

Development of a Search Webware for Electronic Theses and Dissertations in Stand-Alone Institutional Repositories in Nigeria

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ABSTRACT

Postgraduate students in Nigeria universities are faced with the challenge of access to local content literature in the form of theses and dissertations despite the large turnout of these resources. The implementation of stand-alone Institutional Repositories by individual universities did not reduce this challenge mainly due to low-level awareness, thus the resultant effect is the repetitive cycle of researches conducted at postgraduate level in Nigeria. This paper proposed a single web search system that allows for search and discovery of electronic theses and dissertations (ETD) in the stand-alone repositories of Nigerian universities where they are hosted. Three simulated repositories with electronic theses and dissertations were used as the back-end database in order to have a workable model and control over the accessibility of the repositories. Based on keyword search, the web application presents a single interface that displays searched theses and dissertations showing the title, author supervisor and the institutional repository (IR) where the thesis is hosted

Keywords: *Theses and dissertations, Electronic Theses and Dissertations (ETD), Institutional repositories (IR), Nigeria.*

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1. INTRODUCTION

Theses and dissertations in print and electronic format are churned out of the over thirty federal owned universities in Nigeria yearly as part of graduation requirements. Despite the large turnout

of these information resources, two critical challenges are faced by postgraduate students in the course of their research studies. Firstly, the issue of repetitive researches because of the oblivion of researches conducted in other universities. The

second challenge was the access to local content literature to build up their researches. Electronic theses and dissertations (ETD) in university libraries are hosted on digital repositories. In order to access theses and dissertations, postgraduate students have to browse and search individual institutional repository that they were aware of. In addition, each repository has its own search and browse features which the students have to get used to in order to effectively use the system.

In the opinion of Ezema (2011), this situation makes African researchers depend highly on the information generated from the developed countries of Europe and the USA which to a large extent may not follow the format and context of African problems. Schopfel and Soukouya (2013), were of the opinion that research may not be the political priority for most countries in sub-Saharan Africa, including Nigeria, due to major economic and social challenges. They however agreed that there is a consensus effort for open access to scientific information in order to foster scientific development and integration with the global research community. This consensus effort yielded over twenty five stand-alone institutional repositories (IRs) in Nigeria with fifteen of them owned by federal universities and only ten functional repositories (see Table 1). However, due to the advances in technology and the ever growing effort to meet users' information needs in less time, stand-alone repositories in Nigeria have not solved the challenges identified. Postgraduate students still need to browse round individual repositories, albeit digitally, which takes up time as well, like in the case of physically visiting the university libraries.

To solve this challenge, the Nigerian Research and Education Network Federated Repository (NgREN) launched a federated repository in 2017 but this also did not help much because of limitations related with institutional policy autonomy. The NgREN effort may in the long term come to be with policy changes and political will. In the meantime however, a single web search system that allows for search and discovery of electronic theses and dissertations in whichever stand-alone repository the ETD is hosted is highly pertinent to meet postgraduate users' literature information needs.

2. RELATED WORK

A number of research studies have developed aggregator systems in order to improve access to information resources. A pilot study by Alam &

Pandey (2012) developed a prototype model (GeoTheses) to provide a mechanism for the development of a union catalogue for geoscience theses based on open source software. The system was designed using Greenstone digital library software, Apache, PERI and JRE and could be used both offline and online through the web. The system also provided a single user interface for subject and keywords browsing and an interface for document request. GeoTheses was an experimental prototype model that provides a platform for the development of a national union catalogue of Geoscience in India. However, the focus of the system was in bibliographic information of Geosciences theses and not a full-text retrieval system.

Ademola & Adewale (2013) research project was aimed at designing and developing a portal for the management of the workflow of projects in the Department of Electrical and Information Engineering of Covenant University, Nigeria. C# sharp language, HyperText Markup Language (HTML), ASP.Net & My SQL programming languages were used to write codes for different sub-modules- front end design of the portal, active server pages, database management records. The study automated the bibliographic control of researches done in the department; however, the scope was limited to a department. This proposed integrated system when implemented could control the bibliographic control of researches in Nigeria and would be web-based, rather than an intranet research process management tool as in the case of Ademola and Adewale.

