Chapter 9
Model for Constructing Institutional Framework for Scientific Knowledge Management Systems: Nigerian Institutional Repository Innovation Case Applicable to Developing Countries

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Abstract This chapter is a part of an inductive reasoning-based longitudinal study that aims to elicit novel barriers of institutional repository (IR) innovation in developing country contexts. The study reported in this chapter is based on qualitative data collected through observation and secondary data from three Nigerian universities. The findings reveal that reconstructing the institutional framework that supports scientific knowledge management systems (SKMS) in developing countries is a panacea for successful IR innovation. The study provides insights that differ from existing ones where scholars assume that IR barriers are only university based.

Keywords Institutional repository • Scientific knowledge management systems • Institutional framework • Open access initiative • Developing countries

9.1 Introduction

The growth of information and communication technology (ICT)-based scientific knowledge management systems (SKMS) such as institutional repository (IR) has been slow in developing countries. This is considered unacceptable given the fact that in the past IR was heralded as a technology that has the potential to promote access to the scientific knowledge required to support development programs in

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developing countries. Couple with this is experts' assertion that development initiatives in developing countries must be driven by the scientific and local knowledge produced in local contexts [1] and the presumed role IR can play if this is to be achieved [2]. The indication that developing countries must strive to provide ready and timely access to their scientific knowledge output as a way to promote development also makes the need to improve IR innovation outcomes pertinent [2, 3]. Current situation, however, shows that the performance of SKMS has been poor in developing countries. The inability of developing countries to efficiently and effectively use SKMS to promote access to the scientific knowledge required to support their development programs has taken its toll on open access initiatives, including the IR initiative. It also has negative effects on the outcome of national and regional access-to-scientific-knowledge programs such as the Nigerian Virtual Library Project and DATAD program of the Association of African Universities (AAU) [4]. Although a lot of efforts have been made to ameliorate barrier factors of IR innovation in developing countries [5], including Nigeria, for example [6–8], these barriers still persist.

Conclusions reached in existing assessment of IR innovation have popularized the assumption that IR barriers are mainly university based. In other words, scholars assume that the major barriers that impede IR innovation are those that arise as a result of the inability of university libraries, academics, and university management to manage IR innovation challenges [9, 10]. The consequence of this is that researchers have inadvertently popularized the notion that universities can single-handedly deal with the barriers of IR innovation [6, 11]. Popular notions include the need to create awareness, spur acceptance and utilization, and change scholarly knowledge publication culture that are believed to be acceptable for tenure, promotion, and appointment of academics [12]. Existing studies are therefore characterized by scopes (research subjects and samples) that have to do with phenomena and people that are peculiar to universities [13]. Surprisingly however, our findings reveal novel IR barrier factors, that is, how the institutional framework that supports SKMS in Nigeria constraints IR innovation efforts in the country. This chapter is therefore devoted to explaining how key institutions that are involved in the Nigerian SKMS can be reconstructed to support IR innovation in the country. In Nigeria, for instance, key institutions that are involved in the country's SKMS include Nigerian universities, the National Universities Commission (NUC), Association of Nigerian Universities Vice-Chancellors (ANUV), Tertiary Education Trust Fund (TETFund), and Association of African Universities (AAU).

Our observation shows that these institutions deal with varying, but integrated, aspects of scientific knowledge management that the nonintegration of their responsibilities posed a problem that must be addressed. The chapter shows the kind of integration we propose and confirms its potential to promote IR innovation and other forms of SKMS. It shows how the integration of key institutions can support access to the scientific knowledge required for development in Nigeria and in developing countries with similar SKMS structure. In addition, the study corroborates notions propagated in the information systems in developing countries (ISDC) discipline on how institutional capacity impacts successful IR innovation in develop-

ing countries [14, 15]. The remaining parts of the chapter are presented as follows: segment two deals with ICT and development and is followed by segment three which dwells on scientific knowledge production capacity, knowledge divide, and development. The fourth segment deals with the evolution of the open access initiative and its assumed potential as a technology that could support development. Fifth segment deals with how Nigerian SKMS is structured. Sixth segment deals with presentation and discussion of study findings. Segment seven dwells on theoretical elaboration and explanation of the SKMS model and theory that emerged based on the study. Segment eight deals with study conclusion.

9.2 ICT and Development

The term development became popular after the Second World War as a result of the role uneven distribution of economic and political powers played in conflicts that led to the war. Development therefore denotes the level of a country's achievements in terms of its economy, politics, culture, education, information technology (IT), health, environment, and institutions. There are, however, dissenting schools of thought on what constitutes the development of countries around the globe. In contemporary times, development indicators have been subsumed in human development, peace and security, and the environment [16]. It follows that development indicators include basic human needs such as water and sanitation, health, education, shelter, human rights, peace, livelihood, security, safe environment, and finance. Development scholars and experts' interests therefore lie on discussing and measuring the extent to which people are able to attain their natural potentials. They based their arguments on the extent to which people's socio-political, economic, and cultural environment ensure that they achieve their potentials with minimal constraint. Scholars and experts are also interested in proffering measures that will aid governments and citizens to protect and sustain natural environments during the course of their socioeconomic, political, and cultural activities [16].

In the past decades however, there are four main schools of thought in the scholarly discipline of development. The school that may be considered the earliest among these schools is the modernist development school of thought. Modernist thought elaborates the role of modernization when developing assumptions about development [17]. A second development school is the Marxist development school of thought [18]. The assumptions of this school of thought is dominated by Marxism principles. The school looks at capitalism as the major stimulator of economic crisis. The third development school of thought is the neo-Marxism dependency school of thought. This school of thought lays emphasis on the incursion of capitalism into societies across the globe, particularly poor societies, and how this propels unwarranted dependency of poor countries on rich countries [19]. The fourth development school of thought is the contemporary development school of thought which is normally argued from two fronts, namely, the globalist front and localist or neo-populist front. Like the neo-Marxism dependency development theorists, scholars that sup-

port globalist development views rely mainly on postindustrial socio-political, cultural, and economic assumptions. According to the globalist school, central to development is information and communication technology (ICT). Hence, for a country to be adjudged as developed, it must be able to invent or import and diffuse and use ICT to drive its development agenda [20].

