DEVELOPMENT AND USABILITY EVALUATION OF A WEB SEARCH APPLICATION FOR ELECTRONIC THESES AND DISSERTATIONS IN REPOSITORIES OF NIGERIAN UNIVERSITY LIBRARIES

BY

SALAU, SADIAT ADETORO
PhD/SSTE/2015/694

LIBRARY AND INFORMATION TECHNOLOGY
FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

AUGUST, 2021

ABSTRACT

The research process that results in the production of theses and dissertations involves a detailed literature review to support areas of the research study which means search and retrieval of information related to their research must be done to reduce or avoid as much as possible the issue of repetitive research and plagiarism. Despite the large turnout of these research outputs, postgraduate students face two critical challenges in the course of their research studies. Firstly, there are repetitive researches because of the oblivion of researches conducted in other universities. Secondly, there is the issue of access to local content literature in the form of theses and dissertations to build up investigations. To address these challenges, this research study developed and evaluated a web search application for Electronic Theses and Dissertations (ETDs) in federal university libraries in Nigeria to solve the challenge of poor global visibility of electronic theses and dissertations from Nigeria. The study adopted an action research design and used mixed research methodology to achieve the objectives. Four research questions and six hypotheses tested at 0.05 level of significance guided the study. Seventy respondents comprising ten (10) institutional repository administrators and sixty 2018/2019 postgraduate students provided the data for the study. Three sets of data collection instruments (two questionnaires, one interview guide and one observation guide) were administered to the respondents. Triangulation was used to collect data about the management of ETDS in institutional repositories based on policies, contents and system architecture. A task oriented approach was used to collect data from the institutional repository administrators for the assessment objective and postgraduate students for the usability study Data collected was analysed descriptively and inferentially using frequency counts, chart, median and Kruskal-Wallis analysis of variance. Findings from the study revealed that the management of electronic theses and dissertations in Nigerian institutional repositories was poor based on policies, contents and system architecture. Only half of the institution studied had polices for their repositories. In institutions where policies were available, the management of ETDs was poorly and not explicitly stated. Electronic Theses and Dissertations content in the repositories were in portable document format (PDF) and had no copyright measures. The ETD contents in the repositories were also stored in institutional servers and were not registered on the Open Archive Initiative- Protocol for Metadata Harvesting (OAI-PMH) framework. There were few policies and the major challenges identified with the management of these resources in the repositories were content population, funding and inadequately skilled staff. The ETD search application was designed using PHP, WAMP and MySQL. The six hypotheses tested revealed that there was no significant difference in the opinion of postgraduate students on the usability effectiveness, efficiency and satisfaction of the application based on information and transactional queries. The study recommended an ETD policy framework, a content populating workflow and a funding framework for the effective management of ETDs in institutional repositories.

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LIST OF ACRONYMS

DOAR   Directory of Open Access Repositories

ETD   Electronic Theses and Dissertations

IR   Institutional Repositories

NgREN   Nigerian Research and Education Network

OA   Open Access

OAI-PMH   Open Archive Initiative-Protocol for Metadata Harvesting

PDF   Portable Document Format

SHERPA/RoMEO   Securing a Hybrid Environment for Research, Preservation and

                                  Access/ Rights Metadata for Open Archiving

CHAPTER ONE

1.0   **INTRODUCTION**

1.1 Background to the Study

Universities were established with the mission to train a high-level and skilled workforce for national development. According to the National Policy on Education (2013), university education must make significant contributions to national development by providing and developing high-level workforce through quality teaching, learning, and research. The combination of teaching, learning, and research roles can assist in achieving this mission highlighted in the policy through the transfer of information and knowledge.

To achieve this contribution, the cardinal roles entrusted on universities which research is one and the most important should be encompassing and conform to international standards, in terms of conduct, management, dissemination, and preservation. This view is not surprising as research is a pivot that links teaching and learning and in the opinion of Oyedum *et al.* (2015) is an assessment criterion to indicate the level of understanding of the teaching and learning exercises. It is against this context that various researches are carried out in our ivory towers every year. University libraries serve as channels for the access and preservation of these research outputs, which include, journal articles, conference proceedings, theses and dissertations to mention but a few. These libraries participates essentially in the collection, dissemination, and preservation of various research outputs in support of the attainment of the research missions and visions of their parent institutions. Of these research outputs, theses and dissertations form the bulk of which universities attach much importance.

Theses and dissertations are documents of Masters and Doctor of Philosophy (PhD) students that present research investigations and findings which form part of the graduation requirements

recognised by many universities worldwide. Not only do these 'intellectual core' of universities present the significant research and scholarship of the universities they represent, but they are also a valuable historical record of the research and teaching community (Middleton *et al.,* 2015). Alam and Pandey (2012) acknowledged the well-established fact that theses and dissertations have for a while been the foundation of higher education across the world. They believed this important primary source of information is the result of focused and extensive studies and findings guided by experts in the field over a defined period. Ifijeh (2014) also stated that theses contain crucial research findings which can be used and implemented in industries and different sectors of the economy in Nigeria.

Theses and dissertations are a useful origin of information pertaining to research for prospective graduate students, researchers and decision makers (Alam and Pandey, 2012). Thus, there is a need for future accessibility and preservation of these vital information resources for posterity. On the contrary, however, Han (2014) noted that theses and dissertations are not usually accessible through the usual distribution channel of scholarly publication and distribution. This author further stated that within the traditional libraries' workflow, these resources are either partially catalogued or not catalogued at all, thus making them difficult to access. Alam and Pandey (2012) also stressed that the non-publishing status of theses and dissertations have, over time, made university libraries and archives the only access points; thus making accessibility a difficult task. These points have made retrieval of information about theses in Nigeria an uphill task.

The reason for this is obvious, hitherto to the Internet era, university libraries had limited archived, printed theses and dissertations. However, Internet technology and the use of Information and Communication Technology (ICT), changed the paradigm. Printed copies of

dissertations come in an electronic format whose printed copies have either been digitised or are born electronic copies and stored in repositories of university libraries. E-theses was defined by the Digital Access to Research Thesis-Europe (DART-Europe) as an electronic equivalent of a printed thesis. An advantage of the e-theses is the multiple access to a copy of the completed thesis. The ease of access is because millions of users can view just one electronic copy of a thesis, which was quite challenging with the printed copies. Also, the future preservation of theses and dissertations have been made easier with electronic theses and dissertations (ETDs) which is a welcome development especially for libraries in developing countries that over the years have been grappling with the preservation of print theses and dissertations.

The National Policy on Education (2013) posited that since universities' research are relevant to the nation's developmental goals; particular attention must be paid to the promotion, conduct and dissemination of original research and knowledge with the global community. This position is in line with the global open policies to information and knowledge, whose mission is increasing the visibility and accessibility of research output. Open-access (OA) literature are digital, online and free in terms of prices and most copyright and licensing restrictions (Suber, 2015). An important reason, as stated by Prost *et al.* (2015) to make dissertations widely available and accessible, is that it would increase the visibility and impact of an institution's scientific output. They further presented other arguments in favour of open access to theses and dissertation to include quality, representativeness, new ideas, and extensive literature.

The formulation of open access policies and mandates was to ensure that research information is freely accessible. According to Bruns and Inefuke (2016), these policies and mandates have since gained increased acceptance amongst scholars and librarians alike due to the serial crises,

increased demand for information, information explosion and the moral justification of paying for government-funded research. The initiative was envisaged to significantly solve the inaccessibility gap of scientific and research information between developing and the developed world by facilitating the free accessibility and exchange of scholarly publications. Canada (2009) also stated an advantage the open access movement created, which is the possibility of providing an equal opportunity of accessing knowledge to all countries, irrespective of their status. Open access enables researchers put out their findings to a worldwide audience, which in turn increases citations made to their scholarly work. Research output can be accessed through any of the two paths to open access recommended by the Budapest Open Access Initiative (BOAI), which are the OA Institutional repositories (IRs) and OA journals.

The development, design and implementation of institutional repositories (IR) in academic libraries have since 2002 been growing at a steady pace when Clifford Lynch declared them as pertinent facilities for scholarly publishing in the digital times (Ramirez and Hanlon, 2011). Open access repositories were the first initiative of the Institute of Technology, Massachusetts, United States of America in the year 2000. The project objective was to come up with a sustainable long-term digital archive which shall give favourable leverage to study issues on access control, copyrights management, versioning, retrieval, community feedback, and flexible publishing capabilities. Twenty years after, academic libraries all over the world have tapped and are still tapping into the institutional repository project. Since then, libraries have leveraged on the advantages repositories offer to have an archive of information resources for their institutions. This scenario is not surprising as the essential elements of repositories tally with the traditional role libraries play which is to collect, preserve and disseminate information resources, thus making it a viable technological tool that represents physical libraries in the digital environment.

A repository is a digital information resource archive, library or warehouse that enables access to information resources, findings from researches, students theses and dissertations to mention but a few, deposited with the consent of the authors. Significant challenges facing libraries like dwindling budget and increasing subscription rates for electronic resources, space management, high information demand and information explosion made institutional repositories a viable alternative of information accessibility for libraries all over the world (Sengupta, 2014). Thus, libraries 'own' these resources which have been an issue of contention between libraries and publishers of subscribed e-resources, in addition to having interoperable institutional repositories which provide access to IRs in other institutions. With this, libraries in Nigeria would have more sources of information which would quench the information thirst of their users and also increase their e-resources databases for accreditation purposes. Stephen *et al.* (2015) stated that IRs are online solutions for the collection, preservation, and dissemination of findings from tertiary institutions. The authors, however, stated that IRs have metamorphosed to a publishing platform for libraries to visualise the institution's scholarship.

E-theses repositories are digital archives of electronic theses and dissertations established to improve and increase the accessibility of researches which hitherto were hidden and locked away in university libraries. Institutions of learning and libraries worldwide have adopted and supported this initiative because of the advantages of visibility and accessibility of research output that comes with it in the wake of invisibility of scholarly research output from Africa. Suber (2008) reiterated that "theses and dissertations are the most invisible form of useful literature and the most useful form of invisible literature".

Gul *et al.* (2015) also stated that theses are highly confidential documents in higher institutions

that were always put under locks, thus debarring scholars from accessing the researches and findings contained in them. This situation is very frustrating and discouraging for postgraduate students undertaking their research studies, because dissertations are essential origin of information which in the opinion of Sengupta (2014) contains detailed and often unexplored information, including methodology about a particular research area or concept. Accessibility outside the institution thus becomes complicated when submitted in print format. A situation which is not pleasant because in the opinion of Mohee (2016) carrying out research is not enough on its own, the use of the research output matters because it is through the uptake of research that the knowledge developed is made visible and usable.

Furthermore, there is a continuous emphasis on the dearth of research information for postgraduate researchers in developing countries like Nigeria. The Database of African Theses and Dissertations (DATAD) initiative pointed out that research findings from Africa are not often indexed in major international databases; the situation is worsened by the rigid access to theses and dissertations completed in the region, which contains local empirical information and data not available in international literature. Justifying the need for open access to research, Kleinman (2011) stated that new research usually depends on prior research. How then would these 'prior research' be found if Christian (2008) and Ezema (2011) stressed that research generated over the years are in different libraries in Africa which makes accessibility difficult for scholars and students. This development according to Ezema (2011) makes African researchers depend highly on the information generated from the developed countries of Europe and the USA which in no small extent may not follow the format and context of African problems. In Nigerian libraries, the production of theses and dissertations is minimal, and the copies available for public access are in print and physically consulted in a university library (DATAD, 2014).

This situation in addition to the strict and stern policies in place when accessing theses and dissertations is discouraging for Nigerian researchers and research students especially now that libraries all over the world have transited to an era where web technology has become pertinent for the dissemination of scholarly information and communication. Similarly, researchers may not be able to attend many related conferences or follow the vast range of publications available (Alhoori *et al.,* 2015). They may not also access the vast amount of research information published in local journals that are not accessible online, especially in developing countries. In some quarters, it has also been argued that the slow pace in socio-economic and political development in Africa has a link with inadequate information to propel knowledge and development (Ezema, 2011).

The several advantages of having these repositories in institutions of learning consequently propelled Nigerian University libraries to develop and implement repositories. The Directory of Open Access Repository (DOAR), the ranking web of repositories and direct search by this researcher revealed that 12% of university libraries in Nigeria have functional stand-alone repositories which contain ETDs and other digital resources. Interestingly, of this percentage, 72% of these repositories are owned by Federal universities while 21% and 7% are owned by private and state universities respectively. Some of the public university repositories used open-source repository software for development and implementation, while others built proprietary software to manage their collections. However, the downtimes of these repositories and their contents have been low over time. Findings have revealed that most Nigerian IRs are ineffective and underutilised (Hinmikaiye, 2015; Valde, 2016) with contents falling dramatically after the initial take-off of the repositories. Direct interactions and observation by this researcher revealed

some technical and managerial issues not reported in the literature. For example, some of these repositories are still running on older versions of DSpace (an open-source repository software) or have contents especially theses and dissertations uploaded after the initial take-off of the repositories. This situation must be the reason why scholarly information in the form of theses and dissertations from the country and even the continent has not been reflecting in the global scholarly articles. Also, from observation, this researcher noticed that postgraduate students find it challenging to access literature (especially theses and dissertations) online in their areas of interest especially from Nigerian University repositories despite the humble efforts of some institutions at developing repositories.

Corroborating this, Venitha (2015) stated that the research capacity of higher education postgraduate research output is exceedingly low in Africa with African universities producing less than 1% scholarly articles globally. Further compounding the issue of accessibility of theses and dissertations in Nigeria is the fact that there is no fully functional integrated or federated ETD repository system in Nigeria. Valde (2016) believes that the content mass of one institution's repository is insignificant to be worth visiting to browse and search through even if all the theses and dissertations are available in full text. Also, Halbert (2014) advocated for a sole and separate repository for ETDs, giving the advantages of improved access and usability because of specific workflows and metadata related to these resources.

This is true, especially in the wake of the rise of subject repositories. The view of Dahlen and Hanson (2017) resonates with Valde (2016) and Halbert (2014), the authors advocated for discovery tools for library resources stating that they provide a simplified interface which returns fewer results in comparison to general search engines. Roy *et al.* (2016) also stated that the open

manner these research outputs are being generated has made it challenging to preserve them in a centralised system which can support distributed processing. In turn, the researchers are not familiar with the different interfaces; thus, they find it difficult to find what is available to them. Sarkar and Mukhopadhyay (2010) corroborated the opinion of Roy *et al.* (2016) when they stated that researchers' expectations of access to e-resources have also changed and they would prefer a single search interface or access point for e-resources. Rose-Wiles and Hofmann (2013) also justified the advantage of search discovery tools when they stated some librarians are sceptical about the enormous burden of sorting and evaluating results from general search engines that yield too many and irrelevant results.

There are also limited or no source that contains relevant information on these resources in universities. For instance, universities that have their resources catalogued online do not provide bibliographic details of theses and dissertations. Similarly, as this researcher observed, compiled directories or theses abstracts are not published periodically by the different universities, neither do weekly news bulletins published by universities, or the postgraduate schools carry information about completed theses and dissertations. Even the universities with functional repositories do not have documented submission workflows for populating the theses and dissertation community of their repositories. The unavailability of submission workflows is evident in the number of theses and dissertations available in these repositories as at the time of preliminary investigations by the researcher. The situation implied that these repositories were developed and implemented without putting into consideration the peculiar case of Nigeria vis-a-vis technical and managerial issues that have most likely affected the sustainability of these repositories. Roy (2013) opined that there would never be a set of unified best practices for digital repositories because diverse organisational needs cannot support a single group of

recommendations that would function well in all situations. The researcher, however, stated that frameworks provide overall guidance which can be of benefit to individual organisations.

Furthermore, usability evaluation is indispensable, thus it is embedded in the design and implementation of information systems. Usability, according to Federici and Borsi (2010) is assessed by the level of interaction between a designed system and a user. It involves the process of identification of challenges or improvements with designed systems when users interact with the system within a defined environment. (William *et al.,* 2013). Some qualities mentioned by Rubin and Chisnell (2008) that makes a product or service usable includes- accessibility, how efficient, and effective the system or product is, the ease of learning how to use it and how satisfied users are after using it. Aliyu (2015) also stated that usability depends on how effective the system features matches with needs and expectations. A peruse of literature on the usability of repositories in Nigeria have not been reported in the literature even though studies on institutional repositories constitute a high percentage in the Library and Information Science discipline (Joo *et al.*, 2011). Madan and Dubey (2012) stated that usability is essential in the design and implementation of successful and interactive software applications.

Several usability models reported in the literature include Eason usability model, Neilson usability model to mention but a few while methods reported in the literature as approaches, methods, and techniques for usability evaluation include heuristic evaluation, subjective quantitative evaluation, interviews, log analysis to mention but a few. Randolph *et al.* (2015) suggested two usability evaluation methods: usability testing that requires observation and recording of behaviours and activities of users testing the product. The other method is the inspection method that involves usability professionals viewing the product to identify usability defects. According to the authors, the end-user testing is better because systems are user-centred

designed, and thus, feedback from users is imperative. Emphases are on the awareness, acceptance, and availability of repositories without putting into consideration the usability of this technology vis-à-vis its purpose.

Abubakar and Ahmad (2013) asserted that several researchers have pointed to behavioural intention as the most critical determinant of the use of a particular technology. However, behavioural intention or satisfaction is influenced by several usability factors such as effectiveness, effort expectancy, efficiency, performance expectancy, and ease of use to mention but a few. Informational, transactional, and navigational queries are also relevant queries that determine the usability intent of users on search retrieval systems and software. Classifying the three queries based on people's use of web search systems, Jasen *et al.* (2008) stated that users base web search systems services on a variety of purpose that encompasses the three queries. The researchers reported that they are navigational tools that take users to specific uniform resource locators (URLs) or to aid in browsing, conduct e-commerce transactions in addition to finding out information.

Search queries, according to Gabbert (2018), are words and phrases that people type into a search box to come up with informational, navigational or transactional results. According to the authors, informational queries are queries used when a piece of information is needed. Transactional queries, on the other hand, are used when a user intends to complete a transaction like a download or purchase an item while the intention of navigational queries are queries made to find a particular website or webpage. The navigational query was expunged because it does not fit into the scope of the web application. The web application is subject-specific (for ETDs); thus it cannot be used to navigate other websites. Evidence from literature also indicated that

majority of usability studies are about system design principles, verification of its usability vis-a-vis the intended purpose or the improvement of the design of an existing system. In Kuthuria *et al.* (2010) study, web search engines queries were categorised into three, and the researchers mentioned that users' intent was more on informational query than navigational or transactional queries. This study subjectively evaluated the usability of the webware vis-à-vis the intended purpose (informational and transactional purposes).

As the number of digital contents continues to skyrocket, users around the world would continue to rely on the Internet as their first port of call for information resource retrieval. Although there are no hard and fast rules as to how libraries can reduce this trend of relying on the Internet, librarians can take advantage of this technology by designing and developing library aligned systems and applications that are user-centric, efficient and effective (Onaifo and Rasmussen, 2013). They can also ensure increased access to their contents through interfaces that would guarantee the time effectiveness of the user. It is posited that an interface application that would bring together ETDs from the available repositories would be user-centred and be a viable, cost-effective alternative to commercial ETD repositories like ProQuest. This in the opinion of Kennedy (2019) will place libraries as major players in the value chain around the production of knowledge. Based on the aforementioned, it is necessary to assess the existing institutional repositories, identify the challenges vis-à-vis polices, contents and technical issues and design a single web search system that allows for search and retrieval of ETDs in whichever stand-alone repository the ETD is domiciled.

1.2   Statement of the Research Problem

Theses and dissertations are part of graduation requirements in over twenty federal owned universities in Nigeria yearly. The research process that results in the production of these outputs

involves a detailed literature review to support areas of the research study which means search and retrieval of information about theses and dissertations related to their research must be done to reduce or avoid, as much as possible, the issue of repetitive research and plagiarism. Despite the large turnout of these research outputs, postgraduate students face two critical challenges in the course of their research studies. Firstly, there is the issue of access to local content literature to build up empirical investigations and evidences. Secondly, there are repetitive researches because of the oblivion of researches conducted in other universities which usually wastes the researchers' time and resources when discovered. For instance, in 2016, a doctoral student's work in one of the universities under study was turned down at the proposal level after putting in much effort and resources over a period of two years. The reason given for the action was because the research study the student wanted to embark on, was already a finished research study in another university, and the student was fortunate that a visiting professor from that university was on the proposal panel, else he would have embarked on an already conducted research.

Schopfel and Soukoya (2013) opined that research might not be the political priority for most countries in sub-Saharan Africa, Nigeria inclusive due to significant social and economic challenges. They, however, agreed that there is a consensus effort for open access to scientific information to foster scientific development and integration with the global research community. This consensus effort yielded over twenty-five stand-alone IRs with ETDs in Nigeria (Open DOAR); fifteen of them owned by federal universities. However, with the advances in technology and the ever-growing effort to meet users' information needs in less time, these stand-alone repositories in Nigeria have not solved the challenges identified either. The situation thus remains the poor visibility and accessibility of these resources and a cycle of repetitive

researches in universities with postgraduate students claiming oblivion of research studies conducted in other universities.

The reason is that there is no uniform or integrated point of search interface or portal for ETDs in Nigeria, which is the application area for the problem. Also, there are technical issues with the repositories that to the best of the researcher's knowledge has not been reported in the literature. The Nigerian Research and Education Network (NgREN) launched a federated repository for Federal Universities in 2017, but this also did not help much because of limitations related with institutional policies and in Arlitsch and Grant (2018) opinion unwillingness to abandon local control. It is against this backdrop therefore that this study assessed the existing stand-alone repositories, recommended sustainability frameworks and designed a single web search system that allows for search and discovery of theses and dissertations in the stand-alone IRs the ETDs are domiciled.

1.3   Aim and Objectives of the Study

This study developed and evaluated a web search application that retrieves electronic theses and dissertations from institutional repositories of Federal University Libraries in Nigeria.

The following objectives achieved the aim of the study:

1. assess the policies, contents and system architecture of ETDS in institutional repositories (IR) of federal university libraries in Nigeria using the DELOS digital library model;

2. identify the sustainability challenges of institutional repositories in Nigeria;

3. develop a web search application that harvests electronic theses and dissertations from stand-alone repositories of federal university libraries in Nigeria;

4. perform a usability evaluation of the developed web search application;

1.4 Research Questions

The following research questions guided the study.

1. What policies, contents, and system architecture exist for stand-alone ETDs in repositories of Federal university libraries in Nigeria?

2. What are the challenges affecting the sustainability of institutional repositories?

3. What type of web search web application for harvesting ETDs in repositories can be developed for Federal university libraries in Nigeria?

4. Is there a statistically significant difference in the opinion of postgraduate students on usability of the developed web search application?

1.5   Research Hypotheses

The following null research hypotheses were formulated to guide the study and tested at 0.05 level of significance:

$H_0 1$- A statistically significant difference does not exist in the opinion of the postgraduate students in the three universities on the information query usability effectiveness of the web search application

$H_0 2$- A statistically significant difference does not exist in the opinion of the postgraduate students in the three universities on the information query usability efficiency of the web search application

$H_0 3$- A statistically significant difference does not exist in the opinion of the postgraduate students in the three universities on the usability satisfaction of the web search application

$H_0 4$- A statistically significant difference does not exist in the opinion of the postgraduate

students in the three universities on the transactional query usability effectiveness of the web search application

$H_0$5 - A statistically significant difference does not exist in the opinion of the postgraduate students in the three universities on the transactional query usability efficiency of the web search application

$H_0$6- A statistically significant difference does not exist in the opinion of the postgraduate students in the three universities on the transactional query usability satisfaction of the web search application.

1.6 Significance of the Study

The findings of this study will be beneficial to the following- postgraduate students, researchers, institutional repository administrators, university libraries, National Universities Commission, and experts in the field of library and information science.

The recommended sustainability frameworks and recommendations would assist university library administrators, and repository administrators sustain their repositories. The frameworks would also help university libraries yet to develop their repositories to avoid some of the pitfalls identified in this study and develop sustainable repositories. When fully implemented with live repositories, the designed web search system would effectively assist postgraduate students undergoing their research studies in the course of their literature search and help reduce duplicated researches.

The developed web search application can be integrated into the E-learning management platform of universities as a supporting information resource for students. University libraries in Nigeria can include same in their resource catalogue for their users and for accreditation purposes.

The findings of this study and the designed system will serve as a framework for Nigeria Universities Commission or any government agency that may be responsible for the design of a unified e-theses repository for universities in Nigeria in future. Similarly, institutional repository administrators in other institutions like Polytechnics and Colleges of Education can as well use the findings and proposed ETD policy and designed webware as a framework for establishing, developing and integrating their repositories.

Finally, the findings of this study would be an added contribution to the knowledge of information system design and implementation in the field of Library and Information Science.

1.7 Scope and Limitations of the Study

The contents scope in the repositories assessment were electronic theses and dissertations (ETDs). The research study did not replace or build a model repository. It worked with existing repositories to develop the search application.

The study also focused on federal university libraries in Nigeria, other private and state universities with functional repositories in Nigeria or other Nigeria were not included.

The population for the usability evaluation were Agriculture postgraduate students, other users (researchers, undergraduate students) were not included.

The methodological scope of the study was in the use of simulated stand-alone repositories in order to have total control on the workability of the repositories and achieve the aim of the research. This limitation makes the search application 'laboratory ready', thus cannot be deployed as a 'market-ready' research product.

1.8 Operational Definition of Terms

The following terms were operationally defined within the context of the work.

Electronic Theses and Dissertations (ETDs): These are the digital format of Masters and Doctor of Philosophy (PhD) theses and dissertations uploaded for use in repositories of federal universities in Nigeria.

ETD Repositories: They are digital archives for the electronic format of theses and dissertations in federal universities in Nigeria.

Informational Query Effectiveness: Level at which the developed web application is used to successfully access or get theses and dissertations in Nigeria universities.

Informational Query Efficiency: The ability of the developed web application to successfully access or get information about theses and dissertations without wasted effort or energy.

Informational Query Satisfaction: How fulfilled postgraduate students are with the developed web application in successfully accessing information about theses and dissertations.

Institutional Repository (IR): An archive or storage facility for the research outputs of academic staff and students of Nigerian universities which include journal articles, monographs, datasets, theses and dissertations and so forth.

Transactional Query Effectiveness: Level at which the developed web application is used to successfully retrieve or download theses and dissertations.

Transactional Query Efficiency: The ability of the developed web application to successfully retrieve and download information about theses and dissertations without wasted effort or energy.

Transactional Query Satisfaction: How fulfilled postgraduate students are with the developed web application in successfully retrieving and downloading information about theses and dissertations.

Postgraduate Students: These are students that have a first-degree and are studying for an additional degree or certificate in Nigerian federal universities.

Usability Evaluation: An assessment testing of the designed web search application to verify how usable it is based on efficiency, effectiveness and satisfaction.

Webware: Design of a web application that serves as a single point of access to ETDS in library repositories in Nigeria

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Conceptual Review

2.1.1 Concept of open access e-theses and dissertations

A meeting between University Microfilms International (UMI) dissertation publishing, VirginiaTech, ArborText, SoftQuad and the University of Michigan in 1987 heralded the initial planning for electronic theses and dissertation (ETD). The first ETD conference held in 1998, heralding the Networked Digital Library of Theses and Dissertations (NDLTD). According to Sengupta (2014), NDLTD is an international organisation whose objective includes adopting, creating, disseminating and preserving ETDs in diverse disciplines and languages and accessible through its union catalogue.

Today, ETDs and its repositories have spread across all the continents. The digital library and archives of VirginiaTech defined ETD as the electronic equivalent of postgraduate students Masters and Doctor of Philosophy (PhD) research findings, submitted as part of graduate requirements in support of higher degrees. ETDs have the advantage of worldwide accessibility to research and research data, streamlining the work of the graduate school, dynamic

presentation of research output with hyperlinks and multimedia files and reduce storage space for libraries. There are also drawbacks of intellectual property rights and interference of the publication of whole or parts of the theses or dissertation reported in the literature.

Electronic theses and dissertations can come in different formats, some of which are geared towards the long-term preservation of these digital resources. Sengupta (2014) mentioned that the VirginiaTech's recommended list of file formats include Portable Document Format (.pdf) for full text while PowerPoint Presentation (.ppt) and Joint Photographic Experts Group (.jpeg) formats are for additional tools and notices. File formats for images include Graphics Interchange Format (.gif), Tagged Information File Format (.tif), Portable Network Graphics (.png), Moving Picture Experts Group (.mpeg) and Quicktime (.mov.qt). Video file formats are Audio Video Interleave (.avi), Waveform Audio File Format (.wav), and Audio Interchange File Format (.aif) while MPEG-3 is the format for audio files. Other file formats stated were Zip files (.zip), Hypertext Markup Language (.html) and eXensible Mark-Up Language (XML).

One objective of digitising research findings besides accessibility is preservation. In the opinion of Prytherch (2009) preserving digital information resources involves retaining digital materials for long-term so that they can still be accessible even when there are advances in technology.

2.1.2 Development and management of e-theses and dissertation (ETD)   repositories

Development of repositories comes hand in hand with the digitisation process. The contents in an ETD repository are digital. Thus, the digitisation of the backlog of theses and dissertation must precede. Obafemi Awolowo University, Ile-Ife and University of Jos started the digitisation of theses and dissertations in Nigeria in 1980 and 1985 respectively (Baro *et al.,* 2014.) Since then, several universities have also joined the initiative. Baro *et al.* (2013) stated in their study of

twelve repositories in Nigeria that theses and dissertations formed the bulk of library resources digitised. University of Nigeria, Nsukka, as reported by Eke (2011) had deployed staff and technical infrastructure to aid the digitisation project in the library. Similarly, Anunobi and Onyebinama (2011) and Ibinaiye (2012) both reported the digitisation of theses and dissertation at Federal University of Technology, Owerri (FUTO) and Ahmadu Bello University, (ABU) Zaria, respectively. FUTO digitisation process was initiated under the DATAD initiative in Africa, while that of Ahmadu Bello University was initiated by the library management according to Ibinaiye (2012) when they acquired both hard and software to begin the digitisation of resources which included theses and dissertations and seminar presentations.

The development of repositories should be backed up with policies for its management, content recruitment and system operation. In 2008, an international workshop was held at ABU, Zaria which heralded the open access initiative in Nigeria (Okoye and Ejikeme, 2011). Another workshop which also increased the zeal to start up digitisation and repositories in Nigeria was sponsored by United Nations Educational Scientific and Cultural Organisation (UNESCO) for six university librarians on the use of the Greenstone open source software. Finally, two university libraries (Jos and Ife) provided a theses and dissertations digitisation model under the AAU-DATAD programme for ABU, Zaria library to start digitising its postgraduate research findings. (Eke, 2011). Although Eke (2011), Ezeani and Ezema (2011), Musa *et al.* (2014) and Akintunde and Anjo (2012) all reported the institutional repository initiatives in their different institutions, however, nothing about the policy statement of its establishment or content recruitment was reported. The recommendation of Uzuegbu (2012) that an African-wide policy on institutional repository creation by concerned institutions be adopted also gives an insight into the dearth of policies backing the establishment of institutional repositories (IR) in Nigerian

universities. Little wonder, the inconsistent path the repositories have taken.

Outside the shores of Nigeria, Ghosh's (2009) study differed from the stand-alone repository initiatives. This author examined the implementation of Indian ETD repositories with the intention of exploring the possibility for creating a national repository. Ghosh's study reaffirmed the importance of having a national repository for ETDs in India. The author identified some deficiencies in the coverage and availability of full-texts and abstracts of the ETDs managed by the Information and Library Network (INFLIBNET) of the University Grants Commission of India.

Wang (2014) illustrated and explained the process of implementing ETD programmes in a five-staged lifecycle. The ETD programme planning, according to this author, typically should consist of the setting up of a planning committee. The committee should be responsible for advocacy, policy formulation, proposing an implementation plan to mention but a few. The ETD creation, submission and ingestion consist of several workflows' ETDs go through from production to final archival. Access, archiving & preservation and evaluation are also crucial stages in the ETD lifecycle. The stages of implementing an ETD programme is presented in Figure 2.1 below
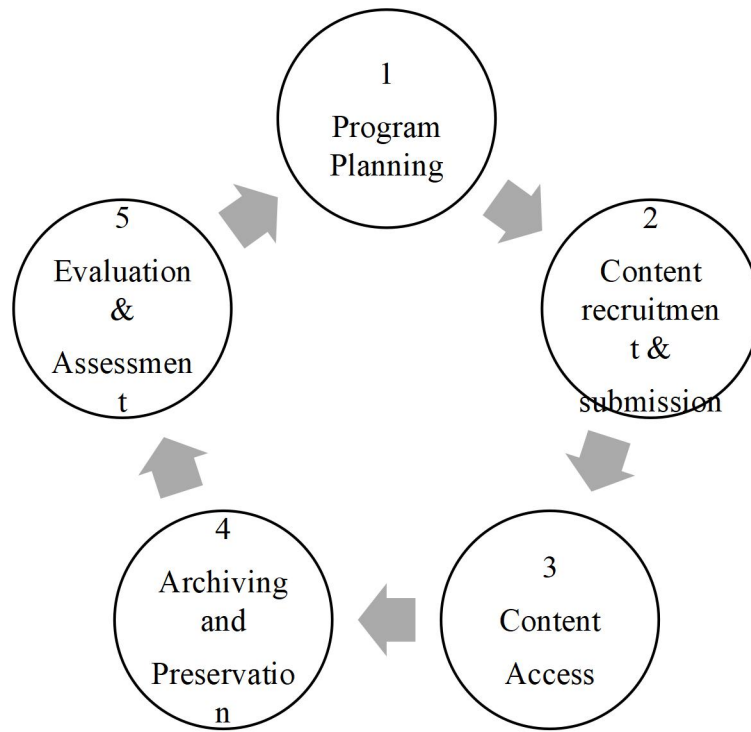
Figure. 2.1: Stages of Implementing an ETD programme (Wang, 2014)

Establishing and developing repositories does not necessarily mean that the contents are automatically in there. Contents are an essential part of the repositories, and so are the policies and practices adopted for managing the content in them (Gul *et al.,* 2015). Dubinsky (2014) also believes that one measure of the success of any IR is the volume and scope of its contents. However, content recruitment and management seem to be a challenge of IR administrators. In the opinion of Li and Billings (2011), content recruitment has been one of the significant issues faced by libraries and IR administrators to date as many IRs have experienced difficulties in content recruitment after their establishment. Nigerian institutional repositories are no exception. Li and Billings (2011) also examined scholarwork@Umass, the institutional repository of the University of Massachusetts, USA, to find out the content recruitment strategies used for its successful development. The aim was to come up with a model that institutions can use. The strategies used and discussed included but not limited to building a partnership with relevant

stakeholders of particular interest, creating a workflow for the graduate school and then evaluating the usage statistics. Another vital strategy employed was harvesting from existing repositories and databases.

Eight interoperability protocols within ETD repositories were assessed by Hakimjavadi and Masrek (2013) using some criteria. The assessment revealed that Protocol for Metadata Harvesting (PMH) was utilised more than the other interoperability protocols despite its limitations. However, ORE surpassed the other protocols in areas related to performance and functionality. Schopfel (2013) investigated what can be done to improve the quality of content and service provision in an open environment. The author's research-based review of communications of thirteen conferences on electronic theses and grey literature outlined five ways institutions can add value to the deposit and dissemination of ETDs. They include interoperability, format, metadata and services. The article reiterated the roles of recent IR developments like data and current research information systems (CRIS) could play in also adding values to ETD. The awareness of open access repositories has no doubt increased over the years with academic staff and institutions directly or indirectly keying and benefiting from open access resources. However, awareness, in many cases, does not necessarily mean active participation. For example, many institutions that were the early adopters of electronic theses and dissertation repositories have along the line reduced or stopped uploading contents to these repositories. Dubinsky (2014) observed that the mean monthly growth rate of newer IRs tripled that of the established IRs which should not be the case for e-theses and dissertations because of the institutional ownership, and so should be an advantage to help increase the content and web visibility of repositories.

