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FOURTH INDUSTRIAL REVOLUTION (4IR) TECHNOLOGIES AS CATALYST FOR PARTNERSHIP AND COLLABORATION AMONG LIBRARIES IN NIGERIA: A REVIEW

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Abstract

This study is a review of fourth industrial revolution (4IR) technologies as catalyst for partnership and collaboration among libraries in Nigeria. The study reviewed relevant literature on issues bothering on concept of partnership and collaboration, concept of fourth industrial revolution (4IR), technologies associated with 4IR, 4IR technologies that can be used for partnership and collaboration in libraries, cloud computing applications that are useful for partnership and collaboration in libraries, importance of 4IR technologies to partnership and collaboration in libraries and challenges of using cloud computing technologies for partnership and collaboration in libraries. The study reviewed relevant literature on the topic of discussion and the researcher used Google search engine to access scholarly articles from open access databases that are relevant to the study which formed the basis for the literature that was reviewed and from where conclusions were drawn.

Keywords: Fourth Industrial Revolution (4IR), Partnership, Collaboration, Technologies, Libraries, Nigeria.

INTRODUCTION

In the 21st Century library environment, to overcome the difficulties presented by complex, dynamic, and changing information environments, building effective forms of partnership and collaboration has become crucial. There is no gain saying that, in this era of information explosion, it is expedient for universities seeking to enhance academic performance and research capacity to recognize the need for partnership and collaboration between their libraries and librarians (Dlamini, Mlambo & Masenya, 2021). With the rapid growth in the volume of information in circulation orchestrated by the convergence and proliferation of ICTs, it has become clearly impossible for libraries of any type, academic libraries in particular to acquire all the information resources both print and online that are necessary to satisfy the growing and dynamic needs of their users. To be able to satisfy the needs of 21st Century users, there is therefore need for partnership and collaboration among libraries, academic library especially.

In the ICT-driven era, it is necessary to adapt and make use of cutting-edge technology linked to the Fourth Industrial Revolution (4IR or Industry 4.0) in order to effectively share resources and collaborate on important profession-related tasks like research. Along with other professions, the information and library industry has also entered the era of the fourth industrial revolution (Industry 4.0) with the development based on 3 main pillars of digital, biological technology and physics. In particular, digital development is based on the core elements like Artificial Intelligence (AI), Internet of Things, (IoT) and Big Data (Big Data) that are directly related to the information and library section. This is believed to bring a huge change in the provision of information to users (Cao, 2019). Artificial intelligence has led to the Industrial Revolution 4.0, which has had an impact on a wide range of professions and sectors. Similarly, higher education is affected by this revolution which aims to improve humankind's educational standards and change society to provide better jobs. Industrial 4.0 is bringing positive changes to the higher education system from task-based characteristics to human-centered characteristics, and libraries and librarians can benefit from these positive changes by using industry 4.0-related technologies to improve their services through partnership, collaboration, and resource sharing (Hussain, 2019).

Librarians especially in academic libraries needs to adopt the use of computers and telecommunications and other sophisticated technologies associated with the 4th industrial revolution to facilitate partnership and collaboration that can lead to the exchange of ideas and

information resources that is required to satisfy the information needs of their user community. Since the information sources and resources that are located in different libraries all over the world have been packaged in digital formats as a result of the digital technologies, libraries and librarians can explore the availability of the technology to partner together and share online databases, electronic journals, online reference tools, web resources, electronic books etc.

CONCEPT OF PARTNERSHIP AND COLLABORATION

Typically, a partnership is a written agreement between two or more parties for the management, operation, and profit sharing of a firm (Kopp, 2022). However, Peterborough Public Library (2019) asserted that partnership in librarianship refers to a mutually beneficial collaboration between the Library and an external organization, individual, business, or community group. Contributions from partners help to provide and/or advertise events, activities, and programs to the public in ways that are advantageous to both parties. Unlike the mergers and acquisitions one encounters as a key growth strategy for corporations, where one company either merges or is acquired by another, libraries seek not to take each other over, but endeavor to create partnerships in an effort to either grow a part of their programs and services not currently available to their patrons or respond to a stalled economy where funding has either been depleted or dissipated. In several examples around the world, this initiative has led to the creation of the joint-use library, where one library type partners with another to provide enhanced and cooperative programs and services. Also, it has also led to alternate types of partnerships where libraries partner with other non-library entities to ensure their mission of service remains vital, even in challenging economic conditions (Massis, 2013).