Mgonzo & Yonah (2014) reported the development of a DSpace@NM- AIST repository system, for collecting, preserving, and sharing scholarly research outputs at The Nelson Mandela African Institution of Science and Technology (NM- AIST). The study was a continuation of an earlier study conducted by the authors on the attitudes and web- usage behaviour of users and how these affect the implementation and future success of purely web- based systems. The system was developed based on the need for a solution to the challenges faced by faculty and students in the collection and dissemination of research materials. It was developed using open source software. Findings obtained from system validation tests showed that the system was viable for the management and sharing of scholarly information at the institution.

The development of the system is based on the need for such a system as a solution for the challenges faced by faculty and students in the collection and dissemination of research materials. The work

presented here is a continuation of a previous work by the same authors that studied the attitudes and web- usage behaviour of users and how these affect the implementation and future success of these systems which are purely web- based. The Dspace@NM- AIST has been implemented usi

Keerthana & Aby Abahai (2015) proposed a metasearch 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 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 back end together. The element of extensibility of the general search engines which the authors included in their system was the ability of the metasearch engine to crawl only the first result pages suggested by the integrated search engines. Their justification for this was that important and highly relevant results were located on the first page of the search engines which is also the main focus of users.

Mgonzo et. al. (2014) designed a DSpace repository system to be used as a platform for collecting, preserving, and sharing scholarly research outputs at The Nelson Mandela African Institution of Science and Technology (NM- AIST). The system was designed using Dspace open source software. The design was a continuation of a previous work by the authors and was based on the need for such a system as a solution for the challenges faced by faculty and students of the institution in the collection and dissemination of research materials.

Al-Juboori (2014) developed an e-library search system containing books and theses using PHP, MYSQL and APACHE with WAMP server. The system had a search-system side with the database and the digital library interface side for the users. The researcher devised a direction of narrowing the many search results returned from searches. He used a combination of approaches, firstly organised knowledge resources based on semantics relationship, analysed information and structuring of

the organised knowledge based on their attributes, characteristics, meaning etc. The aim of the proposed ETD search webware for this study intends to include both submission and retrieval from and of different repositories.

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. The proposed ETD search webware would adopt technology similar to these authors since the web crawler would search the URLs of Nigerian universities institutional repositories.

In Nigeria, Aruleba, Akomolafe & Afeni (2016) studied the existing library retrieval system at the University of Ilorin library. In addition to using the concepts of existing information retrieval system models, a digital library full-text retrieval system was designed and successfully implemented using real-life data. 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. This indicates that 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 research work 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.

Abikoye et. al. (2019) designed a personnel record management system for Ladoko Akintola University of Technology, Ogbomoso using K-Way Merge Sort Algorithm for sorting and merging of data in the database to produce the required information in a requested format. The system was designed by creating a relational database with MYSQL to accept personnel record effectively and, designing a web-based solution using PHP, JavaScript and HTML at the front-end. The developed system introduced k-way merge sort algorithm to query the database in order to generate required report, sorting and collating of different related fields as enquired, merging them to form a single output, and keeping the updated records in the archive for future references.

The novelty of the proposed ETD search webware lies in the fact that there is no unified or aggregated platform for contents in Nigerian institutional repositories

3. SYSTEM ANALYSIS, DESIGN AND IMPLEMENTATION

An initial preliminary assessment was carried out using observation and secondary sources of information (literature review and GOOGLE search) to find out if there were any integrated/unified search portal or repository for these stand-alone ETD initiatives of Nigerian university libraries. A second assessment (empirical) of the repositories was carried out in order to identify which webware model would be applicable and sustainable for Nigerian ETD initiative. The findings are discussed below.

The limitations of the existing institutional repositories in Nigeria are:

1. Institutional repositories were stand-alone, thus wasting the user's time.
2. Institutional repositories are not compliant with the open archive initiative-protocol for metadata harvesting (OAI-PMH) framework for data providers. The Open Archive Initiative-Protocol for Metadata Harvesting (OAI-PMH) is a machine-to machine interface specification that facilitates the retrieval of metadata e.g.

resource description of the resource (title, author, date of publishing, publisher, etc.) or resource location on the Internet (indicated by the URL).

3. Searches for contents in repositories were conducted through general search engines on the web, thus returning many irrelevant search results.

