library has at sometimes closed unexpectedly					
I enjoy the time I spend using the digital library.					
There is never enough information on the screen when I need it					
I think the digital library is inconsistent					
The speed of achieving search results with the digital library is fast enough					
It is easy to make the digital library do exactly what I want					
There are too many steps required to get something to work when using the digital library					

Section D: User satisfaction of Digital Library

Please tick in the appropriate box if you strongly Agree (**SA**), Agree (**A**), Undecided (**U**), Disagree (D) or Strongly Disagree (**SD**) with the following statements.

Statement	**SA**	**A**	**UD**	**D**	**SD**
Doing information searches within digital library is satisfying.					

Using the digital library is mentally stimulating					
I would not like to use the digital library every day					
Using the digital library is frustrating for me					
There have been times in using the digital library when I have felt quite tense					
The digital library has always done what I was expecting					
I think the digital library has sometimes given me a headache					
The digital library presents itself in a very attractive way					

Section E: Learnability of Digital Library

Please tick in the appropriate box if you strongly Agree (**SA**), Agree (**A**), Undecided (**U**), Disagree (D) or Strongly Disagree (**SD**) with the following statements.

Statement	**SA**	**A**	**UD**	**D**	**SD**
If I log out of the digital library, it is not easy to log in again					
It is easy to forget how to perform tasks in the digital library					
The instructions and prompts in the digital library are helpful					
Learning to operate the digital library initially is full of problems.					

I sometimes don't know what to do next in the digital library					
I find that the help information given in the digital library is not very useful					
It takes too long to learn the digital library functions					
The digital library documentation is very informative					
The digital library has helped me overcome any problems I have had in using it					
I keep having to go back to look at the guides when using the digital library					
Learning how to use new functions in the digital library is difficult.					
I will never learn to use all that is offered in the digital library					
The digital library occasionally behaves in a way which can't be understood.					

Section F: Accessibility of Digital Library

Please tick in the appropriate box if you strongly Agree (**SA**), Agree (**A**), Undecided (**U**), Disagree (D) or Strongly Disagree (**SD**) with the following statements.

Statement	**SA**	**A**	**UD**	**D**	**SD**
It is relatively easy to move from one part of a task to another					
I have to seek for assistance most of the time when using digital library					

The software allows the user to be economical of keystrokes					
The digital library is awkward when I want to do something which is not standard					
It is obvious that user needs of persons with VI have been fully taken into consideration					
I would recommend use of this digital library to persons with VI					

Information Retrieval

On a Scale of 1 to 10 where 1=Very Difficult and 10=Very Easy, rate your overall experience of retrieving information you need from your university's digital library.

Very Difficult **Very Easy**

1	2	3	4	5	6	7	8	9	10

Additional Information

1. How important for you is the digital library?

   Extremely important ☐

   Important ☐

   Not very important ☐

   Not important at all ☐

   Not Sure ☐

2. How would you rate your skills and knowledge in using digital library?

   Very experienced and technical ☐

I am good but not very technical ☐

can cope with most operations of the digital library ☐

I find the digital library very difficult to use ☐

3. Do you have any training on assistive technology?

Yes ☐ No ☐

If yes rate your competencies?

Very competent ☐

Average competency ☐

Below average competence ☐

I cannot operate the computer currently ☐

4.

5. What do you think is the best aspect of your digital library and why?

……

……

……

6. What do you think needs most improvement in the digital library and why?

……

……

……

Thank you for your participation.

APPENDIX C: INTERVIEW GUIDE FOR STUDENTS WITH VISUAL IMPAIRMENT

I am a PhD student at Kenyatta University conducting a study on 'Usability of Digital Libraries During Information Retrieval by Persons with Visual Impairment in Selected Pubic Universities in Kenya'. You have selected to participate in this study because you are the best suited candidate. The information you provide will only be used for the purpose of this study and will be treated with utmost confidentiality.

Thank you.

