POTENTIALS OF FOURTH INDUSTRIAL REVOLUTIONS ON LIBRARIES AND INFORMATION SERVICE SECTORS: IMPLICATIONS, EXPECTATIONS AND CHALLENGES

Ogbonna ISAAC-NNADIMELE, PhD
Department of Library and Information Science,
Federal Polytechnic, Nekede, Owerri, Nigeria
oisaac-nnadimele@fpno.edu.ng; +2348033740087

Oyemike Victor BENSON, PhD
Department of Library and Information Science,
Federal Polytechnic, Nekede, Owerri, Nigeria
ovbenson@fpno.edu.ng, bensonoyemike@gmail.com; +2348037931417

Charlie Obichere, PhD
Chief Librarian, Research and Documentation Department,
Federal Polytechnic Library, Nekede, Owerri, Imo State
charlieobichere@gmail.com, +2348034091920

Abstract
The paper advocates for harnessing of the potentials of fourth industrial revolution (4IR) for the transformation of library and information centres. The various components of the fourth industrial revolutions that will drive library service delivery were identified. It examined the current situation in some African libraries, the implications of 4IR for African libraries such as loss of jobs, changes in information service delivery, revisiting of curricula used in African library and information science schools, demands for skill and competency, need for added value services. The various areas of needs for libraries to drive sustainable library practices in 4IR era were articulated, which include need for infrastructural development in libraries, creativity and innovative skills, collaborative initiatives, functional and reliable exchange programmes, viable digital policy and retraining of library and information science professionals.

Keywords
Fourth Industrial Revolution, Libraries, Information Centres

Introduction

Modern information and communication technologies are strongly influencing the routine activities of the library sectors. There is increase in the level of efficiency of service delivery in many sectors that have embraced the trends associated with fourth industrial revolution (4IR). Is this applicable to library and information services? Are librarians actually embracing these technologies towards the simplification of their daily tasks? The 4IR is part of the wind and movement that is redefining the paradigm shift in library and information science. It has driven libraries and librarians to the edge of having to re-evaluate where they are, what they need and how to get to where they should be.

Traditional library and information science practice is giving way to modern library and information science practice with the technological transformation acting as catalyst. Library service delivery is changing in every facet due to the penetration of technologies. Libraries and information centres can no longer be viewed as mere institutions or buildings housing books and other printed information documents. In the same vein, the fourth industrial revolution is greatly re-shaping the global economy. It is based on the fusion of a wide variety of technologies such as robotics, machine learning, data science, internet of things, cloud computing, augmented reality, additive manufacturing (3D printing) and cyber security (Asghar, Rextina, Ahmed & Tamimy, 2020). Fourth industrial revolution has important implications for library and information science profession and has open up the demand for specific skills acquisition. A critical analysis of the fourth industrial revolution within the landscape of librarianship shows that the effective deployment of technologies driving this revolution begins with a comprehensive analysis of the situation on ground and clear view of what is needed. Therefore, this paper is focused on the following specific objectives: present a review of historical development of industrial revolution, discuss the implications of fourth industrial revolution on libraries and service delivery, outline the expectations of librarians and libraries in the fourth industrial revolution era, identify the challenges associated with harnessing fourth industrial revolution and identify strategic keys to harnessing fourth industrial revolution.

Historical Development of the Industrial Revolutions

Historically, the Great Britain is acknowledged as the pioneer of the first industrial revolution where hand production methods started from 1720 to 1840. The first industrial revolution is considered as one of the important advancements in humanity, which started by using water and steam-powered mechanical manufacturing facilities since the end of 18th century (Liao *et al*, 2018).This era was characterized with the source of energy from water and steam technology that generated the mechanical manufacturing industry (Mahmood & Hussain, 2018). In this period, textile and steel were the dominant industries in terms of employment, value of output and capital investments. These technological changes have enabled the exploitation of natural resources and increase production capacity of goods (Dimitrieska, Stankovska & Efremova, 2018). The first industrial revolution changed our lives and economy from an agrarian and handicraft economy to one dominated by industry and machine manufacturing (Xu, David & Kim, 2018).

The second industrial revolution started in 1900 with the invention of the internal combusting engine. The second IR can be traced back early in 1850 -1914 (Hussain, 2019). This was the era of the discovery of electric energy that witnessed the extensive use of electricity in the industry (Mahmood & Hussain 2018).This period was also characterized by many new inventions, such as telephone, radio, telegraph, diesel and gasoline engines, electricity, internal combustion engine, x-rays without which the world today would be unthinkable (Dimitrieska, Stankovska & Efrenova, 2018).

However, the 20th century witnessed the third industrial revolution. Under this period, new technologies such as the internet and the renewable energies changed history (Hussain, 2019). This was the age of the production of digital and industry technology led to the use of computers and the internet. Here, digital technology also produces new technologies to replace old energy sources (Mahmood & Hussin, 2018); while the fourth industrial revolution (4th generation) started in the early 2000s. It involves computer-generated products, such as 3D printing technology, intelligent agents, biotechnologies and nano materials. The technology in 41R creates the future, and it should make things easier for people economically (Yusuf, Walters & Salin, 2020).This age is characterised with

the invasion of the 3rd IR by using super computer technology extensively. In this age, data and information are a major source of technological development by producing great technology (Mahmood & Hussin, 2018).