Serrano-Vincente, *et al.* (2013) proposed a five dimensioned model with forty-eight indicators to assess Spanish institutional repositories. After perusing existing literature, the researchers established some assessment criteria for repositories. The criteria had five divisions and forty-eight sub divisions. Findings from their study revealed that 65% of Spanish repositories had the capacity of data interoperability with other university knowledge systems. Most (83%) of the repositories could import and export metadata and digital objects on a large-scale. 37% and 32% authors and librarians deposited most frequently, although 44% of the repositories had part-time staff. Majority (between 90-100%) of the repositories had full-text documents and marketing tools used in promoting the use of the repositories.

A comparison of university libraries repositories and ProQuest dissertation publishing system was carried out by Clement and Rascoe (2013). The study determined the characteristics common and diverse to both; thus providing valuable information and insights for repository managers. Findings from the study revealed that both systems had systems in place for content submission, content organisation, content archiving and dissemination of ETD contents. The two systems also had characteristics that distinguished it from the other. Thus, the researchers concluded that it was up to each institution's management to decide which of the two systems supports their institution's values, goals, mission and vision. The researchers advocated for an ETD single point where ETDs can be searched for and discovered.

Cayabyab (2015) systematically reviewed ETD initiatives, challenges and future developments. The researcher stated that although several global ETD initiatives were in existence, there was a need for more studies on ETD because of unmet goals of ETD initiatives, especially in developing countries. The researcher also cited references that were pointers to reasons for the

failure of ETD to include minimal access to ETD, policy issues, abandoned systems, and minimal contents added to the database since the initial take-off as identified with Nigerian repositories among others. This research assessed the Nigerian ETD repositories to identify underlying reasons for the unmet goals of the initiatives

Stephen *et al.* (2015) stated that the development of IRs were for the collection, preservation and dissemination of research findings from institutions of higher education. The high cost of developing and maintaining a repository that meets the individual needs of an institution thus compelled many libraries to opt for repository software that were open. Although there are proprietary and open software available for the development of IRs, open software seems more popular. From the literature, DSpace an open software was the most widely used for the deployment of repositories (Tmava and Alemneh 2013; Musa *et al*. 2014; Gul *et al*. 2015).

According to Sengupta (2014) the Directory of Open Access Repositories (DOAR) listed over 150 non-proprietary software used in the implementation of IRs. In the author's submission, for a software to be open, it must meet certain criteria such as open access of the software and source code and also open distribution of license which must be technology-neutral. Some common examples according to the author include Dspace, Eprints, Greenstone, Fedora, BPress, Digital Commons, Drupal, DoKS (Document and Knowledge Sharing), MyCoRe and ETD-DB software. It is worthy to note that many of these software were designed in collaboration with university libraries.

Different institutions and libraries have developed several types of access for ETD in their institutions. Universities Grants Commission of India (UGC) mentioned several types of access, which include the following:

(i). Worldwide/Open Access: This type of access allows content access from users anywhere around the world.

(ii). Intranet/Campus Access: For this type of access, only a set of users in the pre-determined or defined area is allowed access to the ETD contents.

(iii). Mixed Access: Mixed access grants a user access to parts of the ETD. There is also the temporary access where a user restricts access to the whole of the ETD for a particular period of time.

Suber (2008) strongly believes that in order to see a rise in accessibility and by extension impact of ETDs, open access must be embraced. The author stated that, although the perceived notion that there may be future challenges with publishing parts of ETDs was understandable, it was actually baseless. Ramirez *et al*. (2012) also stated that there was a difference between thesis submitted for publication and thesis submitted in fulfilment of higher degrees. According to the authors, many publishers now view ETDs with the lens of pre-prints because of the numerous significant editorials needed to meet up journal or conference standards.

2.1.3 System and network operations of ETD repositories

The Confederation of Open Access Repositories (COAR) working group report for 2011 stated that the value of OA lies in the management of repositories by tying them together in order to achieve aggregation, data mining and generating novel information from the contents available in the repository. Institutional repositories' visibility needs to be enhanced to enable connectivity and synergy which will allow access through different search interfaces. Initially, software that were accessed freely offered developers the flexibility of customising the platform to suit their individual needs, but over the years, these software have included many features which hitherto required customisation. Due to this upgrade, Bankier and Gleason (2014) opined that librarians

can genuinely make a comparison of these software based on attributes that meets their users' needs. These authors gave a comparison of the critical features of five major open repository software platforms, which will assist librarians to focus on features to assist their repositories.

Similarly, Biswas and Paul (2010) compared DSpace and GreenStone open source repository software. Three significant features of DSpace were its unique Lucene search platform and query language, its handle system and interoperability protocol. The search platform uses the syntax of exact term, fielded search, wildcards, Boolean search, proximity search, range search and fuzzy search. The OAI-PMH is used by service providers because it gives an understanding of the harvesting protocol. Greenstone open source repository software, according to Biswas & Paul (2010) has a unique feature because it suits both windows and Unix (Linux sun OS) and serves as a web server. It also includes an in-built administrative function that authorises users to ingest and encrypt new contents. Plug-ins like audio and video clips and also supports multilingual documents can also be developed. Greenstone had the advantage of building on efficient complete metadata searching and browsing features.

Another pertinent issue worthy of note is the system and network configuration of the repositories. Servers' configuration, software specification and customisation, metadata schemas and all that aids the synergy of repositories and other information management platforms especially search systems which increases the visibility of the repositories. According to Onaifo and Rasmussen (2013), the increased significance of having powerful visibility on the result pages of search platforms has brought to light the vital part that search platforms play in information seeking and retrieval. Thus, repositories developed for postgraduate students' use must be highly interoperable with search engines because this crop of researchers does not have

the time to search individual repositories; thus the first port of call is usually a search engine that can return results from these individual repositories.

According to Tmava and Alemnah (2013), open standards enhances interoperability between different institutional repository software platforms and search engines for effective indexing and search capabilities. The authors were of the opinion that with the diverse IR software(s) available, there should be a system collaboration support in order to provide access through diverse online search platforms. They also defined metadata interoperability as a protocol that eases information exchange between repositories and World Wide Web search. A point noted in Bankier and Gleason's (2014) comparison of major open-source software revealed that DSpace software which all the public universities repositories in Nigeria developed their repositories with had limited search engine optimisation (SEO). The limited SEO could be one of the reasons for the poor visibility of the contents from Nigerian repositories apart from the low content population.

Dublin Core schema is the most popular in repositories. However, according to Hogan (2014), there is a disconnection between Dublin core and search platforms like Google. These search platforms never make use of Dublin core, with the exception of Google scholar that uses metadata which expresses bibliographic citations accurately on a large-scale. Dublin core defaults in this area. Five categories of metadata problems were identified by Yaseer (2011). The metadata challenges that had to do with inaccurate vales and elements, misinformation, inconsistent information and inconsistent value representation.

Gbaje (2016) surveyed open access repositories that revealed that 90% of institutional repositories in Nigeria were developed using DSpace open source software; the remaining 10% were developed using EPrints. Corbett *et al.* (2016) opined that when considering a repository

platform to use for libraries, it should tally with the institution's repository goals and ambitions. A review on the comparison of open and propriety software for repositories by the authors revealed common factors why libraries opt for proprietary repository software to include the cost of purchasing and maintaining technical infrastructure and staffing and also the need to allow room for advocacy and populating the repository. On the other hand, flexibility and extensibility advantage in the customisation process and also interoperability skews libraries towards open access. The authors further noted that the distinguishing features between open and paid solutions have started to fade because of the availability of effective support services.

Massicotte and Botter (2017) investigated the extent of linkrot in an institutional repository within a period of four years to determine the degree to which the documents suffered from reference rot, that is, linkrot plus content drift. Of the six hundred and sixty four doctoral dissertations and eleven thousand, four hundred and thirty seven links examined, 77% of links were active while 23% of the links were not accessible. 77% of the links had mementoes links and approximately half exhibited content drift.

Angelova, *et al.* (2018) discussed a prototype system built on data extracted from the IR of Blekinge Institute of Technology (BTH), Sweden. The validation and evaluation of the system was based on the effectiveness of identifying and recommending relevant research areas of theses supervisors. Also, Geltner and Willinsky (2018) presentation was on the progress report of the key characteristics of ScholarlyHub, which was a system designed for the creation and funding of collaborating scholarship network of individuals and communities. The designed system connects different open access (OA) initiatives which the researchers reported lacked a visible and attractive frontend and are not currently interoperable.

According to Baro *et al*. (2014), erratic internet connectivity, absence of submission policies, funding and copyright issues were some challenges identified in Nigerian university libraries. The researchers further stated that if submission of theses and dissertations were not made mandatory for postgraduate students, the students would be unwilling to submit their work for digitisation. On the contrary, however, postgraduate students in Nigerian universities are mandated to their completed masters and PhD research findings to the postgraduate schools for onward submission to the university libraries. The point of order should be that the soft copies of these research findings be uploaded to the repositories. The mandatory submission of the e-copies would have gone a long way to ease the challenge of irregular electricity for digitisation. However, in other to achieve this, a content populating workflow should be in place in order to ease the process, which is one of the objectives of this study. Baro *et. al.* (2014) further recommended cooperation across universities on ETD management, which is also a focus for this study.

2.1.4 Usability evaluation of repositories

Over the last ten years, traditional libraries have been upgraded to Internet based digital libraries. Thus, the assessment and evaluation of novel digital library systems and services has been a struggle (Joo and Lee, 2011). The development of repositories had grown steadily over time as reported in the literature. However, with the development of any technology is the need for evaluation of such technology to measure satisfaction, effectiveness and efficiency of the system. Joo and Lee (2011) believes that there is no consensus on the definition of usability because of its multi-faceted nature.

Usability in the context of integrated repositories can be seen as ease and satisfaction of use of a

repository. Aziz *et al.* (2013) listed different usability evaluation models which have evolved. They include Eason Model, Shackel Model, Nielson Model, ISO 9241-11 and recently Quality in Use Integrated Measurement (QUIM). Seffah *et al.* (n.d) asserted that recently, usability evaluation has become the buzz term of different international standards, directives, and theoretical and empirical research. Several research studies have focused on expanding and developing usability models for evaluating different systems. The emphasis in evaluation studies has prominently system-entered evaluation without corresponding user-centred studies. Thus, Joo. *et al.* (2011) and Joo and Lee (2011) developed instruments for evaluation of academic library websites and digital libraries respectively using survey research design.

2.1.5 Review of integrated repositories and web search portals initiatives across the world

2.1.5.1 The networked digital library of theses and dissertations (www.ndltd.org)

This organisation promotes, adopts, creates, preserves and disseminates ETDs. They also enable knowledge sharing through e-publishing and open access. The organisation was founded in 1996 directed by an informal steering committee. When the scope widened and encompassed more institutions internationally, the organisation retained its acronym NDLTD and had a change of name to the Networked Digital Library of Theses and Dissertations.

2.5.1.2 British library E-theses online service (ETHOS)

This ETD online service was a replacement service that provided access and visibility for the United Kingdom graduate research outputs. The service started in January, 2009 with over 50,000 full-text theses available for immediate download within the first two years.

2.5.1.3 Digital access to research theses (DART-Europe)

The DART-Europe comprise of research libraries in Europe with a common goal of providing

and improving worldwide access to European research theses. This consortium also acts as the working group of the Networked Digital Library of Theses and Dissertations in Europe. They have a single search and discovery portal for the European ETDs and it is managed by the University College, London. The service also advocates to influence decisions on future European ETD implementations and developments.

2.5.1.4 DIVA (http://www.diva-portal.org/)

DiVA - Academic Archive Online is a web publishing platform that facilitates life-long preservation of publications of Swedish universities and colleges of education. It started at the Uppsala University Library as a discovery platform for research findings of students and scholarly publications written at 34 institutions. However, the EPC and participating universities and colleges manages the technical development.

2.5.1.5 Database of African theses and dissertations-DATAD

The poor visibility of Africa's research output onto global mainstream knowledge heralded the idea of DATAD. The idea started based on the recommendation of a pilot project assessment study in year 2000 to index, abstract, and disseminate theses and dissertations completed in African universities.

2.5.1.6 Malaysian theses online (MyTO)

MyTO is an ETD initiative established in 2005 as an integrated repository of theses completed in Malaysia with the aim of sharing the collection between academic libraries in Malaysia electronically. Three private libraries and all government owned libraries participated in the project with the objective of developing a system for the management, storage, preservation and dissemination of theses collection into a central repository to ease item access by the university community.

2.1.5.7 Shodhagaga – National ETD repository of India

The Universities Grant Commission of India mandated uploading of ETDs by postgraduate research students in universities to facilitate open access and visibility. It was set up using DSpace to help doctoral scholars deposit their thesis and make it accessible. The repository can capture, index, store, preserve and disseminate ETD submitted.

2.1.5.8 PQDT OPEN ProQuest digital theses (http://pqdtopen.proquest.com/)

PQDT OPEN provides free access to the full text of open access theses and dissertations in PDF format. ProQuest also has a subscription-based database of theses from all over the world.

2.1.5.9 International information systems for agricultural sciences and technology (AGRIS)
AGRIS is a public domain repository with over 10,000 records including theses and dissertations on Agriculture science and technology. AGRIS is managed by the Coherence in Information for Agriculture Research for Development and has contents provided by over 150 countries from 65 countries. AGRIS usually doesn't link to full text but provides bibliographic information about the language, location and title of thesis title.

2.5.1.10 Regional universities forum for capacity building in agriculture (RUFORUM) knowledge repository

RUFORUM supports the studies and associated research of regional masters and doctoral students in a number of programmes. These research findings of the students are placed in the knowledge repository of RUFORUM. Ten universities in Nigeria are members of RUFORUM, however, the theses from these universities are not reflected in the repository.

2.5.1.11 Nigerian research and education network (NgREN) federated repository

The Nigerian Research and Education Network Federated Repository (NgREN) launched a federated repository with assistance from KnowledgeArc in 2017. The archive brings together

the works from 42 different DSpace instances in the country and provides a hub to showcase and highlight the intellectual output of Nigeria's universities. However, this hub lists the repositories in a glossary form than a central search hub, especially for theses 1and dissertations which is the focus of this study.

2.2 Theoretical Framework

The theoretical framework used for the assessment study and usability evaluation in this study are discussed in the sections below.

2.2.1 Network of excellence on digital libraries (DELOS) digital library reference model

Digital libraries have different models and frameworks developed to guide the implementation of digital libraries which will meet the information needs of various users. (Isah *et al.,* 2013). Two well-known evaluation models for digital libraries are DELOS Reference Model and 5S Theory The concepts of the DELOS model focuses more on the development and implementation stage of digital libraries while the concepts of the 5S model resonates with well developed and implemented digital libraries. The DELOS model is one of the prominent models that have been developed to address challenges generated from the implementation of digital libraries. Six core concepts defined in the model provides the base for digital libraries; they include content, user, functionality, quality, policy and architecture. Isah *et al.* (2013) opined that the DELOS digital library reference model as a conceptual framework designed for the development of appropriate digital library systems. In their opinion, the model also addresses the entities and their relationship in the digital library universe.

Six domains defined by this model include-

i. Contents: this includes all the information objects a digital library contains. Contents include not just objects but data and metadata.

ii. Users: This concept covers the various players that interact with the digital library.

iii. Functionality: These are the services a digital library can offer its users.

iv. Quality: Encompasses the parameters that can be used to assess the functionality of system.

v. Policy: Includes regulations that influence the use of the digital library and its users.

vi. Architecture: Refers to the system entity, and this includes the hard/software components of a digital library. According to Candela *et al.* (2007) architecture is a core concept because of the complex forms of a digital library and because interoperability across digital libraries is essential. The DELOS reference model comprises a three-tier framework: Digital Library (DL), Digital Library Management System (DLMS) and Digital Library System (DLS) and is presented in Figure 2.2 below.
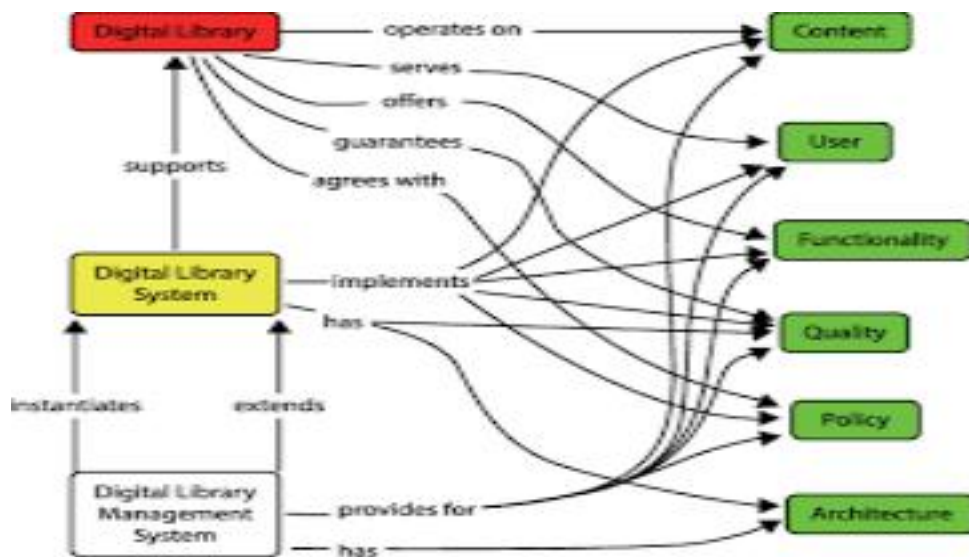
Figure 2.2 DELOS Reference Model Concept Map (Candela *et al.* 2011)

The DELOS digital model is appropriate for this study because one of the tires of the framework can align with management of contents in the digital library. However, despite its attempt at shaping and unifying the development of digital libraries, application of all the concepts of the

model in assessment studies, especially with digital libraries in developing countries is difficult. Isah *et al.* (2013) noticed this limitation in the dearth of researches on the application of all the concepts of the model. The nature of institutional repositories which are the digital libraries/storehouses of ETDS in developing countries like Nigeria are still relatively in the development and implementation stages and thus the appropriate model for this study. The assessment of ETD initiatives using this model would guide ETD repository managers towards better-managed repositories.

This study is based on one tier of the framework, which is the digital library management system. Although it provides for the six domains, this study adapted three domains- contents, policy and architecture. This study exempted the other three domains because the focus of the other domains are on well-established ETD repositories and may not generate comprehensive data. For instance, the functionality domain is about the features a digital library software can offer its users. All of the repositories investigated used DSpace open-access software and thus had uniform information object registration, search and browse services. Including this domain would mean the study investigating the functionality of DSpace software for preserving the ETDs, which is not the focus of this study. On the other hand, several studies (Hinmikaiye, 2015; Mohammed *et al.*, 2019; Valde, 2016) have investigated the quality domain of repositories. The quality domain focuses on the resources and services provided by repositories. Findings from researches that focused on the quality domain revealed poor quality services. The challenges attributed to the poor quality services of repositories is one of the reason for assessing the repositories which this research study conducted.

Heradio, *et al.* (2012) defined the term 'user' in the digital library context using the DELOS model as the following- Digital Library end-users that can be the content creators or consumers.

The authors reviewed the literature on quality evaluation of digital libraries based on the user's perception, limiting their survey to content consumers. Their review concluded that evaluation of digital libraries from the users' perspective is readily available in the digital library community. However, the researches in that area seemed to be at an early stage. This statement can be said to be true because digital libraries are still evolving with many systems and architectural entities. It is even far worse in developing countries that are still grappling with basic infrastructural challenges to keep these systems functional and thus users' perceptions can hardly be sought on systems they hardly use. Even in the developed world, a consensus has not been reached on standard evaluation definition for usability and usefulness of digital libraries (Heredio *et al.,* 2012). This study adapted the following DELOS concepts –policy, contents and system architecture.

2.2.2 Usability evaluation models

Formative and summative evaluation are the two classifications of evaluation according to Assila *et al.* (2016). Hartson *et al*. (2003) defined formative evaluation as an evaluation that that pays attention to challenges that needs to be tackled during the preliminary design stage before a final design version is released. On the other hand, summative evaluation focuses on the usability assessment of the final design. A peruse of research studies on human-computer interaction (HCI) usability evaluation revealed significant studies on subjective and objective methodologies. Objective methods as captured in these studies the use of the system's analytic data which does not directly involves interaction with the users. Subjective evaluation focuses more on perceptions, attitudes and judgments of users based on the assessment of the system.

This part discussed several usability evaluation models, and the factors common to them all

formed the basis of the usability evaluation metrics of this study. They include Eason Model, QUIM Model, Shackel Model, Nielson Model, and the ISO usability models.

2.2.2.1 Eason usability model

Kenneth Eason proposed this model in 1984. According to Madan and Dubey (2012), Eason grouped usability into three parts based on their independency on the platform of the task performed- Task, User and System. Task, User and System have two, three and three sub-attributes, respectively (Aziz *et al.,* 2013). One major challenge with the Eason Model is that the model cannot is only effective with the subjective assessment which means users and their target task must be considered.

2.2.2.2 Shackel model

In 1991, Brain Shackel designed the Shackel Model with four (4) features namely attitude, learnability, flexibility and effectiveness. (Aziz *et al.,* 2013). The constructs in the model were adapted by Booth who included learnability (or ease of use), attitude (or likeability), usefulness and effectiveness. Booth expunged flexibility because in his opinion, it was challenging to assess the flexibility of a system. Instead, he included usefulness as fundamental to usability (Madan and Dubey, 2012)

 2.2.2.3 Nielson model

 Jakob Nielson developed Nielson Model and focused on system acceptability. The model concentrates on the assessment of the user interface of software engineering projects (Aziz *et al.,* 2013). The primary construct for Neilson model is system acceptability and usability. The authors also listed five other subjective and objective attributes such as easy memorability, few error, learnability, satisfaction and efficiency. Madan and Dubey (2012) grouped the system acceptability into practical and social acceptance.

2.2.2.4 International organisation for standardisation (ISO) 9241 – 11

The ISO 9241 according to Aziz *et al.* (2013) is an international standard for guidance on usability based on process-oriented. ISO 9241 gave a model consisting of three attributes; they are satisfaction, efficiency and effectiveness. Satisfaction is a subjective construct from the users perceived point of view, effectiveness describes the assessment form the process interplay while efficiency focuses on assessment of outcomes of the system features (Madan and Dubey, 2012). Unlike, Eason model that focuses on subjective measures alone, ISO 9241-11 has objective assessment measure but has a disadvantage of been abstract according to Aziz *et al*. (2013).

2.2.2.5 International organisation for standardisation 9126

International Organisation of Standardisation 9126 is an international standard that focuses on the advancement of software quality from the viewpoint of the system or product (Aziz. *et al*., 2013). The usability attributes of this model are usability compliance, learnability, operability, attractiveness and understandability.

2.2.2.6 Quality in use integrated measurement (QUIM) evaluation model

In 2006, Ahmed Seffah and a group of other researchers designed the Quality in Use Integrated Measurement (QUIM) model. The model combined the different usability evaluation standards and models into a single model. Aziz *et al.* (2013), stated that QUIM summarises the procedures for setting up quality conditions as well as the identification, validation and implementation of quality product and process metrics. The researchers also asserted that the model is suitable for beginners, although assessment experts and non-experts can also apply the model. QUIM model has 10 constructs and subdivided into 26 measurable benchmarks, with 127 specific metrics. A significant limitation of the model is the invalidation of the optimality of the complete model

(Aziz *et al.,* 2013). However, researchers have adopted, adapted and expanded these factors to suit the context of their work.

Table 2.1 gives a summary of the usability evaluation models reviewed and the factors common to the reviewed models. This study adopted the constructs common to all the models. The other constructs learnability, productivity, understandability to mention but a few that were expunged did not fit in the context of this study.

Table 2.1: Summary of Some Usability Evaluation Models

S/N	Models	Constructs	Constructs common to the six models
1.	Eason Model	i. Task (Frequency, Openness) ii. User (Knowledge, Motivation, Discretion) iii. System (Ease of Learning, Ease of Use, Task Match)	No construct is common to all of the models. However, this study used the model (ISO 9241-11) that contains constructs
2.	Shackel Model	Effectiveness, Learnability, Flexibility, Attitude	common across the models (Effectiveness,
3.	Nielson Model	Learnability, Efficiency, Memorability, Error, Satisfaction	Efficiency & Satisfaction).
4.	ISO 9241-11	Effectiveness, Efficiency, Satisfaction	
5.	ISO 9126	Understandability, Learnability, Operability, Attractiveness, User compliance	
6.	QUIM	Effectiveness, Learnability,	

Efficiency, Satisfaction, Productivity, Trustfulness, Safety, Accessibility, Usefulness and Universality	

2.2.3 Conceptual framework for the study

The first conceptual framework was adapted from the DELOS digital library reference model using three constructs and is presented in Figure 2.3 below.

The operationalisation of the concepts in this framework are:

Policy- These are statement plans or ideas on the implementation of ETD initiatives in Nigerian repositories that specifically guided the acquisition, organisation and dissemination of ETD contents.

Contents- Management of the ETD contents including types, copyright issues and accessibility.

System Architecture: storage servers and interoperability with other digital library software(s) globally.
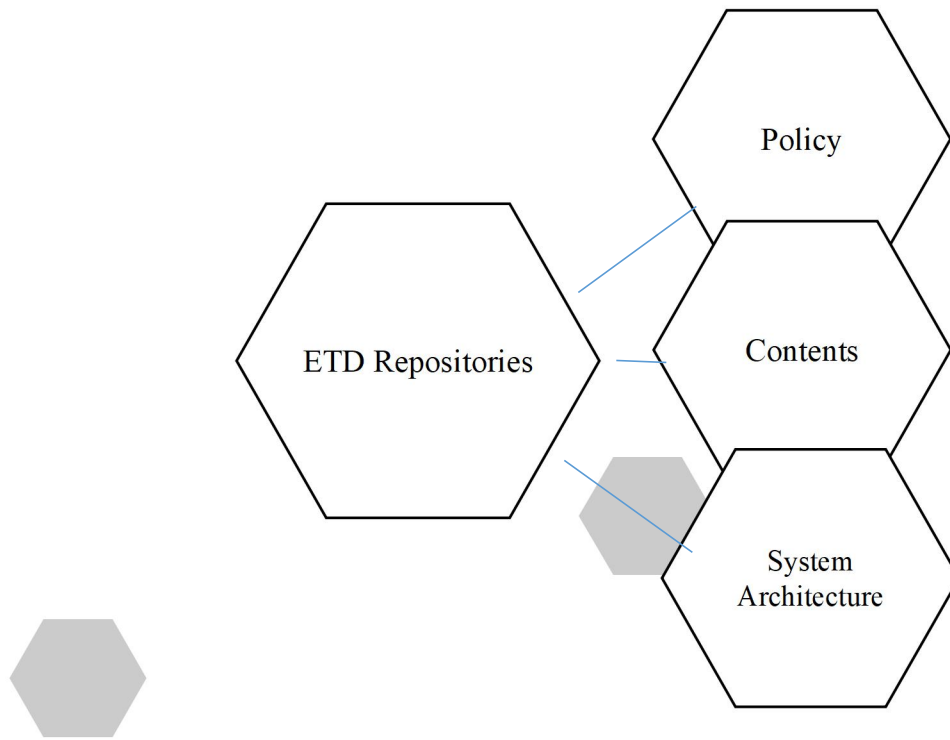
Figure 2.3: Conceptual Framework I

The second framework presented in Figure 2.4 below adapted the constructs found in the common to all the usability constructs discussed under the theoretical frameworks, and they are-Effectiveness Efficiency and Satisfaction. The study introduced informational and transactional query constructs as a basis for usability evaluation.

The conceptual operationalisation of the variables in the second framework are:

Dependent Variables

Informational and Transactional Query Effectiveness: Level at which the developed web application successfully access, retrieve and download information about theses and dissertations in Nigeria universities and give desired results to postgraduate students.

Informational and Transactional Query Efficiency: The ability of the developed web application to successfully access, retrieve and download information about theses and dissertations without wasted effort or energy.

Informational and Transactional Query Satisfaction: How fulfilled postgraduate students were with the developed web application in successfully accessing, retrieving and downloading information about theses and dissertations.

Independent Variables

Universities of postgraduate students
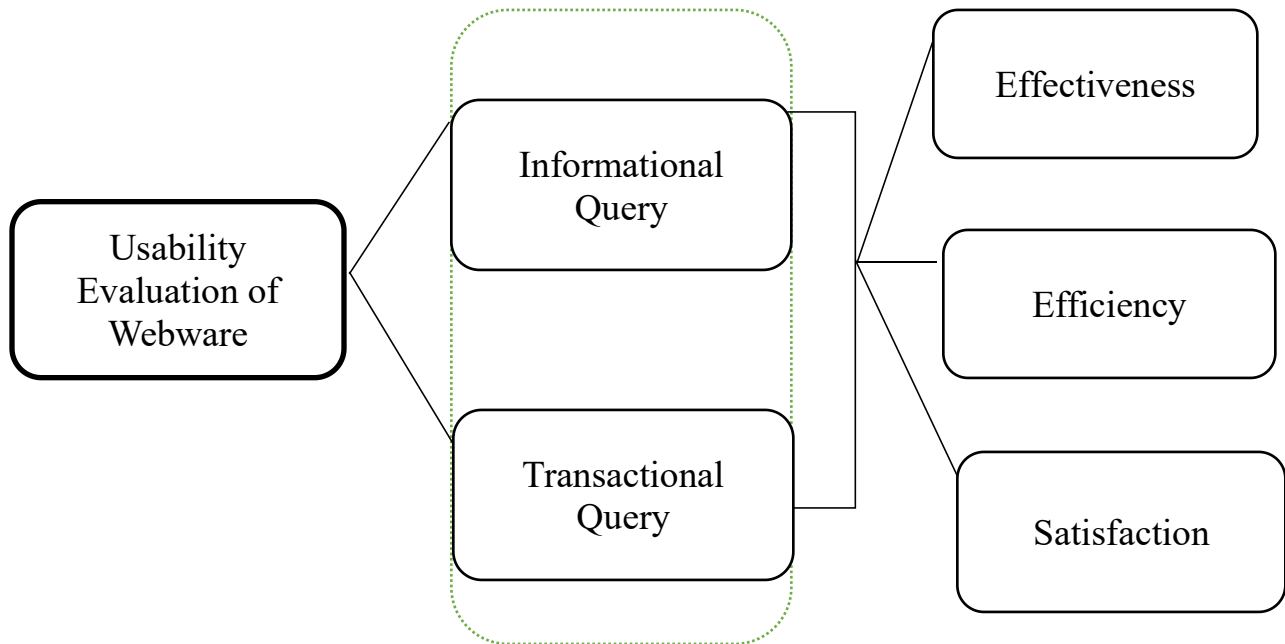
Figure 2.4: Conceptual Framework II

2.3 Review of Related Empirical Studies

Mikeal, *et al.* (2007) explored the development of a unified submission system for ETDs in Texas Digital Library. A proposal heralded a common metadata standard represented by a MODS XML schema in order to facilitate the creation of this federated collection. Also, a common ingestion or submission tool for the ETDs was needed to collect metadata in a consistent and authoritative manner. This submission tool was achieved by analysing the ETD workflows of six universities and identifying a meta-workflow with three stages- ingest-verification-publication. Limitations of the ingestion tool noticed were ambiguity in the interpretation of the schema,

format consistency in certain descriptive metadata elements and name resolution issues. This research adapted the methodology of Mikeal *et al.* for the content populating workflow.

Mohd-Yusuf (2008) wrote an in-depth article on the project phases of the Malaysian theses online (MyTO), which is the centralised national repository for e-theses in Malaysia. The researcher stated three main phases and stages of the successful implementation of the stages. The phases were designed using the waterfall model of the software development life cycle. The system development phase which was the first phase took six months of development while in the metadata phase theses metadata were converted from the management system database of the library to the MyTo system. For the third and final phase, libraries uploaded theses content into the MyTO system. MyTO according to Mohd-Yusuf (2008) was designed with open software while PHP programming language and MySQL database management system were used for system development and to store the theses respectively all of which runs on Apache webserver. In order to make the central repository operational, data conversion and standard metadata adaptation were outlined. The features of MyTO unified system that facilitated users include but not limited to the following: Browsing feature that specified the location of resources availability-this includes the university name and total number of theses in that university. Also, the system included an advanced search query that used a combination of search criteria.

Ghosh (2009) proposed a model for the successful management and distribution of ETD archives in India intending to have a national ETD repository. The researcher proposed that four zonal databanks provides data while a central agency provides the service. Participating universities would be either data providers or ordinary members. Standard and tools to support local developers would be between the central agencies and the zonal data banks. It was further

proposed that in order to maintain quality collection, specific institutions were encouraged to provide data. A significant advantage that facilitated Ghosh's proposed model was the use of only selected elite institutions, which could be justified because the proposed model was a test model before full implementation. A limitation, however, was that the infrastructure components for the proposed model were overwhelming with the zonal data banks. A system for Nigeria repositories would be sustained better with fewer infrastructures to maintain. The web search application used fewer infrastructures since maintenance of infrastructure is usually an issue in Nigeria.

Building on the proposed framework of Ghosh (2009), the University Grants Commission, through the Information and Library Network of India (INFLIBNET) handled the task of implementing and creating the national Indian ETD repository- Shodhaganga. Sheeja (2011) reported that the development of Shodhaganga started as a system for improving research quality in India. In addition, the system was also designed to provide access to Indian theses as well as acting as a digital archive. The Shodhaganga project started with the signing of a memorandum of understanding between the participating universities and INFLIBNET. INFLIBNET built a single server to harvest the metadata that are OAI-PMH compliant from all stand-alone repositories using DSpace software. The content population, as reported by Sheeja (2011) was either through harvesting from the universities or submission by individual scholars, supervisors or university representative. However, the latter required permission from INFLIBNET. The workflow for the unified repository permits the creation of metadata by the theses submitter while the INFLIBNET staff acts as the metadata editor that verifies for completeness and correctness. The gap between Sheeja (2011) and this research study was in the mode of implementation.

Koulouris and Anagnostopoulos (2010) described the electronic ingestion tool for theses at the Athens National Technical University (NTUA). The e-submission tool provided three access policies based on international practice- the WWW free access, the intranet access and the no access. The tool acted as a proxy between the NTUA digital library and the end-user and was based entirely on open source technology, Postgres RDBMS acting as the persistence layer, Sun Microsystems Java as the business layer and the JSP framework as the presentation layer. The strength of the tool was in the automatic reversion of access after the embargo access period is over, from intranet access to free access after one year, and no access to intranet access after one year. The limitation of the tool, however, is that it does not support the full standard controlled vocabulary prototype like the Library of Congress subject heading.

Kathuria *et al.* (2010) investigated the categorisation of 130,000 web queries. Findings from the study revealed that over 75 % of web queries were based on informational queries, while 12% of the web queries represented navigational and transactional queries respectively. Corradi *et al.* (2012) defined and implemented a data system that could support the collaborative and multidisciplinary research projects in neuroscience. A repository was built based on the data model. The platform was not scalable for robust and general neuroscience experiments. The system also required a more robust evaluation.

A pilot study by Alam and Pandey (2012) developed a prototype model (GeoTheses) to for the design geoscience theses union catalogue. The system was designed using Greenstone digital library software, Apache, PERI, and JRE and could be used both offline and online. It also provided a central interface for subject and keywords browsing and an interface for document request. However, the focus of the system was in bibliographic information of Geosciences

theses and not a full-text retrieval system. The model also used only a few samples and thus could not be used for generalisation.