General Information

1. How often do you use the digital library? (Probe for reasons)

Reasons

……
……
……

2. Between the digital library and the physical library, which one do you prefer using the most? (probe for reasons)

Reasons……
……
……

User Friendliness

5.Do you have any difficulties getting into the digital library?

If yes, which difficulties do you face? (Probe for responses)

Difficulties……
……
……

6. Do you find it easy to navigate the digital library pages when searching for information? If not, Probe to get the specific challenges.

   Challenges

   ……

   ……

   ……

   Efficiency

   7. How fast can you get into the Digital Library? If long or very long time, probe for reasons.

   Reasons…….

   ……

   ……

8. How long do you take to retrieve the needed resources from the digital library? If long or very long time, probe for reasons.

   Reasons

   ……

   ……

   ……

   User Satisfaction

9. Would you recommend use of digital library to other persons with visual impairment? Probe for reasons

   Reasons

   …….

   ……..……..……

   ……

10. Do you find it satisfying to use the digital library? Probe for reasons that make it satisfying or not.

Reasons

……

……

……

Learnability

11. Is it easy for you to use the digital library without training or guidance? If not, probe for what makes it difficult to learn?

    ……

    ……

    ……

12. Do you find it easy to learn to use the digital library functions? Probe for reasons why it is easy or difficult.

    Reasons

    ……

    ……

    ……

13. Do you find the help information in the digital library useful? If not, probe for reasons why.

    Reasons

    ……

    ……

    ……

Accessibility

14. Does the digital library have accessibility features for your use? If yes, which ones?

    Accessibility features available

    ……

……

……

15. Is it easy to navigate the digital library using your screen reader/screen magnifier? If not, what challenges do you face? (Probe for responses)

    Challenges……

    ……

    ……

General questions

16. What do you think is the best aspect of the digital library?

    ……

    ……

    ……

17. What would you recommend to be improved in the digital library to make it easier for you and other persons with visual impairment to use?

    ……

    ……

    ……

Thank you.

APPENDIX D: INTERVIEW GUIDE FOR SPECIAL NEEDS LIBRARIANS

I am a PhD student at Kenyatta University conducting a study on 'Usability of Digital Libraries During Information Retrieval by Persons with Visual Impairment in Selected Public Universities in Kenya'. I have selected you as one of my respondents in data collection because you are the best suited candidate. The information you provide will only be used for the purpose of this study and will be treated with utmost confidentiality.

Thank you.

User friendliness

1. In your opinion, how is the usage of the digital library by persons with visual impairment who visit the library? (Probe for the frequency and reasons)
2. In your opinion, do you find the digital library friendly to users with visual impairment? Probe for reasons.
3. How often do users with visual impairment seek your assistance when using the digital library? (Probe for responses)
4. Do users with visual impairment get stuck when using the digital library? Probe for the tasks that are very difficult.

Efficiency

5. Do users seek assistance repeatedly on a similar task? If yes, probe for the most challenging stages of digital information retrieval by users with visual impairment.

User satisfaction

6. Do users with visual impairment complain while using digital library to access information? If yes, what are their main complains

Learnability

7. Do users with visual impairment keep on requesting for training on the use of the digital library? If yes, which are commonly requested training areas?
8. Do users with visual impairment mainly sit with assistants while using the computers inside the library? If yes, what do you think is the reason?

Accessibility

9. Does the digital library contain the internationally recommended accessibility features for persons with visual impairment? if not, what do you think is the possible reason?

Thank you.

APPENDIX E: FOCUS GROUP DISCUSSION GUIDE FOR STUDENTS

I am a PhD student at Kenyatta University conducting a study on 'Usability of Digital Libraries During Information Retrieval by persons with Visual Impairment in Selected Public Universities in Kenya'. I have selected you as one of my respondents in data collection because you are the best suited candidate. The information you provide will only be used for the purpose of this study and will be treated with utmost confidentiality.