Collaboration on the other hand is a contemporary phenomenon that has emerged as a long-term solution for sustaining the development of individuals and organizations. This mode of human relationship has been constructed to aggregate the knowledge, power and resources from people across organization boundaries to solve issues that cannot be accommodated individually. In spite of the important roles of collaboration, there has been, however, a lack of consensus and incoherence in defining the meaning of collaboration across the disciplines. Pham and Tanner's (2015) definition of collaboration is a combined working, learning, and sharing process that is focused primarily on the activities of teaching, learning, and studying among educational participants, in which knowledge can be activated and transferred. In the same vein, American

Association of School Librarians (AASL) (2018) asserted that collaboration means to "work effectively with others to broaden perspectives and work towards common goals" (p. 86). Also, the definition of collaboration from the Merriam-Webster Dictionary (2019) as cited by Kammer and Moreland (2020) stated that collaboration can indeed include cooperation, or any targeted effort to work jointly between institutions. It is worth noting that true collaboration often involves a greater partnership where the collaborators work towards shared or unique goals (Kammer & Moreland, 2020). In the field of library and information science, the word partnership and collaboration are often used interchangeably to denote resources sharing between two libraries or among a group of libraries.

The importance of collaboration between librarians and academics in enhancing the academic success of students and research capacity has been increasingly recognized especially in academic library such as university libraries. Due to the development of digital information, no one organization, body, or library is able to store all the information required by modern civilization. Additionally, libraries must and wish to give everyone complete access to information resources, including those with disabilities, those who reside in rural or isolated areas, and those who are less fortunate economically. Therefore, collaboration and partnership can result in shared resources, shared responsibilities, lower costs, and better results for cooperating libraries (Brown, 2005).

CONCEPT OF FOURTH INDUSTRIAL REVOLUTION (4IR)

Industry 4.0 otherwise referred to as 4IR is the origin of a new revolution. Iberdola (2021) posited that the 4IR is a mix of cutting-edge production methodologies and smart systems that work with people and organizations. The World Economic Forum's founder and executive chairman Klaus Schwab invented the term "4IR," which describes a world in which individuals use linked technology to facilitate and manage their lives as they move between online spaces and offline reality (Miller, 2015; Iberdola, 2021). The blending of the physical, digital, and biological worlds is referred to as the fourth industrial revolution. It combines technological developments in 3D printing, genetic engineering, quantum computing, the Internet of Things (IoT), robotics, and other fields (McGinnis, 2020). It is the driving force behind a variety of goods and services that are quickly turning into necessities for modern living. A voice-activated virtual assistant like Apple's Siri, personalized Netflix suggestions, and Facebook's capability to recognize your face and tag people in a friend's photo were not something that one could have envisioned in the 20th

century. With the help of the cutting-edge and sophisticated technology connected to the 4IR, all these are made possible in the twenty-first century.

The World Economic Forum's founder and executive chairman, Klaus Schwab, claimed that as we enter the fourth industrial revolution (4th IR) era, there are megatrend drivers within the physical, digital, and biological environment that disrupt current norms of human lifestyle, industrial production, and governmental policies. They also have a significant impact on society and individual inequality issues, as well as corporate landscape, government service efficiency, and mass advancement or reverse consequences in some countries (Ahmat & Hanipah, 2018). Hussain (2019) noted that in the 4IR era, people and machines are connecting to each other at enormous speed. Data is being collected and harnessed like never before. Artificial intelligence, Mobile computing, Machine learning and automation of every trade has become a need of the day. These alterations, in the opinion of many, are rare. Similar and less complex processes can be found in libraries, such as the usage of robots and RFID technology in some academic libraries. The books can be shared with users upon request, and the bibliographic record data can be downloaded from the storage. This kind of application is more recent for libraries and is regarded as the leading technology in the library sector. Such cutting-edge technology is seen as a component of recent industrial revolutions. It appears that industry 4.0 technology may be included to use such technology in the libraries to carry out normal tasks for its users (Hassain, 2019).