Fourth Industrial Revolution and its Components

The fourth industrial Revolution, or 4th IR, is the fourth major industrial era since the initial industrial revolution of the 18th century. The term was coined by Klaus Schwab, founder and Executive Chairman of the World Economic Forum to describe a world where individual move between digital domains and offline reality with the use of connected technology to enable and manage their lives. 4IR is known as industry 4.0 signifies the fourth in the series of industrial revolutions, which are characterized by their ability to transform economics, jobs and even society itself through the introduction of new technologies and processes (Deloitted Development, 2018).

The 4IRs is more than just technology-driven changed. Rather, it is powered with disruptive innovation to positively impact our core industries and sectors, such as education, health and business. The key components of 41R that libraries and librarians must be conversant with in the provision of library and information service are:

a. ***Internet of Things:*** The Internet of Things (IoT) refers to the use of information and communication technologies to connect people to a variety of objects (things), not just their computers or smart phones, but also other appliances. Internet of Things (IoT) is a concept that encompasses various objects and methods of communication to exchange information. Today, IoT is more of a descriptive term of a vision that everything should be connected to the internet. The Internet of Things (IoT) refers to the connectivity and association of electronic devices, vehicles (also called as "connected devices" and "smart devices"), structures, buildings, and other devices with electronics, software, sensors, actuators, and communication capabilities which equip the said items to send, transmit and process information (Dadios *et al*, 2018). The IoT are sensors, controllers, machines, people and things organized in a way to realize intelligent identification, location tracking, monitoring, and management. It integrates intelligent sensing, identification technology, wired network and mobile internet for smart communication (Nachandiya, Gambo, Joel & Davwar, 2018). Internet of things no doubt is an ideal emerging technology that influences the clienteles by providing innovative, evolving and efficient library services faster and more convenient.

According to Kogos (2018), Internet of Things is a relatively new concept and has varied definitions. Weber and Weber (2010) as cited in Kogos describe IoT as a world where physical objects are seamlessly integrated into the information network and where the physical objects can become active participants in business processes. In which case, in that environment, service are available to interact with these "smart objects" own the Internet, query their state any information associated with them, taking into accounts security and privacy issues.

b. ***Robotics****:* Robotics will change our lives in the near future. Technically, robots are automated motorized tools, that has the potential to improve the quality of lives at the workplace, it will create new jobs, improve the quality of existing jobs, and give people more time to focus on what they want to do. Customized robots will create new jobs in the library as well as improved the quality of existing jobs carried out in libraries. Robotics aims to replace human in tedious and hazardous tasks. Robots can be deployed in any situation and for any purpose. Robots can take many forms, but some are made to resemble a human's physique (Dadios *et al*, 2018).

c. ***Big Data:*** Big data is the term used to refer to any group of datasets so huge and composite that it is difficult to process the same using traditional data processing applications. Big data analytics is a set of procedures and technologies that entail new forms of integration to uncover large unknown values from large datasets that are various, complex, and of an immense scale (Kibe, Kwanya & Owano, 2018). According to Mutuku and Magutu (2018), the adoption and utilization of Big Data, by both private and public sectors, may contribute to more convenience and improved consumer based service delivery. They noted further that it seems that the adoption and utilization of big data is challenged by the technical limitations to handle the volume, variety and velocity of the data, lack of analytical skills, storage and transport issues; inadequacy in Big Data management, prohibitive financial costs for the purchase of new software and hardware, ethical concerns in the collection and management of big data; lack of appropriate legislation; reluctance by different agencies to share available data; and lack of appreciation of the value. Big data is the driving force for mass data storage, analysis, and processing. The value of big data is realized when an organization is able to leverage it to make decisions. Organizations need to turn big data into meaningful insights in order to benefit from it (Kibe, Kwanya & Owano, 2018).The library in the era of big data should promote the application of big data in the library in order to maintain the development of the library and with the rational thinking to strengthen the wisdom of library construction, to meet the opportunities and challenges bring about "big data", to create a new world.

The smart library service is the core value and significance of the library in the era of big data, which has rejected new vitality and strength into the development of the society which is the technical progress of library service. According to Ruan and Wang (2016), the library in the era of big data should promote the application of big data in the library in order to maintain the development of the library, and with rational thinking to strengthen the wisdom of library construction, to meet the opportunities and challenges bring about "big data", to create a new world.

d. ***Cloud Computing:*** Cloud computing is a well-designed platform that provides infrastructure, software, services for delivering on-demand computing services to everyone with connectivity to a network. It is a web technology that is used to provide services to its clientele through a virtual platform. Here, the user never gets to see the storage facilities or the complexities of the technology put in place for the provision of the services the user enjoys (Adamu, 2018).Cloud computing is defined differently by different scholars. Cloud computing is one of the emerging technologies that can be utilized in teaching, learning as well as service delivery in both public and private sectors. Kibe (2017) outlined the benefits of cloud-based services in public organization to include:

- Cloud-based services save on transmission time of the records, hence, expedites the decision making process in the public institutions;
- The services also increase efficiency and effectiveness in service delivery as technology is highly used in capturing, managing and processing of records as compared to a case where systems are running manually;
- Cloud-based services offer public organization vast storage space. This benefit enables the organizations to save on the physical storage space, which is getting expensive in most contexts, and to maximize the use of available space;

- Cloud-based services also facilitate the realization of multi user access to records thereby enabling ready access to records and real-time collaboration in decision making and task performance. More so, the records can be accessed outside traditional office environment.
- Cloud-based services help preserve records in digital format, hence, increase their longevity by reducing wear and tear.
- They lower operational costs by eliminating the cost associated with buying hardware and software. This is because for instance, if the organization needs to buy a server to store its digital records, this associated cost can be avoided by storing the records online using Google drive;
- Cloud-based services also enhance integrity of records compared to physical records which can be lost, amended or mutilated easily digital records stored in the clouds will stay usually for longer period.

According to Adamu (2018), some of the advantage of cloud computing to libraries include cost saving, flexibility and innovation, user centric, openness, transparency, interoperability, availability anytime anywhere, connect ad converse, create and collaborate. Cloud computing is the emerging trends of handling and supporting information services that takes advantage of numerous open source applications, modules and components. It creates a platform for the globalization of information services, unlimited access to information and communication services, and mass provision of information services (Adamu, 2018).

Cloud computing was built on, existing technologies as like grid computing, high performance computing, parallel computing, distributed computing, powerful integrated computing, only the use of open, integrated, collaborative information architecture and dynamically configurable resources, high scalability, ordered services that can provide communication in a smart campus setting (Kumar, 2017 and Wang, 2017 as cited in Nachandiya *et al*, 2018). Cloud computing as a new model of computing that has brought a paradigm shift in education. This term cloud computing technology as noted by Nachandiya *et al* (2018) attracts the interests of academics and industrial experts. It is a model for enabling ubiquitous convenient, on-demand network access to a shared pool of configurable computing resources (e.g. networks, services, storage, applications, and services) that can be rapidly, provisioned and released with minimal management effort of service provider. Cloud computing improves the service efficiency and visibility of library's collection and management services (Nag & Nikam, 2016).

e. ***Artificial Intelligence:*** Artificial intelligence is a comprehensive discipline developed by computer science, control science, information science, cognitive science, neuroscience, neurophysiology, psychology, linguistics, brain science and other disciplines. Its essence is to study the production of intelligent machines of intelligent systems, simulate human intelligence activities, and extend the science of human intelligence (Yu *et al*, 2019). Although, there is no universally accepted definition of AI it remains the driving force behind the 41R. Artificial intelligence according to Mahomed(2018) offers librarians opportunity to provide services efficiently. AI can prevent 'human error' from occurring in library practices.Artificial intelligence describes the work processes of machines that would require intelligence if performed by humans. The term "artificial intelligence" thus means "investigating intelligent problem - solving behaviour and creating intelligent computer system".

Artificial intelligence covers almost all of the business activities of the smart library. The application of artificial intelligence technology laid the technical foundation for the establishment of a smart library. Applying more applicable artificial intelligence technology to the transformation

and upgrading of smart library can make smart library truly develop into smart library and realize the precision, personalization and initiative of smart library services (Yu *et al*, 2019).

No doubt, artificial intelligence and automation process are changing agents in fourth industrial revolution which will make certain employees redundant and will replace them with new workers with the needed skills (Hussain, 2019) or with machines that do the job cheaper. AI is a device that perceives its environment and takes actions that maximize its chance of successfully achieving its goals.A1 are not restricted only to informing decisions, but also to making them (Dallah, 2019). A1 is usually associated with high-tech robotics automation and science fiction and can seem daunting to some (Mahomed, 2018).

f. ***Radio-frequency identification (RFID***): RFID can be used in library circulation operations and theft detection systems RFID-based systems moved beyond security to become tracking systems that combine security with more efficient tracking of material throughout the library, including easier and faster charge and discharge, inventorying, and materials handling (Khuntia, Mishra & Ramesh, 2016).This technology helps librarians, to reduce valuable staff time spent scanning barcodes while charging and discharging items. RFID is a combination of radio-frequency-based technology and microchips technology the information contained on microchips in the tags affixed to library materials is read by using radio frequency technology, regardless of item orientation or alignment properly.

RFID has the ability to store data and is one type of contactless technology that provides several benefits to support smart campus including visitor authentication, record the attendance of lecturers, and students, record the movement of people and objects and speed up evaluation when disaster strikes room security, electrical equipment automation, recording catalog information, as well as support for self-service lending service (Muhamad et al 2017).

Peculiarities of Fourth Industrial Revolution

The 41R represents a fundamental and paradigm shift in the way library services are designed, executed and carried out. What characterises the fourth industrial revolution is the underlying digital logics that changes everything (Peters, 2017). 4IR does not only bring along disruptive changes in technology and information processing, but also revolutionizes the daily work of employees on all hierarchical levels (Mdluli & Makhupe, 2017). According to Hussain (2019), social media, smart phones, digital cameras, sensors are creating more information than ever before. The flow of information is increasing in alarming rate. The fourth industrial revolution is affecting us whether we know it or not, people and machine are connecting to each other at enormous speed.