Thank you.

User Friendliness

1. Which between the digital library and the physical library do students with visual impairment like using the most? (probe for reasons)
2. Do you have any difficulties getting into the digital library? If yes which ones?
3. Do you find it easy to navigate the digital library pages when searching for information? If not, probe for what makes it difficult.

Efficiency

4. Does it take very long to retrieve the needed resources from the digital library? Probe for the aspects that make it take long or short time.

User satisfaction

5. Would you recommend use of digital library to other persons with visual impairment? Probe for reasons.
6. Do you find it satisfying to use the digital library? Probe for reasons that make it satisfying or not.

Learnability

7. Is it easy for you to use the digital library without training or guidance? If not, what makes it difficult to learn?
8. Do you find it easy to learn to use the digital library functions? Probe for reasons why it is easy or difficult.
9. Do you find the help information in the digital library useful? If not, probe for reasons why?

Accessibility

10. Does the digital library have accessibility features for use by persons with visual impairment? If yes, which ones?
11. Is it easy to navigate the digital library using screen readers or screen magnifiers? If not, what challenges do you face?

General questions

12. What do you think is the best aspect of the digital library?
13. What would you recommend to be improved in the digital library to make it easier for you and other persons with visual impairment to use?

APPENDIX F: CONSENT FORM

Informed Consent

My name is Fridah Gatwiri Kiambati. I am a Ph.D student from Kenyatta University. I am conducting a study on "Usability of Digital Libraries During Information Retrieval by persons with Visual Impairment in Selected Universities in Kenya" The information collected will be used by digital library managers, University Management, and system designers in ensuring that digital information is accessible to all intended users by creating digital libraries that are usable by all categories of users including those with visual impairment.

Procedures to be followed

Participation in this study will require you to fill in a questionnaire containing statements on demographic information, user friendliness of digital library, efficiency, learnability, user satisfaction and accessibility. Please remember that participation in this study is voluntarily that you may ask questions related to the study at any time.

You may refuse to respond to any questions and you may stop an interview at any time. You may also stop being in the study at any time without any consequences to the services you receive from the digital library or any other library now or in the future.

Discomforts and Risks

There are no physical risks involved in this study. However, some questions may require you to disclose personal information that are sensitive and may make you uncomfortable. If this happens, you may refuse to answer these questions if you so choose. You may also stop the interview at any time. The interview may take around 20 minutes of your study time.

Benefits

Your participation in this study will help to form a basis of ensuring that digital information is accessible to all intended users by creating digital libraries that are usable by all categories of users including those with visual impairment.

Confidentiality

The interviews will be conducted in a private setting within the library premise. Your name will not be recorded on the questionnaire. The information you provide will only be used for the purpose of this study. All questionnaires will be coded and secured by the researcher.

Contact Information

If you have any questions you may contact Dr. Carol Mutwiri. On 0722316316 or Dr. Rose Njoroge on 0722978982 or the Kenyatta University Ethical Review Committee Secretariat on chairman.kuerc@ku.ac.ke, secretary.kuerc@ku.ac.ke, secretariat.kuerc@ku.ac.ke

Participant's statement

The above information regarding my participation in the study is clear to me. I have been given a chance to ask questions and my questions have been answered to my satisfaction. My participation in this study is entirely voluntary. I have been assured of confidentiality and I understand that I can withdraw my participation in this study at any time without any consequences.