Xin, *et al*. (2012) designed a methodology for assessing geoportals based on the ISO 9241-11 framework. Users provided feedbacks in an organised way which gave the developers of geoportals the necessary validation instruments for the features and layout in order to identify challenging parts that could be improved upon.

Miah *et al.* (2012) proposed a prototype mashup application for the business problem using action research. The authors stated that since customer demands changes in the business realm, there was a need for innovative use of new technologies like mashup, which was a limitation of the current web development. Technique architecture provided a conceptual model for particular implementation, one of which was prototyped using iGoogle. The system was evaluated to show the effectiveness of the technique. Results showed that usefulness and ease to use were positive.

Ivanovic *et al.* (2012) article which was part of a research project for University of Novi Sad, Serbia described the implementation of a digital repository of ETDs within the current research information system (CRIS). The implementation was based on open-source components which had a system architecture that allowed a smooth interoperability with other systems. Storage of metadata about theses and dissertations were in the MARC 21 bibliographic format. The system was interoperable with ETDs metadata with other CRIS systems, IRs, the NDLTD network members, and LIS. Ivanovic *et al.* (2012) research project was an integration of systems. This research differs in the type of system integration.

Por *et al*. (2012) proposed and developed a prototype that uses the integration of ETD and data

grid technology to alleviate the issue of expandability in Malaysian ETD repositories. The authors recommended a grid-enabled ETD repository system to allow remote and centralised access to knowledge management between the diverse platforms and repositories. An evaluation of the stand-alone repositories in Malaysia revealed challenges such as scalability, expandability, management, and integration of heterogeneous operating systems and data types and lack of uniform search browser. The evaluation also identified limitations with existing open-access software like DSpace, Greenstone, Alchemy web server. Their proposed system was thus able to alleviate usability issues and customise interfaces based on user authority. They further recommended improving the grid system to be able to identify relevant resources, especially when the contents are massive.

Andersson and Svensson (2013) reported that how the National Repository of Sweden DiVA was designed. A well-prepared pilot study of stand-alone institutional repositories preceded the repository development which facilitated the technological design. The first system was to focus on publishing doctoral theses; a well-defined content workflow thus initiated populating the system. However, an expansion of the DiVA scope took place based on the need for bibliometrics and assessment of Swedish research. The host University for the DiVA server was the Uppsala University Library which also acts as the organisational and technical hub. The over thirty-four participating universities, research institutes, and museums contributed to the system design adapting some features and system layout locally.

Andersson and Svensson (2013) also evaluated the DiVA system based on the Finch report. The researchers addressed the technological and organisational criticism of IRs raised in the British Finch Report of 2012. The researchers indicated that the DiVA Consortium had been working on

some challenges in the area of search engine optimisation, infrastructure and preservation, content and publishing and bibliometrics. To enable the visibility and consequently, the number of downloads through search engines, the DiVA administrators facilitated the crawling of the repository contents by adding HTML (Hypertext Markup Language) metadata and using sitemaps. The authors reiterated that 75% of DiVA visibility or referral was linked to GOOGLE and interestingly not library portals or catalogues. The finding implied that facilitating the indexing of repositories by search engines indexing was essential to improving the visibility of repositories. A point that increased the visibility of DiVA was the inclusion of HTML metatags. This point corroborated the findings of Arlitsch and O'Brien (2012) in their study of repositories across the United States of America. Their study revealed that repositories that use Google Scholar metadata schema expressed as HTML metatags experienced higher indexing ratios.

Roy (2013) developed a standard institutional digital repository model and formulated a policy for the University of Burdwan, India. The repository had a multilingual data processing provision with the Bengali language-based interface including additional utilities like federated search and standard subject access system. The researcher also developed a policy model following several standards and open-source software in line with global recommendations. However, the scope of the guidelines used to come up with the policy model was restricted to policies registered in the archive policy database of Registry of Open Access Repository.

Onaifo and Rasmussen (2013) exploratory study examined search engine optimisation (SEO) as a means for improving the visibility of e-contents from Canadian libraries' on the web. The researchers used tools for web analytics for data collection. In addition, the study investigated multiple characteristics from websites which has an effect on the results pages of search engines.

They further investigated and found that a relationship exists between the amount of daily page view received and the website pages a search engines indexes. Although the study used empirical methods of statistical tools to investigate libraries utilisation of search engine optimisation, its non-inclusion of academic libraries was a significant limitation. Also, the tools used found it challenging to identify the exact type of webpage analysed (library designed webpage or content page of repositories digital collection).

Al-Juboori (2014) designed an electronic library discovery system containing books and theses using PHP, MYSQL, APACHE, Windows Apache, My SQL and PHP (WAMP) server. The system had a search-system side with the database and the digital library interface side for the users. Using related knowledge resources based on semantics relationship analysing information and structuring of systematised knowledge based on their attributes, characteristics, and meaning, the researcher devised a direction of narrowing the many search results returned from searches. The aim of the proposed system for this study intends to include both submission and retrieval from and of different repositories.

Simpson (2015) used quantitative correlational research and design science method to design, implement and evaluate a web-based repository. The methodology used in Simpson's study is similar to the methodology of this research study; However, Simpson's study did not field-test the prototype, which was a limitation. Over half of the participants used in the system evaluation also did not have prior experience in immersive virtual environment.

Mishra and Singhal (2015) presented the architecture of a specialised search engine using mobile crawling agents. They posited that an agent-based solution would reduce the unnecessary overhead of returning unnecessary pages to the search engine site. The author's proposed system

used a migrating crawler in a specialised search engine which they envisaged would reduce network traffic since it would only crawl the percentage of documents on the webserver that are of use and not all the documents on the remote site. The mobile agents navigates web to a list of selected Universal Resource Locator (URL) of servers to retrieve documents. This proposed study would adopt technology similar to these authors since the web crawler would search the URLs of Nigerian universities institutional repositories.

Georgas (2013) study investigated the perceptions and preferences of research students using h Google and a federated search tool. The findings revealed that although the students could locate relevant sources using both tools, there was a general preference for the federated search tool. The author concluded that although federated searching had limitations, there was a preference for it. Thus, libraries must continually offer this service and also focus on training students on the use of discovery tools.

Keerthana and Aby Abahai (2015) proposed a meta-search engine to overcome the limitation of searching on a single search engine which cannot index the entire web resources. However, according to the authors, the aggregate results of searching on multiple search engines are not always better. Their study thus proposed a new page ranked algorithm called modified ranking for ranking and optimising the search results based on their relevance and popularity. The metasearch engine comprised the following systems- metasearch engine, graphical user interface, query formulator, metacrawler, redundant URL eliminator, modified ranking, and result regeneration. The system architecture was built using four search engines- Google, Yahoo, Bing, and Ask. Adobe Dreamweaver was used to develop the system-PHP for the front end and MySQL server for the back end. XAMPP Apache distribution was used to link the front and

backend together.

Termens, *et al.* (2015) study analysed the formats of contents in two open repositories in Spain in order to determine the long-term preservation implication of these formats. The study revealed that no alignment existed between the preservation policies of the participating institutions, the technical devices available, and the preserved contents files. However, the two repositories studied were developed based on DSpace software. Roy, *et al.* (2016) study reported the design of AgriCAT which is a unified search interface. The interface eases content discovery and sharing through the interoperability of agriculture institutional repositories that are complaint with the OAI-PMH. The aim of the design was to improve access and visibility of Agricultural researches from India.

Corbett *et al*. (2016) discussed the platform selection issues of repository software. They posited that it was necessary to evaluate existing systems when choosing or implementing new systems. The authors also gave some common factors from the literature for choosing commercial repository Libraries that selected open-source from the literature noted some challenges with customisation, extensibility, flexibility and interoperability. Mustafa (2014) adapted usability factors and criteria in the QUIM usability framework to come up with a model that would find out whether there is a correlation between accessibility and usability of websites. Similarly, Aziz *et al.* (2013) suggested a website assessment model based on QUIM model. Also, the researchers compared and analysed existing usability models and identified the evaluation criteria and characteristics for websites. They, however, did not come up with tools for the empirical assessment for the model.

The website of the central library of Delhi University was evaluated by Pant (2015) using six

usability attributes. According to findings from their study, respondents revealed that the website had information resources that were useful. They, however, reported inadequate help provision for resources available through the website. The researchers, therefore, recommended sustainable assessment for the website. Moumane *et al.* (2016) used the experimental assessment methodology to assess mobile apps. Their empirical evaluation focused on ISO 25062 and ISO 9241 standards, and they primarily evaluated how some constraints with mobile app affects the usability of such apps. The 32 participants performed specific tasks and data was collected for the experiment through direct observation video recording and questionnaires filling.

In Nigeria, Ademola *et al*. (2013) research project was to design and develop a portal that manages the workflow research projects. C# sharp language, HyperText Markup Language (HTML), ASP.Net & My SQL programming languages were used to write codes for different sub-modules- active server pages, front end and database management records. The study automated the bibliographic control of researches done in the department; however, the scope was limited to a department. The web application, when implemented, could control the bibliographic control of researches in Nigeria and would be web-based, rather than intra-networked.

Abba (2014) implemented an IR in a University of Technology, Minna with an open repository software to efficiently archive and store the scholarly output and digitised theses of the university. The functionality of the system includes the ability to register and authenticate users, upload digitised contents such as research publications and theses.

Aruleba *et al.* (2015) presented a novel approach for retrieving relevant information on the web using a breadth-first search algorithm. The system was then evaluated using recall and precision

model. The proposed system according to the authors was developed and implemented using PHP programming language. Results from the evaluation study using fifteen students from three departments (English, Computer Science & Mathematics) revealed swap between recall and precision values which had a lot to do with query formation skills of the students. Firstly, the authors indicated that the system was using the library e-resources, but after the evaluation, results indicated a search on the Internet. Secondly, the assessment was subjective, thus the trade-off between precision and recall rates.

Mohammed and Yousef (2015) study explored an evaluation and comparison model for two unified search devices using different retrieval protocols. A suggestion by the researchers was for the assessment model to be in three parts. 20 participants used think-aloud protocol for the usability testing. Results indicated no statistically convincing difference between the two search devices. The researchers indicated that the results of their study and the proposed framework can help unified search developers improve the performance of devices.

Omame *et al.* (2019) evaluated the usability of web search system based on navigational queries. Twenty one respondents evaluated the usability of five Internet based search systems. The study revealed no statistically convincing difference in the effectiveness of the five search systems based on navigational queries.

Lewandowski (2015) compared the retrieval effectiveness of Google and Bing using a sample size of 1,000 informational navigational queries from German search system. An assessment software was used to collect data and the jurors were crowd-sourced. Findings from the study revealed an outstanding performance of Google for navigational queries while the difference in performance for informational queries was low. The navigational query was expunged in this

study because they cannot work effectively with the federated search tool, which is the aim of this study.

Aruleba *et al.* (2016) studied the existing library retrieval system at the University of Ilorin library and used data in real time to design a digital library system. The designed system had a database and a user interface and was developed and implemented using PHP and MySQL technology. The system improved on the library circulatory and online public access catalogue (OPAC) system by designing a system where the full-text of a requested book can be downloaded or read online. Thus, the user must be registered with the library before the full-text book can be accessed.

Ndubuisi (2017) research study developed and validated a digital repository model for Energy Research Centers in Nigerian Federal universities. Using a modified R & D model of Gall *et al.* (2007) digital library assessment framework, the author designed a digital repository model for the digital collections of the six energy commission research centres in Nigerian universities. The focus of the researcher's work was on building a central intranet and Internet repository because of the non-existence of digital repositories in the libraries of the Energy research centres. This present study differs from the above in the areas of focus and methodology. The focus of the present work is on ETDs in existent repositories, and the methodology is not to build a central repository but a central search system to retrieve results from the stand-alone repositories.

2.4 Summary of the Literature Reviewed

A peruse of existing literature on assessment of IRs in Nigeria specifically indicated that the repositories were stand-alone with no existing initiative to the best of the researcher's knowledge to integrate these repositories. From the perused global literature on the assessment or evaluation of IRs, of the many studies published to date on the assessment indicators identified from

existing literature; several researchers have used different assessment criteria for assessing their IR initiatives based on what is obtainable in the domiciled environment. From the literature reviewed, the DELOS digital library reference model has been used for the design and development of repositories. However, to the best of the researcher's knowledge, no study used parts or all of the concepts for assessment or evaluation of already designed repositories.

Another major factor identified in the literature reviewed was the lack of in-depth assessment study of the stand-alone repositories in Nigeria even when research studies have revealed poor visibility and use of these repositories. Studies by Baro *et al.* (2014), Eke (2011) and Anunobi and Onyebinama (2011) only focused on the digitisation efforts of the repositories in their institutions. Also, the challenges identified by Baro *et al.* (2014) had to do with the digitisation process and not the repositories. The submission policy the authors reiterated was on print theses and dissertations which are already in place.

The focus of many of the researches reviewed was on development and building repositories in Nigeria which is the application area (Abba, (2014); Ademola *et al.* (2013); Ndubuisi, (2017)). Although the design of Ndubuisi (2017) was broader in scope covering six centres, the focus was on one central intra-networked repository. To the best of the researcher's knowledge, focus on service-based efforts and improvements of service-based efforts of digital libraries, repositories or ETD initiatives are minimal. This research is, therefore hinged on this gap in the literature. Also, many of the studies used usability evaluation criteria for evaluation of websites, and usability of search engines for information retrieval; very few studies focused on repositories globally and none in Nigeria. These usability evaluation criteria in the literature focused on the usability metrics only; these studies did not include constructs that act as the basis for the

evaluation. To the best of the researchers' knowledge, no usability evaluation study used constructs that acted as a basis for the usability evaluation study on repositories or its applications. The modified technique used in this study is a contribution to global knowledge.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Research Design

This study is divided into two parts, the empirical study and the application design. Action research design was adopted for the empirical part of the study. Action research (AR) avoids the paradigm of researches that isolates and controls variables thus focusing on researching users' needs and developing products to fulfil those needs (Louis, *et al.*, 2007). This study assessed the existing repositories and developed a web application that harvests searched ETDs from stand-alone institutional repositories of federal universities; thus, there was a need for a research approach that highlights this effort. To achieve this, mixed methodology research using the *QUAN-qual* explanatory mixed-method research strategy was adopted. The mixed research methodology approach uses a combination of quantitative and qualitative data in a single study. The *QUAN-qual* research approach, according to Gay *et al.* (2012) is heavily dependent on quantitative data and uses the qualitative data in the elaboration and explanation of the results derived quantitatively.

For the system design, the web-based development life cycle (WDLC) was used. The system also used the search-time merging system design, integrating web technology, database technology and programming technology using Apache web server, MySQL and PHP (PHP hypertext pre-processor). According to Aziz *et al.,* 2012), the WDLC gives a description of the

processes in the life cycle of a web application; the researchers stated that, although the WDLC is similar to the Systems Development Life Cycle (SDLC), the requirements for WDLC are geared towards web applications. The phases include planning, analysis, design, implementation, publishing, and maintenance. The system for this study, however, combined the implementation, publishing, and maintenance phases under implementation and testing.

3.2 Population and Sampling Techniques

The sampled population used for the empirical part of the study was seventy (70), which comprised ten ETD repository administrators and sixty (60) postgraduate students. Complete enumeration was used to sample the ETD initiative/repository administrators. The breakdown of the sampling techniques is as follows:

The ETD initiatives of the Nigerian Federal Government-owned universities are domiciled in open access repositories. These repositories were identified using three sources

1. DOAR Website (http://v2.sherpa.ac.uk/view/repository_by_country/ng.html)

2. Nigerian Research Education Network NgREN (http://repository.ngren.edu.ng:8080/)

3. Internet Search for the online presence of repositories of the universities listed/not listed on both Open DOAR and NgREN using GOOGLE.

Open DOAR and NgREN websites, lists and provides information on academic open access repositories, including ETD initiatives in Africa and Nigeria, respectively. Open DOAR's overview was not comprehensive because the inclusion on their directory was not compulsory. Some ETD initiatives were also listed on NgREN but were not available on the Open DOAR website. However, in order to take care of inconsistencies, the Internet search for the online presence of the ETD initiatives was used to validate the list from Open DOAR and NgREN.

Nigerian Federal university libraries had a total of 15 functional repositories. For this study; however, 10 of the repositories were purposively sampled based on two criteria:

1. Online presence for three months (The researcher visited the repository websites twice a week for three months from November, 2017 to January 2018)

2. The repositories must have theses and dissertations listed as a community, sub-community, or are embedded in the contents of the faculties.

The list of universities is shown in Table 3.1.

Table 3.1: Assessed Nigerian IRs

S/N	University	Repository URL
1.	Ahmadu Bello University, Zaria	http://kubanni.abu.edu.ng:8080/jspui
2.	Federal University of Technology, Minna	http://dspace.futminna.edu.ng/
3.	Federal University Oye-Ekiti	http://www.repository.fuoye.edu.ng/
4.	Federal University of Technology, Owerri	http://library.futo.edu.ng/index.php/2014-10-22-23-19-25/2015-05-08-10-14-02
5.	University of Ibadan	http://ir.library.ui.edu.ng/
6.	University of Ilorin	http://uilspace.unilorin.edu.ng:8080/jspui/
7.	University of Lagos	http://repository.unilag.edu.ng/
8.	University of Jos	irepos.unijos.edu.ng/jspui/
9.	University of Nigeria, Nsukka	http://repository.unn.edu.ng:8080/xmlui/
10.	Usman Danfodio University, Sokoto	http://oer.udusok.edu.ng:8080/xmlui/

For the web application design, purposive sampling technique was used to select the repositories that were simulated for the design of the web search application. Three universities, whose repositories were accessible, maintained, and had electronic theses and dissertations (full-text or

abstract) for six months (January –June 2018) were selected. The universities were also offering courses at postgraduate level. They are: ABU, Zaria, FUT, Minna and UN, Nsukka. In order to populate the simulated repositories, Agriculture discipline was chosen using a simple random technique from a list of five faculties (Education, Management, Agriculture, Sciences, and Engineering) common to all the universities. The universities and faculties are shown in Table 3.2 below

Table 3.2: Faculties Common to the Sampled Universities

S/N	University	Faculties with theses available on the repositories
1.	Ahmadu Bello University, Zaria	**Education**, Arts, **Engineering**, Social Sciences, **Management**, **Agriculture**, **Sciences**
2.	Federal University of Technology, Minna	Physical Sciences, **Life Sciences**, **Agriculture Sciences**, Information and Communication Technology, **Education Technology**, **Engineering**, **Entrepreneurship and Business Management**
3.	University of Nigeria, Nsukka	Medical Sciences, **Sciences**, Law, **Education**, Arts, **Agriculture**, **Management, Engineering**

The researcher numbered the faculties common to the three universities from 1 to 5 and used an online random number generator to come up with a random number that fell on Agriculture. The total number of agriculture theses (Crop production, Agricultural Economics & Extention, Soil

Science, Animal Production and Aquaculture) in the repositories of the three universities were one thousand, six hundred and twenty (1620). The researcher used Krejcie and Morgan table to determine a sample size of three hundred and seven (307) theses for a population of one thousand, six hundred and twenty (1620) agriculture theses available in the three university repositories. The sample size was approximated to three hundred and seven (310) theses and uploaded to the simulated repositories.

For the usability evaluation of the designed webware, sixty (60) 2018/2019 postgraduate students from FUT Minna, ABU Zaria, and UNN, Nsukka were randomly selected using simple random sampling with replacement. Twenty students were selected in each university in order to have equal representation of the usability of the system. This number was used based on Nielsen (2012) explanation that for quantitative usability evaluation, at least ten respondents are required to get the opinion/perception about how effective and efficient a system is. However, to make up for non-response error, the sample size was rounded up to twenty respondents for each sampled university. The researcher retrieved the list of postgraduate students from the postgraduate coordinators and numbered the names 1 to n^{th}. An online random number generator was used to randomly come up with the first twenty numbers. The students were also selected based on their informed consent and willingness to take part in the experiment. The students that were not available or willing to take part were replaced with another random number generated.

3.3 Data Collection Instruments

Three sets of data collection instruments were used to collect data for this research. (Two sets of questionnaires and one interview schedule and one observation guide). The first questionnaire was a structured ETD repository assessment questionnaire using three constructs (Policy,

Contents and System Architecture) from the Network of Excellence on Digital Libraries (DELOS) Digital Library Reference Model that relates to repositories. The questionnaire comprised four sections that sought information on demographics, policies, contents, and system architecture of ETD repositories. It was used to collect data from the ten (10) IR administrators. The structured nature of the questionnaire necessitated the need for an interview. The interview schedule was used as a support data collection tool in order to retrieve clear explanations on grey areas on questionnaire from five sampled repository administrators. Observation checklist was used in order to validate the data collected from the questionnaire and interview. For example, the list of registered repositories on the website of the Open Archive Initiative had to be checked in order to validate the data collected through the questionnaire and interview. The second questionnaire was a usability evaluation questionnaire based on usability evaluation constructs-effectiveness, efficiency, and satisfaction. The questionnaire was based on an adapted four-point Likert type scale used to collect data on these three usability constructs after performing pre-defined queries/tasks based on the informational and transactional query models. The four Likert scales were used in order to extract a specific response on the usability of the system and avoid central tendency bias. This approach was necessary because an indifference option can affect the outcome of the usability evaluation; thus the suggestion of Simms *et al.* (2019) that there was no convincing psychometric benefit odd-numbered Likert scales have over matched even-numbered scales, was adopted. The questionnaires are attached as appendix A and B. Some of the questions used in the questionnaires were adapted from Assila *et al.* (2016), Joo *et al*. (2011) Sengupta (2014) and Bringula (2016).

3.4 Procedure for Data Collection

Triangulation data gathering techniques were adopted for this study using an adapted research

methodology of Ghosh (2009). This methodology was justified by Gay *et al.* (2012) when the author stated that validity in mixed research methodology is obtained when there are multiple perspectives and preferred methods of qualitative and quantitative data using like surveys, checklist, interviews to mention but a few. Qualitative data was collected based on the three concepts of the Network of Excellence on Digital Libraries (DELOS) Digital Library Reference Model used for this study. The data were collected using questionnaire, interview based on the questionnaire and assessment of the ETD websites through observation to validate the questionnaire and interview data. For the ETD administrators, a letter of introduction (see appendix F) from the department of Library and Information Technology, Federal University of Technology, Minna was obtained and presented to the university library IR staff. The researcher introduced herself and the purpose of the research and sought their consent before data collection through questionnaire and interview to further explain their opinions based on the questions answered. For the design and usability evaluation of the webware, the introduction letter (see appendix F) was submitted to the postgraduate coordinators of the sampled universities to obtain the number of postgraduate students. The consent (see appendix D) of the students was sought to take part in the evaluation study. The researcher then visited the websites of the repositories to observe and validate the answers from the questionnaire and interview.

The usability evaluation test was held in the library and postgraduate faculty classrooms of the universities between May and July 2019. The researcher and a research assistant provided a laptop with internet connection for the students to be able to perform the tasks and fill out the questionnaire. The usability test took approximately ten minutes for each respondent. Some of the students also used their mobile phones, which equally sufficed, because the web search system optimises for mobile devices. The students that were randomly selected but were

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unavoidably absent or were not interested in the usability test were replaced.

For the usability evaluation data collection, a task-oriented approach was used to collect data on the usability of the search system. According to Mohammed and Yousef, (2015), usability tests are conducted via task-based tests with either novice users or experts. Tasks were given to the sixty (60) selected students to be completed using informational and transactional queries. These query models were used as reference points for usability testing because quantitative metrics in usability studies are challenging to interpret in the absence of a reference point (Budiu, 2017). The task started with a practice task intended to familiarise the respondents with the research study set-up and to iron out individual differences among respondents. The selected students performed the queries using the web search application and based on their perceived experience during the task, their responses on the efficiency, effectiveness, and satisfaction of the usability of the webware were recorded by them on the usability evaluation questionnaire.

3.5 Method of Data Analysis

Research question 1 and 2: Descriptively analysed using frequency tables and charts

Research question 3: Developed using the appropriate programming language for web applications.

Research question 4: Descriptively analysed using the median as a measure of central tendency (what most respondents believe) According to Kostoulas (2014), the median is the number found precisely in the middle of the distribution that shows what the likeliest response might be or what the average respondent might think. The analysis of the research questions was done via median with a decision criterion of fx $\geq$ median (agreed), and *fx* $<$ median (disagreed).

Hypothesis 1-6: Inferentially analysed using Kruskal-Wallis analysis of variance tested at a five percent level of significance. Kruskal Wallis analysis of variance was used because it is the non-

parametric alternative of Analysis of Variance (ANOVA). Kruskal Wallis makes use of ranked data rather than the actual data points. Kruskal Wallis also ascertains if the medians of two or more groups are dissimilar. Kruskal Wallis is represented by H symbol and its score is compared to the chi-square critical value (Stephanie, 2016).

3.6 Validity of the Instruments

The data collection instruments (questionnaire, interview and observation checklist) were subjected to validation. They were given to the project supervisors and two lecturers (one from Education Psychology and the other from Computer Science Department of IBB, Lapai and FUT, Minna) for face and content validation, judging the clarity and relevance of each question and option. The supervisors made corrections on the specific tasks and inclusion of negative statements in the different sections of the questionnaire, interview schedule and observation checklist. Their criticisms led to necessary corrections and modifications of the data collection instruments.

3.7 Reliability of the Instrument

To further validate the usability evaluation questionnaire through inter-rater reliability, thirty copies of the questionnaire were distributed to postgraduate students in Federal University of Technology from different disciplines apart from Agriculture. The feedback from the respondents necessitated modifications in the data type finally collected. Cronbach alpha coefficient of reliability was used to calculate the reliability (internal consistency) of the instrument. Section B: IQ Effectiveness- 0.92, IQEfficiency-0.80, IQSatisfaction-0.87, Section C TQEffectiveness-0.70, TQEfficiency-0.78 and TQSatisfaction- 0.77. The overall reliability score of the usability evaluation questionnaire was 0.91.

3.8 System Planning

In this section, the procedure of system planning, analysis and design for the webware was discussed. The system planning stage, according to Valacich *et al.* (2009), involves information gathering from the users of the existing systems. This could be either through direct communication, collecting relevant artefacts or peruse of any related documents. Based on the findings of the initial assessments and limitations of the existing system, the researcher perused nine global integrated ETD initiatives (NgREN (Nigeria), ProQuest (Commercial), Shodhagaga (India), Malaysian Theses Online (Malaysia), DATAD (AAU), DiVA (Sweden), DART-Europe (Europe), NDLTD, British ETHOs (Britain)). The different types of global integrated initiatives included full unified repository management system, ETD search systems, aggregated resource sharing, ETD metasearch systems and bibliographic list of ETDs. It is pertinent to note that the countries that have developed a full unified repository system evolved over the years from simpler ETD information systems. Given the enormous infrastructural and technical commitment invested in full unified repository management system, the researcher used the opinion of Odhiambo (2018) for system design to assess the design options and select the most appropriate alternative. The researcher thus concluded that the suitable and sustainable system given the challenges identified from the findings was a federated web-based search webware, where contents from university libraries repositories would be harvested. This approach was used because it was the only viable option for this research study based on the following.

i. The workability of the live repositories was not entirely reliable.

ii. The universities were not data providers on the OAI-PMH framework.

iii. The universities also treated their ETD metadata as private data set; thus, they were not available to be indexed locally.

3.9 System Analysis

Aziz *et al.* (2012) stated two main activities at this phase, the elicitation of system requirements, which involves gathering and articulating the needs for the system, and the analysis of requirements. These phases will produce requirement specifications. The requirements for the webware were: The frontend (user interface) and the back-end (Repositories) and the functional requirements for each phase.

User Interface:

    i.   Search and browse interface

    ii.   Help panel

    iii.   Administrator's page for including and withdrawing repositories to be harvested

Back-End Repositories

    i.   Theses and dissertations from three university library repositories

3.10 System Design

The system design model for the web application is shown in Figure 3.1. Users search for theses on the webware user interface through a browser. The requests are received by a web server, which then sends it to the database server. The data are sent back to the web server, and the resulting web page is generated and sent back to the user. The system model has two parts the front-end and back end. The front end is the user interface with a search panel where users search for theses. This end is accessed through a browser. The back-end consists of the data services of the system; all the database responses retrieved from the database server passes through the webserver.

Repository I

Query

68
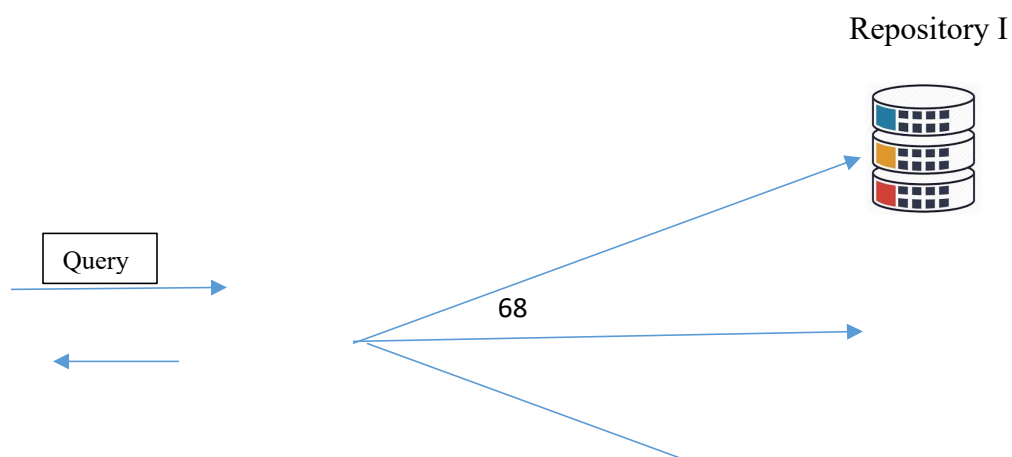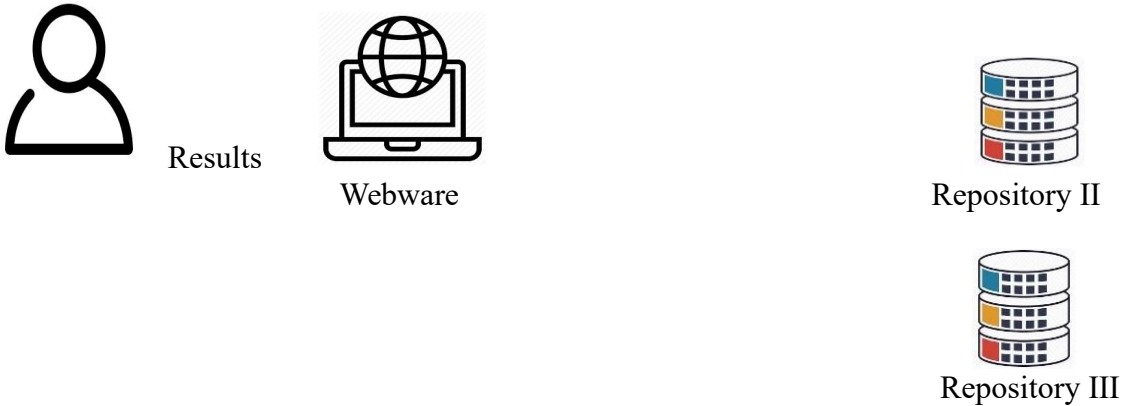
Figure 3.1: System Design Model

The design system for the two phases of the web application are:

User Interface: This is the medium the users interact with and sends a query through. This interface displays search results retrieved from the repositories. The results on the interface link the thesis on the domiciled repositories and provide information on the associated metadata elements regarding the thesis using metadata elements from the Dublin Core metadata schema (date, creator/author, keywords, abstract, title, thesis type, supervisor).

The user interface also has an administrator's panel where repository administrators can submit details of their repositories to be harvested by the search webware. The query federator prevents the user search query and sends the query to the repositories. It then receives replies from the repositories and merges the results into a list. The search-time merging depends on the repositories to provide the search function. The benefit of using the model is that no content indexing is needed.

Back-end Repositories: Three simulated repositories were designed and used in order to create/generate a database in which the search retrieval system can feed. ETD from three existing IRs were downloaded and uploaded to the simulated repositories. The keywords used were adopted directly from the keywords used on the repositories; the researcher also used natural

language indexing (terms from the theses) to increase the number of keywords. The concept of simulated repositories was used to present a workable model that National Universities Commission or any government that intends to take up the project can study in order to avoid pitfalls when deploying the system application with online repositories. The use case diagram is shown in the Figure 3.2 below.
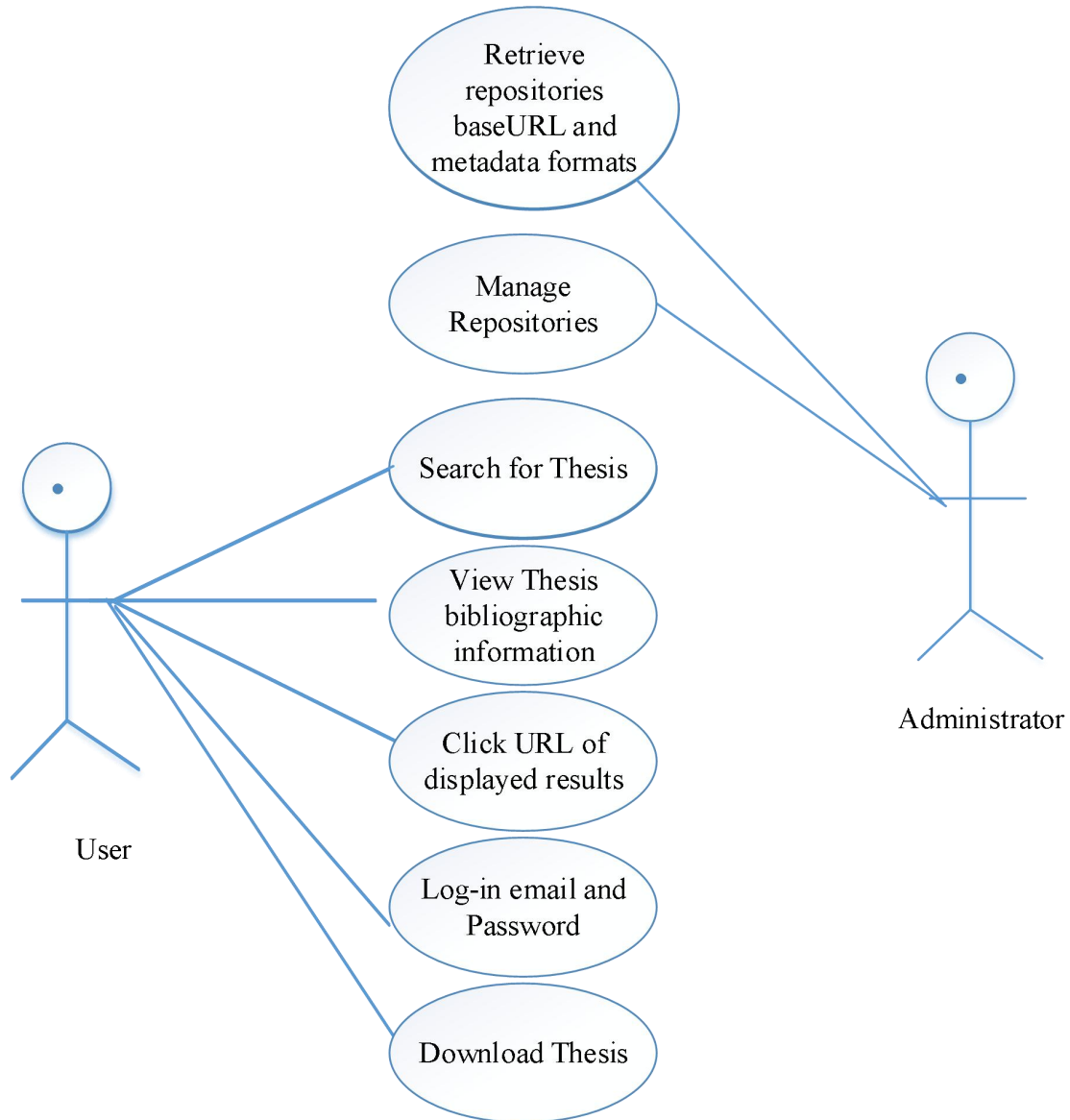
Figure 3.2: Use Case Diagram

Use case diagrams visually show the relationship between users and a designed system or application. The above use case diagram represents all the tasks or activities that a user and administrator can perform using the webware. Each function is described in detail below.