The fourth industrial revolution is characterized by a fusion of technologies that is "blurring the lines between the physical, digital and biological spheres (Schwab, 2016 in Manda & Dhaou, 2019). The fourth industrial revolution is differentiated by the speed of technological breakthroughs, the pervasiveness of scope and the tremendous impact of new systems (Dimitrieska, Stankovska & Efremova, 2018).This latest revolution is shaped by digitization and information technology (Man & Man 2019). 4IR is characterised by a fusion of technologies that is obscuring the barriers between the physical, digital, and biological spheres, industrial revolutions that brought historical economic transformation over the centuries are described as disruptive. The evolution of global industries within fourth industrial revolution is both exciting and scary. Life will change with the 3D printing, the IoT, and the fusion of technologies. (Uzochukwu, Alloysius & Olohi, 2019).

The 4IR can be recognized as the advancement from simple digitization to innovation based on combinations of technologies enabling companies to innovate their business models, including manufacturing and service engineering (Lee *et al,* 2018). Although the 4IR as put forward by Savic (2017) is building upon the 3IR, the difference, and its main contribution, is the fusion of technologies that is blurring the lines between the physical, digital, and biological worlds.The core of this revolution is the creation of new knowledge and values based on connections to various types of information (Yoon, 2017). The fourth industrial revolution is considered to be the outcome of the convergence of a number of technologies in industrial operations. According to Frederick (2016), the 4IR has a new quality that makes it different from the three which preceded it.

One of the major defining characteristics of the 4IR is connectivity. There is an upsurge in the number of devices that will connect to the internet. The 4IR is characterised by: widespread and broadly accessible internet; smaller, cheaper and more powerful sensors; artificial intelligence, and machine learning. The drivers of the change are physical (autonomous vehicles, 3D printing, advanced robots, new materials), digital (internet of things, relationship between things, and people connected by technologies and platforms), and biological (genetic sequencing and genetic engineering, synthetic biology and biological editing (Kuruczleki *et al,* 2016).

Implications of Fourth Industrial Revolutions on Libraries

The changes emanating from 4IR are being received by governments with mixed reactions, as they can contribute to reduction in employment as labour force is overtaken by digital machines. The 4IR will fundamentally change the way we live our everyday life. The greater benefit of 4IR as highlighted by Lee *et al* (2018), is that it has the capacity to enhance the quality of life, letting people work less and better, and have their wants and needs better met by more efficient and productive production systems and digital platforms. Dempsey & Malpas (2018) as cited in Ocholla and Ocholla (2019)asserted that "libraries are transitioning from a collection-based model to a more broadly services-based model. They further note that the library's role is to support their users creative activity in more diffuse ways - as a partner and an advocate"

According to Savic (2017), the prediction is that the impact of the 4IR will be felt by all parts of society and through all of its activities and it will not be a small tremor. Every single activity and every industry will be affected in some way. He noted the three main activities that will be impacted as the way we manufacture products; the way we manage processes and companies; and the way we run our personal lives. This prediction is now becoming a reality. Specifically, the implications of 4IRs are as follows:

- ***Loss of job***: Most librarians are scared of losing their jobs if libraries decides to align fully with the fourth industrial revolution mantra. judging from the pace at which 4IR is overtaking labour force, robots and computers have the potential to eliminate several jobs in office and administration which is a distress to many public workers who fall in this category (Hofisi & Shava, 2017).
- ***Changes in information service delivery:*** the digital divide which is associated with 4IR may affect the pattern of information service delivery in libraries.
- ***Revisiting of the curricula used in Library and Information Science schools:*** the new skills and competences required in operating in libraries can be developed fully when librarians and library educators choose to revisit the curricula used in library schools.
- ***Automation of library operations versus job replacement:*** The 4IR comes with may fears and worries. The actions are not new in any forms, rather they are common attributes that goes with

the various revolutions. When percentage of library routines are fully automated, how does this affect the job status of librarians, is there any hope of sustainability?

- ***Demand for skills and competency***: disruptive technologies are influencing the demand for skills and capabilities in may occupations, therefore library and information professionals must possess the requisite digital skills necessary for navigating the fourth industrial revolution era. Harnessing the 4IR environment for effective library service delivery will lead to the demand for highly skilled workers.

- ***Added value services (AVS):*** librarians can intercept the available technologies and deploy them towards the provision of value added services, in other words, with full integrations of technologies to the provision of library and information science services, library and information professionals will be able to offer value added services to library users.

- ***Creation of new products and services:*** 4IR is bringing about new products and services in libraries. Today, we hear of "*Maker Space*" in libraries, online information service delivery etc.

Expectation of Librarians/Libraries in the Fourth Industrial Revolution Age

Libraries have to develop resources, enable access, and eliminate inequality. This to requires investment in people, technology innovation/creativity, spaces, capacity building/empowerment of staff and users and access and use of resources (Ocholla & Ocholla, 2019). Lee *et al* (2018) contend that institutions need to acknowledge that successful organizations of the fourth industrial revolution will be those that recognize the centrality of people in the organizational life and that the most human-based distinguishing factors will increase their importance as key value drivers affecting the creation and delivery of value.