The limitation observed in the ways globalist theorists represent local factors when observing and drawing conclusions on global development issues led to the emergence of the localist or neo-populist development school of thought. The neo-populist view was made popular in the mid-1970s as results of its paradigm which was then known as neo-populist thinking [21]. Its tenents are based on putting into primary consideration those societies, people, and individuals that are to be developed. To neo-populist theorists "putting into consideration" implies paying strict attention on people, their culture, situations, contexts, and more importantly their local knowledge when judging a society on the extent to which it has diffused and used ICT for socioeconomic and cultural development. As a consequence of this, development economists' postulation that ICT is fundamental to the development of societies resulted in the emergence of further studies that were concerned with evaluating the impact of ICT on development [22, 23]. The study of ICT and development has therefore become of interest to disciplines such as information systems, information science, human computer interaction, computer science, and communication studies, among others. Information and communication technologies have been heralded by scholars in these disciplines as having the capacity to drive operational efficiency of both public and private organizations [24, 25]. It has also been justified in the literature that ICT has efficiently and effectively impacted on managerial productivity of organizations across the globe. With regard to helping organizations to augment and automate the operations they engage in to attain strategic efficiency, ICT has proven to be of high importance. Every form of organization has found ICT very important to the achievement of their corporate goals.

One primary importance of ICT is that it bridges the gap occasioned by space and time. In other words, ICT has helped people, organizations, and societies to communicate data, information, and knowledge irrespective of how wide apart their physical locations are [26]. By so doing, ICT has unprecedentedly reduced the time it takes to transfer data, information, and knowledge irrespective of the physical locations of the entities concerned. In the recent past, advances in telecommunication and mobile technologies have been recognized in the literature as prime factors that aid development [27, 28]. Every sector of the economy of developing countries has been positively impacted by ICT [29]. With regard to the impact of ICT on SKMS, the literature has revealed how the need to produce, organize, disseminate, and preserve scientific knowledge has resulted into the invention of different types of SKMS (e.g., [30]). These range from ICT advances in scientific knowledge content development like text editing application packages, formula creation application packages, data extraction and trapping (including environmental, marine, and geospatial) packages, and automation packages for scientific knowledge warehouses including laboratories, workshops, and libraries. The wide range of solutions ICT that can be used to deploy resulted to assumptions that developing countries

have to look for ways to diffuse and utilize ICT to drive their development goals [15, 31]. However, years of diffusion and use of ICT for diverse purposes and for scientific knowledge management by developing countries seem not to yield expected development outcomes. This is exemplified by the widening of development gap between developing and developed countries. The scenario has resulted into new debates on the actual factors that affect the extent to which ICT impacts the attainment of development goals set by developing countries.

For instance, one of the areas ICT is being diffused and used in developing countries is to support distribution and access to global scientific knowledge through internationalization [32]. Current realities, however, show that there is a wide gap between the scientific knowledge shared and accessed using ICT in developing countries and the actual amount of scientific knowledge produced around the globe. Nonetheless, developing countries have continued to endeavor to use ICT to manage their stock of scientific knowledge as a backdrop of the need to make them available to policy makers and development agents. Yet there is still a clamor on the unavailability of scientific knowledge produced in developing countries to stakeholders. So between 1990 and 2015, a deluge of literature emerged in diverse disciplines. These literature endeavor to explain the factors that determine the extent to which ICT can support access to global scientific knowledge among key stakeholder in developing countries and the factors that determine this [13, 30]. Issues regarding access to global scientific knowledge were therefore assumed to be determined by access to the Internet and the level of investments on computer hardware and software [29]. This results because in real-time and practice the Internet and computer have played vital role in supporting knowledge communication and transfer across the globe. So Internet penetration rate in developing countries, particularly in Africa, grew in an unprecedented rate. For instance, in Nigeria Internet penetration growth rate between 2000 and 2016 grew exponentially to 52% of the country's population. This spurred the use of computers and the Internet in universities and research institutes in the country. It resulted in a number of studies that debated availability of computers and the Internet and their effects on teaching, learning, and research in Nigeria [32, 33]. This trend was also replicated in other developing countries [34–36]. Stakeholders therefore started to evaluate universities in developing countries based on the extent to which they were able to use ICT to achieve acceptable standards of learning, teaching, and research [32].

As a result of this development, reports in the literature indicate that individuals, corporate organizations, intergovernmental organizations, and governments contributed to the growth of ICT investment in developing countries [37]. Despite attempts made by developing countries to diffuse and use ICTs as indicated by the number of computers available to individuals and organizations and Internet penetration growth rate, targeted development goals were still not reached. In reality, there are still persisting needs for mass education, discharge of healthcare services to rural areas, and dissemination of knowledge to support economic activities, particularly in rural areas, among other needs [38]. In places where development goals were reached, the time frame with which the goals were reached normally does not match with projected time frame. This scenario is more profound when it comes to

using ICT to support scientific knowledge management. A good example is the scenario in Nigeria where training on IR was organized for Nigerian universities by the National Universities Commission (NUC) in 2010. The plan was that the training will empower all Nigerian universities to deploy IR in no time. However, as of now, only 13 of the 143 university degree awarding institutions have deployed IR in Nigeria. Issues that concern the failure of developing countries to meet with projected time frame resulted into a deluge of studies. Most of the studies revealed that power supply, cost of ICT, and capacity to diffuse and use ICT by universities are the major factors that hinder ICT use for productive scientific knowledge management in developing countries. See, for instance, conclusions reached in studies done by [7, 8]. While the factors identified in existing studies are important to ongoing debates on ICT and development, issues relating to universities' internal capacity came to the fore in this study. Findings in the study provide new dimension and insights into how internal capacities of universities in Nigeria impacted IR innovation in the country. These issues are discussed in the next segment.

9.3 Scientific Knowledge Production Capacity, Knowledge Divide, and Development

The question on scientific knowledge production capacity of societies across the globe came to the fore as a result of the advent of the knowledge society. This is a backdrop of the way knowledge was construed in contemporary time. Knowledge denotes the end product of activity(ies) systematically carried out that lead(s) to the collection of valid and reliable data and inferences drawn after the data may have been appropriately analyzed and interpreted. Hence, it is believed that any society that has citizens that are able to coordinate activities that lead to knowledge creation across all the sectors of its economy and who do so actively is a knowledge society [39, 40]. So it follows that societies that are tagged knowledge societies are those that invest in facilities and activities that promote the creation of the knowledge required for taking vital decisions. This is considered important because knowledge is required to take decisions that touch contemporary societies' sociocultural, political, and economic lives. Given this new way of viewing what constitutes knowledge in contemporary societies, stakeholders started to construct indices with which societies can be categorized to those that are knowledge societies and those that are not.