Based on these limitations, the researchers concluded that the suitable and sustainable system given the limitations identified from the findings, was a federated web-based search webware, where ETD contents from simulated 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 also treated their ETD metadata as private data set; thus, they were not accessible to be indexed locally.

3.1 System Overview

The system was designed using the web-based development life cycle (WDLC). The WDLC gives a description of the processes in the life cycle of a web application, although the WDLC is similar to the Systems Development Life Cycle (SDLC), the requirements for WDLC are geared towards web applications Abdul-Aziz et. al. (2012). The phases include planning, analysis, design, implementation, publishing and maintenance. However, the proposed ETD webware combined the implementation, publishing and maintenance phases under implementation and testing.

3.2 System Design

The system used the client-server system architecture which works on a request-response model. Its design integrated web technology, database technology and programming technology using Apache web server, MySQL and PHP (PHP hypertext preprocessor). PHP is mainly a general-purpose programming language used to develop dynamic web applications while My SQL is an Oracle-backed open source relational database management system (RDBMS) most often associated with web applications and online publishing. Apache web server establishes a connection between a server and the website browsers (Firefox, Google Chrome, Safari, etc.)

while delivering files back and forth between them. The design system for the two phases of the Webware are described below:

User Interface: This is the medium the users interact with and sends the query through. This interface displays search results retrieved from the repositories. The results on the interface links the thesis on the repositories where it is hosted 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.

Back-end Repositories: The workability of existing 'live repositories' could not be guaranteed for the purpose of the development of this webware, thus, three simulated repositories were designed and used in order to create/generate a test bed which the search retrieval system can feed /harvest from. ETDs from three existing and functional institutional repositories (Ahmadu Bello Unievrsity, Zaria; University of Nigeria, Nsukka; Federal University of Technology, Minna) from the field of Agriculture 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.

Agriculture discipline was chosen using a simple random technique from a list of five faculties common to all the universities. The researchers numbered the faculties 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 from five departments (Crop production, Agricultural Economics & Extension, 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 the minimum sample size of three hundred and ten (310) theses for a population of one thousand, six hundred and twenty (1620) Agriculture theses available in the three university repositories. Three hundred and ten (310) theses were uploaded to the simulated repositories.

The requirements for the simulated repositories were classified into:

- i. Functional/operational requirements
- ii. Security requirements
- iii. System requirements
- iv. User requirements

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.

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.

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

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- a) Ubuntu web server with PostgreSQL database and Tomcat Java server installed
- b) Ram 4GB above
- c) Hard drive 1 TB above

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 localhost especially for running test projects before deploying them online (<http://ossels.com/how-to-deploy-and-run-your-web-apps-using-wamp-server/>).

3.2.1 Flowchart of the Webware

A flow chart represents graphically the process or system that details the sequencing of steps required to create output Kumar (2010).

3.3 System Design Model

The system design model for the web application is shown in Figure 3. Users search for theses on the Webware user interface through a browser. The requests are received by the system, which is then sent to a 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 use case diagram is shown in figure 4.

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.

3.4 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, Malleret & Schöpfel (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. (*See Appendix A*)

The errors observed and reported were effected in the iterated versions of the webware. For instance, the novice participants needed guidance while navigating during 'TEST SCENERIO C. 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 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. The results displayed in Figure 6 below was returned using the keyword 'Agriculture'.

Fig. 8, 9 and 10 displayed the linked results with bibliographic information about the thesis and the download feature in the domiciled repositories.

4. DISCUSSION AND RECOMMENDATIONS

As the number of digital contents continues to skyrocket, library users in Nigeria shall continue to rely on the Internet as their first point of call for information resource retrieval. Although, there are no hard and fast rule as to how libraries can reduce this trend of relying on the Internet, librarians can leverage and take advantage of this technology by designing and developing library aligned systems and applications that are user-centric, efficient and effective (Mishra & Singhal, 2015) like the ETD webware designed in this study. This will ensure increased access to their contents through interfaces that would guarantee that the time of the user is not wasted. It is posited that an interface application that would bring together ETDs from the available repositories would be user-centered and be a viable, cost-effective alternative to commercial ETD repositories like ProQuest. This paper proposed a single web search system that allows for search and discovery of electronic theses and dissertations (ETD) in the stand-alone repositories of Nigerian universities where they are hosted to facilitate ETD access on multiple repositories. It is posited that this system will solve the challenge of access to completed theses and dissertations and the issue of plagiarism.

