RESEARCH PAPER

Knowledge Grid: An Intelligent System for Collaboration and Knowledge Management in Nigerian Universities

Boluwaji A. Akinnuwesi, Adedoyin Odumabo and Benjamin S. Aribisala

Department of Computer Science, Faculty of Science, Lagos State University, Ojo, Lagos State, NG

Corresponding author: Boluwaji A. Akinnuwesi (boluwaji.akinnuwesi@lasu.edu.ng)

Nigeria has 169 universities approved by National University Commission (NUC) with 43 Federal Universities, 47 State Universities and 79 Private Universities. The universities are located in different geographical areas and collaboration among these universities is difficult and this makes accessibility to data and information resource of the universities a problem. As a result quite a number of knowledge built from these resources are locally managed within each university private network that is not shared with other universities due to lack of virtual collaboration on a grid computing platform. Knowledge building and management in a country is a function of the information that one could have access to with ease but non-collaboration of the universities in a virtual environment is a hindrance to quality national knowledge building and management. Thus the need arises to embrace grid system as platform for all universities to pool their resources together and hence make their information resources available and accessible for knowledge building and management. This report presents an overview of Nigeria universities' operations as regard their research and innovation policies and vis-à-vis governance and resource management across public and private universities. Also we did a systematic review and analysis of knowledge grid (KG) technology vis-à-vis its use for knowledge management in Nigerian universities. We focused on identifying the strengths and challenges of knowledge grid development and implementation vis-à-vis the technological, economic and social implications involved in the process. Our future work is to develop a robust knowledge grid model that will allow collaboration among universities in Nigerian community and hence facilitates information and knowledge sharing and management among the universities.

1. Introduction

In a knowledge based economy, universities are instrument for change and growth of the nation. According to National Policy on Education (2012) in Nigeria, university is responsible for developing people with skills and knowledge needed for economic development of a nation (Musa & Ibrahim, 2017). Studies were done by many authors to show the importance of skills acquisition and entrepreneurship development among university students. The vocational training allows students to acquire relevant knowledge, practical skills and empower them economically and aid industrialisation (Akuegwu, 2016; Baderinwa-Adejumo & Akrai, 2017; Esomonu, Esomonu, & Oluwatoyo, 2016; Ezeonwurie, 2017; Medugu, Abdulkarim, & Bashir, 2017). Moreover empirical studies were done to see the effect of technological tools on knowledge management (KM) which bring about effective instructional delivery of knowledge via mobile communication technology (Onwusuru, Uka, & Udeze, 2013), electronic learning (Ibezim, 2013; Oleabhiele, 2015), and grid and cloud computing (Abba & Bakon, 2016; Etim, Erema, & Ekpo, 2016; S. Misra & Adewumi, 2015; Nsofor, Bello, Umeh, & Oboh, 2015). Thus the use of Information and Communication Technology (ICT) is a key factor to achieving effective and efficient teaching and learning in institutions.

Furthermore, management of organisations is based on knowledge and it has become the most important resource more than land, labour, capital etc. (Owoc & Marciniak, 2013; Sanchez, 2001; Wang & Ji, 2005). Knowledge management entails the following functions (Brewster, Ciravegna, & Wilks, 2002; Marwick, 2001; McQueen, 1998; Uren et al., 2006; Zins, 2007): information classification for proper understanding; sharing of ideas; promotion of collaboration among organizations; and standardization of information vis-à-vis easy retrieval. The works of scholars from a multitude of disciplines have suggested that access to a rich diversity of information encourages organisation existence and maintain growth (Owoc & Weichbroth, 2015; Wang & Ji, 2005).

Several techniques have been used in tertiary institutions of learning outside Nigeria to meet up with the challenges and vis-a-vis promotes knowledge-driven economy to ensure good quality, efficiency and ultimately leverage on competitive edge. Examples are: Mauritius (Abbass, 2017), Iran (Yokhaneha & Baghoumian, 2014), Europe (Owoc & Weichbroth, 2015), Asia (Wang & Ji, 2005), Kenya (Murumba & Micheni, 2017), etc. Many studies have also proven that modern knowledge sharing and management system such as knowledge grid (KG) is more effective than traditional ways of sharing and managing knowledge (Sani, 2015; Yokhaneha & Baghoumian, 2014). Thus Knowledge Grid (KG) is an intelligent grid system that provides a sustainable interconnected platform whereby people and relevant digital devices can effectively capture, publish, share and manage knowledge resources (Ohiorenoya & Eboreime, 2014). Knowledge grid (KG) can be employed as a tool for collaboration, access and sharing of individual knowledge among Nigerian universities and hence enhancing research works and other benefits.

According to (Ohiorenoya & Eboreime, 2014), the implementation of KG is still low in Nigerian universities. Collaboration among these universities is difficult and this makes accessibility to information resource of the universities a problem (Ohiorenoya & Eboreime, 2014). As a result quite a number of knowledge built from these resource are locally managed within each university private network that is not shared with other universities due to lack of collaboration (Ohiorenoya & Eboreime, 2014). This work aimed at giving a report on the strengths and weaknesses of the use of Grid system in Nigerian universities. An overview of the operations of the Nigeria universities was reported in this research. Moreover, the technological, economic and social implications of implementing KG in Nigerian universities were presented.

The paper is organised as follows: Section 2 present a contextualized overview of the Nigerian Universities. Section 3 presents the literature review; Section 4 presents strength, challenges and implications of knowledge grid system for knowledge sharing in Nigerian universities. Conclusion and future research are presented in Section 5.

2. Contextualized Overview Of Nigerian Universities
2.1. Composition of Nigerian Universities
There are 169 universities approved by National University Commission in Nigeria (NUC). There are 43 Federal universities; 47 State owned universities = 43; and 79 Private universities. The universities are located in different geographical areas (www.nuc.edu.ng). In addition the universities are classified as follows: (1) Conventional universities – these universities run degree programmes in almost all disciplines; (2) Universities of Technology – these are specialized universities that run technology based degree programmes only; (3) Universities of science and Technology – these are also specialized universities that run only science and engineering based degree programmes; (4) University of Medical sciences – there is one University of Medical Sciences in Nigeria. It is also a specialized university that runs only medical oriented degree programmes; (5) Technical University – there is one Technical University in Nigeria. It is a specialized university that runs only Science and Engineering oriented degree programmes and emphasis is on hands-on training and entrepreneurship.

2.2. Research and Innovation Policy in Nigerian Universities
Research is the process of creating new knowledge or new insights on knowledge, or unlocking knowledge. Innovation is the generation, acceptance and implementation of new ideas, processes, methods and changes. The goal of National ICT Policy is to facilitate the transformation of Nigeria into a knowledge-based economy and becoming a top 20 economy by the year 2020 (*National Information and Communication Technology (ICT) Policy*, June 2012). National Information Communication Technology (ICT) Policy (2012), Science Technology and Innovation (STI) Policy (2011) (Nigeria, 2011), and other related policies have placed importance on research as an vital part of national developmental planning. The policy documents recognized the noteworthy contribution that the university education could make in this respect, both as warehouses of knowledge and as the nation's leading research centres in collaboration with the research institutes.