The following criteria are among the popular criteria that were used to determine if a society is a knowledge society or not: information and communication technology (ICT) and connectivity, usable content, infrastructure and deliverability, and human intellectual capability. Attempts have therefore been made by developing countries to use these indices to access the extent to which they have become knowledge societies. For instance, [40] argued that in sub-Sahara Africa, it is only South Africa that can be said to meet to some extent the knowledge society criteria. Statistics that are available on the amount budgeted by governments of

most developing countries for research show a wide gap between expenditure on research in developed countries and developing countries. Apart from this, the level of information literacy of citizens in developed countries has also been adjudged to be higher than those of the developing countries. Information literacy has been defined as the ability of an individual to adequately recognize when she/he needs information, how to determine what constitute appropriate and adequate information, how to get the information, and how to appropriately use the information to create the knowledge she/he requires for the taking decisions in question [41]. Knowledge societies are believed to have citizens with high information literacy level, who as a result support their countries' knowledge creation agenda and productivity driven by informed decision making. It follows that for those countries that are characterized as knowledge societies, the aggregate of their citizens' information generation activities contributes to their sociocultural, political, and economic development. So institutional frameworks that support the integration of such countries' scientific knowledge generation infrastructure are not taken for granted. See, for instance, the declaration of the President of the United States of America on information literacy [42].

Given the realities in developing countries, their scientific knowledge production capacity can easily be adjudged to be poor [40]. In most cases, the percentages of national budgets devoted to research and development are too poor to trigger significant sociocultural, political, and economic outcomes [43]. Universities in developing countries are also poorly funded and have been accused to lack the knowledge generation infrastructure [44, 45] and the quantum of quality manpower required to drive large-scale research that is capable of producing relevant knowledge that is needed to aid development [44, 46]. Scholars from developing countries therefore prefer to be employed in developed countries where they can maximize their potentials due to the adequacy of existing research facilities [47]. Consequently, scientific knowledge production capacity of universities in developing countries is influenced by several factors. The factors may include availability of research-friendly environment, brain drain, personnel, funds, and access to the right quality and quantity of scientific research [40, 47]. These factors have been well managed in developed countries as exemplified by the quality and the enormous quantity of research they produce. Given this scenario, issue relating to knowledge divide therefore emerged as one of the problems developing countries encounter in their bid to use ICT, particularly the Internet, to support development. Primarily, knowledge divide was construed based on the quantity and quality of knowledge available to people through the Internet [48]. Before the advent of knowledge divide however, issues that have to do with digital divide dominated discussions held on how developing countries are short changed as a result of the role ICT plays in the achievement of global development goals [49]. The invention and proliferation of personal computers (PCs) ameliorated to some extent, the digital divide menace. Outcomes of programs put in place globally to combat digital divide, for instance, through the deployment of telecenters [28] and intergovernmental organizations' support for ICT acquisition and deployment [50] also contributed to the reduction, to some extent, of the digital divide menace. When the challenges of digital divide were

assumed to have been reduced to what was termed "manageable extent," new realities evolved. These realities indicate that eradicating digital divide alone may not solve the problems associated with using ICT to achieve development goals. It was therefore observed that content produced and distributed using ICT is equally important to the use of ICT to support development in developing countries. This resulted to stakeholders' interest on who produces and benefits from the scientific knowledge made available on the Internet [51].

This scenario led to new questions on how best to use ICT to drive development in developing countries. The term knowledge divide was therefore coined to describe the disparity in the quantity and quality of scientific knowledge produced by, and accessible to, developed countries when compared with those of developing countries. Many scholars have suggested that majority of the scientific knowledge available through the Internet are those produced in developed country contexts. See, for instance, [51]. The implication of this according to concerned scholars is that majority of the ideas made available to policy makers, development agents, and governments through ICT-based scientific knowledge outlets do not directly address the situations in developing countries. Some Nigerian scholars, for instance, have outlined the effects of knowledge divide on Nigeria's development programs, for example [7]. The fact that development agents, policy makers, intergovernmental organizations, global development stakeholders, and governments across the globe have come to terms with the notion that development programs implemented in developing countries must be driven by the knowledge generated there also brought to limelight the need to tackle knowledge divide [52]. This therefore led to the efforts made to develop research capacity of scholars in developing countries. Efforts made include those channeled toward increasing their participation in international conferences, workshops, and scholarly meetings where research capacity issues are discussed. For instance, in Nigeria, apart from university-based grants for research, conference attendance, and foreign travels, federal and state governments have programs that are targeted at supporting research, conference attendance, and foreign travels [53]. There are also a number of programs that have been developed to increase the number and quality of scholarly journals published in Nigeria and to ensure that they are included among those available online [54]. These programs also include plans to help scholarly journal publishers to effectively adopt ICT to drive every aspect of the cycle of scientific knowledge production and publishing [55]. It also includes call on journal publishers to serve as media for training emerging scholars [56].

Apart from this, global development initiatives put in place by United Nations practically focus on how to eradicate ignorance in developing countries. Hence, goals set revolved around improving literacy level, promoting education in rural areas and for girls and women, and advising governments on the percentage of national budge that should be dedicated to higher education and research [57]. The inclination to help developing countries to improve its knowledge creation and use capacity is visible in the Millennium Development Goals (MDGs) which has been reinvented to Sustainable Development Goals (SDGs) [58]. It is also visible in New Partnership for Africa Development (NEPAD) strategy to eradicate poverty, igno-

rance, and starvation in Africa through democratic governance and appropriate global partnership for development. In Nıgeria the Kuru Declaration and the national economic empowerment and development strategy of 2005 also paid strong attention on education and expenditure on research and development [59]. Given the role ICT plays in improving access to knowledge, the assumptions about its costs and the barriers associated with access to ICT-based scientific knowledge, the open access initiative was therefore invented to alleviate these barriers. Open access was assumed to be a new antidote for solving the challenges that hamper the free flow of ICT-based scientific knowledge required to support development programs. The role open access plays since its invention and the assumptions of its creators are discussed in the next segment.