I do hereby accept to participate in the study

Name of participant: _____

Signature or thumbprint: _____ Date: _____

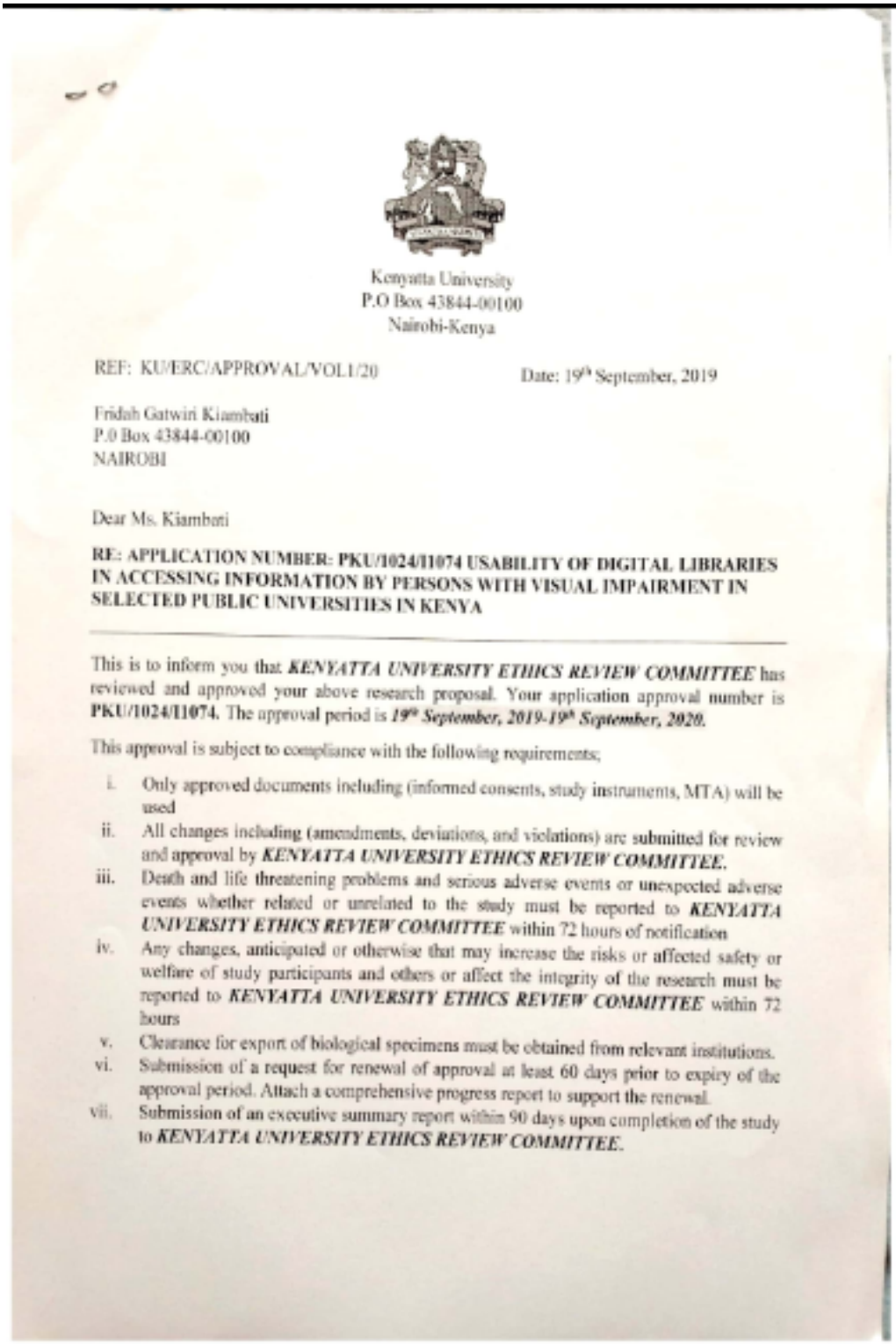
Investigators statement

I, the undersigned, have explained to the participant about the study procedures to be followed, possible risks and benefits that are likely to result from the study as well as how confidentiality will be taken care of.