Nigerian universities undertake more research than other institutions of learning such as Monotechnic, Polytechnic, College of Education etc. Though in conventional universities, their research works tend to be more academic than applied research. In the university, several academia have published their research works in journals and other scholarly publication outlets. Most of these research publications are for career progression and intellectual stature of the researchers. Moreover research outputs reside in individual computers or private servers or university server which are not interconnected for the purpose of information sharing. In addition many of the institutions are lagging behind in the area of research and innovation and are also unaware of the research data, outputs and other research materials available in each University. The need to encourage collaboration among researchers and universities led National University Commission (NUC) in Nigeria to propose the frameworks for the following computing systems: Nigeria University System Management Portal (NUSMAP) that acts primarily as a data collection portal from all the universities and Online Programme Accreditation Portal to automate accreditation process of universities (http://pubs.sciepub.com/ajse/2/2/3/index.html). None of these frameworks support collaboration, information and knowledge management among the Nigerian universities. Thus it is essential in the current time to have a grid system that is knowledge driven and hence help to facilitate data collection, data standardization and data and information sharing among researchers and the universities. In a study by (Yusuf, 2012), poor motivation, poor and irregular funding, obsolete research infrastructure, inadequacy of qualified research personnel, general lack of research focus and poor linkage between researchers and the industrial sector are factors that hinders Nigeria universities researches. These constraints affect the research capacity and thus the national development.

2.3. Research Funding

In Nigeria, there are government agencies responsible to manage research funds provided by the Federal and State government: National Science and Technology Fund (NSTF); Education Trust Fund (ETF) and Tertiary Education Trust Fund (TETFUND); NUC etc. Aside the aforementioned agencies, private companies and agencies also fund research works in the Universities. In addition, research projects are also occasionally funded by international and philanthropic organisations such as World Health Organization (WHO), United Nations Children's Fund (UNICEF), Bill and Melinda Gates Foundation, Ford Foundation etc.

2.4. Forms of Research

Research in the universities may take any of the following forms (i) individual research which is initiated and conducted by researcher(s) and who seek funding from internal or external funding agencies; (ii) Institutional research which is initiated and supervised by the institution(s), or faculty or department and the funding is internal; (iii) Contractual research by external bodies either government, private sector, Non-Governmental Organization etc, they fund the research and have the right of ownership; (iv) Collaborative research which is a joint research with same goals and involving sharing of ideas, facilities between researcher(s), institution(s), organization(s), countries or regions; and (v) Student research that can be an undergraduate or postgraduate student project, supervised by the student's department and the result is reported in student's thesis or dissertation and it is self-funded in most cases (Yusuf, 2012).

2.5. Governance and Resources Management in Nigerian Universities

In Nigeria, the public universities are the Federal and State universities owned and funded by Federal and State government respectively and the private universities are owned and funded by individual, private organization, and religious organizations. National University Commission (NUC) is the government regulatory agency that oversees the proper running, approval and accreditation of academic programmes in Nigerian universities.

Governance and resource management in the Universities are autonomously done by the University internal management with the Vice Chancellor as the Chief Executive Officer. Other members of the university internal management are as follows: University Registrar, Bursar, Librarian, Deans, Directors and Heads of Departments. The internal management oversees the daily running of the university services. Other members of the University management that are external and make strategic decisions about the universities and also regulate the operations of the internal management are the: (i) Visitor, which is the Nigerian President in the case of Federal Universities and the State Governor in the case of State owned Universities; (ii) Chancellor which is appointed by the President for Federal Universities and State Governors for State Universities; (iii) Governing Council which is constituted by the President for Federal Universities and State Governor for State Universities.

2.6. Impact of National Policies and International Cooperation in Nigerian Universities

There are many policies in Nigeria, among which are Information Policy, National Science and Technology policy (*National Information and Communication Technology (ICT) Policy*, June 2012; Yusufu, 2007) etc. Information policy is the rule, regulation, or practice that affects the conception, acquirement, organization, distribution, and evaluation of information (Yusufu, 2007). The goal of any policy is to circumvent some negative effect that has been noticed in the organization. The policies have affected positively the following associations, ministries and government parastatals: Librarians/Information Scientist, Nigeria Computer Society, Mass Media Practitioners, Ministry of Science and Technology, Ministry of Information, Youth and Culture etc. National Science and Technology Information Policy was established as one of the avenue for distribution of usable research findings to industrialists (UNO, 2011).

In 1988, the National Documentation and Information Centre for Science and Technology (NADICEST) was established to promoting information activities amongst higher institutions of learning in Nigeria (Ogunrombi, 1997; Yusufu, 2007). In 1990, Management Information System (MIS) policy was presented to Nigerian universities under the regulation of the National Universities Commission (NUC) (Bretschneider, 1990; Yusufu, 2007). The goal is to make use of information technology in the teaching and research activities of the universities. The impact of this today has brought about computerization in the processing of information and endowment of information services in Nigerian universities (Yusufu, 2007).

International agencies such as WHO (Dim & Onah, 2007), United Nations Educational, Scientific and Cultural Organization (UNESCO) (Meek, Teichler, & Kearney, 2009; Kearney, 2009; Meek & Teichler, 2009; UNESCO, 2009), European Commission (Commission, 2014), United States Agency for International Development (USAID) (USAID, 2015–2020), Ford Foundation (Oranu, 1977; Osemeobo, 2001; Smock & Smock, 1969), World Bank (Babalola, Sikwibele, & Suleiman, 2000; Banya & Elu, 2001) are involved in the activities of Nigerian universities. They support in funding of research, training, curriculum development and provision of technology driven teaching aids.

World Health Organization (WHO) had commission some health research projects for national development in Nigeria (Dim & Onah, 2007; Ike, 2008). European commission carried out many projects in Nigeria community (Commission, 2014). USAID supported education in accordance with National Policy on Education, the quality of and access to education improved equitability and sustainably in Northern part of Nigeria (USAID, 2015–2020). The Research and Development Centre of the University of Agriculture, Abeokuta, Nigeria is one of the projects done by UNESCO (Meek, Teichler, & Kearney, 2009; Kearney, 2009; Meek & Teichler, 2009; UNESCO, 2009). In 2005, the need to carry out reform was completed and implemented under the Nigeria/UNESCO Science, Technology and Innovation (STI) reform initiative (UNO, 2011; UNESCO, 2005). Ever since 2001, the UNESCO Forum has pursued its obligation to help understand, build and maintain knowledge systems through research, as basis for scientific innovation at national, regional and international levels (Meek, Teichler, & Kearney, 2009; Kearney, 2009; Meek & Teichler, 2009; UNESCO, 2009).

In recent times World Bank has selected 16 universities in Nigeria as African Centers of Excellence (NAN, 2018; Wahab, 2018). This is to support the recipients to promote regional specialization among participating universities in areas that address regional challenges and strengthening the capacities of these universities to deliver quality training and applied research. The following Nigerian Universities/institutions are recipients of this award: Lagos State University; Centre for Oilfield Chemicals Research (CEFOR); University of Port-Harcourt; ACE for Genomics of Infectious Diseases, Redeemer's University; and ACE on Neglected Tropical Diseases and Forensic Biotechnology, Ahmadu Bello University etc.