9.4 Open Access, Its Challenges and Development

In order for the open access initiative to solve two major problems – cost and context-specific content issues – that affect the use of ICT in developing countries, it was designed to run on cheap technology and free and open source software. Although the open access initiative was invented in the West, the key focus of its inventors was to make developing countries safe from the menace of knowledge divide and to fight commercial publishers' dominant role in the production and distribution of scientific knowledge [60]. The problem of access to scientific knowledge, particularly those produced using public funds as a result of the business model put in place by commercial publishers, had become a global phenomenon. This is because it affects both developed and developing countries in different ways. The problems, however, had more effects on the development agenda of developing countries than it had on developed countries. Open access inventors that were based in the West therefore started to assume that if libraries, scholars, and organizations in developed countries struggle to meet the cost required to purchase and/or access available commercial publisher-based scientific knowledge, how much more would this affect developing countries. Hence, Steve Harnard's seminal work on IR and Antleman's successful use of open access outlet to justify the assumption that open access outlets promote access to scientific knowledge led to a global call for a paradigm shift in the global scientific knowledge management landscape [61]. Consequently, in developed countries stakeholders started to argue that the payment done to acquire scientific knowledge output that was produced using public funds constitutes dual payment and means exploitation used by commercial publishers.

Developing countries, however, developed their own arguments from the perspective of what should constitute globally acceptable scientific knowledge management practice. According to [62], global scientific knowledge require global use and assessment by stakeholders before it can be adjudged as global scientific knowledge value and validity. In other words, if scientific knowledge produced, for instance, in the West is not available for use in developing countries and in effect, for assessment, then such scientific knowledge may not be adjudged as having

global value and validity. This therefore means that while developed countries enjoyed the advantage of having the capacity to produce the vast majority of scientific knowledge available globally, the fact that the scientific knowledge they produce do not receive the required global peer use and assessment also constitutes a challenge that stakeholders should be mindful of [62].

Given these scenarios therefore, the Budapest Declaration on open access was signed by several countries that believe that the open access initiative has the potential to eradicate problems of scientific knowledge circulation across the globe. The Budapest Declaration formalized the call for free and equitable access to global scientific knowledge. The Declaration led to two major radical changes in the scientific knowledge management landscape. First, it led to the invention of open access journals. Second, it resulted into a new scientific knowledge publishing paradigm scholars referred to as self-archiving [61]. The open access journal was designed to have all the characteristics of the paper and online-based commercial publishers' closed access journals. In other words, open access journals could perform essential functions which have been exclusively reserved for commercial publishers' closed access journals. These functions include: registration of scientific knowledge output, processing (editing, designing, and printing) scientific knowledge output, disseminating scientific knowledge output, and preserving scientific knowledge output for posterity. Two major characteristics, however, distinguished open access journals from those of the commercial publishers' closed access journals. These are, namely, free and no access cost and availability of publications to users on the first day of its publication [60, 63]. In other words, open access journals promise to reduce to the bearest minimum, the time between when scientific knowledge is produced and the time it is made available to users.

The self-archiving paradigm allows scholars to post their scholarly knowledge products online. It is based on the use of websites owned by individuals or those owned by organizations, such as universities, that scholars have affiliation with [61, 64]. Hence, websites owned by individuals and organizations became platforms for self-archiving scientific knowledge output. The self-archiving paradigm over time evolved into the IR model in which universities, and later other research institutions, deploy IR-based platforms where they collect scientific knowledge output of their communities and make them available free of charge on the Internet. Given the nature of open access journals and IR, stakeholders assumed that they will speedily aid the eradication of knowledge divide. It was also conceived that open access journals and IR will make developing countries to have equal access to the global scientific knowledge output they need to support their development programs [8]. Disappointingly, the adoption of open access journals in developing countries has not been as dramatic as one would expect [8]. In fact, most open access journals are published by organizations and individuals in developed countries. This also meant that majority of the papers published in open access journals were authored by authors in developed country contexts and primarily on issues that concern developed countries; see, for instance, [65].

Many factors have been identified that slow the adoption of open access journals in developing countries. Primary among them is the cost of publication. The open

access journal initiative requires that authors should pay publication fees. The agreement is that open access journal publishers are expected to offset the cost of publishing from publication fees paid by authors so as to be able to make publications freely available to the public. Interestingly, open access journals are relatively cheaper to publish when compared to paper-based journals. However, its cost to authors, particularly those in developing country, is too expensive. Charges of most open access journals are done using currencies such as the US dollars, British pound sterling, and Eurozone euro whose values are far beyond currencies used in most developing countries. Apart from this, rigidity and poor institutional capacity have made the transition from closed access journals to open access journals very cumbersome in developing countries [6]. Acceptance of open access journals as appropriate outlet for disseminating scientific knowledge and to determine tenure and promotion of academics has been very slow in developing countries. Open access journals have been therefore criticized based on their free access philosophy, the speed of publication, and publication fee payment. It has been said that these features subvert the culture of quality scholarly knowledge publication associated within centuries.

This is also the case with IR penetration in developing countries. Going by practical experiences, stakeholders' assumption that universities in developing countries will see IR as a good opportunity to circulate the scientific knowledge output that are needed to support development has not been validated [3, 62]. Current statistics on the ownership of IR across the globe disappointingly show that developing countries still trail developed countries in the league of those countries whose universities have deployed IR to support access to scientific knowledge. In Nigeria 14 out of 125 universities are enlisted in the OpenDoar directory of existing IR. Currently, the extant literature has provided information leading to theoretical assumptions on the reasons why IR innovation has had poor performance in developing countries [7, 8, 10]. Central to existing theoretical assumptions is that IR barriers are university based. Hence, majority of the studies that have been done and ongoing studies focus on eliciting IR barriers that are connected to universities [6, 13, 11]. This has resulted in a situation in which the research subjects that are studied by IR scholars are mostly limited to librarians and academics and, on few occasions, university management, students, and IT personnel. Conceptual studies ranging from those written about a decade ago to those produced in recent time seem to limit IR phenomena to universities [2, 7, 9, 62]. There is no doubt that these studies have contributed immensely to ongoing debates on how to improve access to the scientific knowledge needed to support development in developing countries. However, the study reported in this chapter provides novel insights that IR barriers are not limited to those barriers inherent in universities. It proposes how to advance IR innovation outcomes in developing countries by reconstructing the institutional framework put in place to support the SKMS.