Search: A user can search the interface using a known title or keyword.

View Thesis Information: A user can view the bibliographic information of the thesis on the repository site.

Click Displayed Result for URL link of Thesis: A user can click the results which link to where the thesis is hosted.

Log in email and password: The users log in using their credentials in order to access the theses repository.

Retrieve repositories baseURL and metadata formats: The web application administrator can retrieve baseURL of repositories from the respective repository administrators.

Manage Repositories: The web application administrator can include or remove repositories as the case may be.

3.11 Flowchart of the Webware

A flow chart shows a detailed graphical representation of the steps needed to have an outputs (Kumar, 2010). Basic symbols like rectangle, oval, diamond, parallelogram, to mention but a few are used to represent various functions and show the sequence and interconnection of functions with lines and arrows. Figure 3.3 shows the steps required to access and download a thesis using the system in the flow chart.
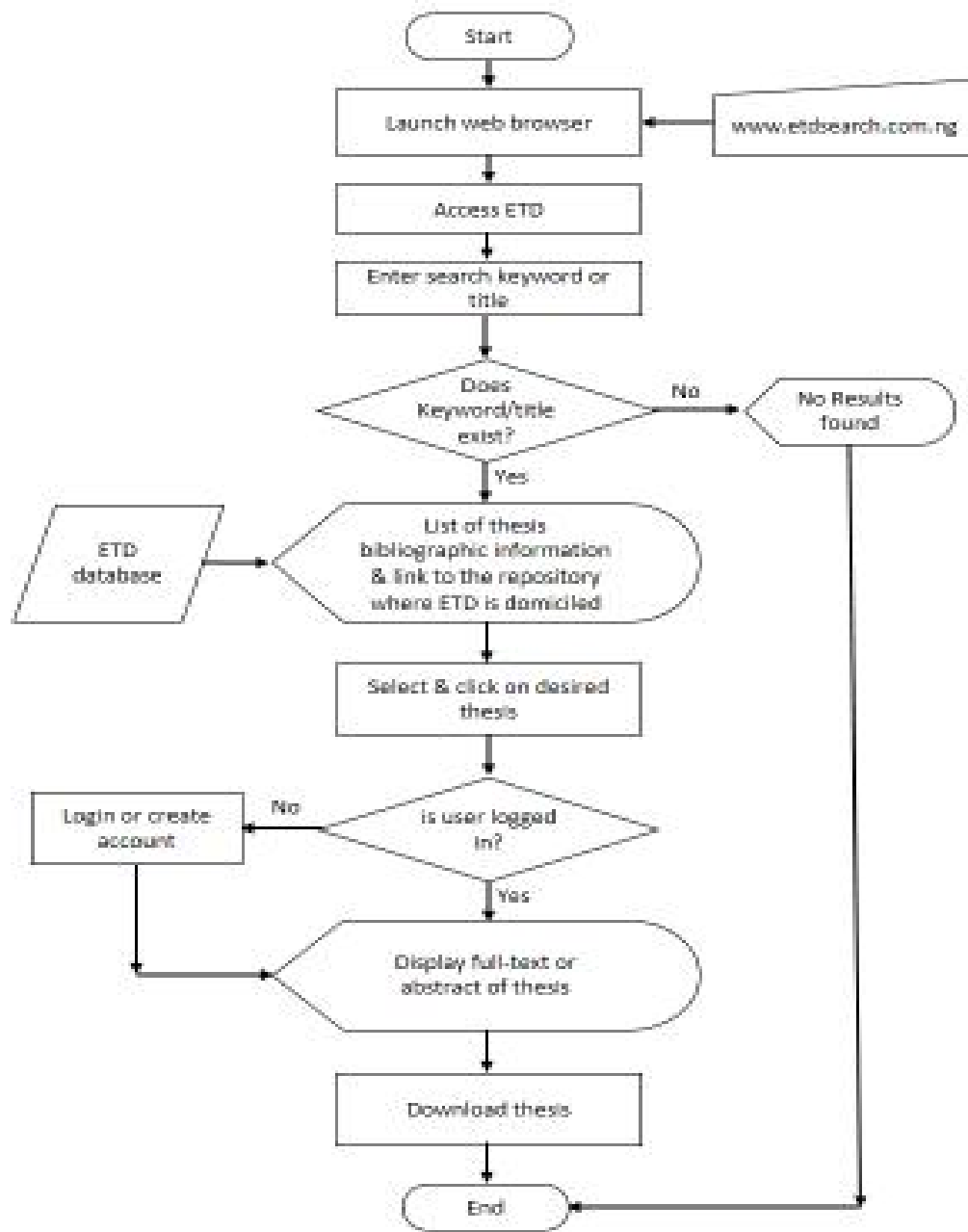
Figure 3.3: System Flowchart

3.12 System Requirements and Operating Environment

The requirements for the simulated repositories were classified into:

i. Functional/operational requirements

ii. Security requirements

iii. System requirements

iv. User requirements

3.12.1 Functional/operational requirements

The repositories had the following functional requirements:

i. Register and authenticate users.

ii. Upload agriculture related theses and dissertations from the three sampled repositories (ABU, Zaria, UNN, Nsukka and FUT Mimna repositories) in portable data format (PDF).

iii. Allow users to download any thesis uploaded.

3.12.2 Security requirements

The repositories had the following security requirements:

i. Deny access from non- authenticated user to the system;

ii. Identify authenticated user for valid access to the system;

iii. Grant access to password reset only if the user can verify his/her authenticity through registered email;

iv. Identify every user with his/her session; therefore the system must ensure a user has no access to any another's session;

v. The system must ensure control privileges are granted to only administrative users.

3.12.3 System requirements

The application is a web-based application that displays on browsers. It also optimises with mobile devices. The security requirements for the repositories are listed below.

i. Browsers: Opera, Mozilla Firefox minimum version 5 or Chrome)

ii. Processor: minimum of 1.00GHZ multi core and above

iii. RAM: minimum of 500MB

iv. Hard drive: minimum of 60GB and above

v. Screen resolution: minimum of 1024 X 768px or better

vi. Operating system (window 7, window 8, window XP and Vista)

vii. For Server

    a) Ubuntu web server with PostgreSQL database and Tomcat Java server installed

    b) RAM 4GB above

    c) Hard drive 1 TB above

3.12.4 Software requirements

The minimum software requirements for the effective development and implementation of the webware are as follows: WAMP 'stack'-Windows, Apache, MySQL Database Server Version and PHP Server Side Scripting running on Windows 10 operating systems. The acronym 'WAMP' is an abbreviation for software stack Windows (OS), Apache (Server), MySQL (Database) and PHP. It automatically installs everything that one needs during web application development so it can be used for creating local host especially for running test projects before deploying them online.

<div align="center">

CHAPTER FOUR

</div>

4.0   **RESULTS AND DISCUSSIONS**

The presentation, analysis and discussion of data collected and the system analysis, design implementation and usability of the web search application are presented in this chapter.

4.1 Response Rate

For the IR assessment, there was a 100% response rate due to the low number of respondents (10). Also for the usability evaluation of the search application, there was a 100% response rate due to the low number of respondents in each group (ABU, Zaria, UNN, Nsukka and FUT Minna) and because of the sampling with replacement technique used. Respondents not willing to participate in the evaluation were replaced with others on the list obtained from the departments.

4.2 User Variables

The user variables are presented in Table 4.1 below

Table 4.1 User Variables

S/N	University	Level of Study			Gender	
		PhD	Masters	PGD	Female	Male
1.	ABU, Zaria	7	8	5	7	13
2.	FUT, Minna	3	17	-	8	12
3.	UNN, Nsukka	2	13	5	9	11
	Total 60	12	38	10	24	36

4.3 Research Objective One

Assessment of policies, contents and system architecture of ETD repositories

4.3.1 Repository policy

Repository administrators were requested to indicate if there was a repository statement/policy

backing the establishment/management of their repositories and the contents of such policies where available. Results in Table 4.2 revealed that five (5) of the university libraries had written policy documents for their institutional repositories, while five (5) did not have policies.

Table 4.2: University Repository Policy

4.3.1.1 ETD policy workflow

Results in Table 4.3 revealed that the policies on preservation and postgraduate students' theses submission were quite high. Also, the researcher observed that although some of the repositories did not have policies, their ETD workflow included preservation and submission by postgraduate students.

S/N	Universities	Yes	No	Working on It
1	Ahmadu Bello University (ABU)			√
2	Federal University Oye-Ekiti (FOYE)		√	
3	Federal University of Technology, Minna (FUTM)			√
4	Federal University of Technology, Owerri (FUTO)			√
5	University of Ibadan (UI)			√
6	University of Ilorin (UNIL)	√		
7	University of Jos (UJ)	√		
8	University of Lagos (UNILAG)	√		
9	Usman Danfodio University, Sokoto (UDUS)	√		
10	University of Nigeria Nsukka (UNN)	√		

S/N	Uni.	Preservation	Withdrawal	PG students theses submission	Funding	Meta data Use	Access	Work-flow
1	UJ	√		√				
2	UNL	√		√				
3	UDUS	√		√				
4	UNIL	√	√	√				√
5	UNN	√	√	√				

Table 4.3: ETD Policy Workflow

4.3.2 Contents

4.3.2.1 Content file types

Repository administrators were requested to state ETD file content file types uploaded to the repositories, content copyright ownership, measures and access level. The results on Table 4.4 revealed that all of the repositories have their uploaded ETD contents in Portable Document Format (PDF).

Table 4.4: Contents File Types

S/N	Uni.	Dataset files	PDF	HTML	Audio Files	Video files	Image files
1	ABU		√				
2	FOYE		√				√
3	FUTM		√				
4	FUTO		√				
5	UI		√				
6	UNIL		√				
7	UJ		√				
8	UNILAG		√				
9	UDUS		√				
10	UNN		√				

4.3.2.2 ETD content copyright ownership

Results on Table 4.5 revealed another pertinent issue with the contents of ETDs in Nigerian IRs. Four (4) of the universities indicated that the copyright of the ETDs belonged to the researcher and the university. Four institutions also indicated that they had no idea while two institutions stated that the researcher owned the copyrights.

Table 4.5: ETD Content Copyright Ownership

	Uni.	Researcher	University	University & Researcher	No Idea
1	ABU		√		
2	FOYE			√	
3	FUTM		√		
4	FUTO				√
5	UI				√
6	UNIL			√	
7	UJ			√	
8	UNILAG			√	
9	UDUS				√
10	UNN				√

4.3.2.3 Content copyright measures

Table 4.6 results showed that Nigerian repositories had inadequate copyright measures for the ETDs.

Table 4.6: Contents Copyright Measures

S/N	Universities	Measures not yet framed	Contents saved as Images	Digital watermark	Metadata Access	Passwords

S/N	Universities	Paid Access	Full-Text Download	Full-Text Download On Request	Metadata Information
1	ABU		√		
2	FGGE		√		√
3	FUTM				√
4	FUTO		√		
5	UI			√	
6	UNIL		√		
7	UJ		√		
8	UNILAG		√		
9	UDUS		√		
10	UNN		√		

4.3.2.4 ETD contents access level

Table 4.7 showed that majority of the repositories allowed full-text download of theses without copyright measures in place.

Table 4.7: ETD Contents Access Level

S/N	Institutions				
1	ABU	X	√		
2	FUD	X	√		
3	FUL	X	√		
4	FOYE	X	√		
5	FUTM	X			√
6	FUTO	X	√		
7	UI	X		√	
8	UNILAG	X			√
9	UDUS	X	√		
10	UNN	X	√		

4.3.3 System architecture

4.3.3.1 Repository servers

Results from Table 4.8 revealed that majority (9) of the universities used institutional-based servers as against commercial or third-party servers.

S/N	Institutions	Cloud Server	Institution Server
1	ABU		√

2	FOYE	√
3	FUTM	√
4	FUTO	√
5	UI	√
6	UNIL	√
7	UJ	√
8	UNILAG	√
9	UDUS	√
10	UNN	√

Table 4.8: Repository Server

4.3.3.2 Open archive initiative (OAI) complaint repositories

Result in Table 4.9 showed that majority of the repositories were not compliant with the OAI framework.

S/N	Institutions	OAI Compliant Repositories
1	ABU	×

2	FOYE	×
3	FUTM	×
4	FUTO	×
5	UI	×
6	UNIL	×
7	UJ	√
8	UNILAG	×
9	UDUS	×
10	UNN	×

Table 4.9: Open Archive Initiative (OAI) Complaint Repositories

4.4 Research Objective Two

Challenges militating against the sustainability of Nigerian ETD repositories

Repository administrators were requested to state the challenges they perceived were militating against the management and sustainability of the repositories.
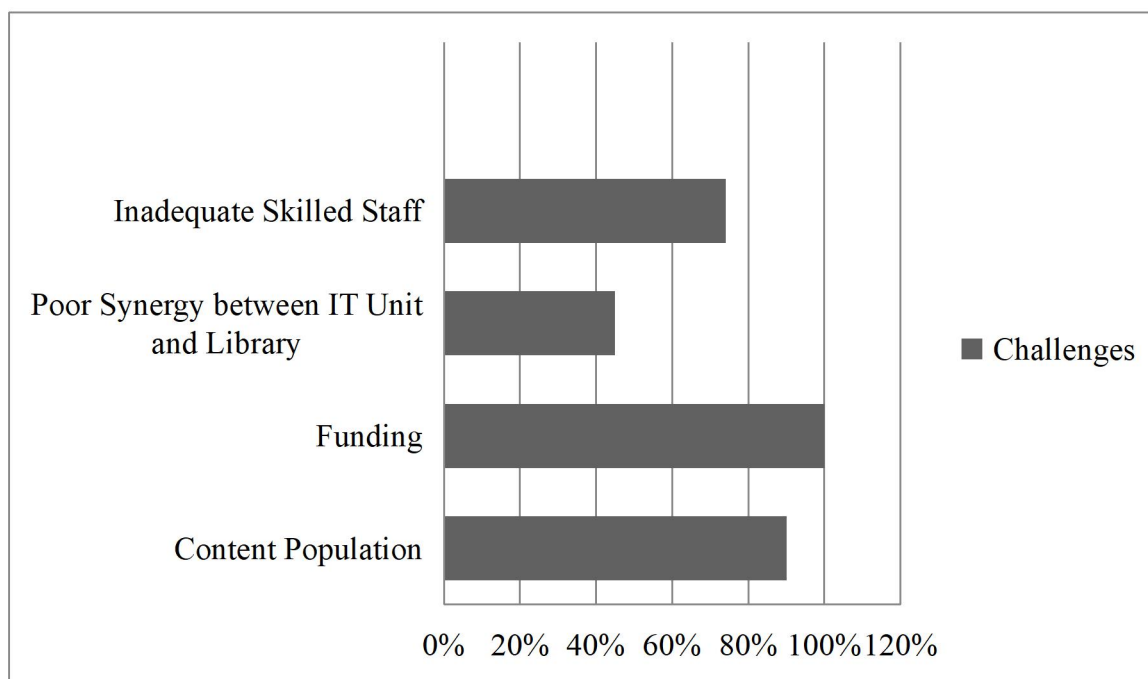
Figure 4.1: Challenges of Sustaining ETDs in Nigerian IR

4.5 Findings from the Interview

Findings from the interview with the repository administrators indicated that the institutions without ETD/IR policy had a policy content workflow which was followed although not documented. Majority of the responses were:

> *We have a policy content workflow that we follow, but it is not written or documented; for instance, we have a submission workflow with postgraduate students submitting electronic copies of masters and PhD theses to the library. The library staff upload same to the repository. We also have conditions which warrant withdrawal of any ETD from the repository.*

The other institutions with IR policy indicated that the institutions had IR policies but did not have specified ETD policy. One of the IR administrators reply was:

'We have an Institutional Repository (IR) policy but not a specified ETD policy; The IR policy covers some of the issues on ETD management'.

Responses on the contents of the policy on preservation revealed that most of the IRs used information migration (from print to electronic) through digitisation and thought the technique was sufficient as a preservation technique. Several repositories administrators' response to the preservation technique indicated in the policy was:

"*We digitise back-log issues of theses and dissertations and upload the same to the repositories. We also back-up the contents daily, although not to any third-party back-up storage or digital preservation platform. We have a data centre sufficient for our back-up*".

This is not sufficient because it did not suffice when one of the institution's repository lost most of its data due to operating systems error.

Findings on the submission policy also revealed that in all the institutions, postgraduate students do not upload directly to the repository. Majority of the responses were:

"*Postgraduate students do not submit directly to the repository; they submit softcopies of theses to the postgraduate school that in turn sends them to the library*".

When asked who uploads these soft copies to the repositories, the IR administrator said "*I and*

some randomly trained library staff.'

Findings also revealed that the library funds were used for the maintenance of the repositories, and during the implementation of the repositories. Majority of the IR administrators were unaware of the OAI-PMH framework. Majority of the responses were-

"During the development and implementation of the repository, we were unaware of the OAI-PMH protocol. We were only aware of the registration with OPENDOAR."

4.6 Findings from Observation

Majority of the repositories did not have copyright measures for their contents. All of the repositories were not registered as data providers on the OAI-PMH. The researcher also observed that although the repositories were using Dublin-core metadata, the keywords used were not optimised for search engines. Majority of the repositories used keywords form the title of the theses.

4.7 Research Objective Three

Develop a web search application that harvests ETDs from stand-alone repositories of federal university libraries in Nigeria

Figure 4.2 represents the diagrammatic representation of the existing system. Users go through each repository that they are aware of in search for theses and dissertations of each university. There are multiple users and multiple repositories, respectively; thus, each user searches for ETD contents in the number of repositories she or he knows about, User 1, 2, 3……n searches repositories 1, 2, 3….n depending on the number of repositories available or that he or she knows about. The situation is an improved version of manually going through the print theses

and dissertations of each university library which wastes the time of the users.

Figure 4.2: Diagrammatic Representation of the Existi
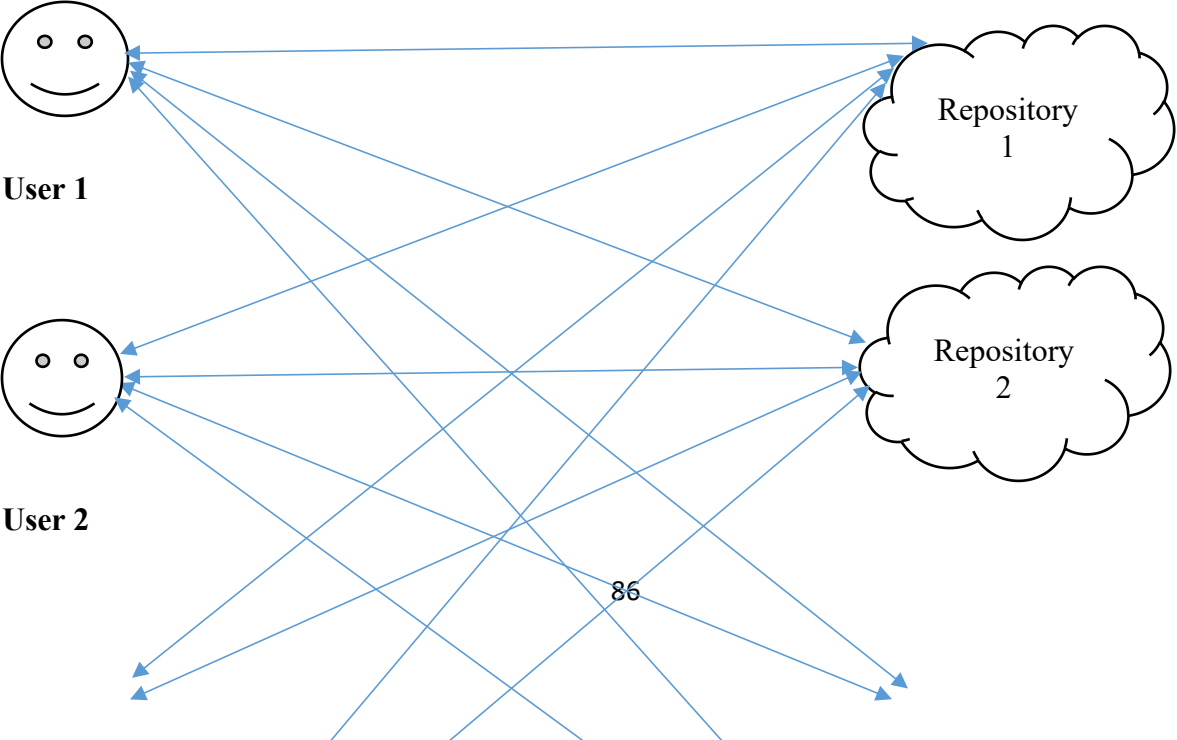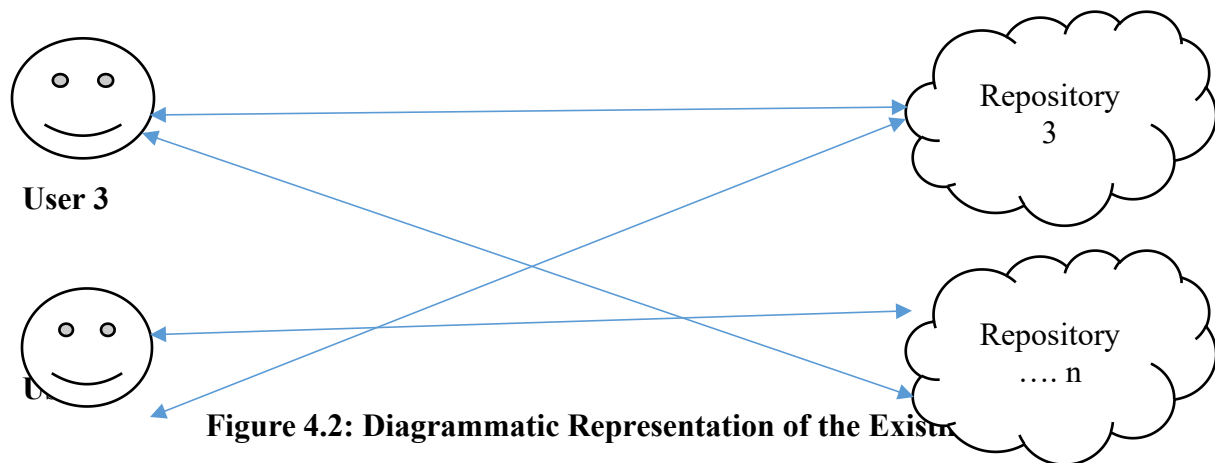
4.7.1 System overview

The developed web application in this study was designed to address the issue of a unified interface for ETD from Nigerian government-owned universities repositories. Below are the features of the proposed web application

1. The web application presents a single interface that displays searched results from three repositories.

2. The interface has an autosuggest feature while searching based on the title of the theses domiciled in the repositories.

3. The results on the interface provide bibliographic information (Author, student, university repository, supervisors, date and abstract) about the ETD and provide a URL link to the repository where the ETD is domiciled.

4. The URL links the thesis in the domiciled repository and provides a view and download option for the selected thesis.

4.7.7 System testing

System testing is pertinent in web application development in order to reduce the effects of errors

after publishing or going online. Functional testing was used to test the web application. Functional testing according to Prost *et al.* (2015) is a type of beta testing where the application is tested against functional requirements and specification. The functional testing was on basic usability based on informational and transactional query models. A manual task–oriented approach with search input entry and output was used. Three participants each from two groups of users- the experienced and the novice search system users were used for the system testing. The participants were requested to carry out a number of search and download activities on the webware. The errors observed and reported were effected in the iterated versions of the webware. For instance, the novice participants needed guidance while navigating during the evaluation. This challenge was fixed by putting up a help panel with instructions and navigation tips. The implementation of the web application is shown below. The homepage screen is shown in Figure 4.3 below. The homepage of the webware displays the main search interface where a user can search a thesis based on title and keyword. The system was deployed online and prospective users can access the web application via the web or mobile platform on www.etdsearch.com.ng.
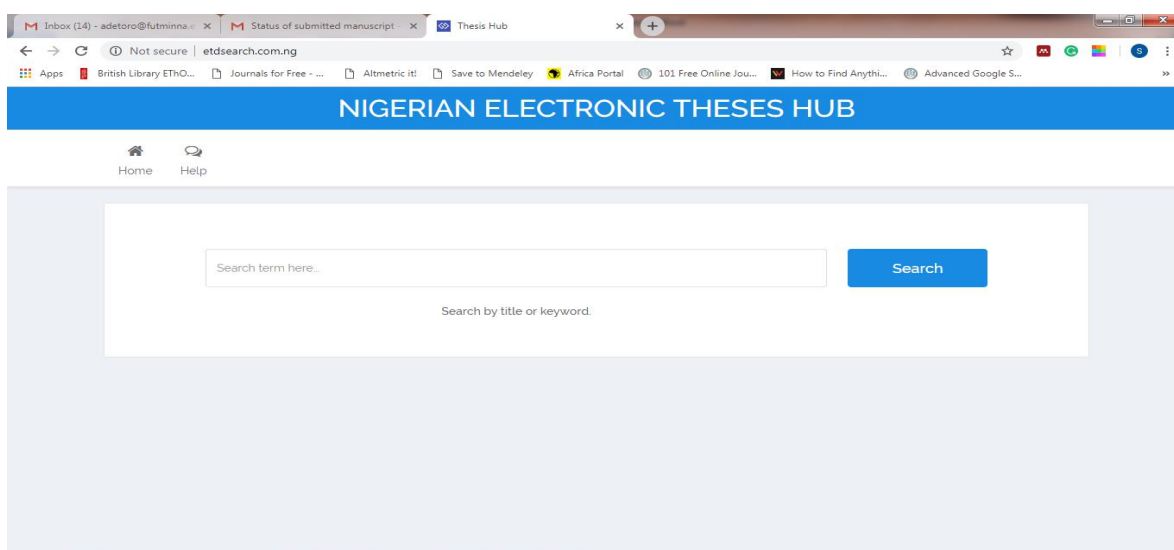
Figure 4.3: Home Page of Webware

The results displayed in Figure 4.4 below was returned using the keyword *'Agriculture'*.

The displayed results showed thesis and dissertations from different repositories. Each result provides a link to the repository where the thesis is domiciled.
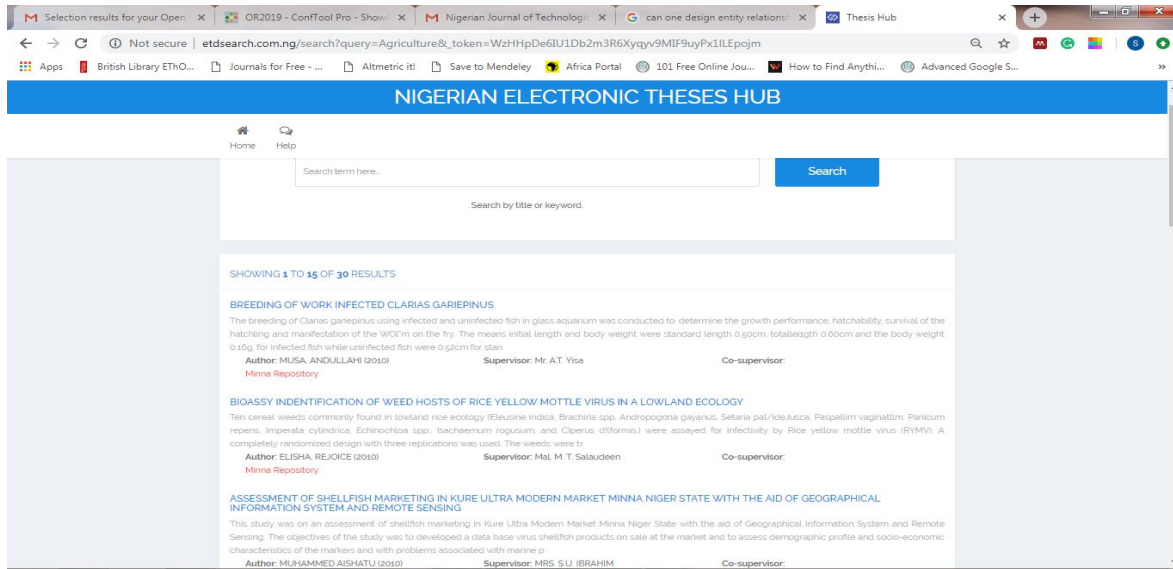
Figure 4.4: Displayed Results

The web application also has an auto-suggest feature based on the theses in the repositories.
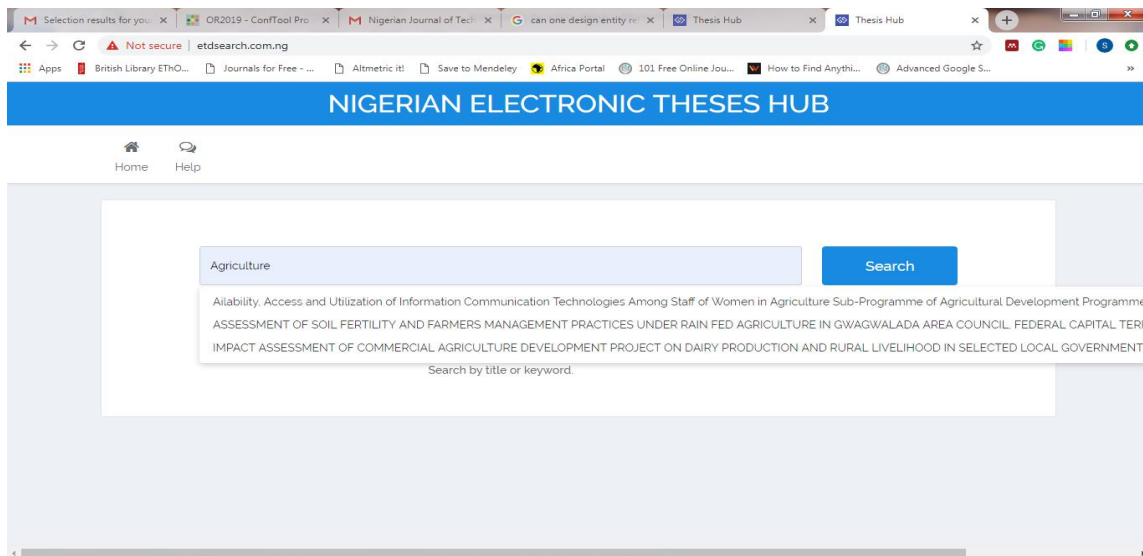
Figure. 4.5: Auto-suggest feature

Log-in details of registered users must be entered before accessing and downloading the thesis.
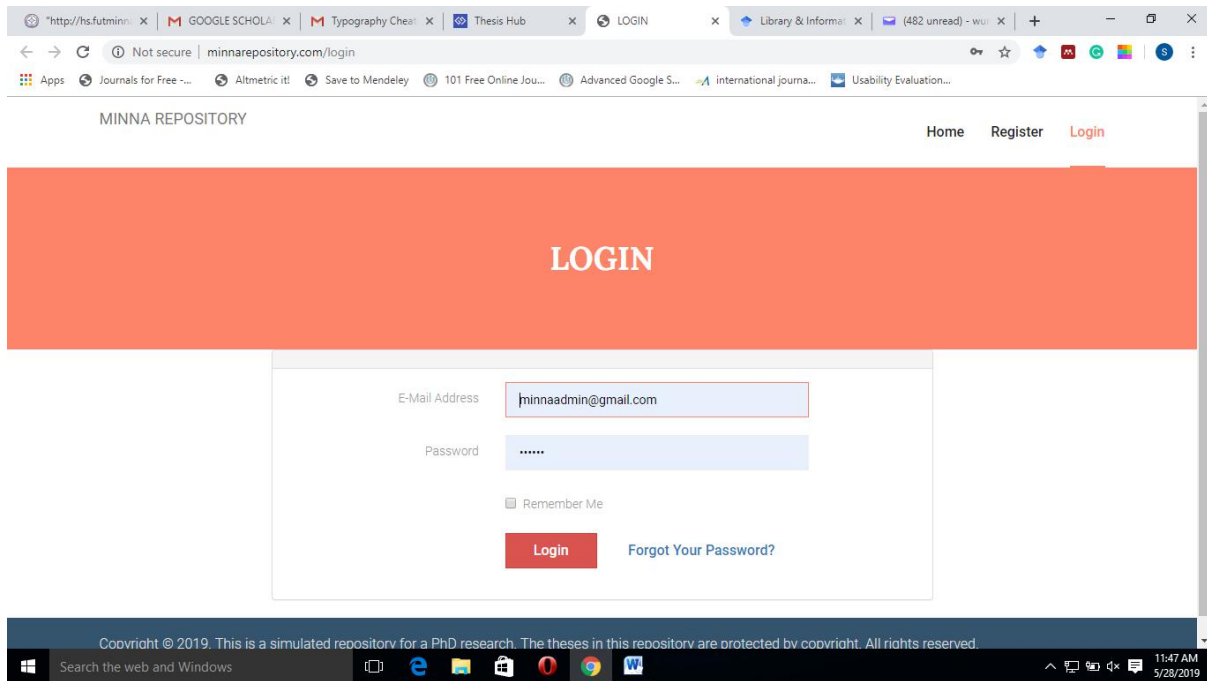
Figure. 4.6: Log-in details

.Figures 4.7, 4.8, and 4.9 displayed the linked results with bibliographic information about the thesis and the download feature in the domiciled repositories.
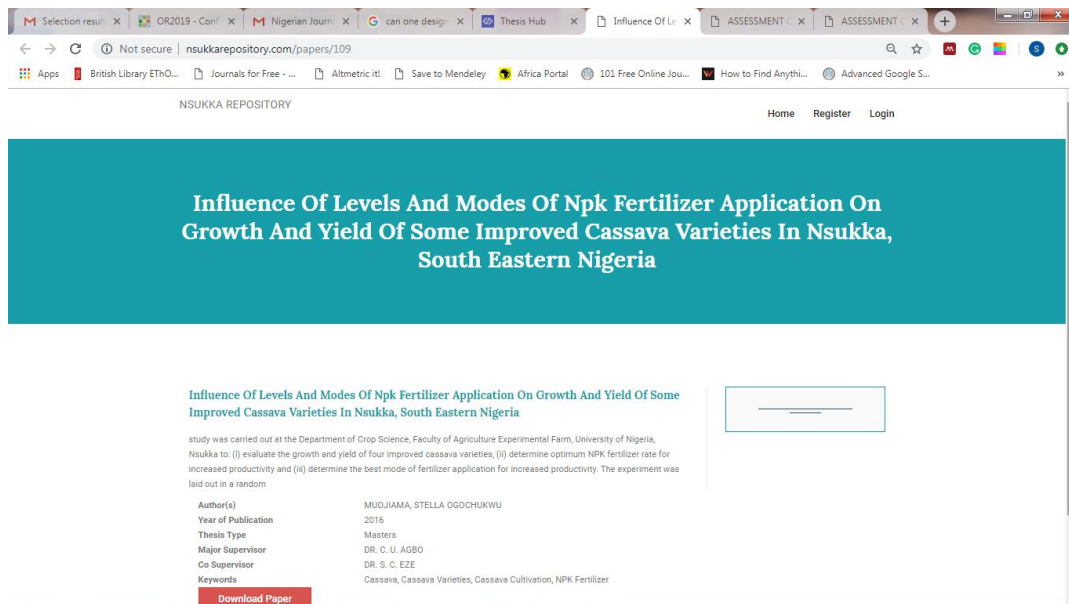
Figure 4.7: Bibliographic information and download feature on simulated repository 1
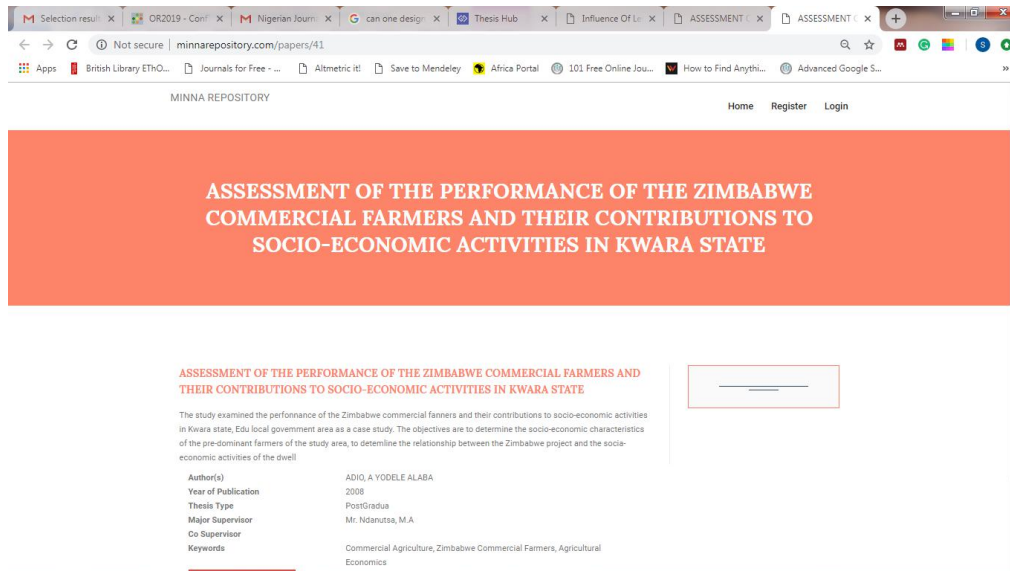
Figure 4.8: Bibliographic information and download feature on Simulated Repository 2
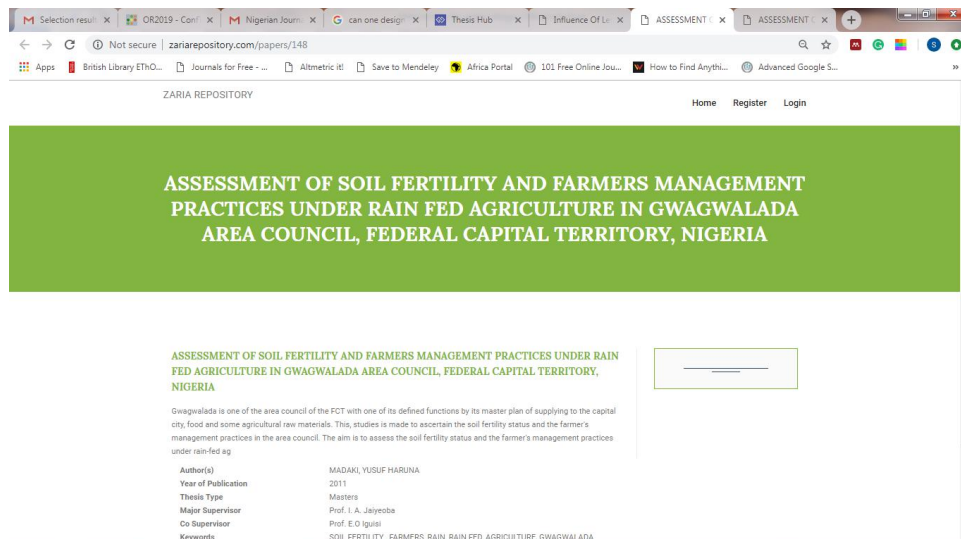
Figure 4.9: Bibliographic information and download feature on simulated Repository 3

4.7.8 Limitations of the web search application

The research study did not replace or build a model repository. It worked with existing repositories to develop the search application.