3. Literature Review
3.1. Search Strategy and Information Source(s) Adopted

Systematic Literature Review (SLR) (Keele, 2007; Khan, Niazi, & Ahmad, 2008) was carried out in this study and the search strategy adopted to get required literatures for this research was composed as follows: (a) Constructed search terms by identifying major keywords, required action and expected results; (b) Determined the synonyms or alternate words for the major keywords; (c) Established exclusion criteria to make exclusion in the course of search and (d) Applied Boolean operators to construct the required search term. Stated below are the results for each stage of the search strategy:

Result for (a):   Nigeria, Tertiary, Institution, Management
Result for (b):   Knowledge, Grid, "knowledge sharing"

Result for (c):	library, blood, HIV, AIDS, Autism, Breast, Cancer, Aquaculture, Hospital, Water, Solar, Manufacturing, Vegetable, Human, Resource, Audit, Drug, Law, Bird, Property
Result for (d):	Nigeria Tertiary institution management Knowledge OR Grid OR "knowledge sharing" -library -blood -HIV -AIDS -Autism -Breast -Cancer -aquaculture -hospital -water -Solar -Manufacturing -Vegetable -Human -Resource -Audit -drug -law -bird -property

The major search terms required to guide our literature search on Google scholar search engine are listed in results for (a) and (b) above. Our aim is to identify all the research works on knowledge management and application of grid technology in knowledge sharing. Our domain of concern is tertiary institutions in Nigeria and abroad. Lots of articles were listed based on the search terms stated in result for (a) and (b) above and many of the articles have no relevance to our research and therefore we excluded the irrelevant articles using the exclusion terms as listed in result for (c). The result for (d) gives the complete search string that we used for our literature search on Google scholar having all the included and excluded terms and terms that are synonyms. Logical operator "OR" helps to combine terms that are synonyms while the negation operator "-" preceding the excluded terms indicates that all articles focusing on such terms must be excluded from the search results.

In this research, selection was from peer-reviewed articles on Google scholar database and we accessed strictly articles gotten using the search term constructed. Resources checked are: conference proceedings, specific journals, book chapter and books. Systematically we reviewed studies on knowledge management using knowledge grid. Studies that met a priori defined inclusion and exclusion criteria were considered for review. Manuscripts that were comments, letters, and editorials were excluded. Studies were properly categorized.

3.2. Study Selection and Data Collection Process
Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Moher, Liberati, Tetzlaff, & Altman, 2009) was adopted to detail the study selection process that established the studies included and those excluded for this research. Studies were properly categorized. **Figure 1** presents the study selection process in PRISMA flow diagram.
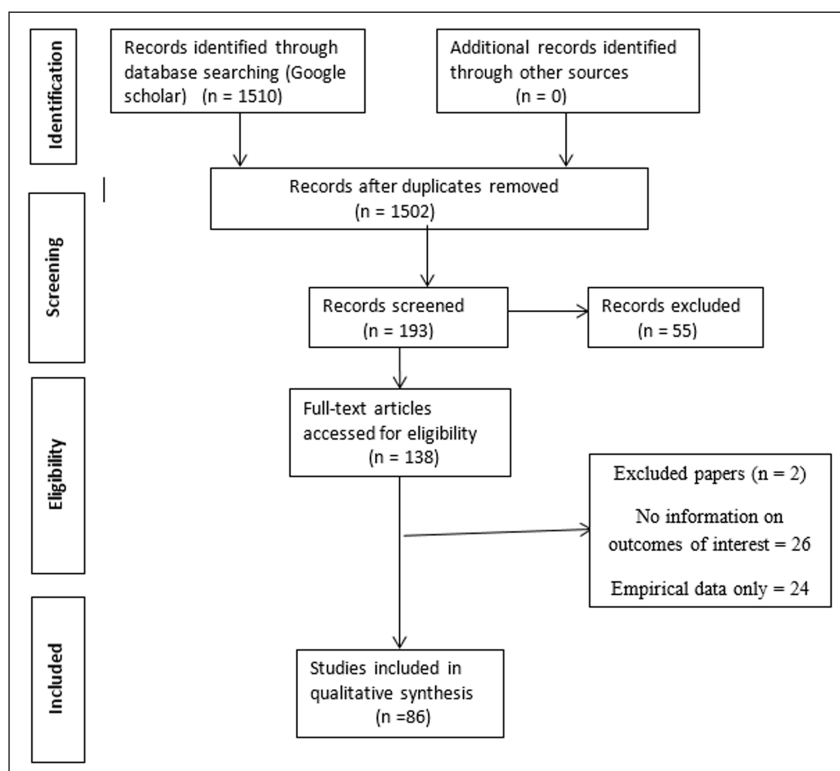

Figure 1: Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Flow Diagram of Included Studies.

3.3. Main Study Results
3.3.1. Knowledge Management (KM) and Knowledge Grid (KG)

Knowledge is a valuable resource and the key factor for any successful organisation and it should be properly managed; thus knowledge is power. Therefore KM is the process used to manage human intellectual assets; hence safeguard and propagate knowledge owned by individuals via a shared resource for people to have access to it. Knowledge Management (KM) process in organizations contains knowledge acquisition, creation, refinement, storage, sharing, and application with the view to ensuring better knowledge practices, enhanced organizational behaviours, better decisions and enhanced organizational performance (King, 2009). Knowledge Management is the act that enhances the growth of organisation and allows innovation and global competitiveness (Nickols 2000).

Universities are structured to be citadel of knowledge. That is academic institutions responsible to make correct knowledge from available and reliable knowledge sources and share with authorized users at the right time. Thus there are relevant mechanisms and technologies (such as Knowledge Grid, Courseware management system etc) that are put in place to facilitate knowledge acquisition, creation, refinement, storage and sharing with the view to ensure adequate scientific research, technological innovation, collaboration and cooperative teamwork. We focused on KG in this paper as an intelligent tool for knowledge management in Nigerian universities.

Knowledge Grid is an intelligent technology for sustainable interconnection of people and computers used to effectively capture, publish, share and manage knowledge resources in the grid of several computer networks of different organizations. It focuses on providing data, services and knowledge resources in a standardized format and hence give well-defined meaning that are understandable at both the machine and human levels (Zhuge and Li, 2004, Zhuge, 2008). According to (Zhuge, 2008): "The knowledge grid environment consists of autonomous individuals, self-organized semantic communities, an adaptive networking mechanism, an evolving semantic overlay keeping meaningful connection between individuals, flows for dynamic resource sharing, and mechanisms supporting effective resource management and providing appropriate knowledge services for problem-solving and innovation. It supports innovation and harmonious development of science, technology and culture". Knowledge Grid is built on the use of high-bandwidth communication networks and high-performance parallel computers for the purpose of mining data (Foster, 2003; Foster & Kesselman, 1999; Foster & Kesselman, 2004; Foster, Kesselman, & Tuecke, 2001; Zaki, 2000). It is premised on computational grid that provides reliable and ubiquitous access to high-end computational resources. KG has been implemented as Parallel and Distributed Knowledge Discovery (PDKD) applications in geographically distributed environment. The KG architecture is built on top of grid toolkits and services and therefore uses basic grid services to construct precise knowledge mining services (Cannataro, Talia, & Trunfio, 2001). The KG services are organized in two hierarchic levels: Core K-grid layer and High-level K-grid layer (Zhuge, 2002). The Core K-grid layer are services directly implemented on the top of generic grid services while High-level k-grid layer are services used to describe, develop, and execute PDKD calculations over the Knowledge Grid. It uses the simple grid services and defines a set of additional layers to the services of distributed knowledge discovery on universally connected computers where each node can be a parallel machine. Knowledge grid allows the alliance of scientists, organizations and enterprises to mine data stored in diverse data warehouses located in different company or establishments (Cannataro & Talia, 2003; Cannataro, Talia, & Trunfio, 2001; Zaki, 2000).