Librarians should take proactive measures in ensuring that they acquire new skills. Balalle and Balalle (2018) affirmed that the requirement of skills, for instance, technological, social and emotional skills are in demand as well as physical and manual skills, will drop at the modern workplace**.** To live, work and exist consistently and successfully in the digital environment requires one to acquire digital skills. According to Jabur (2019, for libraries to extend their plans beyond digitizing their resources and services, they have to consider that all their daily routines/duties require digital skills, including basic information skills to distinguish between trusted and noisy or fake information, and guiding skills to literate users to become able digital citizens. As pointed out by Ocholla and Ocholla (2019), essentially, complex problem solving skills, critical thinking, and creativity/innovation will be critical, but life-long learning/ self-learning and continuing professional development (CPD) is fundamental.

Challenges of Harnessing the Potentials of Fourth Industrial Revolutions and the Way Forward

Although, there are many benefits of the fourth industrial revolution, there are several key challenges that lie ahead. Apparently, 4IR poses serious concerns as it was with other industrial revolutions that proceeded. The various technologies driving the 4IR era are creating challenges as well as opportunities. There are several challenges associated with harnessing 4IR for effective library services delivery.

- ***Fear of Job losses:*** Artificial intelligence and robotics are rapidly increasing the jobs that machines can perform better and faster than people. As noted by Hofisi & Shava (2017), emerging and developing economics are scared to embrace the much popularised 4IR due to the high rate of perceived job losses associated with the concept.

- ***Lack of funds for IT infrastructure:***No doubt, the backbone of the industrial revolution era is nothing other technological devices, however, low level of funds available for the management of libraries is an obstacle to alignment with the 4IR era
- ***Leadership:*** Most leaders resist change, especially, when they are ill-prepared for such changes. The leadership in the 4IR is that as the future speeds toward us with greater velocity, more complexity, and greater uncertainty, we can choose in how we respond to these challenges or become extinct (Mdluli & Makhupe, 2017). As aptly noted by Mdluli and Makhupe (2017), there has been a paradigm shift in leadership over the years and there is a need of new leadership competencies to mesh with the times. They argued further, that we need to grow and develop a new set of leaders, those who operate from their souls, rather than their egos. This is usually a common phenomenon associated with paradigm shift in any profession.
- ***Lack of awareness of cloud computing capabilities:*** Management, staff and students are unaware of full cloud computing service capabilities. This to Chumba (2017) has led to the underutilization of available cloud computing models and services
- ***Inadequate ICT skills:*** most librarians do not possess the requisite ICT skills and technical know-how to exploit cloud computing capabilities such as Google service, Yahoo products, YouTube and even cloud-based social media platforms (Chumba, 2017)
- ***Poor ICT infrastructure and poor internet connectivity:*** Most libraries do not have adequate number of computers and allied technologies for both library staff and patrons. Worth noting is that not all the computers available are functional, also, not all the computers, functioning are fully connected to the internet. Most disheartening part is that the internet connectivity in most libraries remains very slow and hardly yields the desired optimal result.
- ***Privacy and unauthorized access:*** The fundamental truth remains that records saved in the public cloud can be accessed by unauthorized persons, in other words, such records remain vulnerable to malicious manipulation.

The way forward for library and information professionals in the fourth industrial revolution era is hereby presented as follows:

- ***Intensive provision of infrastructural development in libraries:*** Library and information professionals in collaboration with other stakeholders must ensure that infrastructural resources are adequately provided for libraries. Yoon (2017) posit that "if we focus on leveraging the information we have and do not pay sufficient attention to building a basic infrastructure, we will be unable to make the fourth industrial revolution a reality. As noted by Nkosi *et al* (2020), buildings, classrooms, laboratories, and equipments of education are the most significant components of educational infrastructure in universities. If this assertion is anything to go by, then the place of infrastructure in libraries in preparation for the 4IR is non-negotiable.Manda & Dhaou (2019) citing Lom, Pribly & Svitek (2016) pointed out that technology is one of the critical drivers of the 4th industrial revolution. In which case, technologies, such as cloud computing, the internet things (development of smart products), the internet of services (smart mobility and smart logistics) and internet of energy (efficient use of natural resource) have assumed an important role.
- ***Need for creativity and innovation*****:** Creativity is becoming key focus area for employers looking for the 21st century employee (Grzybowka & Lupicka, 2017). According to Schiuma (2017), today's digital era challenges organizations not only to follow the technological trajectories, by developing new technological solutions and/or adopting the latest disruptive technology, but most importantly to become creative and resilient organic

systems that are open to changes and keen to innovate continuously. According to Manda and Dhaou (2019), the 4IR will demand the production of innovative products, business models and production techniques driven by technology.