TECHNOLOGIES ASSOCIATED WITH 4IR

According to Omosekejimi, Ijiekhuamhen and Nweke (2022), industry 4.0, also known as the 4th Industrial Revolution, is the start of a new revolution marked by a fusion of cutting-edge production techniques and smart systems that integrate with organizations and people, as stated in the literature. Many have referred to the 4IR as a new industrial stage in which several emerging technologies are coming together to provide digital solutions. 4IR relies on the use of digital technologies to collect and analyze data in real time, providing useful data to the manufacturing system (Lee, Bagheri & Kao, 2015; Wang et al., 2016a as cited by by Omosekejimi, Ijiekhuamhen & Nweke, 2022). The technology architecture of the 4IR concept is extremely complex (Lee et al., 2015), which is one of the major concerns in this new industrial stage. As a result, the successful implementation of 4IR technologies is still a work in progress (Lee et al., 2015; Babiceanu & Seker, 2016; Dalenogare et al., 2018). The 4IR is accompanied by many

newly developed and sophisticated technology which can be adopted by any organization or profession and utilize to maximize output or services delivery. According to Iberdola as cited by Omosekejimi, Ijiekhuamhen and Nweke, (2022) some of the highly recognized technologies connected to Industry 4.0 include:

1. **Internet of Things (IoT):** The Internet of Things (IoT), which aims to connect the physical and digital worlds, has changed a wide range of industries. Hundreds of millions of gadgets are already connected, and more are becoming smart.

2. **Internet of Service (IoS):** Industry is rapidly "refining" products, processes, and services by linking them to build smart services. Internet-based services have enormous development potential for both providers and customers of IT services. For example, such services can lead to changes in product portfolios, the optimization of an industrial plant's operation via new knowledge platforms, and the virtualization of ICT infrastructures, all while taking IT security into account.

3. **Cobots:** Robotics is continuously developing and the Cobots, specially designed to interrelate physically with humans in collaborative environments are key to industry 4.0. Cobots are created to work with humans, not to take their place. Cobots, often known as people-focused robots, can make and improve the work that humans do. So that people can focus on other duties, the robot can carry out dirty, dangerous, dull, tedious, or repetitive tasks. They enhance output and spare workers from undertaking tiresome and hazardous duties, among other things.

4. **Augmented Reality (AR) and Virtual Reality (VR):** Augmented reality and virtual reality are technologies that combine the real world and the digital world using computer science, enrich the visual experience of both users and consumers by generating immersive experiences. A digitally enhanced or augmented version of the real world can be experienced by the user thanks to augmented reality (AR). VR, on the other hand, entirely replaces that real-world experience with a wholly synthetic one by removing the user from it. VR systems fully block out the outside world since it requires total immersion.

5. **Big data:** Big data technologies are software tools that can analyze, process, store, and extract data from very big and complicated data sets that are too difficult for typical management systems to handle. Since knowledge is power, the full-fledged 4IR will enable us to transform data into knowledge. Big data enables the handling and

understanding of enormous amounts of data for commercial reasons, which is especially important for developing corporate plans or making choices.