9.5 Reconstructing Institutional Framework for Scientific Knowledge Management Systems: Nigerian IR Innovation Case

9.5.1 Structure of Nigerian Scientific Knowledge Management Systems

In Nigeria, like in most other countries, universities play pivotal role in the production and distribution of scientific knowledge. Consequently in Nigeria, most universities lay strong emphasis on the need for creativity, research, and innovation [10]. Apart from universities, Nigeria has a long-standing culture of establishing and maintaining specialized research institutes. Disciplines of the humanities and languages, management and social sciences, and sciences and technology all have government-owned and government-funded research institutes. These research institutes are treated the same way universities are treated, except for the fact that they are not allowed to admit students and are not accredited by the NUC. Nigerian research institutes, however, have strong affinity with Nigerian universities. They work collaboratively together on research that are of national interest. Consequently, institutions that are part of the Nigerian scientific knowledge production and management system that are identified in this study include Nigerian universities, NUC and ANUV. Government-established funding agencies such as the Petroleum Trust Fund (PTF) and TETFund also constitute a significant part of the scientific knowledge management structure in Nigeria. TETFund initiates programs that it funds based on the mandate given to it by government. TETFund, however, funds projects only in federal- and state-owned universities. Private universities do not benefit from their programs. However, major outlets used to disseminate research output in Nigeria are journals, conference proceedings, textbooks, reports, reference materials, compendium, and electronic sources such as websites, portals, databases, and, in the recent time, blogs. Nigeria's scientific knowledge management systems get input from foreign journals, proceedings, textbooks, reports, references, etc. The system relies primarily on electronic sources to access the materials published offshore.

In the recent past, open access sources are being harnessed and form a crucial part of the Nigerian SKMS. A couple of open access journals are published in Nigeria, while most universities in the country are making frantic effort to innovate IR. Major players in the bid to ensure that Nigeria universities innovate IR are the universities, NUC, and Association of Nigerian Universities Vice-Chancellors. The Association of African Universities (AAU) also collaborates with the ANUV to train stakeholders on IR innovation as a way to support its Database for Africa's Theses and Dissertations (DATAD) project. The DATAD project was initiated to collect electronic theses dissertation, of all member universities across Africa. TETFund funds research, conference attendance and foreign travels, and journal publishing done by Nigerian universities and scholars [66]. In a nutshell, institutions

involved in the Nigerian SKMS deal in scientific knowledge production, dissemination, funding, and process coordination.

9.5.2 The Study, Study Site, and Study Investigation

The study aims to explain the barriers of IR innovation in universities in Nigeria as a way to provide other developing countries with explanations on IR innovation success factors. The study was done through empirical observation of IR innovation efforts made by three universities in Nigeria. The universities are made up of two privately owned universities and one publicly owned (federal government) university. The two privately owned universities are, however, at different stages of their IR innovation. While one has plans to present a proposal for IR innovation through its university library to its university management, the other one has no plans for IR innovation. The publicly owned university, however, has an IR that is listed in the OpenDoar directory of IR. Qualitative data was collected through the following methods: observation, analyzing texts and documents, and informal discussions held with a few staff of the universities. Two secondary data sources, official letters and internal memos, were triangulated with data got through observation and discussions. The data analysis technique that was used in the study is thematic data analysis [67, 68] using the Atlas.ti software. Themes regarding the barriers of institutional repository were identified and explained. Theoretical elaboration was done after research findings were presented as a means of building new theories of barriers of IR.

9.6 Findings and Discussing of Findings

9.6.1 Scientific Knowledge Production Capacity

The three universities studied are relatively young universities when compared to more established Nigerian universities. Hence, a good number of the academic staff of the universities are doctoral students in older federal- and state-owned Nigerian universities. This meant that the extent to which academics employed in the universities were involved in independent research is limited. This is mainly because of their commitment to their PhD research and indicates that the capacity of academics to carry out large-scale research in the universities is limited. Also, majority of students in the universities are undergraduate students. The universities have very few postgraduate students who are enrolled for master degrees. The demography of academics and students in the case universities hampers their scientific knowledge production capacity. For instance, one of the staff we discussed with during the observation commented that “if we deploy IR where are we going to get the

contents to deposit in it. Research activities here are not on top gear." During a discussion with another staff, he complained that the quality of undergraduate research is "not something we will want to put out there on the Internet...it could discredit our struggle for quality." There were also complains about inadequacy of facilities such as power supply, access to the Internet, and access to databases of recent publications in scientific journals. One academic staff in one of the universities commented that "...you saw our library, it is not even enough for hundred students talkless of accommodating staff." Another academic staff who recently returned from a postdoctoral research study abroad complained that "I have to buy my own data plans [mobile phone subscription based Internet access] to be able to use the Internet. This did not mean that I have access to required materials. No database here to access publications for my research." Given the situations observed in the case universities, it is logical to conclude that scientific knowledge production capacity of the three universities is very low. Based on our findings, scientific knowledge production capacity of the universities studied was hampered by year of establishment, demography of staff and students, access to the Internet, and Internet-based scholarly resources.

9.6.2 Digital and Knowledge Divide

The digital and knowledge divide menace seem to have shifted from unavailability of computers to lack of access to Internet technology. Observation shows that most academics in the three case universities have self-purchased laptops of different grades and models. Most of them also have self-purchased Internet data plans with which they access the Internet. However, through observation and discussions held during the course of the study, we gathered that academics have issues with Internet connectivity and speed and access to required scientific knowledge contents. One of the academics we discussed with complained that "I have a data plan [Internet access plan] that I purchased from ...[one of the mobile phone service providers] but it never works. You pay and end up having nothing." During a discussion with another academic staff, she complained that "I pay ₦ 1,500:00 [about $4:00] to my university for Internet access, for over three months now I have not had any access, yet they deduct the money for Internet every month." On another instance, one of the academics made a confession of how they manage the knowledge divide situation: "for us in the sciences, we call our friends abroad to send papers to us. Even if you go on the Internet you never get any meaningful thing." Through observation done in the three case university libraries on availability of Internet-based scientific knowledge resources, we were able to determine that availability of scientific knowledge through the Internet was poor. None of the university library had fee-based electronic databases for scientific publications. They only have access to free databases such as HINARI, AGORA, and OARE. Most Google Scholar searches done returned materials published in open access journals and other free access sources. Good as this is, it also shows a gap in the kind of scientific knowledge

academics that have access in the case universities. While it was possible for respondents to use their laptops and mobile phones to access the Internet, poor Internet connectivity and lack of relevant contents constituted the digital and knowledge divides that plagued the case universities, respectively.