Presently, the Grid is used for scientific applications as well as industrial and commercial applications (Cannataro & Talia, 2003). Computational grids are emerging substructure that enables the incorporated use of remote high-end computers, databases, scientific instruments, networks and other resources (Chervenak, Foster, Kesselman, Salisbury, & Tuecke, 2001; Foster & Kesselman, 2004). Grid applications involve large amounts of computing and/or data (Zhuge, 2002). The basic reason for the architecture design of the Knowledge Grid includes Data heterogeneity and large data-set-handling; Algorithm integration and independence; Compatibility with grid infrastructure and grid awareness; Openness; Scalability; Security and data privacy (Cannataro & Talia, 2003).

Knowledge Grid technology has been adopted to build efficient and effective intelligent platform for information retrieval, filtering and mining (Cannataro & Talia, 2003; Zhuge, 2002). Hence, a knowledge management system can be built based on the KG framework for extensive knowledge gathering, sharing, managing and coordination for Nigerian universities.

3.3.2   Summary Reports of Application of Grid Models in Countries Abroad and Nigeria

A. Application of Grid Models in some Countries Abroad

Grid technology has been in existence for many years and been implemented in many countries around the globe. Below are few examples: Zhuge in (Zhuge, 2002) developed a knowledge grid model for sharing and managing globally distributed knowledge resources. This model arranged knowledge in three dimensional knowledge spaces (i.e. Category, Level and Location) and provided a knowledge grid operational language (KGOL). The model enabled people to conveniently share knowledge on the internet with one another however the operation of the knowledge depends on the standardization of the knowledge categories to some level.

Owoc and Weichbroth in (Owoc & Weichbroth, 2015) developed a multi-dimensional knowledge space model that distributed and managed knowledge resources among scholars and students. This hybrid technique used web log analysis and context-aware knowledge. This model ensured fast search for data in a multi-way channel however there are some problems like sparsity, cold-start and efficiency issues.

Cannataro, Talia and Trunfio in (Cannataro et al., 2001) designed a parallel and distributed knowledge discovery system called Knowledge grid which combines data mining techniques and computational grid resources. This allowed the cooperation of scientists across different research centres to mine data and also use knowledge management system. Its main advantage is that, it speeds up headway on very large-scale geographically distributed data mining. Its shortcoming is that it cannot handle petabyte-scale application.

A summary of various applied grid technologies that have been developed and applied in countries abroad for knowledge management in different areas is presented in **Table 1**.

B. Application of Grid Models implemented in Nigeria

A summary of various applied grid technologies frameworks in Nigeria that have been designed to serve as platform for online teaching and learning as well as medium for knowledge sharing is presented in **Table 2**.

Deductions from Reviewed Literature

The follows are the deductions from the reviewed literature:

a. Grid models have wider acceptance and adoption abroad compared to Nigeria.
b. Grid models have limited application in academics.
c. There is currently no real life implementation of grid models in Nigeria particularly in the academics. Most of the grid models are theoretical or conceptual frameworks that are not implemented in real life. Though the grid technology is widely discussed and reported in research papers. However the research on grid technology in Nigerian context is limited and thus more research is required in this area. Moreover more research should be focussed on the real life application of grid based models for information sharing and knowledge management in universities.
d. There is currently no research works on knowledge grid implementation for knowledge sharing and management for Nigerian Universities.
e. None implementation of grid based model in Nigeria is attributed to some factors and these are listed in Section 3.4 below.

3.4. Factors for Poor Adoption of Knowledge Grid Technology in Nigerian Universities

A number of factors have been reported in past works (Murumba & Micheni, 2017; Uzoka et al., 2011) to be responsible for poor adoption and use of grid technology as a platform for implementing knowledge management system in Nigerian tertiary institutions. Though there are few research works on development of conceptual frameworks for grid computing for information sharing in Nigerian context but none of these is implemented in real life. None adoption and implementation of KG is attributed to the following challenges (Awosan, 2014; Micheni & Murumba, 2016; Sanjay Misra & Adewumi, 2015; Ohiorenoya & Eboreime, 2014; Uzoka, Akinnuwesi, Olabiyisi, & Demilade, 2012): The cost of building knowledge Grid is very high; Building a knowledge Grid is complex; Tertiary institution wants to have autonomy, and Knowledge Grid allow resource sharing, which some institutions may not support because of issues of ownership, copyrights, and licensing; Poor Information Technology infrastructures that support Knowledge Grid Technology; Lack of awareness about the advantages of Knowledge Grid technologies; Lack of Information Technology professionals that can use knowledge grid technology; Knowledge Grid services are susceptible to attackers;

Table 1: Summary of Grid Technologies implemented outside Nigeria.

Author(S)	Research Title	Research Description	Applied Area	Technology Used	Continent (Country)
Cannataro, Talia, and Trunfio (2001)	Knowledge Grid: High Performance Knowledge Discovery Service On The Grid	The aim of this paper was the design and implementation of a parallel and distributed knowledge discovery (PDKD) architecture that integrate data mining techniques and computational grid resources. The Knowledge Grid allowed the cooperation of scientists that must mine data that are stored in different research centres	General	Knowledge Grid	Europe (Italy)
Zhuge (2002)	A knowledge grid model and platform for global knowledge sharing	This paper developed a knowledge grid model for sharing and managing globally distributed knowledge resources. The model arranges knowledge in a three dimensional knowledge space (category, level and location) and provides a knowledge grid operational language (KGOL).	General	Knowledge Grid	Asia (China)
Wang and Liqun Ji (2005)	An Effective Knowledge Management Environment Based on Knowledge Grid in Business Organizations	This paper developed a theoretical and pragmatic architecture of knowledge management system based on Knowledge Grid for better implementation of knowledge management (KM) in business organizations to facilitate their growth and development. This paper objectively analysed the environmental problems that most of those enterprises that are knowledge-based encounter in such a distributed, increasingly changing environment.	Business	Knowledge Grid	Asia (China)
Arenas, Comito, Talia et. al. (2008)	Knowledge and Data Management in Grids: Notes on the State of the Art	A review on the use of grids for management of data was carried out. The authors established the significance of knowledge in supporting high-level applications where Grids are used as supporting platforms, engines and tools for complex information systems.	General	Grid computing	Europe
Mach and Owoc (2010)	Knowledge Granularity and Representation of Knowledge: Towards Knowledge Grid	In this paper, relationships between knowledge granularity as a result of different ways of knowledge representation were considered. The paper addressed problem of developing knowledge grid in the context of encapsulation of knowledge including different dimensions and measures.	General	Knowledge Grid	Europe (Poland)
Lecca et al. (2011)	Grid computing technology for hydrological applications.	The paper illustrated the results of six different surface and subsurface hydrology applications that have been deployed on the Grid. This paradigm handles several topics including data management, algorithm optimization, security, performance, and collaboration issues.	Hydrology	Grid computing	Europe (Italy/France)
Owoc and Weichbroth (2015)	Toward knowledge-grid model for Academic purposes	This paper developed a multi-dimensional knowledge space model, designed to efficiently distribute and manage knowledge resources. This hybrid technique combined web log analysis and context-aware knowledge. Final presentation is a useful and valuable tool for students and scholars.	Academic	Knowledge Grid	Europe (Poland)