6. **3D and 4D printing:** Using a computer-generated design, 3D printing, sometimes referred to as additive manufacturing, is a technique for building three-dimensional objects layer by layer. A 3D item is produced by the additive method of 3D printing, which involves building up layers of material. A full thing is divided into thousands of minuscule slices using 3D printing, which then constructs the object slice by slice. These minute layers adhere to one another to create a solid item. Due to the extremely complicated nature of each layer, 3D printers are able to incorporate moving components like hinges and wheels into a single product. On the other side, 4D printing enables the shape-changing properties of 3D-printed things. This extra fourth dimension is referred to as "4D printing." Emerging 4D technology combines 3D printing methods with advanced software, engineering, and material science. Commercial 3D printers, like a Polyjet printer, are used in 4D printing. These printers require "smart" materials rather than regular ones as their input, like a shape memory polymer or hydro-gel. These intelligent materials can modify their shape according to their thermo-mechanical characteristics.

7. **Cloud Computing (CM):** Cloud computing is a comparatively new system logic that gives the user with a large amount of storage space. Businesses and individuals can use these tools by paying a small fee. The functionality of machine data will continue to be retained in the cloud storage system, allowing production systems to be more data-driven even as technology performance improves over time. Since there will be greater data exchange between sites for production-related activities during the industrial revolution, company limits can be reduced. Cloud computing is slowly becoming a consideration by many companies during the process of building their data systems. Although software has not historically been stored in the cloud, more and more apps are being created on the cloud (Xu, 2012).

Also, Deloitte (2015) as cited by Omosekejimi, Ijiekhuamhen and Nweke, (2022) asserted that the 4IR era is defined by technologies such as 3D printing, sensor technology, artificial intelligence, robots, drones, and nanotechnology. Deloitte, on the other hand, claims that many of these technologies are not new, claiming that many of them were invented 20 or 30 years ago. The author however reveals that the recent massive boost in computing power and the reduction in cost along with miniaturization. Tay, Lee, Hamid, and Ahmad (2018) while discussing the

types of technologies associated with the 4IR which the authors described as the characteristics of 4IR listed Cyber-Physical System (CPS), Internet of Things (IoT), Internet of Services (IoS), Big Data and Analytics, Augmented Reality, Autonomous Robots, Additive Manufacturing (3D Printing), Cloud Computing (CM) and Simulation. These technologies have been identified to be playing active roles in the 4IR era giving equal opportunity to different organizations to take advantage of and maximize output.

4IR TECHNOLOGIES THAT CAN BE USED FOR PARTNERSHIP AND COLLABORATION IN LIBRARIES

One of the technologies associated with the 4IR that is very useful for partnership and collaboration among academic libraries is the cloud computing technology. The Internet and centralized distant servers are used in the technology known as "cloud computing" to maintain data, software, and applications. In other terms, it is a computing model in which IT-enabled capabilities that are elastic and scalable are provided to external clients as a service through Internet technology. It was created as a blessing for libraries and is providing them with several chances to integrate their services with clouds (Swapna, Biradar, 2017). A shared pool of resources is made available by cloud computing, including networks, computer processing power, specialized business and user applications, and data storage space. Many businesses and organizations, like Google, Yahoo, Microsoft, and Amazon, among others, are drawn to it and use it for infrastructure solutions. It does not exclude libraries. Utility computing, grid computing, unified computing, web 2.0, service-oriented architecture, and other technologies are all used in cloud computing (Swapna, Biradar, 2017). Cloud computing refers to a network that is hosted in the cloud. It is a type of computing technology that makes it easier to share resources and services across the internet as opposed to having them on local servers, nodes, or individual devices. Because of its capability to provide a shared pool of resources, many libraries across the world are adopting and using the cloud computing technology to form partnership that can lead to collaboration and resource sharing.

According to The Scientific World (2021), cloud computing gives libraries and librarians a way to share distributed resources and services that are owned by many companies or locations. Because cloud computing technology can provide a large pool of resources without the limitation of physical storage, it has become a viable tool that has been adopted for partnership and

collaboration among libraries as participating libraries have their resources stored in the cloud and have their passwords shared to all participants. Today's library is adopting cloud computing technology to provide access to resources and services that it does not own in other to make available to their users new resources and innovative services. Swapna and Biradar (2017) asserted that cloud computing platform facilitates the discovery and sharing of scholarly content among libraries. It acts as collaborative platform to empower libraries for dynamic searching and also for single point search interface, maximizes the usage of all e-resources, customized search across selected sources reduces noise and highlights relevant content and tools to support the complete research lifecycle. For partnering and collaborating libraries, cloud computing technologies is fast becoming a collaborative platform for users and researchers to discover and share knowledge with peers, find and access millions of journal articles, patents and e-books, for the users tagging as well as sharing and discussing of these contents with their peers.