9.6.3 Open Access Adoption Challenges

The level of awareness of open access initiative, particularly IR initiative, differs in the three case universities. In the two case private universities, although existed before the case public university, their open access awareness level was lower. While the public university has an IR that has been listed in the OpenDoar, the two private universities had no IR and have not yet made any formal plans on IR innovation by the time this study started. The situation in one of the private universities is profound; its university librarian claimed that he has heard about IR in the past but has no plan to initiate its innovation. In this particular university, only one of about 15 professional cadre library staff in the university library had a good knowledge of IR. This particular staff claimed that he worked with a private organization that deals with ICT solutions before he was employed in the university library. In the second private university library, IR awareness was high, but formal IR plans had not been made. Other pressing needs such as automation of library operations were given precedence over IR innovation.

The university librarian there indicated that "for now we can't talk about IR. What we urgently need is to have the university provide resources for our automation project." The publicly owned university that has innovated its IR, however, has daunting challenges. Because the IT unit of the university handled the IR innovation project before librarians were employed at the inception of the university, librarians refused to take over the IR project. One of the librarians there complained that "the IR project was the business of the library in the first place, why is it that it is now that they want us to inherit what we did not start." Consequently, we observed that the university's IR has not been well populated with enough publications despite the fact that it has been listed in the OpenDoar. It has also not enjoyed adequate publicity within the university, since this is one of the primary areas where librarians' services are required when it comes to IR projects. When the university librarian was asked about the university's IR project, he simply put: I don't know anything about it, go and ask the IT." The IT director complained that "the library has refused to take over the running of the IR. İt is really making it very difficult for us to progress." The internal crisis between IT and university library continues to constitute a barrier to IR use in the university. Given this revelations, internal organizational capacity seems to play very vital role in IR innovation. The fact that IT unit was given the mandate to carry out IR innovation instead of the university library constituted a barrier of IR innovation in the university.

9.6.4 Institutional Framework

The secondary data collected during the course of the study show that the NUC has organized a couple of training on IR for Nigerian universities. However, NUC invites only librarians and IT personnel to represent universities in these free training workshops. Through discussions with some staff member of the university library, it was gathered that NUC is of the opinions that the two major players in universities with regard to IR innovation are librarians and IT personnel. Consequently, academics are conspicuously omitted in workshops NUC organized on IR innovation techniques. Notions put forward by librarians indicate that this scenario may have resulted because NUC did not take its time to find out those that constitute primary IR innovation stakeholders in universities. The NUC also did not find out from universities about those they felt were primary stakeholders in IR innovation. This scenario contributes to the low level of IR awareness and acceptance among academics in the case universities. Although the ANUV encourage each member vice-chancellor to discuss, encourage and provide resources for IR innovation in their universities, a gesture that seems to be a primary way key institutions communicate with universities on IR innovation.

Findings from discussions held with some librarians revealed that the only place vice-chancellors discuss IR innovation is during the university management meeting. This is considered not enough because university management meetings are only opened to principal university administrators such as deputy vice-chancellors, registrars, bursars, and university librarians. Our observation shows that moves made by vice-chancellors to acquaint their universities with IR innovation end up at the top management level and are mainly based on flimsy discussions on required resources for IR innovation. In addition to this, an IR workshop jointly organized by ANUV and the AAU also adopted NUC's technique of inviting only librarians and IT personnel. Given that AAU liaised with ANUV, who constantly work hand in hand with the NUC to organize workshops, those invited were consequently limited to librarians and IT personnel. The AAU was definitely influenced by ANUV and NUC to adopt existing invitation and participation protocol. This also meant that stakeholders such as academics, students, researchers, etc., that are important to IR innovation were left out of discussion concerning IR innovation in Nigerian universities.

With regard to TETFund, memo sent to universities from TETFund and contents of legislative act that set up TETFund indicate that TETFund has been mandated by government to fund research proposals, attendance of international conferences, foreign travel for research, and journal publishing in Nigeria. TETFund was established as an intervention agency under the TETFund Act of 2011. As stated in its website (www.tetfund.gov.ng), TETFund mandate includes "the responsibility for managing, disbursing and monitoring the education tax to public tertiary institutions in Nigeria." Collaboration between TETFund, NUC, ANUV, and Nigerian universities has the potential to lead to policy regime which will facilitate a situation in which the scientific knowledge output of every research proposal funded

by TETFund would be compulsorily deposited in the author's university IR. This is also applicable to papers presented in conferences attended by Nigerian participants that were sponsored by TETFund. The presumed policy regime would have been instrumental in making journals published using fund interventions from TETFund open access journals. This development has the potential to help Nigerian universities to have more open access journals and in effect, more research papers deposited in their IR. Based on our observation, the major reason why TETFund has not initiated plans that have the potentials to aid IR innovation is because TETFund seems to be ignorant of its potential to support IR innovation in Nigeria. It primarily assumes that disbursing and keeping records of funds meant for tertiary institutions are all it is established to do. Collaboration between TETFund and other IR innovation stakeholders would have been instrumental in making TETFund to realize an equally important mandate. Hence, most journals published with funds from TETFund are largely paper based and are without any form of online presence. Those that have online presence rely primarily on the African Journal Online (AJOL) project. Access to their contents as a result remains largely low and further deepens the knowledge divide syndrome and the extent to which scientific knowledge produced in Nigeria are made available to the global scientific knowledge community.

9.7 Theoretical Elaboration of Study Findings

9.7.1 Theoretical Elaboration of Study Findings

In the library and information science (LIS) discipline where most of the studies done on IR innovation were carried out, factors identified to be crucial to IR innovation include awareness, availability, and accessibility [10]. These factors have also been used in the LIS discipline to assess other forms of online information resources. Awareness, availability, and accessibility of scientific knowledge, however, led to the evolution and proliferation of IR as a way of supporting the availability and accessibility of online information resources [8]. Since the turn of the twenty-first century, global development programs have been refocused to Africa and the development of other developing countries. The role scientific knowledge plays and the setback it access and use suffers because of digital and knowledge divide have been well underscored in the literature [48–50]. The dominant assumption for the development of developing countries is therefore summed up in the fact that global scientific knowledge should be made readily and time available and accessible to developing countries. This resulted into the transfer and diffusion of the Internet and mobile technologies in developing countries. The Internet has therefore been instrumental in making the open access initiative to spread to and within developing countries.