(Contd.)

Author(S)	Research Title	Research Description	Applied Area	Technology Used	Continent (Country)
Caballé, Miguel, Xhafa, Capuano and Conesa (2017)	Using trustworthy web services for secure e-assessment in collaborative learning grids	This paper presented a framework that integrate flexible and interoperable Web based secure e-learning services based on trustworthiness model into e-assessment activities in on-line collaborative learning courses. This service-oriented secure assessment model combined both technological security solutions and functional trustworthiness services	Academic	Grid computing	Europe (Spain, Italy)
McCloughlin and Matthews (2017)	Personal Constructions of Biological Concepts – The Repertory Grid Approach	A review of repertory grid analysis as a tool for investigating the structures of students' representations of biological concepts was carried out. The biological concepts examined are 'natural kinds': a technical class of concepts which 'appear' to have invisible 'essences' meaning carrying more perceptual weight than being perceptually similar.	Academic	Grid computing	Europe (Dublin, Ireland)
Raja, Pandian, Pamina (2017)	Certificate Revocation Mechanism in Mobile ADHOC Grid Architecture	In this paper, the grid architecture was designed by using trace based approach to trace the mobile nodes and thus removed the malicious nodes using the revocation mechanism. The mobility of the nodes which is the major problem in the Mobile Ad-Hoc Network (MANET) was fixed by carefully determining the position and stability time parameters of the mobile nodes.	Communication	Grid computing	Asia (India)
Murumba and Micheni (2017)	Grid Computing For Collaborative Research Systems in Kenyan Universities	This paper identified opportunities, benefits and challenges in using grid technologies to support collaborative research in universities especially Kenyan and encourages developing countries to adopt it because of its benefits	Academics	Grid computing	Africa (Kenya)
Nhien-An Le-Khac, Kechadi and Carthy (2017)	Admire Framework: Distributed Data Mining (DDM) On Data Grid Platforms	This paper presented the ADMIRE architecture; a new framework based on Grid infrastructure for implementing DDM techniques. It is more dynamic and autonomous in the mining, integrating and processing phases.	commercial and academic applications	Grid and peer to peer system	Europe (Dublin, Ireland)
Aouad, Nhien-An Le-Khac, and Tahar Kechadi (2017)	Variance-based Distributed Clustering	In this paper, the need for efficient distributed and grid-based clustering algorithms was presented. Therefore, distributed algorithm based on a variance constraint was proposed. This algorithm improves the quality of clustering while compared with classical local centralized and finds real global data nature.	General	Grid system	Europe (Dublin, Ireland)

Table 2: Application of Grid Technology implemented in Nigerian.

Author(S)	Research Title	Research Description	Applied Area	Technology Used	Operational Status
(Akinyemi, 2003; Akinyemi, Daramola, & Adebiyi, 2007)	Grid-Enabled e-Learning Framework for Nigerian Educational Institutions	An e-learning framework was design for Nigerian Education institutions using Grid technology	Academics	Grid computing	Theoretical framework and not practically in use
(Onyeka, Olawande, & Charles, 2010)	A Grid-Based E-Learning Model For Open Universities	A Grid-based e-learning model for Open Universities was proposed. Universities can set up multiple remotely located campuses within a country e.g. National Open University (NOUN)	Academics	Grid computing	Theoretical framework and not practically in use
(Uzoka, Akinnuwesi, Olabiyisi, & Demilade, 2011)	A case Analysis of factors affecting the adoption of Grid Technology by universities	With the increase in numbers of universities in Africa, lack of basic information technology resources, the adoption of grid computing will increase collaboration, enhanced research, course management and other development. This study identified key challenges of adopting grid computing in tertiary institutions.	Academics	Grid computing	Empirical study only
(Uzoka, Akinnuwesi, Olabiyisi, & Alabi, 2012)	An empirical study of adoption of grid computing as a vehicle for tertiary institutions collaboration	A practical study on the adoption of grid computing as a vehicle for collaboration among tertiary institutions in Nigeria was carried out. A new framework for adoption of this technology was proposed. The key challenges that suggestively affect the adoption of grid computing in tertiary institutions were discussed	Academics	Grid computing	Empirical study only
(Alowolodu, Alese, Adetunmbi, Adewale, & Ogundele, 2013)	Elliptic Curve Cryptography for Securing Cloud Computing Applications	Cloud computing requires that organizations trust that a service provider's platforms are secured and provide a sufficient level of integrity for the client's data. In this paper, Elliptic Curve Cryptography scheme was used as a secure tool to model a secured platform for the Cloud Application.	General	Cloud computing	Theoretical framework and not practically in use
(Ohiorenoya & Eboreime, 2014)	Knowledge Management Practices And Performance In Nigerian Universities	This paper investigated the relationship between knowledge management and performance and their variation in knowledge management effectiveness among Nigerian universities. Six accredited universities were selected, which were classified into two federal, two state and two private universities. Random sampling was used to select the various universities.	Academic	Knowledge Management	Empirical study
(Abdulraheem, Aremu, Adewole, & Muhamme, 2014)	Fingerprint Biometric-Based Cryptographic System as A Security Approach in Grid Environment	This paper examined Grid Architecture where various components of a grid play major role in resource sharing and securing of grid. Biometric-based model was used that provides security for grid users using fingerprint for authentication and authorization	general	Grid computing	Theoretical framework and not practically in use

Unstable power supply; Lack of trust of grid service provider, Inconsistency and high cost of internet, Future increase in cost of grid computing, Poor infrastructure, Lack of technical skilled personnel etc.