The stand-alone repositories used in this study were simulated to have total control on the workability of the repositories This limitation makes the search application 'laboratory ready', thus cannot be deployed as a 'market-ready' research product. Real repositories can be used in

future studies to create a more robust search application.

4.8 Research Objective Four

Perform a usability evaluation of the developed web search system

The usability effectiveness, efficiency and satisfaction of the developed webware were evaluated based on informational and transactional queries and the results are presented below.

4.8.1 Information query usability effectiveness

The data presented in Table 4.10 below were analysed to find out how effectively usable the webware was based, on information query. The total performance score (fx) median (M) for each item was used. The criterion for each statement was Agreed if $fx \geq$ M of 212 (greater than or equal to 212) and Disagreed if $fx <$ M of 212 (less than 212). The results on Table 4.10 showed that the respondents agreed to four statements out of the seven items listed on the information query effectiveness of the federated search application. These items had a median score higher or equal to 212. These statements are 1: I can accurately complete the search using the system (M=213≥212), statement 2: The system was not complicated to use to find the information needed (M=212≥212), statement 3: Overall, the system was useful in helping me locate the information requested (M=219≥212) and statement 7: Overall, I can perform the search

effectively using the system (M=222≥212). The other three statements 4: I cannot locate the information (supervisor) requested (M=88<212), 5: I couldn't locate the information (author) requested (M=82<212) and 6: I cannot locate the information (year) requested (M=77<212) had lower scores than the median score. These results indicated that the respondents disagreed to the statements that they cannot find information on e-theses using the search application.

Table 4.10: Information Query Usability Effectiveness

S/N	Statements	SD 1	D 2	A 3	SA 4	Total Fx	Median M=212	Decision	fx=∑ (SD value*statement value + D value*statement value +A value* statement value + SA value*statement value)
1	I can accurately complete the search using the system	-	-	27 45%	33 55%	213	fx≥M	Agreed	
2	The system was not complicated to use to find the information needed	1 1.6%	2 3.3%	20 33.3%	37 61.6%	212	fx≥M	Agreed	
3	Overall, the system was useful in helping me locate the information requested	-	-	21 35%	39 65%	219	fx≥M	Agreed	
4	I cannot locate information (supervisor) requested	34 56.6%	24 49%	2 3.3%	-	88	fx<M	Disagreed	
5	I cannot locate information (author) requested	40 66.6%	18 30%	2 3.3%	-	82	fx<M	Disagreed	
6	I cannot locate information (year) requested	46 76.6%	11 18.3%	3 5%	-	77	fx<M	Disagreed	
7	Overall, I can perform the search effectively using the system	1 1.6%	-	15 25%	44 73.3%	222	fx≥M	Agreed	

4.8.2 Information query usability efficiency

The data presente

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d in Table 4.11 were analysed for information query efficiency. The median (M) of the total performance score (fx) for each item of the universities assessed was used. The criterion for each statement was Agreed if $fx \geq$ M of 205 (greater than or equal to 205), and Disagreed, if $fx <$ M of 205 (less than 205). The results on Table 4.11 showed that the respondents agreed to three statements out of the six items listed on the information query efficiency of the federated search application. These statements are statement 1: I was able to complete the search quickly using the system (M=210≥205), statement 5: The search system responds efficiently to the search made (M=210≥205) and statement 6 (M=210), the search results were specific to the information requested (M=206≥205). The respondents disagreed with the other three statements. They are statement 2: The system requires few steps to find the information requested (M=155<205), statement 3: Overall, the time taken to complete the search was minimal (M=204<205) and statement 4: I did not recover from mistakes easily (M̄=103<205) had lower scores than the median score.

Table 4.11: Information Query Usability Efficiency

S/N	Statements	SD 1	D 2	A 3	SA 4	Total fx	Median M= 205	Decision
1	I was able to complete the search quickly using the system	-	3 5%	24 40%	33 55%	210	$fx \geq$M	Agreed
2	The system requires few steps to find the information requested	9 15%	18 30%	22 36.6%	11 18.3%	155	fx<M	Disagreed
3	Overall, the time taken to complete the search was minimal	-	4 6.6%	28 46.6%	28 46.6%	204	fx<M	Disagreed
4	I did not recover from mistakes easily	21 35%	37 61.6%	-	2 3.3%	103	fx<M	Disagreed
5	The search system responds efficiently to the search made	-	3 5%	24 40%	33 55%	210	$fx \geq$M	Agreed

6	The search results were specific to the information requested	-	3 5%	28 46. 6%	29 48. 3%	206	$fx \geq M$	Agreed

$$fx = \sum (SD\ value*statement\ value + D\ value*statement\ value + A\ value*\ statement\ value + SA\ value*statement\ value)$$

4.8.3 Information query satisfaction

The data presented in Table 4.12 were analysed for information query satisfaction. The median (M) of the total performance score (fx) for each item of the universities assessed was used.

The criterion for each statement was Agreed if $fx \geq$ M of 212 (greater than or equal to 212) and Disagreed if $fx <$ M of 212 (less than 212). The results on Table 4.12 indicated that the participants agreed to five statements out of the nine items listed on the information query satisfaction of the federated search application. These items had a median score higher or equal to 212. These statements are statement 1: I am satisfied searching using the system to find the information requested (M=213≥212), statement 2: I feel comfortable using the system to find the information requested (M=214≥212), statement 3: I will like to use this system to find in my field (M=213≥212), statement 4: The information provided by the system is clear (M=212≥212) and statement 5: Overall, I am satisfied with the ease of completing the task using the system (M=212≥212). The respondents disagreed with the other four statements, statement 6: The search system did not meet my expectations (M=94<212), statement 7: The system was not pleasant to use (M=83<212), statement 8: I will not recommend this search system to my colleagues (M=86) and statement 9: I do not think this system will be beneficial for information acquisition (M=< 77) had lower scores than the median score.

Table 4.12: Information Query Satisfaction

S/N	Statements	SD 1	D 2	A 3	SA 4	Total Fx	Median $\bar{x}=212$	Decision
1	I am satisfied searching using the system to find the information requested	-	1 1.6%	25 41.6%	34 56.6%	213	fx≥$\bar{x}$	Agreed
2	I feel comfortable using the system to find the information requested	-	1 1.6%	24 40%	35 58.3%	214	fx≥$\bar{x}$	Agreed
3	I will like to use this system to find theses in my field	1 1.6%	-	24 40%	35 58.3%	213	fx≥$\bar{x}$	Agreed
4	The information provided by the system is clear	-	2 3.3%	24 40%	34 56.6%	212	fx≥$\bar{x}$	Agreed
5	Overall, I am satisfied with the ease of completing the task using the system	-	2 3.3%	24 40%	34 56.6%	212	fx≥$\bar{x}$	Agreed
6	The search system did not meet my expectations	27 45%	32 53.3%	1 1.6%	-	94	fx<$\bar{x}$	Disagreed

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S/N	Statement	SD	D	A	SA	Total	Median	Decision
7	The system was not pleasant to use	38 63.3%	21 35%	1 1.6%	-	83	fx<x̄	Disagreed
8	I will not recommend this search system to my colleagues	34 56.6%	26 43.3%	-	-	86	fx<x̄	Disagreed
9	I do not think this system will be beneficial for information acquisition	43 71.6%	17 28.3%	-	-	77	fx<x̄	Disagreed

$fx= \sum$ (SD value*statement value + D value*statement value +A value* statement value + SA value*statement value)

4.8.4 Transactional query usability effectiveness

The data presented in Table 4.13 were analysed for transactional query effectiveness. The median ($\bar{x}$) of the total performance score (fx) for each item of the universities assessed was used. The criterion for each statement was Agreed if $fx \geq \bar{x}$ of 207 and Disagreed if $fx < \bar{x}$ of 207. The results on Table 4.13 showed that the respondents agreed to three statements out of the five items listed on the transactional query effectiveness of the federated search application. These items had a median score higher or equal to 207. These statements are statement 1: I can effectively complete the search task using the system. ($\bar{x}$=209≥205), statement 2: I can effectively complete the log-in task of the thesis I selected ($\bar{x}$=209) and statement 3: I can effectively download the thesis using the search system ($\bar{x}$=207≥207). The respondents disagreed with two statements, statement 4: The system was complicated to use for the transactional tasks ($\bar{x}$=100<207) and statement 5: Overall, I was not able to achieve the transactional tasks using the system ($\bar{x}$=90<207) had lower scores than the median score.

Table 4.13: Transactional Query Usability Effectiveness

S/N	Statements	SD 1	D 2	A 3	SA 4	Total Fx	Median M=20	Decision

				7			
1	I can effectively complete the search task using the system.	-	1 1.6 %	29 48.3 %	30 50 %	209	$fx≥M$	Agreed
2	I can effectively complete the log-in task of the thesis I selected	-	1 1.6 %	29 48.3 %	30 50 %	209	$fx≥M$	Agreed
3	I can effectively download the thesis using the search system	2 3.3 %	3 5%	21 35%	34 56.6%	207	$fx≥M$	Agreed
4	The system was complicated to use for the transactional tasks	27 45 %	26 43.3%	7 11.6 %	-	100	$fx<M$	Disagreed
5	Overall, I was not able to achieve the transactional tasks using the system	32 53.3%	26 43.3%	2 3.3%	-	90	$fx<M$	Disagreed

$fx= \sum$ (SD value*statement value + D value*statement value +A value* statement value + SA value*statement value)

4.8.5 Transactional query usability efficiency

The data presented in Table 4.14 were analysed for transactional query efficiency. The median ($\bar{x}$) of the total performance score (fx) for each item of the universities assessed was used. The criterion for each statement was Agreed Agreed if $fx ≥ \bar{x}$ of 120.5 and Disagreed if $fx < \bar{x}$ of 120.5. The results in Table 4.14 revealed that the participants agreed to five statements out of the ten items listed on the transactional query efficiency of the federated search application. These items had a median score higher or equal to 120.5. These statements are statement 1: I was able to complete the search task on time using the search system ($\bar{x}$=211≥120.5), statement 2: I was able to complete the log-in task on time using the search system ($\bar{x}$=199≥120.5), statement 3: I was able to complete the download task on time using the search system ($\bar{x}$=199≥120.5), statement 6: The search system responds slowly to the search task ($\bar{x}$=126≥120.5) and statement

10: Overall, the time taken to complete the transactional task was minimal ($\bar{x}=191\geq120.5$). The respondents disagreed to the other five statements. They are statement 4: The search task required too many steps to accomplish ($\bar{x}=115<120.5$), statement 5: I could not recover from mistakes easily ($\bar{x}=96<120.5$), statement 7: The search system responds slowly to the log-in task ($\bar{x}=113<120.5$), statement 8: The search system responds slowly to the download task ($\bar{x}=114<120.5$) and statement 9: The download task required too many steps to accomplish ($\bar{x}=105<120.5$).

S/N	Statements	SD 1	D 2	A 3	SA 4	Total Fx	Median $\bar{x}=$ **120.5**	Decision
1	I was able to complete the search task on time using the search system	-	3 5%	23 38.3%	34 56.6%	211	$fx\geq\bar{x}$	Agreed
2	I was able to complete the log-in task on time using the search system	2 3.3%	5 8.3%	25 41.6%	28 46.6%	199	$fx\geq\bar{x}$	Agreed
3	I was able to complete the download task on time using the search system	3 5%	4 6.6%	24 40%	29 48.3%	199	$fx\geq\bar{x}$	Agreed
4	The search task required too many steps	18 30	29 48.3	13 21.	-	115	$fx<\bar{x}$	Disagreed

	to accomplish	%	%	6%				
5	I could not recover from mistakes easily	26 43.3%	33 55%	-	1 1.6%	96	$fx<\bar{x}$	Disagreed
6	The search system responds slowly to the search task	16 26.6%	29 48.3%	8 13.3%	7 11.6%	126	$fx\geq\bar{x}$	Agreed
7	The search system responds slowly to the log-in task	21 35%	29 48.3%	6 10%	4 6.6%	113	$fx<\bar{x}$	Disagreed
8	The search system responds slowly to the download task	18 30%	33 55%	6 10%	3 5%	114	$fx<\bar{x}$	Disagreed
9	The download task required too many steps to accomplish	23 38.3%	30 50%	6 10%	1 1.6%	105	$fx<\bar{x}$	Disagreed
10	Overall, the time taken to complete the transactional task was minimal	2 3.3%	7 11.6%	29 48.3%	22 36.6%	191	$fx\geq\bar{x}$	Agreed

Table 4.14: **Transactional Query Usability Efficiency**

$fx= \sum$ (SD value*statement value + D value*statement value +A value* statement value + SA value*statement value)

4.8.6 Transactional query usability satisfaction

The data presented in Table 4.15 were analysed for transactional query satisfaction. The median (M) of the total performance score (fx) for each item of the universities assessed was used. The criterion for each statement was Agreed for each item is Agreed if $fx \geq$ M of 203.5 and Disagreed if $fx <$ M of 203.5. The results in Table 4.15 showed that the respondents agreed to six statements out of the twelve statements listed on the transactional query satisfaction of the federated search application. These items had a median score higher or equal to 203.5. These statements are statement 1: I enjoyed the search task using the system (M=211≥203.5), statement 2: I enjoyed

the log-in task using the system (M=208≥203.5), statement 4: I feel comfortable using the system for the transactional task (M=205≥203.5), statement 5: I would use the system more frequently to search for theses (M=208≥203.5), statement 6: I would use this system more frequently to download theses (M=207≥203.5) and statement 7: The information provided by the system for the task is clear (M=219≥203.5). The respondents disagreed to the other six statements. They are statements 3: I enjoyed the download task using the system (M=202<203.5), statement 8: Overall, I am satisfied with the ease of completing the task using the system (M=200<203.5), statement 9: The search system did not meet my transactional expectations (M=101<203.5), statement 10: I will not recommend this search application to my colleagues (M=91<203.5), statement 11: I do not think this system will be beneficial to information acquisition (M=89<203.5) and statement 12: The system was not pleasant to use (M̄=83<203.5).

Table 4.15: Transactional Query Usability Satisfaction

S/N	Statements	SD 1	D 2	A 3	SA 4	Total Fx	Median M=203.5	Decision
1	I enjoyed the search task using the system	-	-	29 48.3%	31 51.6%	211	$fx \geq M$	Agreed
2	I enjoyed the log-in task using the system	-	1 1.6%	30 50%	29 48.3%	208	$fx \geq M$	Agreed
3	I enjoyed the download task using the system	1 1.6%	5 83.3%	25 41.6%	29 48.3%	202	$fx < M$	Disagreed

No	Statement	SD	D	U	A	fx		Decision	
4	I feel comfortable using the system for the transactional task	-	3 5%	29 48.3%	28 46.6%	205	$fx \geq M$	Agreed	
5	I would use the system more frequently to search for theses	1 1.6%	2 3.3%	25 41.6%	32 53.5%	208	$fx \geq M$	Agreed	$fx= \sum$ (SD value *state ment value + D value
6	I would use this system more frequently to download theses	1 1.6%	4	22 36.6%	33 55%	207	$fx \geq M$	Agreed	
7	The information provided by the system for the task is clear	-	2 3.3%	17 28.3%	41 68.3%	219	$fx \geq M$	Agreed	*state ment value +A value
8	Overall, I am satisfied with the ease of completing the task using the system	2 3.3%	4 6.6%	26 43.3%	28 46.6%	200	$fx < M$	Disagreed	* state ment value
9	The search system did not meet my transactional expectations	19 31.6%	41 68.3%	-	-	101	$fx < M$	Disagreed	+ SA value *state ment
10	I will not recommend this search application to my colleagues	32 53.5%	28 46.6%	1 1.6%	-	91	$fx < M$	Disagreed	value)
11	I do not think this system will be beneficial to information acquisition	33 55%	26 43.3%	-	1 1.6%	89	$fx < M$	Disagreed	
12	The system was not pleasant to use	38 63.3%	21 35%	1 1.6%	-	83	$fx < M$	Disagreed	**4.9** **Resea rch**

Hypotheses

In this section, six null hypotheses formulated for this study and tested at 0.05 level of significance were tested using Kruskal Wallis analysis of variance and is presented in the tables below using the results of the analysis performed on the data. They are:

H_01- A statistically significant difference does not exist in the opinion of the postgraduate students in the three universities on the information query usability effectiveness of the web

search application

$H_0$2- A statistically significant difference does not exist in the opinion of the postgraduate students in the three universities on the information query usability efficiency of the web search application

$H_0$3- A statistically significant difference does not exist in the opinion of the postgraduate students in the three universities on the usability satisfaction of the web search application

$H_0$4- A statistically significant difference does not exist in the opinion of the postgraduate students in the three universities on the transactional query usability effectiveness of the web search application

$H_0$5 - A statistically significant difference does not exist in the opinion of the postgraduate students in the three universities on the transactional query usability efficiency of the web search application

$H_0$6- A statistically significant difference does not exist in the opinion of the postgraduate students in the three universities on the transactional query usability satisfaction of the web search application.

4.9.1 $H_0$1- A statistically significant difference does not exist in the opinion of the postgraduate students in the three universities on the information query usability effectiveness of the web search application.

This result of this hypothesis was broken down to four tables (Tables 4.16, 4.17, 4.18 and 4.19). Results in Table 4.16 showed the *f*x data points for the three universities; 4.16 showed the assigned ranks to data points and 4.17 showed assigned ranks to data points of each university

and Table 4.18 revealed the results of the hypothesis tested. The critical chi square value (X^2) of 5.9915 is more than the H score of 0.19; therefore, the null hypothesis that a statistically significant difference does not exist in the opinion of the postgraduate students in the three universities (ABU, FUT, and UNN) on the information query usability effectiveness of the search application is not rejected.

Table 4.16: *f*x data points for Information Query Effectiveness

Groups	Data Points
Ahmadu Bello Uni. Zaria	25, 28, 31, 71, 73, 73, 76
Federal University of Tech. Minna	25, 26, 26, 71, 71, 74, 77
University of Nigeria, Nsukka	26, 29, 31, 69, 71, 72, 75

Table 4.17: Assigned Ranks to Data Points (Ascending order)

S/N	Data Points	Assigned Ranks	S/N	Data Points	Assigned Ranks	S/N	Data Points	Assigned Ranks
1	25	1.5	8	31	8.5	15	72	15
2	25	1.5	9	31	8.5	16	73	16.5
3	26	4	10	69	10	17	73	16.5
4	26	4	11	71	12.5	18	74	18
5	26	4	12	71	12.5	19	75	19
6	28	6	13	71	12.5	20	76	20
7	29	7	14	71	12.5	21	77	21

Table 4.18: Assigned Ranks to Data Points of Each University

S/N	ABU Data Points	Assigned Ranks	FUT Data Points	Assigned Ranks	UNN Data Points	Assigned Ranks
1	25	**1.5**	25	**1.5**	26	4
2	28	**6**	26	**4**	29	7
3	31	**8.5**	26	**4**	31	**8.5**
4	71	**12.5**	71	**12.5**	69	**10**

5	73	**16.5**	71	**12.5**	71	**12.5**
6	73	**16.5**	74	**18**	72	**15**
7	76	**20**	77	**21**	75	**19**
	Total	**81.5**		**73.5**		**76**

To calculate the Kruskal Wallis H test, the H statistics equation was used

$$H = \left[\frac{12}{n(n+1)} \sum_{j=1}^{c} \frac{T_j^2}{n_j} \right] - 3(n+1)$$

Where,

n = sum of answered responses for all samples (21)
T_j = sum of ranks in each group (81.5, 73.5, 76)
n_j = size of answered items of each group (7)

$H = 12/21(21+1) [(81.5)^2/7 + (73.5)^2/7 + (76)^2/7] - 3(21+1)$

$H = 12/462 [\underline{6642.25} + \underline{5402.25} + \underline{5776}] - (63 + 3)$
$\qquad\qquad\quad 7 \qquad\quad 7 \qquad\quad 7$

$H = 0.026(2545.78) - 66$

$H = 66.190 - 66$

$H = 0.19$

Table 4.19: Hypothesis $H_0 1$ Result

Calculated H Statistics	Critical X^2 value	Df	Alpha level	Decision
0.19	**5.9915**	2	0.05	$H_0 1$ Not Rejected

4.9.2 $H_0 2$- A statistically significant difference does not exist in the opinion of the postgraduate students in the three universities on information query usability efficiency of the web search application.

This result of this hypothesis was broken down to four tables (Tables 4.20, 4.21, 4.22 and 4.23). Results in Table 4.20 revealed the fx data points for the three universities, Table 4.21 showed the assigned ranks to data points, Table 4.22 showed assigned ranks to data points of each university and Table 4.23 displayed the results of the hypothesis tested. The critical chi square X^2 value of 5.9915 is more than the H score of 0.26; therefore, the null hypothesis that a statistically significant difference does not exist in the opinion of the postgraduate students in the three universities (ABU, FUT, and UNN) on information query usability efficiency of the search application is not rejected.

The fx data points for the three groups are:

Table 4.20: fx data points for Information Query Efficiency

Groups	Data Points
ABU, Zaria	67, 34, 68, 31, 70, 74
FUT, Minna	73, 56, 70, 34, 69, 70
UN, Nsukka	70, 65, 66, 38, 71, 62

Table 4.21: Assigned Ranks to Data Points (Ascending order)

S/N	Data Points	Assigned Ranks	S/N	Data Points	Assigned Ranks	S/N	Data Points	Assigned Ranks
1	31	**1**	7	65	**7**	13	70	**13.5**
2	34	**2.5**	8	66	**8**	14	70	**13.5**
3	34	**2.5**	9	67	**9**	15	70	**13.5**
4	38	**4**	10	68	**10**	16	71	**16**
5	56	**5**	11	69	**11**	17	73	**17**
6	62	**6**	12	70	**13.5**	18	74	**18**

Table 4.22: Assigned Ranks to Data Points of Each University

S/N	ABU Data Points	Assigned Ranks	FUT Data Points	Assigned Ranks	UNN Data Points	Assigned Ranks
1	67	**9**	73	**17**	70	**13.5**
2	34	**2.5**	56	**5**	65	7
3	68	**10**	70	**13.5**	66	8
4	31	**1**	34	**2.5**	38	4
5	70	**13.5**	69	**11**	71	16
6	74	**18**	70	**13.5**	62	6
	Total	**54**		**62.5**		**54.5**

To calculate the Kruskal Wallis H test, the H statistics equation was used

$$H = \left[\frac{12}{n(n+1)} \sum_{j=1}^{c} \frac{T_j^2}{n_j} \right] - 3(n+1)$$

Where,

n = sum of answered responses for all respondents (18)
Tj = sum of ranks in each group (54, 62.5, 54.5)
nj = size of answered items of each group (6)

H= 12/18(18+1) [(54)² + (62.5)² + (54.5)²] - 3(18+1)
                    6   6   6

H=12/342 * [2916 + 3906.25 + 2970.25] - (54+ 3)
                 6   6   6

H= 0.03508 * [1632.08] - 57

H= 0.266

Table 4.23: Hypothesis H₀2 Result

Calculated H Statistics	Critical X^2 value	Df	Alpha level	Decision
0.26	5.9915	2	0.05	H₀2 Not Rejected

4.9.3 H$_0$3- A statistically significant difference does not exist in the opinion of the postgraduate students in the three universities on information query usability satisfaction of the web search application.

This result of this hypothesis was broken down to four tables (Tables 4.24, 4.25, 4.26 and 4.27). Results in Table 4.24 showed the *fx* data points for the three universities, Table 4.25 revealed the assigned ranks to data points, Table 4.26 showed assigned ranks to data points of each university and Table 4.27 showed the results of the hypothesis tested. The critical chi square (X^2) value of 5.9915 is more than the H-score of 1.62; therefore, the null hypothesis that a statistically significant difference does not exist in the opinion of the postgraduate students in the three universities (ABU, FUT, and UNN) on the information query usability satisfaction of the search application is not rejected.

The *fx* data points for the three groups are:

Table 4.24: *fx* data points for Information Query Satisfaction

Groups	Data Points
ABU, Zaria	72, 73, 74, 71, 72, 32, 29, 28, 26
FUT, Minna	71, 70, 70, 70, 73, 27, 25, 26, 24
UN, Nsukka	70, 71, 68, 71, 67, 35, 29, 32, 27

Table 4.25: Assigned Ranks to Data Points (Ascending order)

S/N	Data Points	Assigned Ranks	S/N	Data Points	Assigned Ranks	S/N	Data Points	Assigned Ranks
1	24	**1**	10	32	**10.5**	19	71	**20.5**
2	25	**2**	11	32	**10.5**	20	71	**20.5**
3	26	**3.5**	12	35	**12**	21	71	**20.5**
4	26	**3.5**	13	67	**13**	22	71	**20.5**
5	27	**5.5**	14	68	**14**	23	72	**23.5**
6	27	**5.5**	15	70	**16.5**	24	72	**23.5**
7	28	**7**	16	70	**16.5**	25	73	**25.5**

| 8 | 29 | **8.5** | 17 | 70 | **16.5** | 26 | 73 | **25.5** |
| 9 | 29 | **8.5** | 18 | 70 | **16.5** | 27 | 74 | **27** |

Table 4.26: Assigned Ranks to Data Points of Each University

S/N	ABU Data Points	Assigned Ranks	FUT Data Points	Assigned Ranks	UNN Data Points	Assigned Ranks
1	72	**23.5**	71	**20.5**	70	**16.5**
2	73	**25.5**	70	**16.5**	71	**20.5**
3	74	**27**	70	**16.5**	68	**14**
4	71	**20.5**	70	**16.5**	71	**20.5**
5	72	**23.5**	73	**25.5**	67	**13**
6	32	**10.5**	27	**5.5**	35	**12**
7	29	**8.5**	25	**2**	29	**8.5**
8	28	**7**	26	**3.5**	32	**10.5**
9	26	**3.5**	24	**1**	27	**5.5**
	Total	**149.5**		**107.5**		**121**

To calculate the Kruskal Wallis H test, the H statistics equation was used

$$H = \left[\frac{12}{n(n+1)} \sum_{j=1}^{c} \frac{T_j^2}{n_j} \right] - 3(n+1)$$

Where,

n = sum of answered responses for all samples (27)
Tj = sum of ranks in each group (149.5, 107.5, 121)
nj = size of answered items of each group (9)

H= 12/27(27+1) [(149.5)² + (107.5)² + (121)²] - 3(27+1)
                           9   9   9

H=12/756 [22350.25 + 11556.25 + 14641] - (81+ 3)
                 9   9   9

H= 0.01587[5394.167] - 84

H= 85.62-84

H= 1.62

Table 4.27: Hypothesis H_03 Result

Calculated H Statistics	Critical X^2 value	Df	Alpha level	Decision
1.62	5.9915	2	0.05	H_03 Not Rejected

4.9.4 H_04- A statistically significant difference does not exist in the opinion of the postgraduate students in the three universities on transactional query usability effectiveness of the web search application.

This result of this hypothesis was broken down to four tables (tables 4.28, 4.29, 4.30 and 4.31). Results in Table 4.28 revealed the *f*x data points for the three universities, Table 4.29 showed the assigned ranks to data points, 4.30 showed assigned ranks to data points of each university and Table 4.31 showed the results of the hypothesis tested. The critical chi square (X^2) value of 5.9915 is more than the H score of 0.32; therefore, the null hypothesis that there is no significant difference in the opinion among the postgraduate students in the three universities (ABU, FUT, and UNN) on the transactional query usability effectiveness of the search application is not rejected.

The *f*x data points for the three groups are:

Table 4.28: *f*x data points for Transactional Query Effectiveness

Groups	Data Points
ABU, Zaria	29, 30, 67, 70, 71
FUT, Minna	75, 72, 74, 33, 26
UN, Nsukka	67, 66, 63, 37, 35

Table 4.29: Assigned Ranks to Data Points (Ascending order)

S/N	Data	Assigned	S/N	Data	Assigned	S/N	Data	Assigned

	Points	Ranks		Points	Ranks		Points	Ranks
1	26	**1**	6	37	**6**	11	67	**11**
2	29	**2**	7	63	**7**	12	70	**12**
3	30	**3.5**	8	64	**8**	13	71	**13**
4	33	**3.5**	9	67	**9.5**	14	72	**14**
5	35	**5**	10	67	**9.5**	15	75	**15**

Table 4.30: Assigned Ranks to Data Points of Each University

S/N	ABU Data Points	Assigned Ranks	FUT Data Points	Assigned Ranks	UNN Data Points	Assigned Ranks
1	29	**2**	26	**1**	35	**5**
2	30	**3**	33	**4**	37	**6**
3	67	**10**	67	**10**	63	**7**
4	70	**12**	72	**14**	64	**8**
5	71	**13**	75	**15**	67	**10**
	Total	**40**		**44**		**36**

To calculate the Kruskal Wallis H test, the H statistics equation was used

$$H = \left[\frac{12}{n(n+1)} \sum_{j=1}^{c} \frac{T_j^2}{n_j} \right] - 3(n+1)$$

Where,

n = sum of answered responses for all samples (15)
Tj = sum of ranks in each group (40, 44, 36)
nj = size of answered items of each group (5)

H= 12/15(15+1) [(40)^2 + (44)^2 + (36)^2] - 3(15+1)
             5   5   5

H=12/240 [1600 + 1936 + 1296] - (45+ 3)
              5   5   5

H= 0.05[966.4] - 48

H= 0.32

Table 4.31: Hypothesis H$_0$4 Result

Calculated H Statistics	Critical X^2 value	Df	Alpha level	Decision
0.32	5.9915	2	0.05	H$_0$4 Not Rejected

4.9.5 H$_0$5- A statistically significant difference does not exist in the opinion of the postgraduate students in the three universities on transactional query usability efficiency of the web search application.

This result of this hypothesis was broken down to four tables (Tables 4.32, 4.33, 4.34 and 4.35). Results in Table 4.32 revealed the *f*x data points for the three universities, Table 4.33 showed the assigned ranks to data points, 4.34 showed assigned ranks to data points of each university and Table 4.35 showed the results of the hypothesis tested. The critical chi square (X^2) value of 5.9915 is more than the H-statistic of 1.37; therefore, the null hypothesis that a statistically significant difference does not exist in the opinion of the postgraduate students in the three universities (ABU, FUT, and UNN) on the transactional query usability efficiency of the search application is not rejected.