Investigator's Name: _____

Signature _____ Date _____

APPENDIX G: ETHICS REVIEW CLEARANCE



Kenyatta University
P.O Box 43844-00100
Nairobi-Kenya

REF: KU/ERC/APPROVAL/VOL1/20 Date: 19th September, 2019

Fridah Gatwiri Kiambati
P.0 Box 43844-00100
NAIROBI

Dear Ms. Kiambati

RE: APPLICATION NUMBER: PKU/1024/I1074 USABILITY OF DIGITAL LIBRARIES IN ACCESSING INFORMATION BY PERSONS WITH VISUAL IMPAIRMENT IN SELECTED PUBLIC UNIVERSITIES IN KENYA

This is to inform you that ***KENYATTA UNIVERSITY ETHICS REVIEW COMMITTEE*** has reviewed and approved your above research proposal. Your application approval number is **PKU/1024/I1074.** The approval period is ***19th September, 2019-19th September, 2020.***

This approval is subject to compliance with the following requirements;

i. Only approved documents including (informed consents, study instruments, MTA) will be used
ii. All changes including (amendments, deviations, and violations) are submitted for review and approval by ***KENYATTA UNIVERSITY ETHICS REVIEW COMMITTEE.***
iii. Death and life threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to ***KENYATTA UNIVERSITY ETHICS REVIEW COMMITTEE*** within 72 hours of notification
iv. Any changes, anticipated or otherwise that may increase the risks or affected safety or welfare of study participants and others or affect the integrity of the research must be reported to ***KENYATTA UNIVERSITY ETHICS REVIEW COMMITTEE*** within 72 hours
v. Clearance for export of biological specimens must be obtained from relevant institutions.
vi. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. Attach a comprehensive progress report to support the renewal.
vii. Submission of an executive summary report within 90 days upon completion of the study to ***KENYATTA UNIVERSITY ETHICS REVIEW COMMITTEE.***

Prior to commencing your study, you will be expected to obtain a research license from National Commission for Science, Technology and Innovation (NACOSTI) https://oris.nacosti.go.ke and also obtain other clearances needed.

Yours sincerely

Prof. Judith Kimiywe

CHAIRPERSON- KENYATTA UNIVERSITY ETHICS REVIEW COMMITTEE.

APPENDIX H: NACOSTI RESEARCH PERMIT

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: 346919

Date of Issue: 15/May/2020

RESEARCH LICENSE

This is to Certify that Ms.. Fridah Gaiwiri Kiambati of Kenyatta University, has been licensed to conduct research in Kiambu, Nairobi, Uasin-Gishu on the topic: USABILITY OF DIGITAL LIBRARIES IN ACCESSING INFORMATION BY PERSONS WITH VISUAL IMPAIRMENT IN SELECTED PUBLIC UNIVERSITIES IN KENYA for the period ending : 15/May/2021.

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E-mail: dg@nacosti.go.ke / registry@nacosti.go.ke
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APPENDIX I: KREJCIE AND MORGAN (1970) SAMPLE SIZE DETERMINATION

N	*S*	*N*	*S*	*N*	*S*
10	10	220	140	1200	291
15	14	230	144	1300	297
20	19	240	148	1400	302
25	24	250	152	1500	306
30	28	260	155	1600	310
35	32	270	159	1700	313
40	36	280	162	1800	317
45	40	290	165	1900	320
50	44	300	169	2000	322
55	48	320	175	2200	327
60	52	340	181	2400	331
65	56	360	186	2600	335
70	59	380	191	2800	338
75	63	400	196	3000	341
80	66	420	201	3500	346
85	70	440	205	4000	351
90	73	460	210	4500	354
95	76	480	214	5000	357
100	80	500	217	6000	361
110	86	550	226	7000	364
120	92	600	234	8000	367
130	97	650	242	9000	368
140	103	700	248	10000	370
150	108	750	254	15000	375
160	113	800	260	20000	377
170	118	850	265	30000	379
180	123	900	269	40000	380
190	127	950	274	50000	381
200	132	1000	278	75000	382
210	136	1100	285	1000000	384

Note.—*N* is population size. *S* is sample size.

Source: Krejcie & Morgan, 1970