This study used simulated repositories with ETDs from one discipline. It is recommended that future studies increase the number of disciplines in the simulated repositories or use live repositories with ETDs from all the disciplines. It would be interesting to see future studies comparatively analysing the retrievability and effectiveness between the webware and institutional repositories.

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18. <http://ossels.com/how-to-deploy-and-run-your-web-apps-using-wamp-server/>.

Table 1: List of universities with functional repositories and the urls

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/

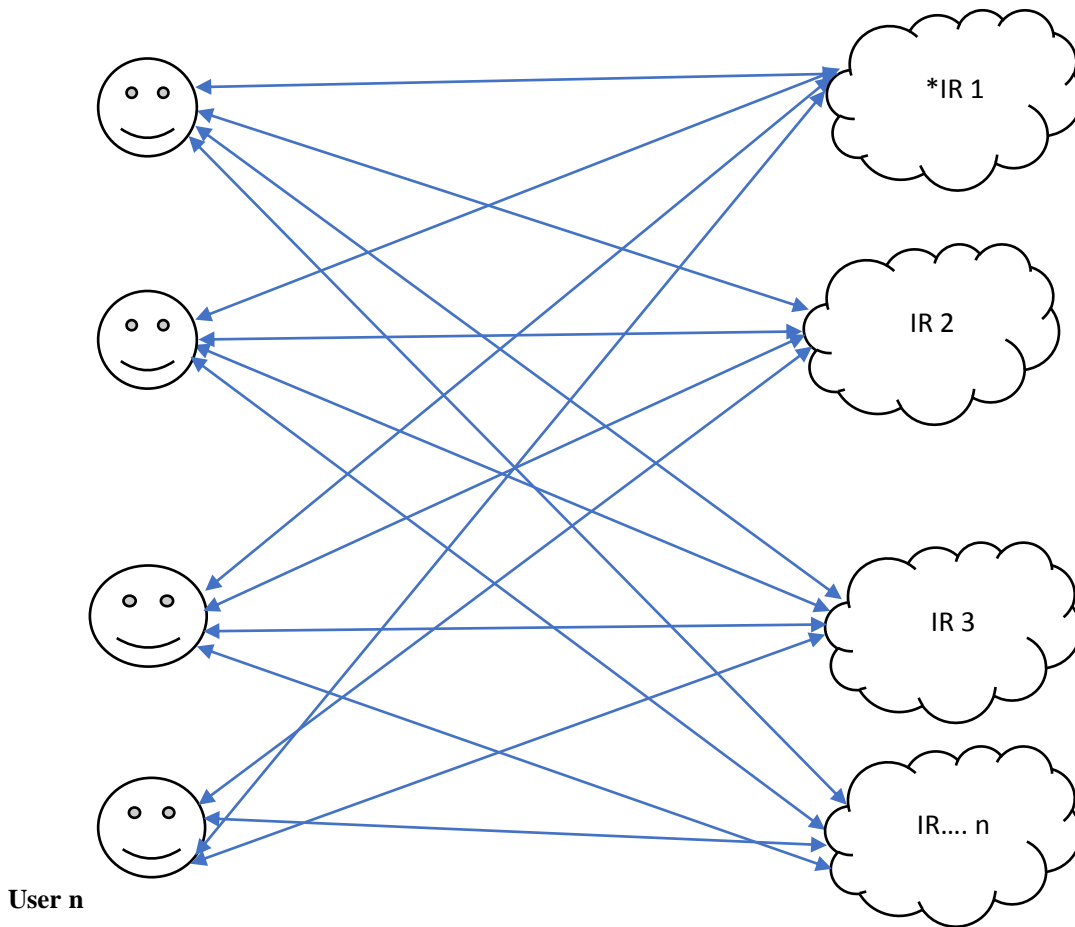


Fig. 1. Diagrammatic Representation of the Existing System

*IR (Institutional Repositories)