The *f*x data points for the three groups are:

Table 4.32: *f*x data points for Transactional Query Efficiency

Groups	Data Points
Ahmadu Bello Uni. Zaria	70, 64, 64, 33, 31, 57, 42, 41, 36, 65
Federal University of Tech. Minna	72, 73, 70, 36, 28, 30, 30, 33, 30, 67
University of Nigeria, Nsukka	69, 62, 65, 46, 37, 39, 41, 40, 39, 59

Table 4.33: Assigned Ranks to Data Points (Ascending order)

S/N	Data Points	Assigned Ranks	S/N	Data Points	Assigned Ranks	S/N	Data Points	Assigned Ranks
1	28	**1**	11	39	**11.5**	21	64	**21.5**
2	30	**3**	12	39	**11.5**	22	64	**21.5**
3	30	**3**	13	40	**13**	23	65	**23.5**
4	30	**3**	14	41	**14.5**	24	65	**23.5**
5	31	**5**	15	41	**14.5**	25	67	**25**
6	33	**6.5**	16	42	**16**	26	69	**26**
7	33	**6.5**	17	46	**17**	27	70	**27.5**
8	36	**8.5**	18	57	**18**	28	70	**27.5**
9	36	**8.5**	19	59	**19**	29	72	**29**
10	37	**10**	20	62	**20**	30	73	**30**

Table 4.34: Assigned Ranks to Data Points of Each University

S/N	ABU Data Points	Assigned Ranks	FUT Data Points	Assigned Ranks	UNN Data Points	Assigned Ranks
1	31	**5**	72	**29**	37	**10**
2	33	**6.5**	73	**30**	39	**11.5**
3	36	**8.5**	70	**27.5**	39	**11.5**
4	41	**14.5**	36	**8.5**	40	**13**
5	42	**16**	28	**1**	41	**14.5**
6	57	**18**	30	**3**	46	**17**
7	64	**21.5**	30	**3**	59	**19**
8	64	**21.5**	33	**6.5**	62	**20**
9	65	**23.5**	30	**3**	65	**23.5**
10	70	**27.5**	67	**25**	69	**26**
	Total	**162.5**		**136.5**		**166**

To calculate the Kruskal Wallis H test, the H statistics equation was used

$$H = \left[\frac{12}{n(n+1)} \sum_{j=1}^{c} \frac{T_j^2}{n_j} \right] - 3(n+1)$$

Where,

n = sum of answered responses for all samples (30)
Tj = sum of ranks in each group (162.5, 136.5, 166)
nj = size of answered items of each group (10)

H= 12/30 * (30+1) [(162.5)² + (136.5)² + (166)²] - 3(30+1)
                        10   10   10

H=12/930 * [26406.25 + 18632.25 + 27556] - (90+3)
                  10   10   10

H= 0.013* [7259.45] - 93

H= 94.37 – 93

H = 1.37

Table 4.35: Hypothesis H₀5 Result

Calculated H Statistics	Critical X² value	Df	Alpha level	Decision
1.37	5.9915	2	0.05	H₀5 Not Rejected

4.9.6 H₀6- A statistically significant difference does not exist in the opinion of the postgraduate students in the three universities on transactional query usability satisfaction of the web search application.

This result of this hypothesis was broken down to four tables (tables 4.36, 4.37, 4.38 and 4.39). Results in Table 4.36 revealed the *f*x data points for the three universities, Table 4.36 showed the assigned ranks to data points, Table 4.37 showed assigned ranks to data points of each university and Table 4.38 showed the results of the hypothesis tested. The critical X² value of 5.9915 is more than the H score of 1.52; therefore, the null hypothesis that a statistically significant difference does not exist in the opinion of the postgraduate students in the three universities (ABU, FUT, and UNN) on the transactional query usability satisfaction of the search application

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is not rejected.

The *f*x data points for the three groups are:

Table 4.36: *f*x data points for Transactional Query Satisfaction

Groups	Data Points
Ahmadu Bello Uni. Zaria	28, 31, 31, 35, 66, 68, 68, 71, 71, 72, 74, 74
Federal University of Tech. Minna	27, 27, 28, 30, 67, 68, 70, 70, 70, 71, 71 ,72
University of Nigeria, Nsukka	72, 64, 64, 64, 62, 65, 77, 68, 36, 30, 27, 27

Table 4.37: Assigned Ranks to Data Points (Ascending order)

S/N	Data Points	Assigned Ranks	S/N	Data Points	Assigned Ranks	S/N	Data Points	Assigned Ranks
1	27	**2**	13	62	**13**	25	70	**25**
2	27	**2**	14	64	**15**	26	70	**25**
3	27	**2**	15	64	**15**	27	71	**28.5**
4	28	**4.5**	16	64	**15**	28	71	**28.5**
5	28	**4.5**	17	65	**17**	29	71	**28.5**
6	30	**6.5**	18	66	**18**	30	71	**28.5**
7	30	**6.5**	19	67	**19**	31	72	**32**
8	31	**9**	20	68	**21.5**	32	72	**32**
9	31	**9**	21	68	**21.5**	33	72	**32**
10	31	**9**	22	68	**21.5**	34	74	**34.5**
11	35	**11**	23	68	**21.5**	35	74	**34.5**
12	36	**12**	24	70	**25**	36	77	**36**

Table 4.38: Assigned Ranks to Data Points of Each University

S/N	ABU Data Points	Assigned Ranks	FUT Data Points	Assigned Ranks	UNN Data Points	Assigned Ranks
1	28	**4.5**	27	**2**	27	**2**
2	31	**9**	28	**4.5**	27	**2**

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3	31	**9**	30	**6.5**	30	**6.5**
4	35	**11**	31	**9**	36	**12**
5	66	**18**	67	**19**	62	**13**
6	68	**21.5**	68	**21.5**	64	**15**
7	68	**21.5**	70	**25**	64	**15**
8	71	**28.5**	70	**25**	64	**15**
9	71	**28.5**	70	**25**	65	**17**
10	72	**32**	71	**28.5**	68	**21.5**
11	74	**34.5**	71	**28.5**	72	**32**
12	74	**34.5**	72	**32**	77	**36**
	Total	**252.5**		**226.5**		**187**

To calculate the Kruskal Wallis H test, the H statistics equation was used

$$H = \left[\frac{12}{n(n+1)} \sum_{j=1}^{c} \frac{T_j^2}{n_j} \right] - 3(n+1)$$

Where,

n = sum of answered responses for all samples (36)
T_j = sum of ranks in each group (252.5, 226.5, 187)
n_j = size of answered items of each group (12)

H= 12/36(36+1) [(252.5)^2/12 + (226.5)^2/12 + (187)^2/12] - 3(36+1)

H= [12/1332 * 63756.25 + 51302.25 + 34969] - (111)
           12   12   12

H= 0.009* [12502.292] - 111

H= 1.52

Table 4.39: Hypothesis H$_0$6 Result

Calculated H Statistics	Critical X^2 value	Df	Alpha level	Decision
1.52	5.9915	2	0.05	H$_0$5 Not Rejected

4.10 Summary of the Findings

1. 50% of the university libraries studied had policies. However, the libraries that had policies only had elements of ETDs as contents embedded in the policies. The mechanism for policy implementation for ETDs was not defined in the policies.

ii. Policies on preservation and submission of ETD by postgraduate students featured prominently among the policy contents.

iii. Theses in PDF format were the most uploaded form of contents on the repositories. Audio, video and datasets in any format were not available in the repositories.

iv. Majority of the IR administrators indicated that the universities and the students equally owned copyrights of the theses uploaded onto the repositories.

v. Majority of the repositories did not have copyright measures for their theses. Also, users could download full-text either freely or on request.

vi. Majority of the repositories were run on institution-based servers.

vii. Majority of the repositories were not compliant with OAI-PMH.

2. The major challenges militating against the sustainability of Nigerian ETD Repositories according to the study were funding, content population and inadequately skilled staff.

3. A web application that harvests ETDs from stand-alone repositories was designed using PHP, MySQL and Apache web server.

4. The usability evaluation of the web application showed that a statistically significant difference does not exist in the opinion of the postgraduate students in the three universities on the information query usability effectiveness of the search application.

ii. The usability evaluation of the web application showed that a statistically significant difference does not exist in the opinion of the postgraduate students in the three universities on the information query usability efficiency of the search application.

iii. The usability evaluation of the web application showed that a statistically significant difference does not exist in the opinion of the postgraduate students in the three universities in the three universities on the information query usability satisfaction of the search application.

iv. The usability evaluation of the web application showed that a statistically significant difference does not exist in the opinion of the postgraduate students in the three universities on the transactional query usability effectiveness of the search application.

v. The usability evaluation of the web application showed that a statistically significant difference does not exist in the opinion of the postgraduate students in the three universities on the transactional query usability efficiency of the search application.

vi. The usability evaluation of the web application showed that a statistically significant difference does not exist in the opinion of the postgraduate students in the three universities on the transactional query usability satisfaction of the search application.

vii. Overall, the web application was satisfactorily usable with few technical issues related to internet connectivity speed and user log-in details.

4.11 Discussion of the Findings

4.11.1 Institutional repository policy

Table 4.3 revealed that five (5) university libraries had written policy documents for their institutional repositories, while five (5) did not have policies. However, the researcher noted that the libraries that had written policies only included ETDs as contents embedded in these policies. The researcher observed that the mechanism for policy implementation for ETDs was not defined in the policies, and this reflected in the management or operation of the ETDs in the repositories. This situation implied that there was no policy for the management of ETDs in Nigerian library repositories. Although, most of the libraries under study had policies for their print theses, the *modus operandi* for the management of print theses are different from ETD; thus, these policies cannot be applied. It was also noted that ETDs were visualised with the same lens as journals and conference articles which should not be the case. ETDs are not third-party research outputs from external publishers; they are published and partly owned by the universities. Thus, separate policy implementation should reflect on how they should be managed and organised. Imposition and implementation of policy is vital in the successful implementation of any project. (Cayabyab, 2015). In line with the findings in this research, Ashikuzzaman (2018) mentioned that the absence of a clear institutional policy was a constraint for IR development because of the uncertainty that would exist about the norms to be adopted in specific cases. In the case of this study, the absence of a clear ETD policy reflected in the content population and access, copyright and even preservation measures.

4.11.2 ETD policy workflow

Results in Table 4.4 revealed that the policies on preservation and postgraduate students' theses submission were quite high. Also, the researcher observed that although some of the repositories did not have policies, their ETD workflow included preservation and submission by postgraduate students. Ironically, the researcher however, noted that the theses and dissertations of some of

these repositories were quite low while some repositories had not uploaded theses and dissertations after the initial take-off. One of the strong indicator of the success of any repository according to Kounoudes and Zervas (2011) is the number of submissions which includes a high number of submissions and the frequency of submissions. The situation with ETD initiatives in Nigeria based on the data provided and shown on Table 4.4 implied that although postgraduate students submitted electronic copies of their final theses to the libraries, they do not upload same to the repository. The findings of Salau *et al.* (2018) (see appendix G) corroborated this; the researchers found out that there were no designated staff in charge of uploading ETDs to the repositories. Including this task to the workflow of library staff that are already burdened with other activities is counterproductive and a pointer to the low submissions of ETDs in the repositories.

The researcher also observed that the preservation mechanism for these repositories was for short-term; which is the preservation of the print copies through conversion to digital copies. This observation was revealed in Anyaoku *et al.* (2018) study where a good number of the institutions indicated that they provided long-term digital preservation in their IR in the form of information migration. It can be inferred from Anyaoku *et al.* (2018) study that information migration referred to was the digitisation of print copy theses to electronic or digital copies. Although, digitisation is a form of short-term preservation for print theses and dissertations, preservation of electronic information resources takes a different form from print information resources. Gbaje (2011) study corroborated this assertion when the study revealed a significant finding that there was no national digital preservation policy and implementation strategy adopted by Nigerian National Information centres. Nine years down the line, the same situation still exists for electronic information resources in institutional repositories in Nigeria.

Digital preservation of the ETD was missing, which meant that that long-term preservation was not included the preservation policies. Digital preservation measures like emulation, digital archaeology, replication (Lots of Copies Keeps Stuff Safe LOCKSS) to mention but a few were not embedded in the preservation policies or even when setting up these repositories. This finding is in line with the conclusion of Gbaje and Mohammed (2017) that academic institutions in Nigeria deployed IR as a strategy for preservation of their digital objects and assumed that creating a back-up was sufficient to ensure long-term accessibility, which is not, because of the evolution of technology. According to Ovenden (2019), one of the central missions of libraries is the preservation of knowledge. However, Ovenden noted that in recent times, the focus of the profession has shifted greatly from preservation to access in terms of the professionals and also budget. It is pertinent to also note that preservation strategy was well-developed for print resources but lacking for digital resources as evident in the findings of this study.

This assumption is not in Nigeria alone. Wyk and Mostert (2014) similarly reported that the draft IR policy of the University of Zulu, South Africa did not explicitly indicate preservation measures for contents in its repositories. Although issues related to long term digital preservation as it relates to access in the future are still prevalent in developed countries, developing countries are not even in the loop of these issues based on some of the management practices observed from this study. Arlistsch and O'Brien (2014) opined that librarians were great believers in standards and procedures for the development and implementation of repositories. However, the case is different with the ETD repositories in Nigerian federal university libraries. None of the repositories had metadata and data reuse, which is very pertinent to digital contents on the Internet. The reason for this could be because most of the repositories were not data suppliers on

the OAI-PMH framework; this would have enabled a well-defined data use or re-use policy.

ETD in Nigerian IR are not well managed for effective service delivery and long-term accessibility. It is rather sad that while developed countries were already visualising the impact of ETDs via citation counts and using the data generated from them for societal impacts, developing countries are still grappling with issues related to policy formulation and implementation, content population, and even funding.

4.11.3 Content file types

The results on Table 4.5 revealed that all of the repositories have their uploaded ETD contents in Portable Document Format (PDF). This result mirrors the findings of Gbaje and Mohammed (2017) and Termens *et al* (2015) negates that of Rimkus *et al.* (2014). However, despite being the dominant file format, Cayabyab (2015) reported some concerns of PDF not supporting full-text search and its proprietary status as challenges to data management. The view of Cayabyab was also shared by Termens *et al.* (2015) because of the encryption of PDF files to prevent manipulation in Spanish repositories. The authors saw it as a potential hindrance for future file migration with consequences for long-term preservation of the repository objects. Franke *et al.* (2017) thus advocated for open, standardised and sustainable file formats as a focus of attention for institutional repositories in order to avoid problems of accessibility in the future.

Conspicuously absent from the ETD contents uploaded to the repositories were audios, videos, and images. These files constitutes data sets in used in the research. Examples are computer codes, maps, and interview recordings to mention but a few. The submission of supplementary file formats along with theses and dissertations is a relatively new phenomenon that arose as a result of digital forms of these contents. Doty *et al*. (2015), in their study, stated that data sets are included as supplements to ETD submissions for research replication and transparency.

According to the researchers, academic libraries all over the world are offering research data archival services in support of this new trend. Shearer *et al.* (2015) also stated that beyond providing access to ETDs, repositories were developing other functionalities, especially facilitating text and data mining. It is therefore crucial that Nigerian university library repositories are not left out of this trend despite the late adoption. The major challenge, however, is not the issue of advocacy but the readiness of libraries to accept and preserve these contents. Libraries must also have their repositories well customised and organised to include the different file formats datasets can come and leverage on these to also increase contents.

4.11.4 Content copyright ownership

Results on Table 4.6 revealed another pertinent issue with the contents of ETDs in Nigerian IRs. Four (4) of the institutions indicated that the copyright of the ETDs belonged to the researcher and the university. Four institutions also indicated that they had no idea while two institutions stated that the researcher owned the copyrights. Before the advent of digital forms of theses and dissertations, this was not an issue primarily because visibility and accessibility were restricted to the walls of the library. With electronic format, however, the issues are different, because these contents can now be accessed globally. The implication of not indicating whose intellectual property theses and dissertations are, can bring about a conflict of interest, with both parties not knowing the limit to which they can use these documents. It is generally believed in this part of the world that research studies for postgraduate degrees are commissioned works (submission of thesis included) in exchange for a certificate, and thus the copyright belongs to the University. This is however not the case in all instances; for example, in a case of a third party funded postgraduate study, the funding university uploads the thesis to its repository, the commissioning university also uploads to its repository. The graduate student may also want to publish some

contents from the thesis. The issue, thus, is who owns what and to what extent? Another major challenge which has been sparsely reported with Nigerian repositories is publishers' rejection of manuscript because of ETDs published in repositories (Mccutcheon, 2010) which can be attributed to the low number of ETDs in these repositories.

4.11.5 Contents copyrights measures

Table 4.7 results showed that Nigerian repositories had inadequate measures to protect the copyright of the ETD contents. Majority of the repositories (8) in this study did not have copyright measures in place. Cayabyab (2015) reported that issues related to copyright from the literature included worries of students about their research being stolen. These worries are valid, especially in the Nigerian IR setting where majority of the ETD contents are open. Although open access aids the research need of scholars, inadequate copyright measures can be counterproductive for developing countries where intellectual property policies are not well documented and implemented. The use of digital watermarks, for example, would give access to users but make direct copying of these contents difficult. Caution should, however, be taken in the use of copyright measures such as encryption as highlighted in the study of by Termens *et al.* (2015) which could have consequences for long-term preservation of the repository objects.

4.11.6 Content access level

Table 4.8 showed that majority of the repositories allowed full-text download of theses without copyright measures in place. This measure improves access to these research output and increases visibility which can discourage plagiarism. The knowledge that a thesis, when completed shall be uploaded to an institutional repository will discourage plagiarism because it implied that it will be discovered. However, in Nigeria, it can be counterproductive because of

the ill managed repositories and low contents in theses repositories. It is a source of concern because these documents could be indiscriminately used and copyright violated. Although ETDs are classified as grey literature whose copyright does not belong to commercial publishers (Schöpfel and Farace, 2010), there is always the concern about plagiarism, especially where contents can be copied. Interestingly, the situation is not peculiar to Nigeria or developing countries alone. The study of Prost and Schöpfel (2013) revealed that some repositories displayed minimal level of openness for theses due to challenges such as inadequate awareness, copyright concerns, plagiarism concerns to mention but a few. However, university libraries can employ copyright measures like using passwords and restricting direct copying of contents after downloads.

4.11.7 Repository server

Results from Table 4.9 revealed that majority (9) of the universities used institutional-based servers as against commercial or third-party servers. This indicated that Nigerian institutional repositories had not adopted cloud computing measures for storage of ETDs seven years after Ifijeh (2014) recommended the adoption of cloud computing for the operations of the digitised theses in Nigerian academic libraries IRs. Cayabyab (2015) also observed that none of the literature reviewed on ETDS in their research article discussed the feasibility of cloud computing despite the hesitance of patronising ETD because of the reliability of storage device preservation which is said to last 15-20 years.

Cloud servers, in this case, can be defined in two ways. One is the library's use of cloud services to store, preserve, and back up contents of the repository. The second instance is the use of commercial repository software that automatically hosts and manages all contents on a cloud

server. Cloud computing technology can be a good technique to preserve knowledge, however, libraries should be cautious of the business models of shared servers and cloud computing sites. The reason for this can be attributed to the reliability of these technique for longer periods.

4.11.8 OAI-PMH complaint repositories

An overwhelming majority of Nigerian repositories are not data providers on the OAI framework. In fact, the observation checklist offered a contradictory position on University of Jos that indicated that their IR were registered as data providers on the OAI-PMH protocol. They were not listed on the OAI-PMH website (https://www.openarchives.org/Register/BrowseSites). The reason for the inconsistency may be due to software upgrade without a corresponding update on the OAI-PMH website. This means the repository administrators did not update their records after a major software upgrade. This non-compliance of Nigerian IRs with the OAI-PMH framework explains the unavailability of ETDs from Nigerian universities in global databases such as Database of African Theses and Dissertations (DATAD) and Networked Digital Library of Theses and Dissertations (NDLTD). Another reason for the poor visibility of ETDs from Nigerian universities is, the unavailability of any networked platform that either centralises the ETDs in a database or harvests ETDs for the stand-alone repositories.

The repositories in Nigerian IR were not registered on the OAI-PMH platform. The OAI-PMH protocol allows service providers to harvest and process metadata (bibliographic information) for the items in a repository. International service providers or aggregators use the data provided to feed their databases for visibility, thus making searching faster. Tmava and Alemneh (2013) opined that open standards interconnectivity between IR platforms and online search systems, such as Ask.com, to index elements of metadata offer beneficial search capabilities. The minimum standard of interoperability for repositories is the OAI-PMH (Shearer *et al.,* 2015). It

is also the most utilised protocol among ETD providers (Hakimjavadi and Masrek, 2013).

The researcher also observed that the repositories were not optimised for search engines. The reason for this can be related to the use of Dublin core metadata for DSpace repositories. This revealed another pertinent reason for poor global visibility. Hogan (2014) stated that there is a disconnection between Dublin Core and general-purpose search engines like Google. In a related study, Arlitsch and O'Brien (2014) carried out a search engine optimisation study in University of Utah's digital repository. Their study revealed low indexing ratio on Google Scholar and a further subsequent study found out that those repositories that used Google Scholar recommended metadata schemas expressed as meta-tags in HTML had higher indexing ratios. Tmava and Alemneh (2013) supported this finding when they stated that regardless of other contributing factors, rich metadata that is consistently encoded was responsible for making the digital items more discoverable. These studies were, however, focused on search engine optimisation and not necessarily interoperability with metadata harvesters. A good number of the repositories in this study used the Dublin-Core metadata which are not registered on the protocols that enable other information systems to collect and gather non-linkrot metadata outside the repositories' environment. Further studies can be carried out on the usability of the metadata in Nigerian IRs to find out this gap. In most cases in developing countries like Nigeria, the poor synergy between the information technology (IT) units of universities and the librarians causes technical issues like search engine optimisation and interoperability. The researcher observed that in most cases, the IT units customised their repositories without due consultation and input from the librarians to find out how these repositories can be tailored to meet users' needs.

4.11.9 Information query effectiveness

The information query usability evaluation revealed uniform results in the effectiveness of the Webware. Majority of the participants reported that the federated search application was effective in meeting their information queries about ETDs (Table 4.11). These results indicated that the federated search application assisted postgraduate students greatly in retrieving information on theses and dissertations relevant to their studies conducted in other universities. This is probably because the information query is usually the first intention of any postgraduate student looking for ETDs for their research studies. This result is similar to Coates (2014) that revealed that local users of Auburn University ETD collection had more of informational queries from search engines seeking information about theses from specific Auburn researchers. 70% of participants in Mohammed and Yousef (2015) study also stated that federated search tools provided an easy way to find their information resources. Questions about availability, location, year of publication are some of the information the search web application in this study takes care of and has been found usable. In a similar finding, Wakeling *et al.* (2017) usability study of worldcat.org, (a global online catalogue) found that respondents frequently mentioned using the online catalogue to determine the location of information resources. Of particular interest in Wakeling *et al.* (2017) study which resonates with what the webware in this study does is that PhD students used Wordcat to identify all the literature in their area from a single access point. In this study, postgraduate students will not need to search for individual repositories or travel to in search for research findings related to their studies, thus making access to library information resources easier. According to Bracke, *et al.* (2008) in the educational context, systems such as the federated search application have lowered the obstructions to information resources while providing increased the use of result-based learning. Roy, *et al.* (2016) also opined that this type of web portal is advantageous for researchers because it enables worldwide connection to

resources through a federated search portal. Also, according to Saparova *et al.* (2014) information gotten through federated search systems is beneficial for on the spot information needs of physicians through a single search.

4.11.10 Information query efficiency

The study revealed that information query usability evaluation revealed mixed results in the efficiency of the Webware. Majority of the participants reported that the federated search application was efficient in meeting their information queries about ETDs (Table 4.12), although they disagreed to statements 2 and 3 (The system requires few steps to find the information requested and overall, the time taken to complete the search was minimal). Although, the participants disagreed that the system required a few steps to find the information requested; these few steps are minimal when compared to steps from general search engines. Nelson *et al.* (2008) stated the expectations of personalised search engine users to include finding the information available on the second and third pages of general search engines on the first page of a personalised search engine. The respondents also disagreed with statement 3 (The system requires few steps to find the information requested) had a weak disagreement. The reason attributed to this can be Internet connectivity and the number of tasks the respondents were requested to carry out. The respondents' agreement with statement 1 that they were able to complete the search quickly using the system is an indicator of this. They also agreed that they could recover from mistakes quickly, which is another strong indicator of the information query efficiency. These results mirrors Hultman *et al.* (2018) usability testing of NLP-PIER (a self-service search engine for clinical researchers) that also revealed mixed results. Participants graded NLP-PIER marginally usable yet also stated that the search engine would be useful in their research and that they had current and future projects which the system would also be

useful. These discrepancies in usability evaluation indicates that information systems will never be 100% usable especially at the initial development stages. Usability evaluation should therefore be a continuous process. User behaviour studies using federated tools like the designed webware in this study and search engines can be carried out in future to verify the statement 3.

4.11.11 Information query satisfaction

The study revealed that the respondents agreed to all five statements that supported their Information Query satisfaction with the webware and disagreed to the four statements that were not in support of the Information Query satisfaction with the webware. (Table 4.13). These results showed a high level of satisfaction with the use of the webware as a federated tool for retrieving ETDs. This result is similar to the findings of Warraich, *et al.* (2009) usability assessment of a unified search system at Punjab University; a good number of the participants were satisfied with the essential functions of the search product. Similarly, Zhang *et al.* (2013) evaluation results indicated a high level of satisfaction with the Human-Animal Bond Research Initiative Central repository. However, respondents reported usability issues related to metadata input. In this study, the respondents agreed that they would like to use the system to find theses (Statement 3); they also disagreed that the system did not meet their expectations (Statement 6) and that they will not recommend the system to their colleagues. Emde *et al*. (2009) also got similar results, when all the participants (faculty) in their usability study of academic library website stated that they would recommend the federated search tool to their students as a good place to begin their research.

These results implied that users' search expectations are changing and academic libraries must incorporate search systems that resonate with their expectations. Donaldson and Nelson (2011) stated that searching and finding open access resources from different sources is difficult and

time consuming for researchers. Similarly, Sarkar and Mukhopadhyay (2012) and Byamugisha (2010) in different research studies observed the paradigm shift of users from distributed access to access through a single gateway or access point, and also automated push and pull remote library services.

4.11.12 Transactional query effectiveness

Results on Table 4.14 showed that respondents agreed to statements supporting the effectiveness of the system for transactional queries for ETDs; and disagreed to statements not supporting the effectiveness of the system for transactional queries. Transactional queries are important to complete the whole cycle of information retrieval. Studies have shown that it is not enough to know where to find information, access to the information is equally important. According to Sankar and Kavitha (2015), modern ICT tools like the designed webware in this study acts as an effective intervener and has become a boon to avoid duplication of research studies as well of the utilisation of theses.

4.11.13 Transactional query efficiency

Results on Table 4.15 revealed that respondents agreed to statements supporting the efficiency of the system for transactional queries for ETDs; and disagreed to statements not supporting the efficiency of the system for transactional queries.

4.11.14 Transactional query satisfaction

The transactional query usability evaluation satisfaction results on Table 4.16 reported that the participants were satisfied with the webware for meeting their transactional queries about ETDs. They agreed to all positive statements supporting transactional query satisfaction and disagreed to the statements that do not support transactional query satisfaction. Interesting, the respondents agreed to statement 3 (I was able to complete the download task) on Table 4.13, but disagreed to

statement 3 on Table 4.16 (I enjoyed the download task using the system).

Two reasons can be attributed for the varied opinions. Firstly, to download theses from the repositories, user registration and details are required to complete the process. Participants expected that the download access should be without the log-in details. They may not have found this process efficient nor were they satisfied with the ease of completing the download task because it was expected that the search application should be able to provide download access automatically from the repositories. However, the challenge associated with the log-in details was based on some university policies to ensure restricted access to their ETDs. Studies of Ballard and Bliane (2011) and Neal (2009) reported that web users want on the spot access to their search objects. Similarly, Wakeling *et al.* (2017) study also suggested that majority of the users that used worldcat.org from search systems did not complete the task of linking the local library webpage, because they were likely seeking the full text version of the search objects which worldcat does not provide. The restricted access of ETDs in some repositories in Nigeria must take cognisance of this information seeking behaviour and provide open access to ETDs albeit with copyright measures in place.

Secondly, Internet connectivity was another factor that affected the transaction query, which is downloading theses. The study of Saparova *et al.* (2014) revealed similar results in their evaluation of MedSocket-a federated medical search engine. Respondents were showed a high level of satisfaction with the search system but had challenges with the download speed. The results in the transactional query usability satisfaction indicated that the federated search application would assist postgraduate students greatly in retrieving theses relevant to their studies conducted in other universities. However, the technological capability in terms of log-in access and Internet speed of the repositories are challenges that must be improved upon in order to

notice its net benefits.

4.11.15 Research hypothesis $H_0 1$

A statistically significant difference does not exist in the opinion of the postgraduate students in the three universities on information query usability effectiveness of the web search application

The result for the first hypothesis suggested that the opinion of the postgraduate students on how effective the search application is in retrieving information about e-theses from the repositories was the same in the three universities. In a similar study, Mohammed and Yousef (2015) study found no significant effectiveness difference between two federated search tools in terms of searching capabilities. Hanrath and Kothman (2015) equally reported a similar study that showed that over 80% participants rated their impression of 'Primo' a new search tool as positive. The implication of these results shows that there is a paradigm shift in the search behaviour of students that libraries have to take cognisance of. According to Lown *et al.* (2013) and Asher *et al.* (2012) Google has widened the expectations of users in terms of search and retrieval, thus libraries adoption of these search tools. Collaborating this assertion, Salau and Gama (2015) also opined that users of electronic information would mostly use sources of access that can give them less challenges and offer more advantages to them especially for teaching and research; federated search tools offer this advantage. Korah and Cassidy (2010), found a high rate of federated search among students of Sam Houston State University and stated that federated tools presented information in a simple, user-friendly way that required little formal knowledge of information organisation and searching techniques which made it attractive to many students.

4.11.16 Research hypothesis $H_0 2$

A statistically significant difference does not exist in the opinion of the postgraduate

students in the three universities on information query usability efficiency of the web search application

The result for the second hypothesis suggested that the opinion of the postgraduate students about the efficiency of the search application in retrieving information about e-theses from the repositories was the same in the three universities. Connaway (2015) stated that it is imperative for libraries to save the time of their users by providing elements of modern information ecosystem where users are not required to visit multiple interfaces to stay informed. This should be the one of the reasons for the uniform result of this hypothesis. The webware provides access to theses from different repositories through one single access point.

4.11.17 Research hypothesis $H_0 3$

A statistically significant difference does not exist in the opinion of the postgraduate students in the three universities on information query usability satisfaction of the web search application

The result for the third hypothesis suggested that the opinion of the postgraduate students about the satisfaction of the search application in retrieving information about theses from the repositories was the same in the three universities. There are issues with providing access to licensed e-contents like e-journals, e-books to mention but a few. ETDS are however local e-contents which libraries can leverage on to increase the usage of their electronic resources. Connaway and Faniel (2015) believes that locally produced e-content is getting more attention in recent times.

4.11.18 Research hypothesis $H_0 4$

A statistically significant difference does not exist in the opinion of the postgraduate students in the three universities on transactional query usability effectiveness of the web

search application

The result for the fourth hypothesis suggested that the opinion of the postgraduate students on how effective the search application was in downloading information about e- theses from the repositories was the same in the three universities. Information discovery is as important as information delivery. In OCLC (2009) users' and librarians' expected that online catalogue will not only discover their information needs, but also deliver them because discovery alone was not sufficient. The uniform results of the hypothesis are expected because the respondents were able to download the theses they searched for, thereby completing the process. Studies have indicated that web users want instant access to information resources (Ballard and Bliane, 2011; Neal, 2009, Wakeling, *et al.* 2017). Although there were varied opinions on the download task, this had little to do with the effectiveness of the system.

4.11.19 Research hypothesis H_05

A statistically significant difference does not exist in the opinion of the postgraduate students in the three universities on transactional query usability efficiency of the web search application

The result for the fifth hypothesis suggested that the opinion of the postgraduate students about the efficiency of the search application in downloading information about e-theses from the repositories was the same in the three universities. The result of this hypothesis resonates with 'time as convenience' for users to mean any efficiency-based value that users ascribe to their experience with libraries; which influences users' actions and choices throughout the process of seeking information (Connaway and Faniel, 2015; Connaway *et al.,* 2011).

In the opinion of Dempsey (2012), libraries now operate alongside other information service providers like GOOGLE, AMAZON and Facebook which has caused a paradigm shift in the way

users experience library online services. Research studies have indicated that users choose to use the Internet because is it the most convenient and cost effective and not necessarily the best source. This same information seeking behaviour applies to the sources of information on the Internet. Users would most likely use sources that are convenient but also completes the whole information seeking process which includes retrieving the resource.

4.11.20 Research hypothesis $H_0 6$

A statistically significant difference does not exist in the opinion of the postgraduate students in the three universities on transactional query usability satisfaction of the web search application

The result for the sixth hypothesis suggested that the opinion of the postgraduate students about the satisfaction of the search application in downloading information about e- theses from the repositories was the same in the three universities. The end user information retrieval challenge associated with searching across multiple repositories and learning the retrieval features is solved with the use of the federated search application in this study. In the foreseeable future there will be increasing demands from users for simplified access. Thus, libraries must find ways to deliver easier routes for retrieving information. Librarians all over the world are known to save the time of the user, thus search applications such as the one in this study is needed. The researcher found limited literature on the usability of institutional repositories or federated search tools for institutional repositories despite the fact that several studies have found low use of repositories in Nigeria. It is envisaged that the federated search application for repositories will increase the usage of the IR contents. Further research can be conducted to compare these usages.

The study concluded that although there is a need to include more features and fix some usability

issues based on transactional queries, the use of the federated search application would increase postgraduate students' confidence in retrieving information about postgraduate researches conducted in other universities. It will also provide access to information from multiple repositories through a single access point, thus allowing to conduct more accurate searches.

CHAPTER FIVE

5.0   **CONCLUSION AND RECOMMENDATIONS**

5.1 Conclusion

Conceptualising the digital library management system for ETDs in developing countries revealed some salient issues. The ETD initiatives in repositories of Nigerian federal universities have not made remarkable progress as digital libraries, based on policy, content and system architecture. This research study concluded that ETDs in Nigerian IRs are not well managed for effective service delivery and long-term accessibility. The ill-management of the ETD initiatives is the reason for the poor global visibility and accessibility of these research output from this part of Africa. It is rather sad that while developed countries were already visualising the impact of ETDs through citation counts and using the data generated from them for societal impacts, developing countries are still grappling with issues related to policy formulation and implementation and content population.

Although issues related to long term digital preservation as it relates to access in the future are still prevalent in developed countries, developing countries are not even in the loop of these issues based on some of the management practices observed from this study. It goes without saying that majority of the institutional repositories of federal universities in Nigeria were set up due to what Bringula (2016) referred to as 'normative pressure' (institutions adopted practices or innovations because stakeholders are embracing the same practice) with little or no sustainable plans in most cases. A pointer to this is the non-documentation of policies related to ETDs, non-inclusion of copyright measures, and partial inclusion of librarians in some universities as against the staff from the information technology unit in the initial implementation committee for repositories; the implication was thus shaky and ill-managed repositories.

This has led to the near-comatose state of most of these repositories with pertinent issues involving the core of librarianship like acquisition, preservation and even dissemination not properly stated where there are policies. Incidentally, some of the institutional repositories from developed countries published challenges encountered while setting up their repositories and managing the research output therein with solutions in some cases over a decade ago. A source of concern is why developing countries like Nigeria did not leverage these solutions. Different research studies that can solve most of the domestic challenges in developing countries are buried in these theses and dissertations which repositories would have exposed.

The study also revealed that the use of institutional servers has been a major cause of downtimes for the repositories. Issues related to server space and electricity has caused some institutions to lose the ETD contents in their repositories. Cloud servers can be a viable alternative to institutional servers if the emphasis is only on access; but can be counterproductive for long-term digital preservation. Libraries have been known as deposit spaces of information for long. However, libraries especially in developing countries needs to be prepared to disseminate knowledge and make it accessible in new ways. It is also important that they become major players participating in the value creation chain surrounding the production of knowledge. For instance, taking up publishing of theses and dissertations. Kennedy (2019) was of the opinion that for universities to remain financially viable especially with the ubiquitous nature of information now, libraries must take up lead roles in the platform ecosystems of private capital geared towards public good. Libraries must therefore weigh all options available to them and make an informed assessment based on access and preservation.