4. Strengths, Challenges And Policy Implications of Using Knowledge Grid For Knowledge Management In Nigerian Universities

4.1. Strengths of Knowledge Grid System for Nigerian Universities

a. Easy access to resources

Knowledge Grid allows easy access to the centralized or distributed computing resources.

b. Allows Knowledge Mining

The KG technology fast-track progress for very large-scale geographically distributed knowledge mining by permitting the incorporation of numerous currently incoherent approaches and technologies (Cannataro & Talia, 2003). Knowledge Grid technology was adopted to build efficient and effective intelligent platform for information retrieval, filtering and mining (Cannataro & Talia, 2003; Zhuge, 2002).

c. Employs Parallel Utilization

Knowledge Grid had been developed for the implementation of Parallel and Distributed Knowledge Discovery (PDKD) systems on top of grid systems such as the Globus Toolkit and Legion (Cannataro & Talia, 2003). It allows executions of high-performance data intensive in distributed and parallel applications.

d. Allows Resource Sharing

Knowledge-grid systems allow resource sharing. It brings faster and easier transfer of files between collaborators at different universities. It makes use of knowledge discovery and Grid technologies. Therefore, allow sharing of knowledge among the individual scholar and organisation in the grid platform.

e. Virtual Collaboration

Knowledge Grid technology allows virtual collaboration of resource across individual organisation that are linked together in the grid platform. Knowledge grid allows the alliance of researchers to mine data stored in different research centres and also analysts that use knowledge management system function on diverse data warehouses located in different universities (Cannataro & Talia, 2003; Cannataro et al., 2001). This in turn will increase research works among scholars and hence enhance global development.

f. Security and Data Privacy

Security and data privacy issues are important features in wide area distributed systems. The knowledge grid services have valid support to cope with user authentication, security and data privacy. Basic grid functionality (e.g., Globus security infrastructure – GSI) is able to provide secure client-server communications without affecting the usability of the grid infrastructure and services(Cannataro et al., 2001).

g. Algorithm Integration and Autonomy

Knowledge grid allows the incorporation of different data mining algorithms and these algorithms are autonomous from the data mining algorithms used for knowledge mining (Cannataro et al., 2001).

4.2. Policy Implications of Using Knowledge Grid in Nigerian Universities

a. Economic Implications

Knowledge Grid system will promotes knowledge-driven economy to achieve quality, efficiency and ultimately leverage on competitive edge. The implementation of Knowledge Grid system will also bring global contributions to the world development, especially Nigerian economic development. Despite Knowledge Grid importance globally, the attention that Nigerian society had given to it is poor, feeble and unsteady, which in turn had affected its knowledge management efficiency and economic development (Ohiorenoya & Eboreime, 2014).

b. Technological Implications

Knowledge grid is constructed on top of computational grid that provides reliable and ubiquitous access to high-end computational resources. KG is built on the use of high-bandwidth communication networks and high-performance parallel computers for the purpose of mining data. It uses the simple grid services and defines a set of additional layers for the services of distributed knowledge discovery on universally

connected computers where each node can be a parallel machine. This technology is particularly useful for large organizations, environments and enterprises that manage and analyse data that are geographically distributed in different data repositories or warehouses (Micheni & Murumba, 2016). Grid applications often involve large amounts of data, and this requires much of Internet and Web infrastructures.

c. Sociological Implications
Knowledge Grid provide user-friendly interaction with users and make it easier for virtual collaboration among the Universities on the Grid. This will brings organisational efficiency, allow a platform to share and manage information/knowledge.

d. Other Implications
Other implications of implementing Knowledge Grid in Nigerian Universities include the followings: faster and easier transfer of files between the collaborators at different geographical location of their universities; Easier access to distributed computational resources on the Knowledge Grid; allow mining of knowledge from the Knowledge Grid; improve Nigerian economy and in turn global economy; permit virtual collaboration of individual University as a collaborator and can allow participation from their various locations.

5. Conclusion and Future Works
The development and growth of any organisation is determined by the knowledge management system employed. Thus building a platform for collaboration and knowledge sharing among Nigerian Universities using knowledge Grid will be of great importance especially to the academic environment. Knowledge grid system had been implemented in developed nations in Europe and Asia as presented in **Table 1**, but had not yet been implemented in Nigeria as in **Table 2**. As mentioned above, there are numerous advantages of Knowledge grid to Nigerian Universities. Despite the importance of knowledge grid system globally, the attention that Nigerian universities give to knowledge management using knowledge grid is poor, feeble and unsteady and hence poor collaboration and knowledge sharing among the universities. Therefore, there is great need for Nigerian organisations especially academic institutions to decide and improve organizational practices, principles, procedures, and methodologies on how knowledge can be created, shared, managed, and distributed. There are research opportunities in this area, and thus our future work will be to develop a knowledge grid system for Nigerian Universities that will allow collaboration among the Universities in Nigeria and hence facilitate knowledge sharing.

Competing Interests
The authors have no competing interests to declare.

References

Abba, A and **Bakon, KA.** 2016. An Overview of Cloud Computing Platform for E-Learning in Institutions of Higher Learning in Nigeria. *International Journal of Information System and Engineering*, 4(1): 48–54.

Abbass, NS. 2017. Importance of knowledge management at Mauritius Institution of Education. *International Journal of Educational Administration and Policy Studies*, 9(11): 134–145. DOI: https://doi.org/10.5897/IJEAPS2017.0533

Abdulraheem, M, Aremu, DR, Adewole, KS and **Muhamme, KJ.** 2014. Fingerprint Biometric-Based cryptographic System as a security Approach in Grid Environment. *Journal of Computational & Modelling*, 4(2): 41–58.

Akinyemi, A. 2003. Web-based learning and cultural interference: Perspectives of Arab students. *Paper presented at the E-Learn: World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education.*

Akinyemi, IO, Daramola, JO and **Adebiyi, AA.** 2007. Grid-Enabled e-learning Framework for Nigerian Educational Institutions, Nigeria Computer Society. *Paper presented at the 21st National Conference Proceedings.*

Akuegwu, BA. 2016. Developing Entrepreneurship Culture among University Students in South-South, Nigeria. *Mediterranean Journal of Social Sciences*, 7(2): 315–324. DOI: https://doi.org/10.5901/mjss.2016.v7n2s1p315

Alowolodu, OD, Alese, BK, Adetunmbi, AO, Adewale, OS and **Ogundele, OS.** 2013. Elliptic curve cryptography for securing cloud computing applications. *International Journal of Computer Applications*, 66(23): 10–17.

Awosan, R. 2014. Factor analysis of the adoption of cloud computing in Nigeria. *African Journal of Computing & ICT*, 7(1): 33–42.

Babalola, JB, Sikwibele, AL and **Suleiman, AA.** 2000. Education as aided by the World Bank: A critical analysis of post-independence projects in Nigeria. *Journal of Global South Studies*, 17(1): 155.

Baderinwa-Adejumo, AO and **Akrai, NA.** 2017. Entrepreneurial education as a means of ameliorating the menace of unemployment in Nigeria: a case study of selected tertiary institutions in south west Nigeria. *Indian Journal of Science*, 24(89): 17–23.