While cost of technology acquisition has been identified as major barrier factor [8], other factors such as organizational and institutional capacity to innovate Internet-based SKMS [14] and environmental factors – power supply, adequate infrastructure, dominant beliefs, etc. – have also been identified [7, 69]. In the ISDC field, Internet and environmental factors such as cost, capacity to innovate, power supply, dominant organizational beliefs, etc., were believed not to be the only dominant barrier factors. Barrier factors external to organizations, particularly institutional framework that can facilitate empowerment and collaboration of key institutions, have been underscored [15, 31]. The assumption that was generated as a result of this logic is that developing countries need institutional capacity that will facilitate the understanding of SKMS innovation requirements. This is to say that developing countries need to know how key institutions can collaborate in order for them to be able to put into check the intricacies of SKMS innovation [7]. The ISDC discipline has also proved that the evolution of both internal and external capacities required for SKMS innovation can be more meaningfully understood if assessed as a process and not as a state [15]. This therefore indicates that the development of both internal and external SKMS innovation capacities is progressional. This assumption therefore led to the following propositions derived based on the findings of this study and insights available in the extant literature: *SKMS innovation in developing countries should focus on understanding how to progress through internal capacity building to external capacity building in order to ensure institutional collaboration.* This proposition is explained in the next segment of using two models that emerged based on the study findings.

9.7.2 Emergent SKMS Innovation Model

The models derived through theoretical elaboration of the study findings is represented in Figs. 9.1 and 9.2. The models indicate the progression processes of IR innovation in developing contexts using examples from Nigeria. See, for instance, Fig. 9.1 below. Figure 9.1 shows two levels of IR innovation. The first level shows internal capacity level, and the second shows cross institutional collaboration level. In other words, the model points out that there are two levels in the building of IR innovation capacity. It further shows three possible progressions that can be adopted by stakeholders to move from internal capacity building (level one) to cross institutional collaboration (level two). Level one explains the ability of universities to manage their internal capabilities, that is, their scientific knowledge production capacity, digital and knowledge divide, and open access adoption challenges. These issues have been addressed in a variety of studies on organizational impact on IS innovation (e.g., [7, 8, 70]. Internal capability of an organization involves its ability to manage organizational and social structures, learning and knowledge management, and the impact ICT may have on the outcomes of activities put in place to manage these factors [70, 71].

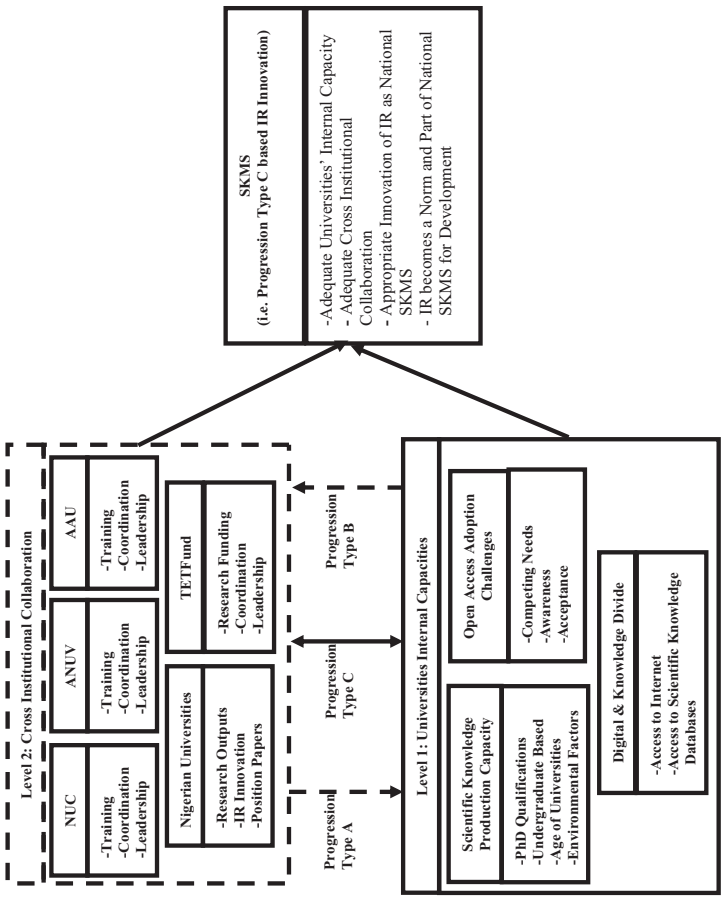

Fig. 9.1 Dynamics of SKMS (IR) innovation

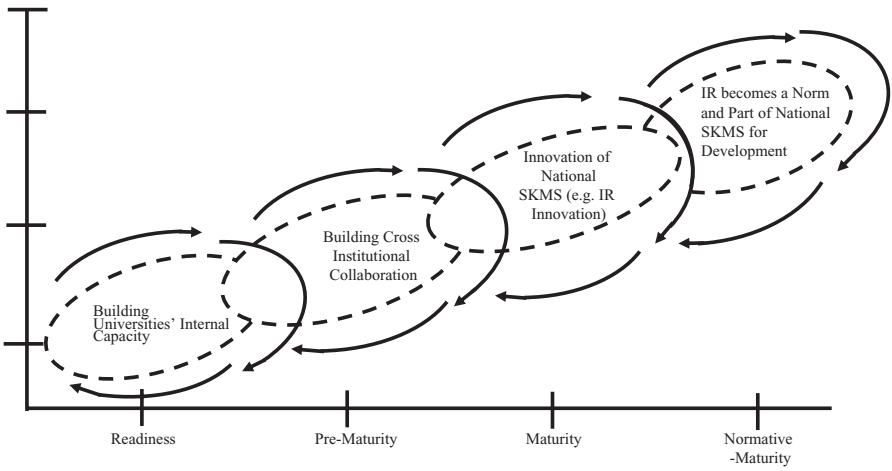

Fig. 9.2 SKMS innovation capacity level

Level two has to do with the ability of national SKMS to be able to identify key institutions and put in place programs that will facilitate their collaboration. This entails making key institutions to know and understand their immediate and extended roles in the successful innovation of SKMS, in the case of this study IR innovation. Although key institutions have constitutionally determined mandates, the model derived in this study indicates that such functions can be aligned with SKMS needs in order for the nation to be able to derive maximal benefits from these institutions. The example derived in this study is that TETFund should insist that every research that is funded by it must be deposited in the IR deployed by authors' universities and that the journals it funds should be open access journals. It is important to note that the progression is not sequential; in the sense that universities' internal capacities must be built before building collaboration capacity of key institutions. Our intention is to present a process that is interwoven and emergent. Given our intention therefore, practical experiences of each university and those of key institutions become the point through which actions to be taken must be determined. Room should also be given for the use of clues that may be derived through joint practical experiences of universities and/or identified key institutions. This therefore means that dialogue and frequent communication among universities and the key institutions must be ensured.