Based on the findings of the study, the study concluded that the management of ETDs in

Nigerian repositories in terms of policies, funding, contents access and technology is poor, thus the reason for the poor global visibility and accessibility of ETDs from Nigeria. Although, this study focused on ETD of federal university libraries and as such, cannot make a generalisation of ETD management in other institutions' repositories; the results mirrors what may be obtainable in these institutions. Therefore, there is a need for a management paradigm shift which the recommended sustainability frameworks in this study addresses.

The ETD search application developed in this study will also help solve the challenge of poor global visibility of theses and dissertations from Nigeria, thus reducing repetitive and plagiarised researches and also increasing access to local literature for postgraduate students.

5.2 Contribution to Knowledge

This thesis has contributed to knowledge through the following:

Institution administrators

1. The developed web search application can be integrated into the E-learning management platform of universities as a supporting information resource for students. University libraries in Nigeria can include same in their resource catalogue for their users and for accreditation purposes.

2. The findings of this study and the designed system will serve as a framework for Nigeria Universities Commission or any government agency that may be responsible for the design of a unified e-theses repository for universities in Nigeria in future. Similarly, institutional repository administrators in other institutions like Polytechnics and Colleges of Education can as well use the findings and proposed ETD policy and designed webware as a framework for establishing, developing and integrating their repositories.

University Libraries

1. The recommended sustainability frameworks and recommendations proposed in this study will assist university library administrators, and repository administrators sustain their repositories. The frameworks will also help university libraries yet to develop their repositories to avoid some of the pitfalls identified in this study and develop sustainable repositories. When fully implemented with live repositories, the designed web search system would effectively assist postgraduate students undergoing their research studies in the course of their literature search and help reduce duplicated researches.

2. The developed web search application can be integrated into the E-learning management platform of universities as a supporting information resource for students. University libraries in Nigeria can include same in their resource catalogue for their users and for accreditation purposes.

Researchers

1. The study also provided assessment findings on ETDs in Nigerian IRs based on policies, contents and system architecture. This findings can serve as literature for further studies.

2. When fully implemented with live repositories, the designed web search system would effectively assist postgraduate students undergoing their research studies in the course of their literature search and help reduce duplicated researches.

5.3 Recommendations

The researcher recommended three sustainability frameworks for policy, content population, and

funding of ETD repositories among other recommendations

1. Policy for the Management of ETDs in Nigerian University IRs

The need for a policy to enhance the proper implementation and management of systems cannot be overemphasised. According to Gbaje (2011), a policy is a strong component of plans of actions designed to guide and facilitate the successful implementation of any project. The researcher divided the process of coming up with a policy into three, policy formulation, implementation and evaluation. The three processes indicated above does not necessarily have to follow the direct order of formulation-implementation and evaluation, except in cases of novel systems and programmes. The policy process can also be from evaluation-formulation to implementation in cases of existing policies. This study evaluated the existing policies of institutional repositories and found a dearth of policy specifically for ETDs. Thus, the study proposed the ETD policy below which university libraries can customise and implement depending on their programmes. To the best of the researcher's knowledge based on the findings from this study, and from several studies in the literature (Ashikuzzaman, 2018; Corletey, 2011; Baro and Otiode, 2014; Uzuegbu, 2012; Baro *et al,* 2014), there was no global harmonised policy precisely for ETD in any Nigerian federal university library. However, there is evidence in the literature of case by case policy for individual institutions. Thus, in coming up with this draft policy, several sources were consulted. They include the Directory of Open Access Repositories (Open DOAR) policy tool, Registry of Open Access Repository Material Archiving Policies, (ROARMAP), the publishers' policy and archiving list of Securing a Hybrid Environment for Research, Preservation and Access/ Rights Metadata for Open archiving (SHERPA/RoMEO). Other sources were the digital preservation policies for National information centres proposed by Gbaje (2011) and digital repository policy for University of Burdwan proposed by Roy (2013).

These sources inspired some of the contents in the ETD management policy of this study.

Policy principle statement

The draft policy is to preserve and manage the indigenous research findings in the form of theses and dissertations present and long-term purpose. The frequency of the policy review should be annually to ensure currency to trends and developments. This can, however, be decided by participating libraries based on peculiar situations, technology changes and overall university policy changes.

Policy mission

The primary mission of the proposed policy is to ensure that ETD in Nigerian Universities are available and accessible across borders for short-and long-term use.

Table 5.1: Policy Contents of ETD Management Policy Framework for Federal University Libraries

S/N	Policy Contents	Activities
1.	Acquisition	Acquisition workflows, submission rules, submission form and formats
2.	Contents	Types, file format, access level
3.	Quality control	Mechanism for ensuring the quality of ETDs uploaded
4.	Preservation	File retention periods, mechanisms to ensure access to contents overtime
5.	Copyright & Intellectual property	Copyright licensing issues and measures
6.	Embargo	Length of time before thesis/dissertation is uploaded
7.	Metadata Re-Use	Metadata schema, modalities for access and reuse
8.	Staff Training	Types of ETD management staff, training periods
9.	Funding	Sources of funds for maintenance of the ETD repository
10.	Technical Support	Issues related to standards, system architecture, security
11.	Withdrawal	Situations necessitating the removal of an uploaded thesis

Content population policy

Populating the repository with electronic theses and dissertations shall be through:

1. Graduating postgraduate students: The postgraduate students shall compulsorily deposit their ETDs. The elements of the metadata schema to be used should be explicitly spelt out. E.g. Date (Should this be the date of completion of thesis or date of publication in the repository).

2. Digital library staff: Back-log of E-theses and dissertations submitted to the libraries but not uploaded to the repositories

3. Digitisation staff: Back-log of print theses and dissertations digitised and uploaded to the repositories.

4. Institutions can, however, decide if they have the human and technical capacity for option three and four above.

Content policy

The following file contents may be uploaded alongside the full-text ETD to form contents in the repository.

i. Research Data of the ETD (computer codes, survey/interview data, to mention but a few).

ii. Maps and photographs/images

iii. Videos

The decision of which of these contents that should be made available to the public either full-text or bibliographic information should be decided by the Institutions and authors as the case may be. Access to contents in the ETD repositories shall be over the Internet where possible. Open theses shall be accessible for download to the public for free while selected ETDs shall be available for document processing fee. Royalties shall be paid the copyright owners of the ETDs with 'paid' status. These decisions should be made based on copyright access status discussed in the copyright policy.

Quality control policy

a. Only completed and approved electronic formats of theses and dissertation must be uploaded to the repositories. The postgraduate school, library and research office should

synergise to ensure a smooth quality assurance process from acquisition to dissemination and storage. An application with an in-built Postgraduate school template can be designed to be included in either open source repository software or in-house built software to take care of quality control issues.

b. Designated digital library staff involved in the acquisition workflow will review the theses submissions and bibliographic details for acceptance or rejection based on the policy guidelines. Only duly signed submission approval would clear the student for graduation.

Digital preservation policy

Depending on the software deployed for the management of ETDs, university libraries should decide the following modalities for effective and efficient long- and short-term digital archiving and preservation of ETDs.

a. Length of retention of the ETDs (full-text files or metadata files) on the repository server from the date of deposition (< 10years, 10-20years, 20-50years, indefinitely)

b. Modalities should be in place for the following

i. long term preservation techniques (Replication, digital archaeology) or back up in external archives-

ii. daily, weekly or monthly back up based on current best practices

iii. migration of file formats or software emulations for old file formats

iv. Digital Archiving of item bitstreams

Preservation tools and techniques like XENA (XML Electronic Normalising for Archives) and TRAC (Trustworthy Repositories Audit & Certification: Criteria & Checklist) or any other appropriate digital preservation software can be embedded for long term digital preservation and

assessment.

Copyright and intellectual property policy

Institutions should decide the level of intellectual property right students and the institutions own and for how long. This should be decided at the point of registration and in collaboration with the postgraduate school. A detailed description of individual and institution's rights over the document, describing distribution conditions and changes that may occur to the conditions in the future. The intended research may be separated into normal research commercial researches. These statuses would also determine what the thesis deposit agreement would be (Open access, embargoed or closed access). Copyright consent terms and conditions for the transfer agreement of ETDs should be specified. E.g. are you aware that after the final deposit of your ETD to the repository-you have transferred all rights to your research to the University-with implications. Awareness about the creative commons license should be introduced to postgraduate students.

Copyright measures

Institutions should decide should copyright measures is workable for them. Digital watermarking and the use of passwords are good and viable options.

Embargo policy

Length of embargo period can be decided for theses and dissertations under the 'research by publication' and 'commercial research status'. A period of six months to two years after the oral/exit seminar of the thesis is sufficient, but this can be decided on individual bases.

Metadata reuse

Institutions may decide modalities for providing data to service providers on the OAI-PMH platform and for how long. Modalities for Metadata use/reuse should be clearly stated based on institutional preferences. This include which metadata schema to be used and which ones to be

made available to service providers.

Training policy

For the effective management of ETDs, the following staff would manage the ETD repository:

i. repository manager/administrators- Facilitates overall management and administration of the repository. He/she is the repository team leader and thus ensures that the repository policy mandate is adhered to and reviewed periodically to meet current and global standards.

ii. digital librarians- Assist the repository administrator in the management of the repository.

iii. product developers- In charge of developing market-ready prototypes form the research output of the repository.

iv. computer programmers/engineers-In charge of technical issues related to the software/hardware components of the repository

v. communication experts- In charge of marketing the research output and product of the repository to the global world through various channels.

The staff list would be updated as need arises.

A review of training needed to meet up with trends in the management of repositories should be taken every two years in-house and aboard for the different cadre of staff. Institution libraries should also ensure that postgraduate students are adequately trained about the acquisition and copyright workflow.

Funding policy

Sustainable funding models/sources for the management of the ETD should be defined. Funding models may include but not limited to TETFUND/IGR, integration with commercial ETD publishers, processing fees, funding from research products, research funded models (certain percentage (1%) of funded PhD/Masters researches) and any of the various available business

models that may be suitable and sustainable.

Technical support policy

There are available in-house and commercial repository solutions available. Institutions may decide to adopt one or both depending on funding capacity. The use of in-house technical support may be cost-effective, but the choice of commercial solutions. The commercial solution may leave more room to increase and improve additional services on the repository. Cyber security issues and insurance can be assessed from time to time and adequate measures and upgrade in place.

Withdrawal policy

The full text of ETDs would be removed from the repository in cases but not limited to, the following:

i. Copyright violation/plagiarism

ii. Contents of patents/trade secret

2. Recommended content populating workflow for ETDs in Nigerian repositories

Content remains the backbone of digital repositories. A repository without contents can be likened to shelves without books. One of the challenges of the Nigerian university library repositories, as revealed in this study was content population. Thus, the research proposed a content population workflow embedded with postgraduate students. Mikeal, *et al.,* (2007) proposed a content submission system for ETDs for universities under the consortium of Texas universities. Several universities in Europe and America also have platforms and workflows were their postgraduate students ingest ETDs to be managed in their repositories. Building on this evidence in the literature, the content populating workflow proposed in this study included a quality control technique in the workflow which was necessary for the application area (Nigeria).

The quality control technique would be in the form of an application built based on the approved postgraduate school theses template. The application would assist to reduce the upload of non-approved ETD contents to the repository.

WORKFLOW   **PARTICIPANTS**
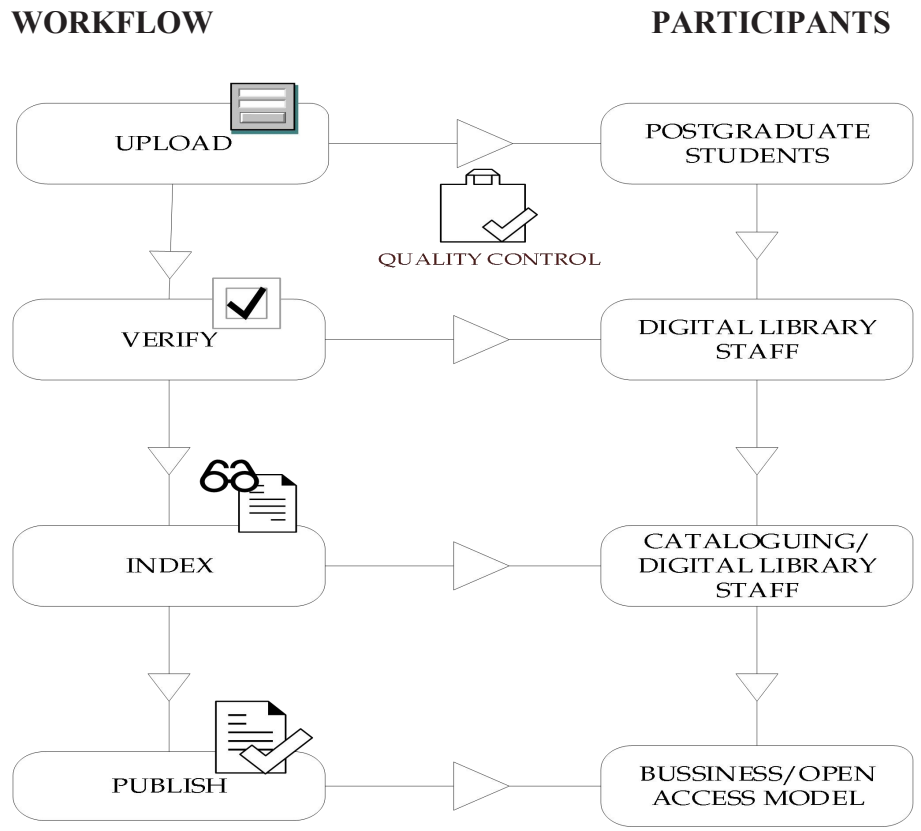
Figure 5.1: Recommended ETD content populating workflow in Nigerian IR (Inspired from Mikeal *et al.*, 2007)

Upload stage: Postgraduate students upon completion, submission and approval of hard/soft copies by the postgraduate schools of the various Universities would be required to register with the IR for authentication and onward upload of their thesis/dissertation and supplementary files or documents including the research data, maps, videos, audios and images. The following few steps would be followed:

i. Registration with the repository.

ii. The postgraduate student submits the descriptive metadata (name, title, year, keywords, supervisors and abstract) of the thesis/dissertation.

iii. Selection of copyright license/embargo type (Partial, full or no copyright)

iv. Acceptance of copyright license type selected.

v. Submission of the full text of the thesis/dissertation PDF format with a standard name format. For example, adetoro_2019

Quality control: In order to ensure that only approved postgraduate school format thesis and dissertations are uploaded, a template add-on (API) can be included at the upload stage to the repository software. ETDs that do not conform to the template would be rejected. A digital acknowledgement/receipt of uploaded thesis/dissertation should be shown at the time of final clearance.

Verify stage: This stage would be an iterative cycle between the repository staff and the student. The repository staff ensures the accuracy of the approved metadata schema vis-à-vis the contents of the thesis/dissertation submitted. A digital acknowledgement of acceptance or rejection is automatically sent to the student's registered email address. If the thesis submitted is rejected, details of grey areas or areas of correction should be included. This iterative cycle goes on until the thesis is accepted. The student would present the acceptance receipt for clearance from the library.

Index stage: Cataloguers may use the Library of Congress subject headings (LCSH) as tools for controlled vocabulary to generate keywords. Cataloguers can also research on search engine optimised keywords to be included in in the metadata schema. The bibliographic record of the

approved thesis should be included in the library online catalogue with a link to the repository to increase visibility. The keyword generated from the controlled vocabulary would aid content identification process of the theses. They also qualify as metadata.

 Publish stage: The publish/deposit stage is the final stage in this content population workflow. This stage would ensure publishing workflows like digital watermarking, bookmarking, digital preservation of the submitted theses and dissertations. The University library management may then decide the percentage of these submitted full-text theses/dissertations it would make open or publish using the business model.

3. Recommended funding model for Nigerian ETD repositories

 The adoption of a funding model for the published ETDs would go a long way to ensure the sustainability of the repositories in addition to developing, creating and sustaining value for these research output. It would also help increase institutional support when they can be viewed as a self-sustaining project. From the data collected, it can be inferred that libraries do not have a well spelt out plan for sustaining their repositories, hence the many challenges they are facing. Thus, a funding model approach using the Business Model Canvass by Alexander Osterwalder was proposed. Rasuli *et al* (2015) stated that using a business model aims at defining the structure of an enterprise or organisation in such a way that it (expectedly) creates and captures value.

i. Key Activities: What are the unique things that a repository or collection of ETDs in repositories can do to deliver its propositions?

ii. Key Partners: What can the managers of the ETD collection outsource in order to focus on its key activities?

iii. Value Propositions: What is marketable about ETDs, why would the customer segments use them?

iv. Customer Relationships: Mode of interaction with the users of ETDs through their journey on matters arising.

v. Customer Segments: Who are the users of ETDs and its findings?

vi. Channels: How would ETDs be promoted and delivered

vii. Revenue Streams: How would universities go about earning revenue from ETD propositions?

viii. Key Resources: What unique strategic asset must the collection of ETD have in order to compete?

ix. Cost Structure: What are the major cost drivers, and how are they linked to revenue.

4. University libraries should view ETD repositories as a publishing system for their ETDs. Thus, they leverage on the 'theory of network effect' by using cloud-based infrastructure and services such that the value of the IR increases as more people use it. In cases of financial incapacity, the use of shared server can come in as an alternative, although, it may not be as robust as the cloud-

based infrastructure or commercial repositories, it will take care of challenges like electricity and Internet connectivity which would also go a long way in easing the technical burden of maintaining the repositories.

5.   There is a need to tap into the commercial potential of research findings of theses and dissertations, thus research communication and commercialisation of the best indigenous technology-based research findings from ETDs of each university should be adopted. One of the ways to achieve this is by establishing a research incubation programme for postgraduate students. The incubation programme should take the students through various processes from research product validation and development to pitching and access to funds and grants. Communication experts can then use the libraries' various social media outlets and memorandum of understanding to reach out to potential organisations that will find these products useful.

6. Repositories functionality should be upgraded to research information management systems that would include value-added services such as full publishing, research profiles, scholarly workflow facilitator, and networking hub where registered users can get regular updates about current uploaded research resources related to their areas of research interests. Open-source software like DSpace-CRIS and VIVO can be adopted.

7. A forum of Nigerian university libraries ETD IR administrators should be set up in order to discuss and find solutions to the management of these research outputs.

8. Internet Speed is an issue when downloading theses online, thus effort should be put in place to compress files or put supplementary pages on data compartments.

9. Upgrade to the web application should include filters to reduce the search time.

5.4 Future Research Work

This research assessed ETDs in federal university repositories and recommended sustainability frameworks for these repositories. It also demonstrated the usability of a designed web application to solve the challenge of poor global visibility of ETDs from Nigeria. Future research work can focus on:

1. Comparative analysis of the perception of different group of users on the usability evaluation of the webware. The significant difference in their opinions can be tested.

2. Assessment survey of issues and challenges related to the management of journal and conference proceedings in institutional repositories.

3. Comparative analysis of the effectiveness of the webware and institutional repositories is also an area that can be explored in future studies.

4. Studies can also focus on the efficacy and applicability of the recommended frameworks in this study.

REFERENCES

Aaron, T. (2016). *Are IR a dead end?* Retrieved from Musings about librarianship: musingsaboutlibrarianship.blogspot.com/.../are-institutional-repositories-failing.html

Abba, E. (2014). *Implementation of Institutional repository using Dspace repository software at Federal University of Technology. Minna.* Undergraduate research project, Federal University of Technology. Minna.

Abdulkadir, A. (2011). *The use of Dspace software in the preservation and management of specific library resources.* Seminar paper, ABU Zaria, Kashim Ibrahim Library.

Abubakar, F. M. & Ahmad, H.B. (2013). The moderating effect of technology awareness on the relationship between UTAUT constructs and behavioural intention to use technology: A conceptual paper. *Australian Journal of Business and Management Research*, 14-23.

Acerbis, R., Bongio, A., Brambilla, M., Butti, S., Ceri, S. & Fraternali, P. (2008). Web applications design and development with WebML and WebRation. . *5.0, Objects, Components, Models and Patterns,* 11, 392-411.

Ademola, A. Adewale, A., & Ike, D.U. (2013). Design and development of a university portal for the management of final year undergraduate projects. *International Journal of Engineering and Computer Science*. *2*(10), 2911-2920.

Akintunde, S. A. & Anjo, R. (2012). *Digitising Resources in Nigeria: An overview.* Retrieved from University of Jos Institutional Repository website: https://dspace.unijos.edu.ng/jspui/bitstream/123456789/465/1/Digitizing%20resources%20in%20Nigeria.pdf

Alam, N. M. & Pandey, P. (2012). GeoTheses: Development of a union catalogue of Indian geoscience theses using GSDL. *The Electronic Library, 30*(4), 456-468.

Algharibi, A. & Arvanitis, T. N. (2011). *Adapting the UTAUT as a tool for validating user's needs on the implementation of e-trial software systems.* A paper presented at the BCS conference on Human Computer Interaction, Newscastle.

Alhoori, H. Ray Choudhury, S., Kanan, T., Fox., E., Furuta, R., & Giles, L. C. (2015). *On the relationship between open access and altmetrics.* A paper presented at the 2015 iConference,* Illinois.

Aliyu, M. M. (2015). *Design and implementation of web-based academic information system (WEBAIS) for Nigerian Universities.* Masters Thesis, Ahmadu Bello University, Zaria.

Al-Juboori, A. F.M.A. (2014). Design and Implementation of an e-library search system. *International Journal of Innovation and Applied Studies, 7*(4), 1321-1329.

Andesson, S. & Svensson, A. (2013). Repositories Recreated: The Finch report versus DiVA in Sweden. *Information Services and Use*, 183-189. dx.doi.org/10.3233/ISU-130696

Angelova, M. Devagiri, V.M., Boeva, V., Linde, P. & Lavesson, N. (2018). *An expertise recommender system based on data from an institutional repository (DiVA)*. A paper presented at the 22nd International Conference on Electronic Publishing, Canada.

Anunobi, V. C., & Onyebinama, O.C. (2011). *ETDs initiatives in Federal University of Technology, Owerri (FUTO): Successes, challenges, prospects.* International Symposuim on Electronic Theses and Dissertations. Cape Town.

Anyaoku, E. N., Echedom, A.U.N., & Baro, E. E. (2018). Digital preservation practices in university libraries: An investigation of institutional repositories in Africa. *Digital Library Perspectives, 36*(1), 41-64. doi:doi.org/10.1108/DLP-10-2017-0041

Aquil, A. Sulaiman, A., & Azizur, R. (2014). Theses and dissertations in institutional repositories: An Asian perspective. *New Library World,* 115(9), 438-451. doi:10.1108/NLW-04-2014-0035

Arlitsch, K. & Grant, C. (2018). Why so many repositories? Examining the limitations and possibilities of the institutional repositories landscape. *Journal of Library Administration, 58*(3), 264-281. doi:10.1080/01930826.2018.1436778

Arlitsch, K. & O'Brien, P.S. (2014). Invisible instituional repositories addressing the low indexing ratios of IR in Google. *Library Hi Tech*, 60-81.

Aruleba, K. D., Akomolafe, D.T., & Afeni, B. (2016). A full text retrieval system in a digital library environment. *Intelligent Information Management, 8,* 1-8. doi:dx.doi.org/10.4236/iim.2016.81001

Aruleba, K.D., Aremu, R.D., Oriogun, P.K., Agbele, K.K. & Agbo, A. O. (2015). Evaluation of full text search retrieval system. In C. Uwandia, A. Aderounmu & A. Sodiya (Eds.), *Information Technology for Inclusive Development* (pp 154-159). Akure, Nigeria: NCS.

Asher, A. D. (2013). Paths of discovery: Comparing the search effectiveness of EBSCO discovery service, summon, google scholar, and conventional library resources. *College and Research Libraries,* 74(5), 464-488.

Ashikuzzaman, M. (2018). *Brief information about institutional repositories.* Retrieved from www.lisbdnet.com: http://www.lisbdnet.com/brief-information-institutional-repository/

Assila, A. Oliveira, K.M., & Ezzedine, H. (2016). Standardised usability questionnaires: features and quality focus. *Electronic Journal of Computer Science and Information Technology, 6*(1), 15-31.

Aziz, N. S., Kamaludin, A. & Sulaiman, N. (2013). Assessing website usability measurement. *International Journal of Research in Engineering and Technology*, 2(9), 386-392, 10.15623/ijret.2013.0209058

Aziz, A., Koromos, A., Gao, J., & Golong, M.S. (2012,). *A methodology for the development of web-based information systems: Web development team perspective*. A paper presented at the 18th Americas Conference on Information System (AISeL), Seattle.

Ballard, T. &. Blaine, A. (2011). User search limiting behaviour in online catalogs: Comparing catalog use to search behaviour in next generation catalogs. *New World, 112*(5/6), 261-273.

Bankier, J. G. &. Gleason, K. (2014). *Institutional repository comparison.* UNESCO. Retrieved from http://works.bepress.com/jean_gabriel_bankier/22/

Baro, E. E., Godfrey, V.Z., & Eze, M.E. (2014). Electronic theses and dissertations and IR; roadmap to research visibility in Africa. *Preservation, Digital Technology and Culture, 43*(3), 114-126.

Baro, E. E., & Otiode, P.G. (2014). Electronic theses and dissertations initiatives: A survey of university libraries in Nigeria. *International Information & Library Review, 46*, 41-50. doi:10.1080/10572317.2014.936265

Baro, E. Oyeniran, K. G., & Ateboh, B. (2013). Digitisation projects in university libraries in Nigeria: The journal so far. *Library Hi Tech News, 9*(21-26).

Bepress. (2014). *Building a framework for IR success: A roadmap. research on institutional repositories: Articles and presenatations.* Working Paper. Retrieved from http://digitalcommons.bepress.com/repository-research/86

Biradar, B. S., & Banateppanavar, K. (2012). Design and developement of institutional repository using DSpace.: A case study of Kuvempu University. *International Journal of Digital Library Systems, 1*(13), 1-13.

Biswas, G. & Paul, D. (2010). An evaluation study on the open-source digital library softwares for IR: Special reference to dspace and greenstone digital library. *International Journal of Library and Information Science, 2*(1), 1-10.

Bracke, P. H. (2008). Evidence-based medicine search: A customizable federated search engine. *Journal of Medical Library Association, 96*(2), 108-113. doi:10.3163/1536-50505.96.2.108

Bringula, R. P. (2016). Factors affecting web portal information services usability: A canonical correlation analysis. *International Journal of Human-Computer Interaction, 32*(10). doi:10.1080/10447318.2016.1199180

Bruns, T. &. Inefuke, H. W. (2016). Purposeful metrics: Matching institutional repository metrics to purpose and audience. In D. S. Burton & B. Callicott (Eds.), *In Making Instituional Repositories Work.* West Lafayette: Purdue University Press.

Budiu, R. (2017). Quantitative vs qualitative usability testing. *Nielson Norman Group.* Retrieved from http://www.nngroup.com/articles/quant-vs-qual

Byamugisha, H. (2010). Digitising library services for new modes of information use in Uganda . *Library Management, 1*(2).

Canada, D. (2009). *Open access and developing countries.* Retrieved from http://eprints.rclis.org/bitstream/10760/13757/1/OA_and_Developing_Countries.pdf

Candela, L., Castelli, D., Ferro, N., Ioannidis, Y. & Koutrika, G. (2007, March 14). The DELOS digital library reference model: Foundations for digital libraries. *D-Lib Magazine* 13(4), 1-10, doi: 10.1045/march2007-castelli

Candela, L., Castelli, D., Ferro, N., Ioannidis, Y., & Koutrika, G. (2011). *Digital library model in a Nutshell.* Retrieved from www.dlorg.ed/uploads/Booklets/booklet21x21nutshellweb.pdf

Cayabyab, T. A. C. (2015). A review of emerging ETD initiatives, challenges and future developments. *International Journal of Information and Education Technology, 5*(10), 1-10, doi:10.7763/IJIET.2015.V5.609

Christain, G. E. (2008). *Issues and challenges to the development of open access instituional repositories in academic and research institutions in Nigeria.* Ottawa: International Research and Development Centre. Retrieved from http://idlbnc.idrc.ca/dspace/bitstream/10625/36986/1/127792.pdf

Clement, G. P. & Rascoe, F. (2013). ETD Management and publishing in the ProQuest system and the university repository: A comparative analysis. *Journal of Librarianship and Scholarly Communication,* 1(4), 1-10, doi:dx.doi.org/10.7710/2162-3309.1074

Coates, M. (2014). Electronic theses and dissertations: Differences in behaviour for local and non-local users. *Library Hi Tech,* 32(2), 1-10, doi:10.1108/LHT-08-2013-0102

Connaway, L. S. (2015). *The library in the life of the user: Engaging with people where they live and learn.* Dublin: OCLC Research.

Connaway, L. S., Dickey, T.J., & Radford, M.L. (2011). If it is too inconvenient I'm not going after it: Convenience as a critical factor in information-seeking behaviours. *Library & Information Science Research,* 33(3), 179-190.

Connaway. L.S. & Faniel, I. M. (2015). Reordering Ranganatharn: Shifting user behaviours, shifting priorities. In L. S. Connaway (Ed), *The library in the life of the user: Engaging with people where they live and learn.* (490-607). Dublin: OCLC Research.

Corbett, H., Ghaphery, J., Work, L. & Byrd, S. (2016). *Making nstitutional repositories work: Choosing a repository platform:.* USA: Purdue University Press. Retrieved from http://scholarscompass.vcu.edu/libraries_pub/33

Corletey, A. (2011, September 13-17). *Institutional repositories for open access: The Ghanaian experience.* A paper presented at the 14th International Symposuim on ETDs, Cape Town.

Corradi, l. Porro, I., Schenone, A., Momeni, P., Ferrari, R., Ferrara, M., Anulfo, G. & Fato, M. (2012). A repository based on a dynamically extensible data model supporting multidiscipline. *BMC Medical Informatics and Decision Making,* 12(115), 1-10. Retrieved from http:www.biomedcentral.com/1472-6947/12/115

Creaser, C. Fry, J., Greenwood, H., Oppenheim, C., Probets, S. & Spezi, V. (2010). Authors' awareness and attitude toward open access repositories. *New Review of Academic Librarianship,* 16(51), 145-161.

Cybermetrics, L. (2015). *Ranking Web of Repositories.* Retrieved from http://repositories.webometrics.info/en/world

Dahlen, S. P. & Hanson, S. (2017). Preference vs. authority: A comparison of student searching in a subject-specific indexing and abstracting database and a customized discovery layer. *College and Research Libraries,* 78(7), 878-888, doi:doi.org/10.5860/crl.78.7.878

DATAD. (2014). Retrieved from https://www.aau.org/programmes-and-services/current-projects/database-of-african-theses-and-dissertations-research-datad-r/

Dempsey, L. (2012). Thirteen ways of looking at libraries discovery & the catalogue: scale, workflow, attention. *EDUCAUSE Review Online.*

Dempsey, L. (2015). *From infrastructure to engagement: Thinking about the library in the life of the user.* A paper presented at the 24th Annual Interlibrary Loan Conference, St Paul.

Dlamini, N. N. & Snyman, M. (2017). Institutional repositories in Africa: obstacles and challenges. *Library Review, 66*(6/7), 535-548. doi:https://doi.org/10.1108/LR-03-2017-0021

Donaldson, R. L., & Nelson, D.W. (2011). *The 2012 promise of open access textbooks:.* Florida Virtual Campus. Retrieved from http://www.openaccesstextbooks.org/pdf/ModelDraft.pdf

Doty, J., Kowalski, M. T., Nash, B.C., & O'Riordan, S.F. (2015). Making student research data discoverable: A pilot program using dataverse. *Journal of Librarianship & Scholarly Communication, 3*(2). doi:http://dx.doi.org/10.7710/2162-3309.1167

Dubinsky, E. (2014). A current snapshot of institutional repositories: growth rate, disciplinary content and faculty contributions. *Journal of Librarianship and Scholarly Communication, 2*(3), 1167.

Eke, H. N.(2011). Digitising resources for University of Nigeria repository: process and challenges. *Webology, 8*(1), 1-10.

Eke, H. O. (2014). Internet search strategies employed by library and information science students of University of Nigeria for research. *Library Philosophy and Practice, Paper 1194.* Retrieved from http://digitalcommons.unl.edu/libphilprac/1194

Emde, J. Z., Morris, S.E., & Claaseen-Wilson, M. W. (2009). Testing an academic library website for usability with faculty and graduate students. *Evidence Based Library and Information Practice, 4*(4), 1-10.

Ezeani, C. N. & Ezema, I. J. (2011). Digitising institutional research output of University of Nigeria, Nsukka Library. *Library Philosophy and Practice.*

Ezema, I. J. (2011). Building open access institutional repositories for global visibility of Nigerian scholarly publication. *Library Review,* 60(6), 473-485. doi:10.1108/00242531111147198

Federici, S. & Borsi, S. (2010). *Usability evaluation : models, methods and applications.* Center for International Rehabilitation Research Information and Exchange (CIRRIE). Retrieved from www.researchgate.net/publication/228079044usability evaluation models methods and applications

Franke, H. Gamalielsson, J. & Lundell, B. (2017). Institutional repositories as infrastructures for long-term preservation. *Information Research, 22*(2)., 1-10. Retrieved from http://informationR.net/ir/22-2/paper757.html

Fredrick, W. (2014). *Policies related to the implementation of openness at research intensive universities in the United States: A descriptive content analysis.* Mini dissertation, University of South Alabama.

Gabbert, E. (2018). *The three types of search queries and how you should target them.* Retrieved from www.wordstream.com/blog/ws/2012/12/10/three-types-of-search-queries

Gall, M. D., Gall, J. P. & Borg, W.R. (2007). *Educational Research: An introduction* (8th ed.). Boston: Pearson Education .

Gay, L. R., Mills, G.E., and Airasian, P. (2012). *Educational research competencies for analysis and applications* (10th ed.). Boston: Pearson Education.

Gbaje, E. S. (2011). *Digital preservation policy and implementation strategies for national information centres in Nigeria.* Dissertation, Ahmadu Bello University, Zaria.

Gbaje, E. S. (2016). *The journey towards open access initiatives in Nigeria.* Seminar, EIFL.

Gbaje, E. S & Mohammed, M.F. (2017). Long-term accessibility and re-use of institutional repository contents of some selected academic institutions in Nigeria. *IFLA World Congress.* Godansk.

Geltner, G. & Willinsky, J. (2018). *ScholarlyHub: A progress report at six months.* A paper presented at the 22nd International Conference on Electronic Publishing, Toronto.

Georgas, H. (2013). Google vs. the library: students preferences and perceptions when doing research using GOOGLE and a federated search tool. *Portal: Libraries and the Academy, 13*(2), 165-185. doi:10.1353/pla.2013.0011

Ghosh, M. (2009). E-theses and Indian academia: A case study of nine ETD digital libraries and formulation of policies for a national service. *International Information & Library Review, 41*(1), 21-33. doi:10.1080/10572317.2009.10762794

Gul, S., Tun-Nisa, N., Gupta, S. & Riyaz, S. (2015, November, 04-06). Content management in ETD repositories. *18th International Symposuim on ETD.* New Delhi, India.

Hakimjavadi, H. & Masrek, M.N. (2013). Evaluation of interoperability protocols in repositories of electronic theses and dissertations. *Program, 47*(1), 34-59. doi:http://dx.doi.org/10.1108/00330331211296303

Halbert, M. (2014). Guide to options for ETD programs. In *Guidance Documents for Lifecycle of Management of ETD.* Atlanta: Educopia Institute.

Han, Y. (2014). Guidelines for collecting usage metrics and demonstration of value for ETD programs. In *Guidance Documents for Lifecycle Management of ETDs.* Educopia.

Hanrath, S. & Kothman, A. (2015). Use and usability of a discovery tool in an academic library. *Journal of Web Librarianship, 9*(1). Retrieved from https://doi.org/10.1080/19322909.2014.983259.