- ***Need for collaborative initiatives:*** Librarians should engage in meaningful collaborative initiatives that have the capacity to transform the library sector.According to Manda and Dhaou (2019), collaboration is critical during transformation or change. They noted further that collaboration between the various actors in the 4IR is critical in ensuring the success of the 4IR which will not only disrupt business but government and society.
- ***Need for strong leadership*****:** Libraries cannot align successfully with the trends and demands of the 4IR in the absence of strong and positive leadership. In the views of Manda & Dhaou (2019), the success of the 4IR will depend on leadership from all sectors working together to leverage the opportunities and addresses the challenges of the 4IR.
- ***Need for training in libraries*****:** retraining and skills development among librarians are the sure way to effectively harness the potentials of 4IR. Librarians need to organize specialized skill training that will empower librarians to cope with the demands of the new age.Demand for highly skilled labour is projected to increase, hence, the need to focus on developing the "future skills', some of which don't exist (Manda & Dhaou, 2019).
- ***Need formulation of strong and well-articulated policies***: The successful adoption of new and emerging technologies brought by the 4th industrial revolution requires the implementation policies and other mechanisms that are responsive to the challenges and opportunities brought by digital transformation (Manda & Dhaou, 2019).41Rs calls for a way of formulating policy and regulations.

Conclusion

Technologies remain core to the provision of library and information services in the new age known as fourth industrial revolution era. There is need to harness the potentials of 4IR for the transformation of library and information centres in Africa. No doubt, 4IR is linked with implications like loss of job, changes in approach to information services, automation of library operations, demand for skills and competency and creation of new products and services. The challenges that needed to be addressed to effectively harness the potentials of 4IRS include lack of skill and courage, resistance to change, job loss, lack of funds. Conclusively, to maximally harness the potentials of 4IR, there is need to develop innovative capacity, formulation of policy and training and retaining of library and information science professionals, among others.

REFERENCES

Adamu, H. (2018). *Perception of librarians towards the use of cloud computing technologies in Nigerian university libraries.* In: Kwanya, T., Kiplang'at, J., Wamukoya, J. & Niraine, D. (Eds.) *Digital technologies for information and knowledge management*. Nairobi: the Technical University of Kenya

Adendorff, C., Lutshaba, U. & Shelver, A. (2018). Policy implications of the 4th industrial revolution for the cultural and creative economy, Research Work Submitted to the Department of Arts and Culture, Rhodes University.

Adeniran, A. O. (2016). Impacts of the fourth industrial revolution on transportation in the developing nations. *International Educational Scientific Research Journal*, 2 (11), 56 - 60.

Ahn, I. & Noh, Y. (2018). A Study and survey of the perception towards makerspaces of the public library. *International Journal of Knowledge Content Development & Technology,* 8 (2), 5 - 22.

Antoniuk, L., Gemego, L. Dyba, V. & Polishchuk, Y. (2017). Barriers and opportunities for hi-tech innovative small and medium enterprises development in the 4th industrial revolution era. *Problems and Perspectives in Management,* 15 (4), 100 - 113 http://dx.doi.org/10.21511/ppm.15(4).2017.09.

Aramide, K. A., Lawal, W. O. & Odunlade, R. O. (2018). Information needs and library service delivery for students with visual impairment in Oyo state, Nigeria. *IASL Conference Proceedings*

Asghar, S., Rextina, G., Ahmed, T. & Tamimy, M. I. (2020). The fourth industrial revolution in the developing nations: challenges and road map. https://www.southcentre.int/wp-content/uploads/2020/02/RP102_The-Fourth-Industrial-Revolution-in-the-Developing-Nations-Challenges-and-Road-Map_EN-1.pdf

Balalle, H. & Balalle, R. (2018). Fourth industrial revolution and future of workforce. *International Journal of Advance Research, Ideas and Innovation in Technology,* 4 (5), 151 -153.

Benson, O. V., Igbokwe, J. C. & Onyam, I. D. (2020). Towards repositioning libraries and information centres for the fourth industrial revolution era. Papers presented during Nigerian Library Association, Anambra State Chapter 2020 Conference and Annual General Meeting held at Prof. Kenneth Dike State Central E-library, Awka, Anambra State, 1-3, 2020.

Bloem, J., vanDoorn, M. Duivestein, S., Excoffier, D., Maas, R. & Ommeren, E. (2015?). The fourth industrial revolution: things to tighten the link between IT and OT VINT Research Report No. 3 of 4

Chaputula, A. H. & Mapulanga, P. M. (2016). Provision of library services to people with disabilities in Malawi. *SA Jnl. Libraries and Information Science,* 82 (2), 1-10. http://sajlis.journals.ac.za. Doi: 10.7553/82-2-1619

Chumba, H. (2017). Adoption of cloud computing at the technical university of Kenya: opportunities and challenges In: Kwanya, T., Kiplangat, J. & Wamukoya, J. (eds.). *Emerging trends in information and knowledge management.* Kenya: Moi University Press

Dadios, E.P.*et al* (2018). Preparing the Philippines for the fourth industrial revolution: a scoping study. Discussion Paper Series No. 2018 -11.