The model shows three major progression types experienced in Nigeria. The progression types were represented using arrows tagged as progression type a, progression type b, and progression type c. Progression type c is taken to be the ideal progression based on the findings of the study. This is because it represents a progression that is determined by communication and dialogue between university(ies) and key institution(s). The dual-pointed arrow indicates continuous communication and dialogue through which logics of IR innovation is shared. In the case of progression type a, the idea is that the institutions that provide(s) training, funds,

leadership, and coordination for IR innovation provide IR innovation logics that do not put into consideration needs that are necessitated by contextual issues in universities. A good example as revealed in the study is the ways those to attend sponsored training we determined. There are also indications that identified key institutions do not consider the role other institutions within the SKMS of Nigeria could play in facilitating the achievement of IR innovation goals. Hence, collaboration among them was absent. Our study shows that the NUC, ANUV, and AAU that have constantly organized IR innovation training have not considered that TETFund could be of help to the country's IR innovation aspirations. In practice, the NUC, ANUV, and TETFund have not come together to reflect on how the different roles they play could synergized to ensure IR innovation success in Nigeria. This results because progression type a is the dominant progression types adopted in Nigeria. The absence of collaboration among identified key institutions resulted in the broken border of the box that housed them in the model shown in Fig. 9.1.

Progression type b represents a scenario in which IR innovation logics are communicated to key institutions by university(ies). Considering the nature of key institutions identified and the study, the transfer of IR innovation logics from universities to key institutions are done through knowledge spillover. In other words, most of the information key institutions have on IR innovation experiences of universities are those that are brought to them by principal officers of universities, particularly by vice-chancellors. Given the extent of awareness and acceptance of IR among academics (who by academic culture produce vice-chancellors), it will be logical to say that information provided to key institutions by vice-chancellors may not represent typical experiences of IR innovation in universities. This denotes a likely weak transfer of IR innovation logics and experiences from universities to key institutions who are meant to coordinate, fund, and provide leadership to universities with regard to IR innovation. This is the reason why the arrow that indicates communication between university(ies) and key institution is represented by a broken arrow.

We consider progression type c as the ideal progression. Our assumption is that universities and key institutions must jointly develop a progression strategy that incorporates both internal capacity development and cross institutional collaboration. For instance, universities can through the NUC make TETFund to come up with a policy regime that will ensure that academics that received grants from them become adhere to open access requirements. Conversely, TETFund can also through the NUC advice universities to provide further awareness information to academics in order for them to know more about the open access initiative. This is likely to make academics to see policy regimes put in place, for instance, by TETFund, as policies meant to facilitate national SKMS efforts and not to frustrate their research efforts and to debar them from getting funds from TETFund. If this scenario is enshrined, each university is provided with opportunity to explain its IR innovation challenges to relevant institutions eradicate IR problems, reinvent loose ends intertwined in the IR innovation process, and support appropriate IR innovation plans. Progression type c facilitates a four-step progression subtypes, namely, readiness, prematurity, maturity, and normative progressions. This is represented in Fig. 9.2 below.

As shown Fig. 9.2 the readiness level has to do with the period a university builds its internal capacity and in effects its readiness to innovate IR. A university's readiness involves building its scientific knowledge production capacity, eradicating digital and knowledge divide and promoting its open access adoption plans through the length and breadth of the university. The university then progresses to building collaboration with key institutions such as, in the case of Nigeria, other Nigerian universities, NUC, ANUV, TETFund, and, if need be, AAU. During the progression period, IR innovation will start to take a strong stand within the university. From the prematurity level of both universities and key institutions progress to maturity level where IR innovation has come to be known as notable part of national SKMS. Issues regarding appointment, promotion and tenure, and acceptable publication outlets and practices in connection with IR innovation would have been ironed out. Identified institutions would have deregulation expanded mandate that will make them redefine their roles. This level progresses to the cultural level where IR innovation and use have become the norm, cultural, and taken for granted by universities and the institutions that support it. At this stage IR innovate has become a traditional part they indicates. Consequently, the progressions outlined are therefore taken to be social activities that could be socially constructed. It therefore follows that it will involve the identification, assessment, review, and building of norms, values, and socially negotiated acceptable ways of SKMS innovation.

9.8 Conclusion

The chapter reinforces argument on the fact that both internal factors inherent in organizations and institutional factors inherent in macro-contexts are important to IS innovation. This argument has been restated in this chapter with a sense of commitment to the validity of calls made by stakeholders on the importance of micro-contexts to successful IR innovation. While attention is paid on larger contexts, we note that the technology in question and the contexts of organizations, in our case universities, are very fundamental to how progressions can be made from readiness through prematurity level to the normative level. As shown in the study, each of the universities studied had different contextual challenges that influenced the extent to which their internal capabilities were built to be receptive to IR innovation. The nature of institutions that exist at the micro level also impacts on the ways they are able to initiate programs that are supportive of SKMS. Here national culture comes to bear. The ways organizations display the level of flexibility required to expand its mandate to support equally important missions that are capable of supporting societal development become an issue. TETFund, NUC, ANUV, and AAU are organizations that have strong affinity with government. They have therefore built their organizational logics based on orientations that are similar to those of public organization. Their creativity and ability to align their official mandates with other mandates that are not explicitly expressed in the books remain low. We therefore conclude that frequent communication and dialogue among universities and key

institutions that are part of national scientific knowledge structure are important to ensure that they do what is required to support SKMS innovation meaningfully.

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