CLOUD COMPUTING APPLICATIONS THAT ARE USEFUL FOR PARTNERSHIP AND COLLABORATION IN LIBRARIES

Some of the organization that provides cloud computing application and their application that are useful for partnership and collaboration in libraries according to Dutt (2015) are:

✓ **OCLC's Webscale:** OCLC is perfectly using cloud computing for libraries and set an example for others. OCLC has been functioning as a cloud computing vendor because they provide cataloguing tools over the Internet and allow member institutions to draw on their centralized data store (Fox, 2009). OCLC has implemented the plan of library management systems i.e. worldshare management services (WMS). This service has many areas like acquisitions, analytics, resource sharing, cataloguing and license management components. It offers the entire library collection management in a cloud based application. The main purposes of webscale are that libraries can share their resources, data, and innovation with ease.

✓ **Ex-Libris Cloud:** Ex-Libris is a well-known American provider of library software. To automate library operations, it offers cloud-based solutions. Most of its products were created for locally implemented solutions, and only subsequently were they modified for hosting environments. According to their website, Ex-Libris technologies are being used by more than 5300 libraries in more than 80 countries to automate their library resources. It enables libraries to increase their productivity, cut operating expenses, and increase value by introducing new services. Through its Alma library-based system, it has altered the manner that traditional library

resource management is provided. In addition to providing significant cost savings overall, using a centralized cloud service and implementing software allows libraries to easily influence the community's cooperative efforts to deliver efficient services for their users (Sarit, 2011).

✓ **Duraspace's DuraCloud:** Duraspace provides open source repository solutions by undertaking turnkey projects for organizations and libraries to enable them to share scholarly literature using DSpace and Fedora Commons. It is particularly devoted to improve and sustain Fedora and DSpace. These open source repository solutions are very famous for IR solutions. Its new service DuraCloud provides digital preservation support services in the cloud, which is cost effective and simple for libraries. DuraCloud helps libraries to move content to the cloud and store it with different service providers to eliminate the risk of data loss. The cloud solutions offered include online backup, preservation and archives, media access, online sharing, and cloud broker.

✓ **OSS Labs:** OSS labs from India is using Amazon's elastic cloud computing platform owing to the various capabilities of Amazon such as high durability of data, ISO standards based strong information security and flexibility. It is expected that the OSS labs will be able to provide robust open based solutions to demanding customers (OSS Labs, 2014). OSS Labs offer hosting and maintenance services for Koha ILS and DSpace IR. OSS Labs use Amazon"s cloud services. Library operations have become very cost effective and the library staff needs not to worry about maintenance of software etc.

Goswami and Choudhury (2014) also highlited some 21st Century technological tools that can be used for partnership and collaborations in libraries to include:

✓ Wikis
✓ Social Media (Facebook, LIS Links etc.)
✓ RSS Feed
✓ Blog
✓ Instant Messaging
✓ Podcast
✓ Mashup
✓ Flicker
✓ Social Bookmarking

IMPORTANCE OF 4IR TECHNOLOGIES TO PARTNERSHIP AND COLLABORATION IN LIBRARIES

The importance of cloud computing technology (an important technology associated with the 4IR) to partnership and collaboration in libraries, academic libraries especially cannot be over emphasized. According to Kumar (2021), cloud computing makes collaboration for resources sharing between different libraries much easier. Libraries in the 21st Century should use the cloud computing network, platform and tools and functions to share their resources and services for the benefit of their various clients. With cloud computing technology, different location of library community can come together virtually and contribute in real time to a given project through shared storage. Some of the important use of cloud computing technology for the enhancement of library services that can help partnership and collaboration to thrive according to Dutt (2015) are:

1. **Allows for E-books Sharing among Partnering Libraries:** Cloud computing platform is now becoming popular for sharing e-books. With the ability to share electronic books among partnering libraries, users of these libraries can have access to electronic information resources that is not originally owned by their libraries.