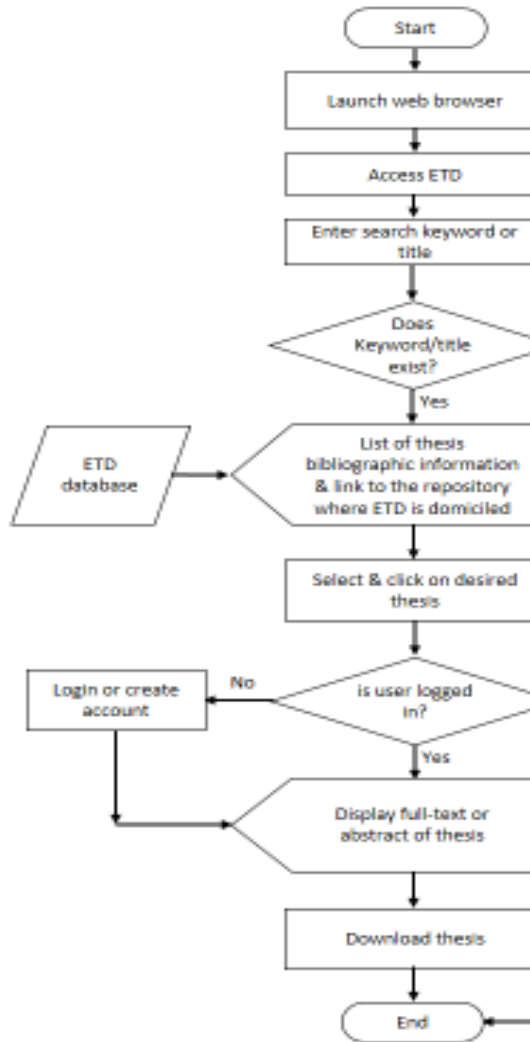


Fig. 2. System Flowchart

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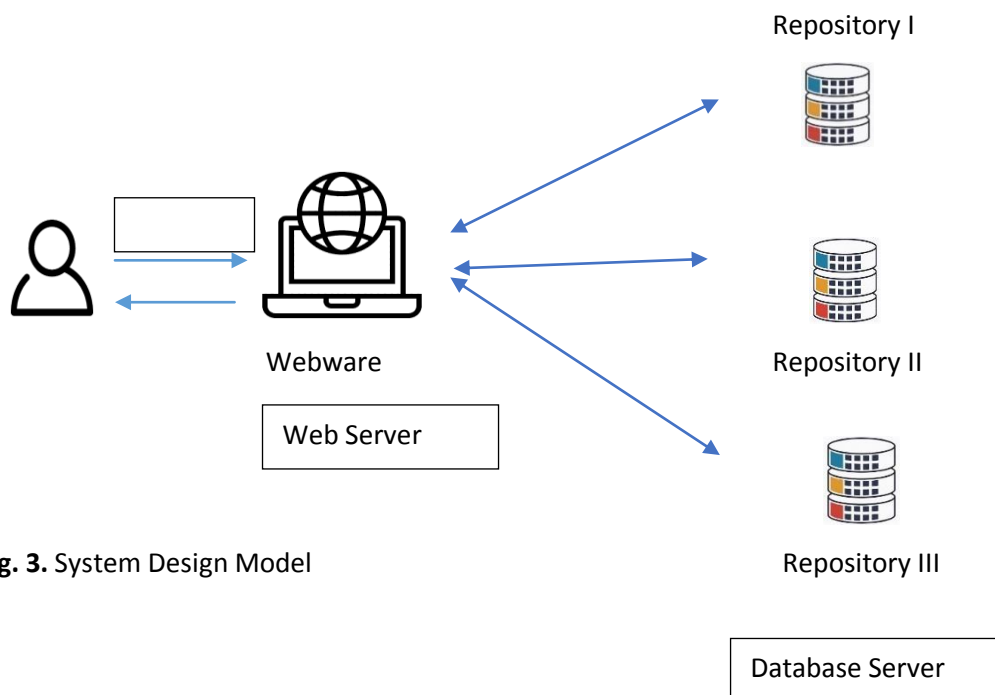