Deloitted Development (2018). The fourth industrial revolution is here are you ready? Available online at: https://www2.deloitte.com/content/dam/Deloitte/tr/Documents/manufacturing/Industry4-0_Are-you-ready_Report.pdf

Dimitrieska, S., Stankovska, A. & Efremova, T. (2018). The fourth industrial revolution - advantages and disadvantages. *Economics and Management,* 15 (2), 182 - 187.

Ezeabasili, A. C. & Umeji, C. E. (2019). Inclusive library services: an imperative for academic libraries in Nigeria. *Library Research Journal. 3(1), 73 - 78https://journals.unizik.edu.ng/index.php/lrj/article/view/54/54*

Frederick, D. E. (2016). Libraries, data and the fourth industrial revolution (Data Deluge column). *Library Hi Tech New,* 33 (5), 9 – 12. https://doi.org/10.1108/LATN.05-2016.0025

Grzybowska, K. & Lupicka, A. (2017). Key competencies for industry 4.0. *Economics & Management Innovations,* 1 (1), 250 - 253

Hill, H. (2013). Disability and accessibility in the library and information science literature: a content analysis. FLMS Publications. 126. https:// ir.lib.uwo.ca/fimspub/126

Hofisi, C. & Shava, E. (2017). Challenges and opportunities for public administration in the fourth industrial revolution. *African Journal of Public Affairs,* 9 (9), 203 - 215.

Hussain, A. (2019). Industrial revolution 4.0: implication to libraries and librarians. *Library Hi Tech*. Doi: 10.1108/LHTN-05-2019-0033

Igwebuike, E. U. & Agbo, A. D. (2015). Creating a friendly environment for easy access and use of the library for the disable: role of information professionals. *Journal of Emerging Trends in Computing and Information Science,* 6 (1), 1- 6

Iroeze, P. C., Umunakwe, G. C. & Eze, J. U. (2017). Library services for the physically challenges in south-east, Nigeria: origin and challenges. *International Journal of Advanced Library and Information Science,* 5 (1), 393 - 405

Jabur, N. (2019). What role might libraries play in the fourth industrial revolution? *Journal of Information Studies and Technology,* 2 (6); https://doi.org/10.5339/jist.2019.6.

Jakarata public library. *The Social Sciences,* 12 (1), 5 - 10

Johnannessen, J. (2019). *The emergence of the fourth industrial revolution: an historical introduction to knowledge management and the innovation economy.* Bingley: Emerald.

Kibe, L. (2017). Impact of cloud-based services on records management in public organizations in Kenya. In: Kwanya, T., Kiplangat, J. & Wamukoya, J. (eds.). *Emerging trends in information and knowledge management.* Kenya: Moi University Press

Kibe, L. W., Kwanya, T. & Owano, A. (2018). *Techniques and tools of big data analytics at the technical university of Kenya and Strathmore university.* In: Kwanya, T., Kiplang'at, J.,Wamukoya, J. & Niraine, D. (Eds.) *Digital technologies for information and knowledge management*. Nairobi: The Technical University of Kenya

Kogos, A. (2018). *Security and privacy challenges in implementation of the internet of things in homes*. In: Kwanya, T., Kiplang'at, J., Wamukoya, J. & Niraine, D. (Eds.) *Digital technologies for information and knowledge management*. Nairobi: The Technical University of Kenya

Kuruczleki, E., Pelle, A., Laczi, R.& Fekete, B. (2016). The readiness of the European Union to embrace the fourth industrial revolution. *Management,* 11 (4), 324 - 347

Lee, J., & Lim, J. (2017). The prospect of the fourth industrial revolution and home healthcare in super-aged society. *Annals of Gerlatric Medicine and Research,* 21 (3), 95 - 100

Lee, M. *et al* (2018). How to respond to the fourth industrial revolution, or the second information technology revolution? Dynamic new combinations between technology, market, and society through open innovation. *Journal of Open Innovation: Technology, Market, and Complexity.*

Liao, Y., Loures, E. R, Deschamps, F., Brezinski, G. & Venancio, A. (2018). The impact of the fourth industrial revolution: a cross-country/region comparison. *Production,* 28, e20180061.2018. DoI: 10.1590/0103-6513.20180061

Litsalia, A. S. & Selvam, S. G. (2018). *Systematic literature review as a means of promoting effective use of e-resources in institutions of higher learning in Kenya.* In: Kwanya, T., Kiplang'at, J., Wamukoya, J. & Niraine, D. (Eds.) *Digital technologies for information and knowledge management.* Nairobi: The Technical University of Kenya

Lyons, A. C., Zucchetti, A. Kass-Hanna, J. & Cobo, C. (2019). The future work and education for the digital age: bridging the gap between digital skills and employability for vulnerable populations

Mahmood, M. F. & Hussin, N. (2018). Information in conversion era: impact and influence from 4th industrial revolution. *International Journal of Academic Research in Business and Social Sciences,* 8 (9), 320 - 328

Malemia, L., Abdullah, H. Dube, G. & Chaura, M. ( ). Inclusive academic libraries in the 21st century: a comparative study of Mzuzu university library and St. John of God college of Health science library in Mzuzu, Malawi.