Banya, K and **Elu, J.** 2001. The World Bank and financing higher education in sub-Saharan Africa. *Higher Education*, 42(1): 1–34. DOI: https://doi.org/10.1023/A:1017584501585

Bretschneider, S. 1990. Management information systems in public and private organizations: An empirical test. *Public Administration Review*, 536–545. DOI: https://doi.org/10.2307/976784

Brewster, C, Ciravegna, F and **Wilks, Y.** 2002. User-centred ontology learning for knowledge management. *Paper presented at the International Conference on Application of Natural Language to Information Systems*, Stockholm, June 27–28. Available @ https://pdfs.semanticscholar.org/3ef9/205940da6ac04ca3f5c97b717ea0214c8ec1.pdf. Date Accessed: February 17, 2018.

Cannataro, M and **Talia, D.** 2003. The knowledge grid. *Communications of the ACM*, 46(1): 89–93. DOI: https://doi.org/10.1145/602421.602425

Cannataro, M, Talia, D and **Trunfio, P.** 2001, November. Knowledge grid: High performance knowledge discovery services on the grid. In: *International Workshop on Grid Computing*, 38–50. Berlin, Heidelberg: Springer. DOI: https://doi.org/10.1007/3-540-45644-9_5

Chervenak, A, Foster, I, Kesselman, C, Salisbury, C and **Tuecke, S.** 2001. The Data Grid: Towards an architecture for the distributed management and analysis of large scientific datasets. *Journal of Network and Computer Applications*, 23: 187–200. DOI: https://doi.org/10.1006/jnca.2000.0110

Commission, E. 2014. *International cooperation and development.*

Dim, CC and **Onah, HE.** 2007. The prevalence of anemia among pregnant women at booking in Enugu, South Eastern Nigeria. *Medscape General Medicine*, 9(3): 11.

Esomonu, NPM, Esomonu, MN and **Oluwatoyo, GK.** 2016. Ensuring the Validity of Technical Skill Assessment Outcomes in Technology Education in Nigeria. *US-China Education Review*, 6(5): 286–293. DOI: https://doi.org/10.17265/2161-623X/2016.05.002

Etim, PJ, Erema, UB and **Ekpo, US.** 2016. The Use of Cloud Computing Tools And Teachers Effectiveness in The Teaching of English Language In Cross River Tertiary Institutions. *Equatorial Journal Of Education And Curriculum Studies*, 1(2): 30–40.

Ezeonwurie, OA. 2017. Assessment of Information And Communication Technology Skills Needed by Secretaries In Colleges of Education In North West Nigeria For Effective Work Performance. *Online Journal of Arts, Management and Social Sciences (OJAMSS)*, 2(3).

Foster, I. 2003. The grid: A new infrastructure for 21st century science. *Grid Computing: Making the Global Infrastructure a Reality*, 51. DOI: https://doi.org/10.1002/0470867167.ch2

Foster, I and **Kesselman, C.** 1999. The Grid: Blueprint for a Future Computing Infrastructure. 105–129.

Foster, I and **Kesselman, C.** 2004. The Grid2: Blueprint for a New Computing Infrastructure.

Foster, I, Kesselman, C and **Tuecke, S.** 2001. The anatomy of the grid: Enabling scalable virtual organizations. *The International Journal of High Performance Computing Applications*, 15(3): 200–222. DOI: https://doi.org/10.1177/109434200101500302

Ibezim, NE. 2013. Technologies needed for sustainable E-learning in university education. *Modern Economy*, 4(10): 633–638. DOI: https://doi.org/10.4236/me.2013.410068

Ike, S. 2008. The Pattern of Admissions into the MedicalWards of the University of Nigeria Teaching Hospital, Enugu. *Nigerian journal of clinical practice*, 11(3): 185–192.

Kearney, ML. 2009. Higher education, research and innovation: Charting the course of the changing dynamics of the knowledge society. *Higher education, research and innovation: Changing dynamics*, 7.

Keele, S. 2007. *Guidelines for performing systematic literature reviews in software engineering* (Vol. 5). Technical report, Ver. 2.3 EBSE Technical Report. EBSE.

Khan, SU, Niazi, M and **Ahmad, R.** 2008. Systematic Literature Review Protocol for Software Outsourcing Vendors Readiness Model (SOVRM). *School of Computing and Maths, Keele University, UK TR/08-01.*

Available @ https://www.researchgate.net/profile/Siffat_Ullah_Khan/publication/271541930_ICICT_
Bannu_Pakistan_2008/links/54cc858c0cf29ca810f53dc4.pdf. Accessed Date: March 1, 2018.

King, WR. 2009. Knowledge management and organizational learning. In: *Knowledge management and organizational learning*, 3–13. Boston, MA: Springer. DOI: https://doi.org/10.1007/978-1-4419-0011-1_1

Marwick, AD. 2001. Knowledge management technology. *IBM systems journal*, 40(4): 814–830. DOI: https://doi.org/10.1147/sj.404.0814

McQueen, R. 1998. Four views of knowledge and knowledge management. *AMCIS 1998 Proceedings*, Available @ http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.39.6031&rep=rep1&type=pdf. Date Accessed: February 17, 2018, 609–611.

Meek, VL and **Teichler, U.** 2009. Higher education, research and innovation: changing dynamics. *Report on the UNESCO Forum on Higher Education, Research and Knowledge, 2001−2009*. International Centre for Higher Education Research Kassel, University of Kassel.

Meek, VL, Teichler, U and **Kearney, ML.** 2009, September. Higher education, research and innovation: Changing dynamics. In: *A report on the UNESCO forum on higher education, research and knowledge*. International Centre for Higher Education Research Kassel, University of Kassel.

Medugu, JD, Abdulkarim, AHA and **Bashir, M.** 2017. Assessment of Training Facilities of Electrical/Electronic Trade at National Directorate of Employment's Skills Acquisition Centres, For Job Creation in Adamawa State, Nigeria. *International Journal of Education and Social Science*, 4(3): 24–32.

Micheni, E and **Murumba, J.** 2016. The promise of grid computing technologies for e-learning systems in Kenya. In: *2016 IST-Africa Week Conference*, 1–9. IEEE. DOI: https://doi.org/10.1109/ISTAFRICA.2016.7530581

Misra, S and **Adewumi, A.** 2015, December. An analysis of the suitability of cloud computing services in the Nigerian Education Landscape. In: *2015 International Conference on Computing, Communication and Security (ICCCS)*, 1–4. IEEE. DOI: https://doi.org/10.1109/CCCS.2015.7374203

Moher, D, Liberati, A, Tetzlaff, J and **Altman, DG.** 2009. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Annals of internal medicine*, 151(4): 264–269. DOI: https://doi.org/10.7326/0003-4819-151-4-200908180-00135

Murumba, J and **Micheni, E.** 2017. Grid Computing For Collaborative Research Systems in Kenyan Universities. *The International Journal of Engineering and Science (IJES)*, 6(4): 24–31. DOI: https://doi.org/10.9790/1813-0604022431

Musa, UA and **Ibrahim, I.** 2017. Analyzing Factors That Contribute For Timely Completion of Research Work Among Postgraduate Students In Federal Universities In Nigeria. *Jurnal Psikologi Malaysia*, 31(3).

NAN. 2018. World Bank selects LASU, CU, 15 other varsities as African Centres of Excellence. *Punch news paper online*. Available @ https://punchng.com/world-bank-selects-lasu-cu-15-other-varsities-as-african-centres-of-excellence/. Accessed Date: November 2, 2019.