Fig. 3. System Design Model

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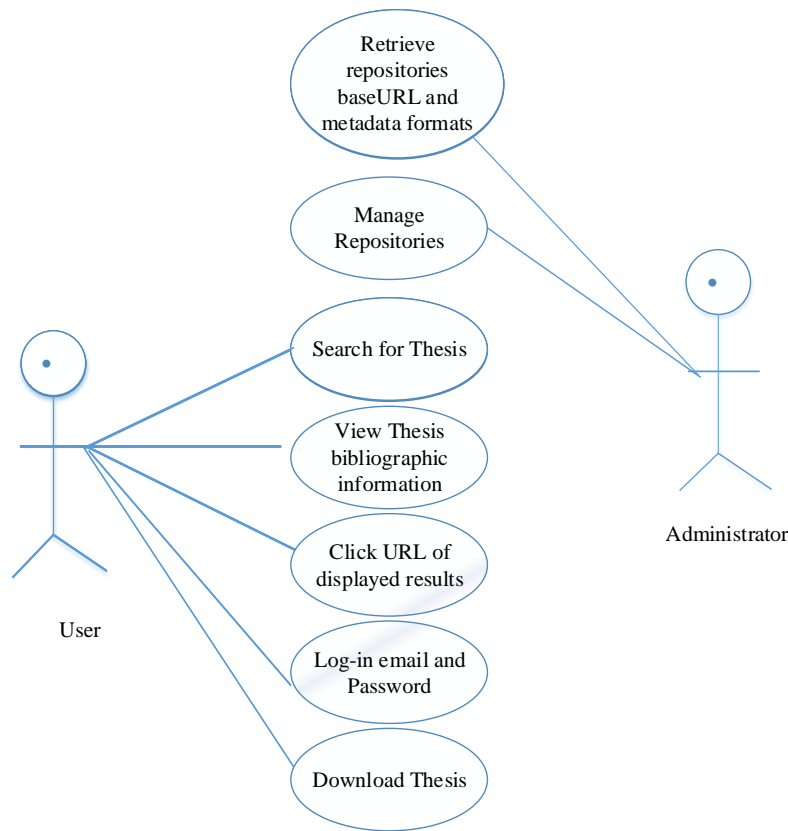


Figure 4: Use Case Diagram

Relational Data Structure

repos
id
name
url
created_at
updated_at

users
id
full_name
phone_number
email
password
role
repo_id
remember_token
created_at
updated_at

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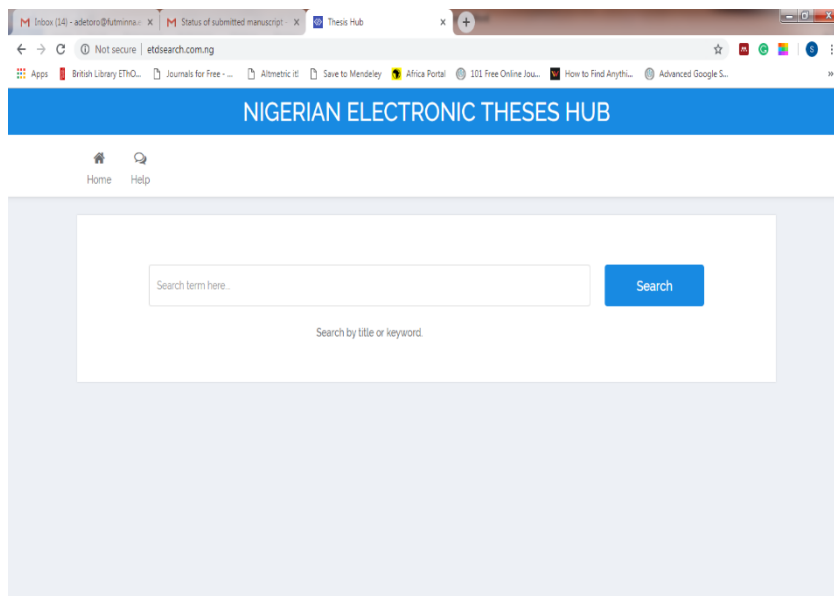
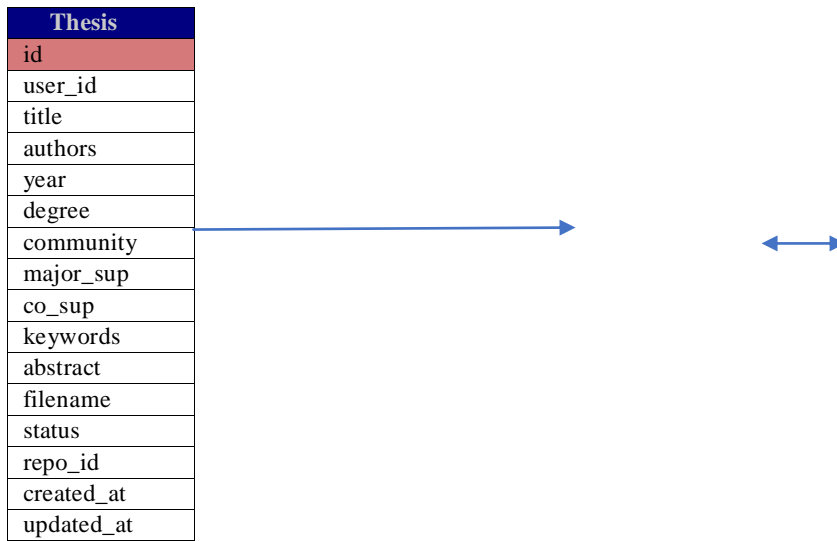