2. **Allows for Union/Shared Catalogue/OPAC:** Partner libraries can share access to each other's individual collections on a single platform by using a cloud computing platform. Union catalog creation is made incredibly simple by cloud computing.

3. **Easy Document Download Service:** Users of partnering libraries can easily download any documents belonging to any of the library binded by the partnering agreement as long as they have the access and password to the network.

4. **Allows for Digital Preservation/Scanning Service:** Partnering libraries can avoid duplicating such time-consuming work by centralizing digitization and scanning tasks. Libraries that collaborate and partner together can also conserve their collections collectively in digital form as archives.

5. **Current Awareness Service is made Easy:** Providing current awareness service to all patrons of collaborating libraries will become easy with cloud computing. The application is often configured to deliver update of new resources uploaded by any of the partnering libraries simultaneously to all users almost at the same time. Therefore, all users of the partnering libraries can become aware of newly uploaded resources at the same time.

6. **Document Sharing is made Easy:** Document sharing among partnering libraries is made easy with cloud computing. This is because, no restrictions on the resources pulled together by partnering libraries.

7. **Information Literacy/Orientation:** User education programs, information literacy and library orientation programs can be conducted for users of partnering libraries on the cloud. The libraries in collaboration can keep the tutorials, videos, presentations and files on the cloud for users' consumption.

CHALLENGES OF USING CLOUD COMPUTING TECHNOLOGIES FOR PARTNERSHIP AND COLLABORATION IN LIBRARIES

Like every other technology, cloud computing also has some challenges that mitigate its usage for partnership and collaboration in libraries. Some of them according to Dutt (2015) are:

1. **Privacy and security of Data:** It is a very big concern that there could be risk about the privacy and security of users' data. If password are not effectively protected, sensitive information about the users or collaborating libraries can be accessed by others in cloud If the proper security model is not put in place, then the data stored on the cloud may be vulnerable to attacks from viruses, theft, etc. In addition, there is also the risk of data loss if there is system failure or improper backup.

2. **Network Connectivity and Bandwidth Issue:** It is also a big concern that this service is directly connected to Internet connectivity. If there is connection failure, then the users will not be able to access because the service as it is provided through Internet. Also more bandwidth is required, as it may not work on low-speed Internet connections.

3. **Providers Have Supreme Power Over Partnering Library's Resources:** The cloud computing services are provided by third party, the libraries using it have very little power to maintain or customize their services. It is very difficult to access the physical location of servers and the libraries have to depend on the service providers. Also libraries using the cloud computing are totally dependent on provider for backup, updates, restore and disaster recovery.

4. **High Subscription Cost:** Initially the cost of this service could be higher as there are some common services for partnering libraries. Also, cloud computing providers may increase the cost of their services in the future and partnering libraries may end up paying higher charges.

5. **Flexibility is Limited:** It has limited flexibility for users as cloud computing is provided by third party. So there is little scope for customization as per specific requirements of the users.

CONCLUSION

Cloud computing is an associated technology of the 4th Industrial Revolution that is a new phenomena in the library. This phenomenon is in developing stage and will be very helpful for the libraries for partnership and collaboration among other purposes, if libraries can adopt it for to the benefits of their users. Libraries in developed nations of the world are already using the cloud computing technology for sharing resources among cooperating libraries and the awareness about this technology is slowly spreading to developing nations of the world such as Nigeria. Thus, this technology will be of huge use to libraries for partnership and collaboration purpose if adopted. There is therefore no gain saying that cloud computing technology can provide libraries with opportunities to improve their services and relevance in today's information society if they can pull their resources together using this technology through partnership and collaboration. It can bring several benefits for libraries and portray their image in a positive light to their user community.

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