Hartson, T.S. Andre A, & Will, R.C. (2003). Criteria for evaluating usabilty evalaution methods. *International Journal of Human Computer Interaction, 15*(1), 145-181.

Heradio, R. Fernandez-Amoros, D., Cabrerizo, F.J. & Herrera-Viedima, E. (2012). A review of quality evaluation of digital libraries based on users' perception. *Journal of Information Studies, 38*(3), 269-283. doi:10.1177/0165551512438359

Hinmikaiye, B. V. (2015). *Awareness and use of institutional repositories among academic staff in the federal universities of north central Nigeria.* Masters Thesis, Bayero University Kano.

Hogan, P. (2014). Metadata, schema.org, and getting your digital collection noticed. Retrieved from Alatechsource: www.alatechsource.org/blog/2014/07/metadata-schemaorg-and-getting-your- digital-collection-noticed.html-3

Hultman, G. M. (2018). Usability evaluation of an unstructured clinical document query Tool for Researchers. *AMAI Joint SummitsTranslational Science*, 84-93.

Ibinaiye, I. D. (2012). Challenges and prospects of digitisation of library resources in Nigeria universities: The experience of Kashim Ibrahim library. *European Journal of Glabalization and Development Research, 5*(10), 287-299.

Ifijeh, I. (2014). Adoption of digital preservation methods for theses in Nigerian academic libraries: Applications and implication:. *Journal of Academic Librarianship, 40*, 399-404.

International Federation of Library Associations (2017). *Best practices for national bibilographic agencies in a digital age*. Retrieved from : https://www.ifla.org/best-practice-for-national-bibliographic-agencies-in-a-digital-age/node/8527

Isah, A. Mutshewa, A., Serema, B.C. & Kenosi, L. (2013). Digital libraries: Analysis of DELOS reference model and 5S theory. *Journal of Information Science, 1*(4), 38-47. doi:dx.doi.org/10.1633/JISTaP.20131.43

Ivanovic, L. Ivanovic, D & Surla, D. (2012). Integration of a research management system and an OAI-PMH compatible ETD repository at the University of Novi-Sad, Republic of Serbia. *LRT, 56*(2), 104-112.

Jain, A.K. & Veeranjaneyulu, K. (2012). Repository of Indian national agricultural research & education system (NARES)-Open access to institutional knowledge. Working Paper available oasis.col.org/handle/11599/1830

Jasen, B. B. (2008). Determining the informational, navigational and transactional intent of web queries. *Information Processing and Management, 44*, 1251-1266.

Jean-Claude, F. (n.d.). *Enterprises data modelling using the entity relationship model.* Lecture Slides, New York University, Computer Science.

Jeng, J. (2006). *Usability of the digital library: An evaluation model.* PhD Dissertation, Rutgers University.

Joo, S. & Lee, J.Y. (2011). Measuring the usability of academic digital libraries: Instrument development and validation. *The Electronic Library*, 523-537.

Joo, S., Lin, S. & Lu, K. (2011). A usability evaluation model for academic library websites: Efficiency, Effectiveness and Learnability. *Journal of Library and Information Studies, 9*(2), 11-26.

Kathuria, A., Jasen, J., Hafernik A. & Spink, A. (2010). Classifying the user intent of web queries using k-means clustering. *Internet Research, 20*(5), 563-581.

Keerthana, I.P & Aby Abahai, T. (2015). An Intelligent metasearch engine for efficient web document retrieval. *IOSR Journal of Computer Engineering, 17*(2), 45-54.

Kennedy, M. L. (2019) Ethics of artificial intelligence explored in research library issues. *Research Library Issues 299*. Retrieved from http://www.arl.org/news/ethics-of-artificial-intelligence-explored-research-library-issues/

Kitchin, R, Collins, S. & Frost, D. (2015). *Funding models for open access repositories.* Maynooth University Dublin. doi:http://dx.doi.org/10.3318/DRI.2015.4

Kleinman, M. (2011). *Faculty self-archiving attitudes and behavior at research universities: A literature Review.* Seminar Paper, University of Michigan.

Korah, A. &. Cassadi, A. (2010). Students and federated searching: A survey of use and satisfaction. *Computer Science, 49*(4). doi:DOI:10.5860/rusq.49n4.325

Kostoulas, A. (2014). *How to interprete ordinal data.* Retrieved from https://achilleaskostoulas.com/2014/02/23/how-to-interpret-ordinal-data/#report

Koulouris, A. & Anagnostopoulous, A. (2010). Theses e-submission tool at the national technical university of Athens. *OCLC Systems and Services: International Digital Library Perspectives, 26*(2), 123-132.

Kounoudes, A. D. & Zervas, M. (2011). *Best practices and policies in institutional repositories development.* A paper presented at the 3rd International Conference on Qualitative and Quantitative Methods in Libraries. Athens.

Kumar, A. (2010). *Computer basics with office automation.* Delhi: IK International Publishing.

Laerd Statistics. (2015). Retrieved from Kruskal-Wallis H test using SPSS statistics. Statistical tutorials and software guides: statistics.laerd.com

Leddy, P.D. & Ormrod, J.E. (2016). *Practical research: Planning and design.* Buston: Pearson.

Lewandowski, D. (2015). Evaluating the retrieval effectiveness of web search engines using a representative query sample. *Journal of the Association for Information Science and Technology, 66*(9), 1763-1775.

Li, Y. & Billings, M. S. (2011). Strategies for developing an institutional repository: A case study of ScholarWorks@ UMass Amherst. *Libraries' and Librarians' Publications, Paper 69*.

Loius, C. L. (2007). *Research methods in education.* London: Routledge.

Lown, C., Tito, S. & Boyer, J. (2013). How users search the library from a single search box. *College & Research Libraries, 74*(3). doi:10.5860/crl-321

Madan, A. & Dubey S.K. (2012). Usability evaluation methods: A literature review. *International Journal of Engineering Science and Technology, 4*(2), 590-599.

Marjit, U. & Jana S. (2009). *Mashups: An emerging content aggregation web 2.0 paradigm.* A paper presented at 7th International CALIBER Conference, Puducherry.

Markland, M. (2006). Institutional repositories in the UK: what can the Google user find there? *Journal of Librarianship and Information Science, 38*(4), 221-228.

Massicotte, M. & Botter, K. (2017). Reference rot in the repository: A case study of ETDs in an academic library. *Information Technology and Libraries*, 11-28.

Mccutcheon, A. (2010). *Impact of publishers' policy on ETD distribution options within the United States.* PhD Dissertation, Ohio University.

Miah, S.J., Debuse, J.C.W., Gammack, J., & Pigott, D. (2012). *A portal based web-service development using mash-up approach*. A paper presented at the 2012 Conference on Information Systems Applied Research. New Orleans.

Middleton, C.C., Dean, J. & Gibertson, M.A. (2015). A process of original cataloguing of theses and dissertations. *Cataloguing and Classification Quartely, 53*(2).

Mikeal, A. B. (2007). *Developing a common submission system for ETDs in the Texas Digital Library.* Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download;jsessionid=D26561EBA5AA5080F03156E 25AF255AB?doi=10.1.1.116.3387&rep=rep1&type=pdf

Madan, A. & Dubey, S. K. (2012). Usability evaluation methods: A literature review. *International Journal of Engineering Science and Technology*, 4(2), 590-599.

Mishra, A. & Singhal, A. (2015). Architecture of a specialised search engine using mobile. *International Journal of Computer Science Engineering, 4*(3), 90-93.

Mohamed, K. & Yousef, A. H. (2015). Evaluating federated search tools: usability and retrievability. *The Electronic Library, 33*(6), 1079-1099. doi:https://doi.org/10.1108/EL-12-2013-0211

Mohammed, M.F., Abdullahi, I. M., & Tijjani, A (2019). Marginal use and absolute non- use of digital library resources and services by faculty members in Ahmadu Bello University, Zaria. *Journal of the Nigerian Library Association, 52*(1), 89-101.

Mohd Yusuf, Z. (2008). *Malaysian Theses Online: An approach for managing universities electronic theses and dissertations.* Retrieved from https://core.ac.uk/.../pdf/14330227.pdf.

Mohee, R. (2016). How universities can boost research uptake. *SciDevNet Africa's PhD Renaissance Series*. Retrieved 10 06, 2016, from www. scidev.net/global/knowledge-economy/opinion/universities-boost-research-uptake.html

Moumane, K. I., Idri, A. & Abran, A. (2016). Usability evaluation of mobile applications using ISO9241 and ISO 25062 standards. *SpringerPlus, 5*(548). doi:10.1186/s40064-016-2171-z

Musa, A. U., Musa, S. & Abdulkadir, A. (2014). Institutional digital repositories in Nigeria: Issues and challenges. *IOSR Journal of Humanities and Social Science,* 19(1), 16-21.

Mustafa, S. (2014). *Is an assessible website a more usable one?* Mini-Thesis, Carnegie Mellon University.

National Policy on Education (2013) *Federal Republic of Nigeria National Policy on Education*. Nigerian Educational Research and development Council (NERDC), Lagos.

Ndubuisi, C.J. (2017). *Development and validation of a digital library model for energy research centers in Nigerian federal universities.* PhD Dissertation, University of Nigeria, Nsukka.

Neal, J. G. (2009). What do users want? What do users need? W(h) ither the academic research library? . *Journal of Library Administration*, 49(5), 463-468.

Nelson, M. L., Klein, K. & Magudamudi, M. (2008) Correlation of expert and search engine rankings. *Digital libraries*. Retrieved from www.arxiv.org/abs/0809.2851.

Nielson, J. (2012). *How many test users in a usability study?* Retrieved from www.nngruop.com/articles/how-many-test-users/

OCLC. (2009). *Online Catalogs: What users and librarians want.* Dublin: OCLC Research.

Odhiambo, D. (2018, June 28). System design in software development. *Meduim.* Retreived from https://medium.com/the-andela-way/system-design-in-software-development-f360ce6fcbb9

Okoye, M. O. &. Ejikeme, A. N. (2011). Open access, institutional repositories, and scholarly publishing: The role of librarians in south-eastern Nigeria. *Library Philosophy and Practice.*

Omame, I. M., Abifarin, F.P. & Udoudoh, S.J. (2019). Usability evaluation of web search engines using navigational query model: Examples from library and information services,. *i-manager's Journal on Information Technology, 8*(2), 1-10. doi:doi.org/10.26634/jit.8.2.16106

Onaifo, D. & Rasmussen, D. (2013). Increasing libraries' content flexibility on the web with search engine optimisation. *Library Hi Tech, 31*(1), 87-108.

Orduna-Malea, E. & Lopez-Cozar, D.E. (2015). The dark side of open access in google and google scholar: the case of latin American repositories. *Scientometrics, 102*(1), 829-846.

Ossels, A. (2017). How to deploy a web application in WAMP server. Retrieved from https://www.youtube.com/watch?v=5VDwNmwEM5s

Ovenden, R. (2019). *Librarians' role in preserving digital information.* Retrieved from Carnegie Reports: https://www.carnegie.org/news/articles/libraries-role-in-preserving-digital-information/

Oyedum, G. U. Abedoh, G.O., Saka, K.A., & Alhassan, J.A.(2015). Impact of electronic resources on university library services: A comparative analysis of Federal University of Technology, Minna and Ibrahim Badamasi Babangida University, Lapai. *Journal of Information Education Science and Technology, 2*(2), 70-79.

Pant, A. (2015). Usability evaluation of an academic library website: Experience with the central science library, University of Delhi. *The Electronic Library, 33*(5), 896-915. doi:10.1108/EL-04-2014-0067

Park, J., Yang, C., Tosaka, Y., Ping, Q., & El-Mimouni, A. (2016). Developing an automatic crawling system for populating a digital repository of professional development resources: A pilot study. *Journal of Electronic Resources Librarianship*, 63-72. doi:10.1080/1941126X2016.1164549

Por, L.Y., Ong, S.Y., Beh, D., & Ismail, M. (2012). A grid enabled e-theses and dissertations repository system. *The International Arab Journal of Information Technology, 9*(4), 392-401.

Prost, H., Malleret, C. & Schopfel, J. (2015). Hidden Treasures: Opening data in PhD dissertations in social sciences and humanities. *Journal of Librarianship and Scholarly Communication, 3*(2). doi:http://dx.doi.org/10.7710/2162-3309.1230

Prytherch, R. (2009). *Harrods's Librarians' Glossary and reference Book.* UK: Routledge.

Ramirez, M. & Hanlon, A. (2011). Asking for permission: A survey of copyright workflows for institutional repositories. *Portal: Libraries and the Academy, 11*(2), 683-702.

Ramirez, M. L., Dalton, J.T., McMillan, G., Read, M. & Seamans N. H. (2012). Do open access electronic theses and dissertations diminish publishing opportunities in the social sciences and humanities? *College & Research Libraries*. Retrieved from http://crl.acrl.org/content/early/2012/04/05/crl356.short

Randolph, G.B., Brain, M.M. & Robert, R.H. (2015). Concept mapping usability evaluation: an exploratory study of a new usability inspection method. *International Journal of Human-Computer Interaction, 31*(9), 571-583.

Rasuli, B., Alipour-Hafezi, M. & Solaimani, S. (2015, July). *Understanding electronic theses and dissertations through a business model perspective: The case of irandoc ETDs*. 18th International symposuim on Electronic Theses and Dissertations. New Delhi.

Rimkus, K, Padilla, T, Popp, T & Martin, G. (2014). Digital preservation file format policies of ARL member libraries: an analysis. *D-Lib Magazine, 20*(3/4).

Rose-Wiles, L. & Hofmann, M. M. (2013). Still Desperately Seeking citations: Undergraduate research in the age of web-scale discovery. *Journal of Library Administration, 53*(2/3).

Roy, B. K. (2013). *Designing institutional digital repository for the University of Burdwan: A FLOSS based prototype.* PhD Dissertation, University of Burdwan.

Roy, K. B, Biswas, S.C. & Mukhopadhyay, P. (2013). Global visibility of Indian open access instituional digital repositories. *International Research: Journal of Library and Information Science, 3*(1), 182-194.

Roy, K. B, Biswas, S.C. & Mukhopadhyay, P. (2016). AgriCat: A one-stop shop for OAI-based open access agriculture repositories. *Journal of Agriculture Informatics, 7*(1), 107-118.

Rubin, J. & Chisnell, D.(2008). *Handbook of usability testing: How to plan, design and conduct effective test.* Indiana: Wiley.

Salau, S. A. & Gama U.G. (2015). Access to and use of e-journals by academic staff of federal universities in north central Nigeria and the federal capital territory. *African Journal of Library, Archival and Information Science, 25*(2), 161-171.

Salau, S.A, Oyedum, G. U, Abifarin, F. P. & Udoudoh, S.J. (2018). *Management of ETDs in selected Nigerian institutional repositories*. A paper presented at the 3rd CARLIGH/AAU International Conference, Accra.

Sambo, A. (2008). *Research Methods in Education.* Ibadan: Stirling-Horden.

Sankar, P. & Kavitha, E.S. (2015). Shodhganga-repository for ETDs: A boon for researchers. *Asian Journal of Multidisciplinary Studies, 3*(12), 92-99

Saparova, D., Belden, J. & Williams, J. (2014).) Evaluating a federated medical search engine. Tailoring the methodology and reporting the evaluation outcomes. *Applied Clinical Informatics, 5*(2), 731-745.

Sarkar, P. & Mukhopadhyay, P. (2010). Designing single-window search service for electronic theses and dissertations through metadata harvesting. *Annals of Library and Information Studies, 57*(4), 356-364.

Schopfel, J. (2013, March 13). Adding value to electronic theses and dissertations in institutional repositories. *D-lib Magazine, 19*(3/4). Retrieved from http://www.dlib.org/dlib/march13/schopfel/03schopfel.html

Schopfel, J & Farace, D. J. (2010). Grey Literature. In M. J. Bates (Ed.), *Encyclopedia of Library and Information Sciences* (pp. 2029-2039). London: CRC Press.

Schopfel, J. & Soukouya, M. (2013, November 13). Providing access to ETD: A case study from Togo. *D-Lib Magazine, 19*(11/12). Retrieved from https://www.dlib.org/dlib/november13/schopfel/11schopfel.html

Seffah, A., Dongaee, M., Kline, R.B., & Padda, H. K. (n.d). *Usability Measurement: A roadmap for a consolidated model.* Retrieved from https:hec/unil.ch/docs/files/53/322/measure_seffah.pdf

Sengupta, S. S. (2012). Status of E-theses repositories with special reference to India. *Library Philosophy and Practice, 764*. Retrieved from http://digitalcommons.unl.edu/libphilprac/764

Sengupta, S. S. (2014). *E-theses repositories in the world: A critical analysis.* PhD Dissertation, Savitribai Phule Pune University, India.

Serrano-Vincente, R., Melero, R. and Abadal, E. (2013). *Evaluation of Spanish institutional repositories based on criteria related to technology, procedures, content, marketing and personnel.* Retrieved from http://digital.csic.es/bitstream/10261/168591/1/ACCEPTADO-survey-repos.pdf

Shearer, K. A. (2015). *Promoting open knowledge and open science: Report of the repositories.* COAR, Germany.

Sheeja, N. K. (2011). The development of Indian electronic theses and dissertations: An overview. *Journal of Academic Librarianship.* doi:10.1016/j.acalib.2011.08.01

Simms, L. Z. (2019). Does the number of response options matter? Psychometric perspective using personality questionaire data. *Psychological Assessment*, 31(4), 557-566. doi:dx.doi.org/10.103/pas0000648

Simpson, E.D. (2015). *VWExplorer: A repository for archiving immersive virtual world artifacts.* PhD dissertation, Colorado Technical University.

Stephanie. A. (2016). *Kruskal Wallis H test: Definition, examoles & assumptions*. Retrieved from statisticshowto.datasciencecentral.com/Kruskal-wallis/

Stephen, G., Whyte, A. & Rans, J. (2015). *Using eprints to build a research data repository for University of East London.* Retrieved from https://www.dcc.ac.uk/resources/developing-rdm-services/using-eprints-build-repository-uel

Suber, P. (2008). Open access to electronic theses and dissertations. *DESIDOC Journal of Library & Information Technology, 28*(1), 25-34.

Suber, P. (2015). *Open Access overview: Focusing on open access to peer-reviewed research articles and their preprints.* Retrieved from http://legacy.earlham.edu/~peters/fos/oversiew.htm

Termens, M., Ribera, M. & Locher, A. (2015). An analysis of file format control in instituional repositories. *Library Hi Tech, 33*(2), 162-174.

Tmava, A. M. & Alemneh, D. G. (2013). Enhancing content visibility in institutional repositories:Overview of factors that affect digital resources discoverability. In Schamber, L. (Ed.) *Data, Innovation, Wisdom: Scholarship in action*. (pp. 855-859). doi:10.9776/13437

Uzuegbu, C. P. (2012). *Academic and research institutions repository: A catalyst for access to development information in Africa*. A paper presented at the 78th IFLA General Conference and Assembly, Finland.

Vaishnavi, V., & Kuechler, W. (2015). *Design science research in information systems*. Retrieved from http://www.desrist.org/design-research-in-information-systems/

Valacich, J., George, J. & Hoffer, J. (2009). *Essentials of system analysis and design* (4th ed.). United States: Prentice.

Valde, E. F. (2016). *Let IR RIP*. Retrieved from SciTechSociety: scitechsociety.blogspot.com/2016/07/let-ir-rip.htm

Venitha, P. (2015). *The role of research and postgraduate studies in African higher education. .* Dakar: Africa Higher Education Summit.

Volgels, R. (n.d.). *A 6-step guide to web application testing*. Retrieved from https://usersnap.com/blog/web-application-testing/

Wakeling, S., Clough, P. & Connaway, L.S. (2017). Users and uses of a global union catalog: A mixed-method study of worldcat.org. *Journal of the Association of Information Science and Technology, 68*(9), 2166-2181.

Wang, L. X. (2014). Guidelines for implementing ETD programs-roles and responsibilities. In *Guidance Documents for Lifecycle Managment of ETD.* Atlanta: Educopia Institute.

Warraich, N.F., Ameen, K. & Tahira, M. (2009). Usability study of a federated search product at Punjub University. *Library Hi-Tech News*, 14-15.

Williams, B. Yen, P.Y., Rojas, M. & Schnall, R. (2013). Assessment of the health IT usability evaluation model (Health-ITUEM) for evaluating mobile health (mHealth) technology. *Journal of Biomedical Informatics*, 1080-1087.

Wyk, B.V. & Mostert, J. (2014). African IRs as contributors to global information: A South African case study. *Mousaion, 32*(1), 98-114.

Xin, H. E., Persson, H. & Ostman, A. (2012). Geoportal usability evaluation. *International Journal of Spatial Data Infrastructure Research, 7*, 88-106.

Yasser, C. M. (2011). An analysis of problems in metadata records. *Journal of Library Metadata, 11*(2), 51-62.

Yiotis, K. (2008). Electronic theses and dissertation (ETD) repositories: What are they? where do they come from? how do they work? *OCLC Systems & Services, 24*(2), 101-115. doi:10.1108/10650750810875458

Zhang, T., Maron, D.J., & Charles, C.C. (2013). Usability evaluation of a research repository and collaboration websites. *Journal of Web Librarianship, 7*(1), 58-82.

QUESTIONAIRE FOR IR ADMINISTRATORS

Dear Respondent,

The questionnaire is aimed at collecting data on a Ph.D. research project. Kindly respond to the questions to enable the researcher successfully complete the study. All information provided would be used for educational purpose only and your anonymity is guaranteed.

Salau, Sadiat Adetoro

SECTION 1: POLICIES AND FUNDING
Tick the answers that apply to your institution. Please tick [√] appropriately in the boxes
Q1. Do you have a policy statement backing the establishment/management of your institution's repository?

a. Yes

b. No

c. Still working on developing a policy

Q2. If your answer to question 2 is yes, please tick [√] which of these is/are covered in the policy document.

S/N	Policies
1	Preservation of contents
2	Withdrawal of contents
3	Funding
4	Compulsory submission of Electronic Theses and Dissertations by postgraduate students to the repository
5	Metadata use and re-use
6	Content access
7	Others (Please specify)

Q3. What was the source of funding for the implementation of your IR? Please tick [√] appropriately in the boxes.

S/N	FUNDING SOURCES
1.	Special grant provided by institution's administration

2.   Grant awarded by an external agency like NUC or
        TETFUND, CARNIGIE, MACARTHUR
3.   Institution's IT services
4.   Institution's Library
5.   Others (please specify)

Q4. What is the source of funding for the maintenance of your IR? Please tick √ the appropriate options.

S/N	FUNDING SOURCES
1.	Special grant provided by institution's administration
2.	Grant awarded by an external agency like NUC or TETFUND
3.	Institution's IT services
4.	Institution's library
5.	None
6.	Others (Please specify)

SECTION 2: REPOSITORY CONTENTS

Q1. Which of the following files and file formats of Electronic Theses and Dissertations is available on your Institutional Repository?

S/N	FILE FORMAT
1.	PDF
2.	HTML
3	Office format(doc, ppt, xcl)
3.	Codes
5.	Video (MPEG, AVI etc.)
6.	Audio (WAV, MP3 etc.)
7.	Images (TIFF, GIF, JPEG etc.)

Q2. Which of the following access level to ETDs your IR applies to your institution.

S/N	ACCESS LEVEL
1.	Full text only to Institution Members
2.	Full text only to subscribers of the repository
3.	Full text to anyone accessing the E-theses repository
4.	Metadata/bibliographic information only to non-institutional users
5.	Metadata/bibliographic information only to all users
6.	Paid access to full text of ETDs
7.	Full text to anyone on request

8.   Others

Q3. What measures are taken by your institution to protect copyright of Electronic Theses & Dissertations (ETD) deposited in the repository?

1. Digital Watermarking

2. Password is set for full-text of the ETD

3. Metadata access only

4. Measures are not yet framed

5. Others

Q4. Who owns the copyright of the ETD after submitting to the repository?

1. Researcher/author

2. University

3. Both the researcher and the University

4. Depends on the content of the thesis

5. Not yet decided

6. No idea

Q5. Who uploads and creates the metadata records for the theses and dissertations in your institution's repository?

S/N

1.   Post graduate student
2.   Repository administrator

3.   ETD contributor but verified by repository administrator

4.   Randomly trained library staff

5.   Trained Submitter

6.   Others (please specify)

SECTION 3: SYSTEM ARCHITECTURE

Q1. Is your university repository registered as a data provider on the Open Archives Initiative-Protocol for Metadata Harvesting (OAI-PMH)? The protocol aids in the harvesting of the metadata in your repository.

S/N
1.   Yes
2.   No
3.   I don't know

If your answer to the question above is yes, please state the OAI base URL

………………………………………………………..

Q2. On which of the following servers does your Institutional Repository run? Please tick √ the appropriate options.

S/N   **SERVERS**
1.   Institutional server
2.   Cloud server

APPENDIX B
INTERVIEW SCHEDULE
POLICY
1. Do you have an IR/ETD policy? Is the ETD policy embedded in the IR policy?

2. Contents covered in the policy/ETD policy workflow
   A. Preservation- which digital preservation technique do you use?
   B. Submission-Do your PG students upload to the repository or submit to the library?
   If no, who uploads to the repository?
C. Funding-Who funds the routine maintenance of the repository?
D. Metadata Use/Reuse-How do I use the metadata of your repository? Is it open, Can I use it with permission?

CONTENTS
1. What level of access do you provide for your ETDs?
2. What copyright measure do you have in place for the uploaded ETDs?

SYSTEM ARCHITECTURE

1. Which storage server do you use-Institution or cloud based server?.
2. Have you registered your repository with the OAI-PMH?, If no, Why?

APPENDIX C
OBSERVATION CHECKLIST

1. CONTENT FILE FORMAT

a. Visit each repository URL.
b. Check the ETD community
c. Check the file types uploaded in each discipline.

2. CONTENT COPYRIGHTS MEASURES
a. Visit each repository URL
b. Download some theses.
c. Try and copy and paste (to know if the thesis is passworded or encrypted)
d. Observe other copyrights measures (digital watermarking)

3. CONTENT ASSESS LEVEL
a. Vist each repository URL
b. Search for theses and download
c. Observe if full text, full text on request metadata, or restricted access.

    CONTENT METADATA
        1. Observe the keywords used in the metadata.

APPENDIX D
USABILITY EVALUATION QUESTIONAIRE

Dear Participant,

The purpose of this academic research study (conducted by Salau, Sadiat Adetoro PhD/SSTE/2015/694 from the department of Library and Information Technology, FUT Minna) is to evaluate the usability of a search retrieval web application for electronic theses and dissertations in Nigerian repositories (A repository is a digital library that contains electronic information resources-in this case e-theses and dissertations).

Informed Consent

1. I hereby voluntarily grant my permission for participation in the project as explained above
2. I understand my right to choose whether to participate in the usability evaluation and that the information given would be handled confidentially
3. I am aware that the results of the evaluations would be used only for the purpose of academic research.

Please note the following- Your participation in this study is very important to the researcher.

1. Please answer the questions in the attached questionnaire as completely and honestly as possible. This should take approximately 10 minutes of your time.
2. The results of the study will be used for academic purposes only

Signature   Date

…………………………..   ………………………

TASKS TO BE PERFORMED

The following tasks are to be searched on the web application **www.etdsearch.com.ng** and your responses (Strongly Disagreed [SD], Disagreed [D], Agreed [A], Strongly Agreed [SA] are to be recorded based on the statements on usability effectiveness, efficiency and satisfaction of the web search system.

SECTION A: USER VARIABLES

1.   Level of Study: PhD [   ]   Masters   [   ]   Postgraduate Diploma   [   ]

2.   Gender: Male [ ]   Female   [   ]

3.   Level of Internet Searching Skills – High   [   ]   Low   [   ]

SECTION B: USABILITY EFFECTIVENESS, EFFICIENCY AND SATISFACTION USING INFORMATIONAL QUERY

Kindly tick (√) your responses on the **EFFECTIVENESS of** the web search system with the statements below based on the tasks you performed using the system.
Strongly Disagreed [SD], Disagreed [D], Agreed [A], Strongly Agreed [SA]

S/N	Task		Statements	SD	D	A	SA
1	**Log on to www.etdsearch.com.ng Make a search using the keyword 'COWPEA' and identify** The major supervisors of any three **(3)** theses selected by you. The students that authored the theses. The year the theses were completed	IQEFC1	I can accurately complete the search using the system				
		IQEFC2	The system was not complicated to use to find the information needed				
		IQEFC3	Overall, the system was useful in helping me locate the information requested				
		IQEFC4	I could not locate the information (supervisor) requested				
		IQEFC5	I could locate the information (author) requested				
		IQEFC6	I could not locate the information (year) requested				
		IQEFC7	Overall, I can perform the search effectively using the system				

	Statements	SD	D	A	SA
IQEFF1	I was able to complete the search quickly using the system				
IQEFF2	The system requires few steps to find the information requested				
IQEFF3	Overall, the time taken to complete the search was minimal				
IQEFF4	I could not recover from mistakes easily				
IQEFF5	The search system responds efficiently to the search made				
IQEFF6	The search results were specific to the information requested				

Kindly tick (√) your responses on the **EFFICIENCY** of the web search system with the statements below based on the tasks you performed on page 1 using the system.

Kindly tick (√) your responses on your **SATISFACTION** with the web search system using the statements below based on the tasks you performed on page 1 using the system

	Statements	SD	D	A	SA
IQSAT1	I am satisfied searching using the system to find the information requested				
IQSAT2	I feel comfortable using the system to find the information requested				
IQSAT3	I will like to use this system to find theses				
IQSAT4	The information provided by the system is clear				
IQSAT5	Overall, I am satisfied with the ease of completing the task using the system				
IQSAT6	The search system did not meet my expectations				
IQSAT7	The system was not pleasant to use				
IQSAT8	I will not recommend this search system to my colleagues				
IQSAT9	I do not think this system will be beneficial for information acquisition				

SECTION C: USABILITY EFFECTIVENESS, EFFICIENCY AND SATISFACTION USING TRANSACTIONAL QUERY

Kindly tick (√) your responses on the **EFFECTIVENESS** of the web search system with the statements below based on tasks you performed using the system

S/N	Task		Statements	SD	D	A	SA
1	**Search for any thesis using the keywords 'RURAL FARMERS'** Note: *Do not use the autosuggest, make sure you complete the search using the keywords **a. Click on the title of any thesis from Zaria**	TQEFC1	I can effectively complete the search task using the system.				
		TQEFC2	I can effectively complete the log-in task of the thesis I selected				
		TQEFC3	I can effectively download the thesis using the search system				

open access repository b. Log-in with Email- zariaadmin@gmail.com password 000000 c. Download the thesis	TQEFC4	The system was complicated to use for the transactional tasks					
	TQEFC5	The thesis I downloaded from the system was related to the task I performed					
	TQEFC6	Overall, I was not able to achieve the transactional tasks using the system					

Kindly tick (√) your responses on the **EFFICIENCY** of the web search system with the statements below based on the tasks you performed above using the system

	Statements	SD	D	A	SA
TQEFF1	I was able to complete the search task on-time using the search system				
TQEFF2	I was able to complete the log-in task on-time using the search system				
TQEFF3	I was able to complete the download task on-time using the search system				
TQEFF4	The search task required too many steps to accomplish				
TQEFF5	I could not recover from mistakes easily				
TQEFF6	The search system responds slowly to the search task				
TQEFF7	The search system responds slowly to the log-in task				
TQEFF8	The search system responds slowly to the download task				
TQEFF9	The download task required too many steps to accomplish				
TQEFF10	Overall, the time taken to complete the transactional task was minimal				

Kindly tick (√) your responses on the **SATISFACTION** of the web search system with the statements below based on the tasks you performed on page 3 using the system

	Statements	SD	D	A	SA
TQSAT1	I enjoyed the search task using the system				
TQSAT2	I enjoyed the log-in task using the system				
TQSAT3	I enjoyed the download task using the system				
TQSAT4	I feel comfortable using the system for the transactional task				
TQSAT5	I would use the system more frequently to search for theses				

TQSAT6	I would use this system more frequently to download theses in my field				
TQSAT7	The information provided by the system for the task is clear				
TQSAT8	Overall, I am satisfied with the ease of completing the task using the system				
TQSAT9	The search system did not meet my transactional expectations				
TQSAT10	I would not recommend this search system to my colleagues				
TQSAT11	I do not think this system will be beneficial to information acquisition				
TQSAT12	The system was not pleasant to use				

APPENDIX E
USABILITY EVALUATION RELIABILTY SCORE

Reliability Statistics

Cronbach's Alpha	N of Items
.912	49

Case Processing Summary

		N	%
Cases	Valid	29	96.66
	Excluded[a]	1	3.33
	Total	30	100.0

a. Listwise deletion based on all variables in the procedure.

FEDERAL UNIVERSITY OF TECHNOLOGY MINNA
SCHOOL OF INFORMATION AND COMMUNICATION TECHNOLOGY (SICT)
DEPARTMENT OF LIBRARY AND INFORMATION TECHNOLOGY

VICE – CHANCELLOR:
Prof. Abdullahi Bala *PhD, fssn*

REGISTRAR:
    Tel:+234(0)80368880881.   **Mr. A.N Kolo**, *B. Sc., MSC, ACIPM*
Fax: +234(0) 66 223275   **Telegram**: FUTECH, Minna
HEAD OF DEPARTMENT:
Dr. K. A Saka, *NCE, BLIS (ABU), MLS (BUK), Ph.D (UniMaid)*
E-mail:s.katamba@futminna.edu.ng
                                    Tel: 07038706880

22nd August, 2019

Sir/Ma,

LETTER OF INTRODUCTION: SALAU, Sadiat Adetoro
PHD/SSTE/2015/694

I hereby introduce SALAU, Sadiat Adetoro a PhD student in the Department of Library Information Technology, FUT Minna.

She is working on her project, title. **'Development and Usability Evaluation of a Search Webware for Electronic Theses and Dissertations in Nigerian University Libraries'** Please kindly render her the necessary assistance to enable her complete her research work.

Thanks for your anticipated cooperation.

Dr. K. A. Saka
Head of Department/LIT

APPENDIX G
LIST OF PUBLICATIONS FROM THE STUDY

1. **Salau, S.A.,** Oyedum, G.U., Abifarin, F.P., & Udoudoh, S.J. (2018, July 9-11). *Management of Electronic Theses and Dissertations in Selected Nigerian IRs*. 3rd CARLIGH/AAU International Conference, Accra.

2. **Salau, S. A.** & Oyedum, G.U. (2019) Sustainability and challenges of electronic theses and dissertations in Nigerian Institutional repositories. *Journal of Applied Information Science & Technology*. 12(2) 202-210. (https://www.jaistonline.org/vol12no2i_2019.html)

3. **Salau, S.A.,** Oyedum, G.U., Abifarin, F.P., Udoudoh, S.J. & Alhassan, J.A (2020).Performance assessment of electronic theses and dissertations initiatives in Nigeria. *Digital Library Perspectives*. 36(2) 127-148 DOI: 10.1108/DLP-01-2020-0001 (https://www.emerald.com/insight/content/doi/10.1108/DLP-01-2020-0001/full/html)

4. **Salau, S.A.,** Abifarin, F.P., Udoudoh, S.J. & Alhassan, J.A (2020). Usability Effectiveness of a Federated Search Tool for Electronic Theses and Dissertations in Nigerian Repositories. *Performance Measurement and Metrics* 22(1).

5. **Salau, S.A.,** Abifarin, F.P., Abba, E. & Oyedum, G.U. (2021). Development of a Search Webware for Electronic Theses and Dissertations in Stand-Alone Institutional Repositories in Nigeria. *African Journal of Management Information System*. 3(1).