Fig. 5. Home Page of Webware

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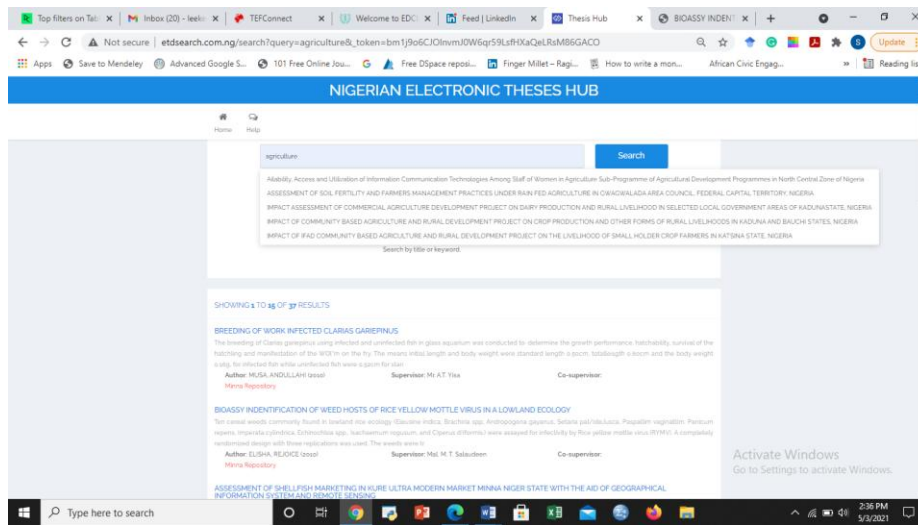


Fig. 6. Displayed Results

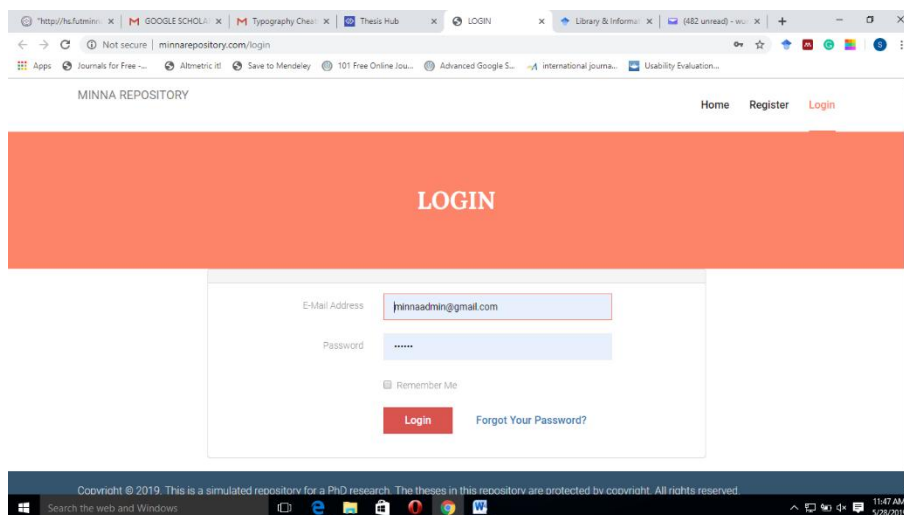


Fig. 7. Log-in details of registered users when accessing and downloading the thesis from the host repository.