National Information and Communication Technology (ICT) Policy. June 2012. Available @ https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&cad=rja&uact=8&ved=2ahUKEwjg64XUptzlAhUgQEEAHfgdDVwQFjABegQIABAC&url=https%3A%2F%2Fwww.researchictafrica.net%2Fcountries%2Fnigeria%2FNigeria_National_ICT_Policy_(draft)_2012.pdf&usg=AOvVaw3skeBxuDbe37UNJ6y4Kn8U. Date Accessed: November 09, 2019.

Nickols, F. 2000. KM overview. URL: http://home.att.net/~discon/KM/KM_Overview_Context.htm. Date Accessed: October 18, 2015).

Nsofor, CC, Bello, A, Umeh, EA and **Oboh, CO.** 2015. The Future of Educational Technology in the 21st Century Nigeria: Changing Educational Landscape through Emerging Technologies. *Journal of Educational Policy and Entrepreneurial Research (JEPER)*, 2(3): 28–37.

Ogunrombi, SA. 1997. Exhibitions in university libraries. *Library Review*. DOI: https://doi.org/10.1108/eb051440

Ohiorenoya, JO and **Eboreime, OF.** 2014. Knowledge management practices and performance in Nigerian Universities. *European Scientific Journal, ESJ*, 10(16): 400–416.

Oleabhiele, EO. 2015. Effects of E-learning Strategy on Students' Achievement in Economics. *Asia Pacific Journal of Education, Arts and Sciences*, 2(1).

Onwusuru, IM, Uka, CS and **Udeze, CC.** 2013. Utilization factors of Mobile Communication Technology (MCT) for Creating Opportunities for Reflection and Collegiality for Professional Development Purpose of Technology Teachers in Anambra State of Nigeria. *African Journal of Computing & ICT*, 6(3).

Onyeka, E, Olawande, D and **Charles, A.** 2010, November. A Grid-based e-learning model for Open Universities. In: *2010 International Conference for Internet Technology and Secured Transactions*, 1–4. IEEE.

Oranu, RN. 1977. The impact of the Ford Foundation on vocational teacher education in Nigeria: implications for future development.

Osemeobo, GJ. 2001. Is traditional ecological knowledge relevant in environmental conservation in Nigeria? *The International Journal of Sustainable Development & World Ecology*, 8(3): 203–210. DOI: https://doi.org/10.1080/13504500109470077

Owoc, M and **Marciniak, K.** 2013, September. Knowledge management as foundation of smart university. In: *2013 Federated Conference on Computer Science and Information Systems*, 1267–1272. IEEE.

Owoc, M and **Weichbroth, P.** 2015. Toward knowledge-grid model for academic purposes. In: *3rd International Workshop on Artificial Intelligence for Knowledge Management (AI4KM 2015)*, 5–9.

Sanchez, R. 2001. *Knowledge management and organizational competence.* Oxford University Press, Inc.

Sani, UT. 2015. Effects Of Cooperative Learning Strategy On Senior Secondary School Students' Performance In Quantitative Chemistry in Kebbi State, Nigeria. *Journal of Education and Social Sciences*, 1: 30–35.

Smock, AC and **Smock, DR.** 1969. Ethnicity and attitudes toward development in Eastern Nigeria. *The Journal of Developing Areas*, 3(4): 499.

UNESCO. 2005. Decade of Education for Sustainable Development: 2005–2014. *Draft International Implementation Scheme.*

UNESCO. 2009. *Higher Education, Research and Innovation: Changing Dynamics* (I. C. f. H. E. R. Kassel & (INCHER-Kassel) Eds.). Germany.

UNO. 2011. *Science, Technology and Innovation (STI) Policy*. Available @ https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&cad=rja&uact=8&ved=2ahUKEwjp4onlp9zlAhVPXMAKHbqBC6YQFjABegQICxAE&url=http%3A%2F%2Fworkspace.unpan.org%2Fsites%2Finternet%2FDocuments%2FUNPAN048879.pdf&usg=AOvVaw3tzFUcpr21rSs0R6KoVUWK. Date Accessed: November 09, 2019.

Uren, V, Cimiano, P, Iria, J, Handschuh, S, Vargas-Vera, M, Motta, E and **Ciravegna, F.** 2006. Semantic annotation for knowledge management: Requirements and a survey of the state of the art. *Web Semantics: science, services and agents on the World Wide Web*, 4(1): 14–28. DOI: https://doi.org/10.1016/j.websem.2005.10.002

USAID. 2015–2020. USAID/Nigeria Country Development Cooperation Strategy. Available @ https://www.usaid.gov/sites/default/files/documents/1860/Nigeria_CDCS_2015-2020.pdf. Accessed Date: November 09, 2019.

Uzoka, FME, Akinnuwesi, BA, Olabiyisi, SO and **Alabi, D.** 2011, May. A case analysis of factors affecting the adoption of grid technology by universities. In: *2011 IST-Africa Conference Proceedings*, 1–14. IEEE.

Uzoka, FME, Akinnuwesi, BA, Olabiyisi, SO and **Demilade, A.** 2012. An empirical study of potentials of adoption of grid computing as a vehicle for tertiary institutions collaboration. *International Journal of Business Information Systems*, 10(3): 245–263. DOI: https://doi.org/10.1504/IJBIS.2012.047530

Wahab, B. 2018. See 16 Nigerian Universities selected as Centre of Excellence by World Bank. *Pulse Ng.* Available @ https://www.pulse.ng/communities/student/see-16-nigerian-universities-selected-as-centre-of-excellence-by-world-bank/8gy337d. Accessed Date: November 02, 2019.

Wang, H and **Ji, L.** 2005. An Effective Knowledge Management Environment Based on Knowledge Grid in Business Organizations. *Communications of the IIMA*, 5(4): 91–100.

Yokhaneh, M and **Baghoumian, R.** 2014. A study on the impact of the quality of management education on the new economy-knowledge: Evidence from members of OIC countries. *Management Science Letters*, 4(8): 1655–1660. DOI: https://doi.org/10.5267/j.msl.2014.7.020

Yusuf, AK. 2012. An appraisal of research in Nigeria's university sector. *JORIND*, 10(2): 320–330.

Yusufu, A. 2007. An Overview of Nigeria Information Policy. *Samaru Journal of Information Studies*, 7(1): 8–12. DOI: https://doi.org/10.4314/sjis.v7i1.40597

Zaki, MJ. 2000. Parallel and distributed data mining: An introduction. In: *Large-scale parallel data mining*, 1–23. Springer, Berlin, Heidelberg. DOI: https://doi.org/10.1007/3-540-46502-2_1

Zhuge, H. 2002. A knowledge grid model and platform for global knowledge sharing. *Expert Systems with Applications*, 22(4): 313–320. DOI: https://doi.org/10.1016/S0957-4174(02)00019-2

Zins, C. 2007. Conceptual Approaches for defining Data, Information, and Knowledge. *Journal of the American Society for Information Science and Technology*, 58(4): 479–493. DOI: https://doi.org/10.1002/asi.20508