Man, G. & Man, M. (2019). Challenges in the fourth industrial revolution. *Land Forces Academy Review*, xxiv, 4 (96), 303

Manda, M. I. & Dhaou, S. B. (2019). Responding to the challenges and opportunities in the 4th industrial revolution in developing countries. ICEGOV 2019, April 3-5, 2019. Melboune, VIC, Australia Proceeding of the 12th International Conference on Theory and Practices of Electronic Governance (ICEGOV2019), Melbourre, VIC, Australia, April 3-5, 2019, 10 pages. https://doi.org/10.1145/3326365.3326398.

Mdluli, S. & Makhupe, O. (2017). Defining leadership competencies needed for the fourth industrial revolution: leadership competencies 4.0

Moisey, S. D. (2007). The inclusive libraries initiative: enhancing the access of persons with developmental disabilities to information and communication technology. The Developmental Disabilities Bulletin, 35 (1), 5 - 71.

Musangi, P. S., Odero, D. & Kwanya, T. (2018). *Information commons: a service model for academic libraries in Kenya.* In: Kwanya, T., Kiplang'at, J., Wamukoya, J. & Niraine, D. (Eds.) *Digital technologies for information and knowledge management*. Nairobi: The Technical University of Kenya

Mutuku, C. M. & Magutu, J. (2018). *Facilitating big data utility in Kenya.* In: Kwanya, T., Kiplang'at, J., Wamukoya, J. & Niraine, D. (Eds.) *Digital technologies for information and knowledge management.* Nairobi: The Technical University of Kenya

Nachandiya, N., Gambo, Y., Joel, N.B. & Davwar, P. (2018). Smart technologies for smart campus information system. *Asian Journal of Research in Computer Science, 2 (2),* 1-7; DOI: 10.9734/AJRCOS/2018/450S1

Nkosi, T., Aboginije, A., Mashwama, N. & Thwala, W. (2020). Harnessing fourth industrial revolution (41R) for improving poor universities infrastructures in developing countries - a review. Proceedings of the International Conference on Industrial Engineering and Operations Management, Dubai, UAE, March 10 -12, 2020.

Ocholla, D. N. & Ocholla, L. (2019). Responsiveness of academic libraries in South Africa to research support in the 4th industrial revolution: a preliminary study. Available online at:

Oparaku, D. C., Anyanwu, E. U. & Benson, O. V. (2017). Next generation of library and information science practitioners: the way forward for infusing new skills and competencies. In: Kwanya, T., Kiplangat, J. & Wamukoya, J. (eds.). *Emerging trends in information and knowledge management.* Kenya: Moi University Press

Peters, M. A. (2017). Technological unemployment educating for the fourth industrial revolution, *Educational Philosophy and Theory*, 49 (1) 1 - 6, DoI: 10.1080/00131857.2016.1177412.

Rashid, A. A. (n.d). The fourth industrial revolution impact to the future of sustainable urban development in Malaysia. Available online at: https://www.academia.edu/36382024/THE_FOURTH_INDUSTRIAL_REVOLUTION_IMPACT_TO_THE_FUTURE_OF_SUSTAINABLE_URBAN_DEVELOPMENT_IN_MALAYSIA

Savic, D. (2017). Rethinking the role of grey literature in the fourth industrial revolution. 10th conference on Grey literature and repositories: *Proceedings (Online). Prague National Library Technology.*

Schiuma, G. (2017). Arts catalyst of creative organizations for the fourth industrial revolution. *Journal of Open Innovation: Technology, Market and Complexity,* 3 (2), 1-12

Schwobel, C. (2018). The goods of the fourth industrial revolution: philosophies and religions in the age of deep learning

Technical Education and Skills Development Authority (2016). Technological change is coming: the fourth industrial revolution labour market intelligence report.

Tweve, J. T. (2018). Digital information literacy application among academic staff at Tumaini university Dar Es Salaam College In: Kwanya, T., Kiplang'at, J., Wamukoya, J. & Njiraine, D. (Eds.) Digital technologies for information and knowledge Management. Narobi: The Technical University of Kenya

Uzochukwu, O. C., Alloysius, N. T. & Olohi, E. S. (2019). Re-engineering Nigeria economy through fourth industrial revolution: a case of Agro-Allied firms in Nigeria. *International Journal of Applied Economics, Finance and Accounting,* 5 (1), 14 - 30; DoI: 10.33094/8.2017.2019.51.14.30

Xing, B. & Marwala, T (2017). Implications of the fourth industrial age on higher education. Available online at: https://arxiv.org/ftp/arxiv/papers/1703/1703.09643.pdf

Xu, M., David, J. M. & Kim, S. H. (2018). The fourth industrial revolution: opportunities and challenges. *International Journal of Financial Research.* 9 (2), 90 - 95

Yoon, D. (2017). What we need to prepare for the fourth industrial revolution. *Healthcare Informatics Research,* 23 (2), 75 - 76. https://doi.org/10.4258/hir.2017.23.2.75.

Yusuf, B., Walters, L. M. & Sailin, S. N. (2020). Restructuring educational institutions for growth in the fourth industrial revolution (41R): a systematic review. https://doi.org/10.3991/jiet.vI5i03.11849