INNOVATIVE 4TH INDUSTRIAL REVOLUTION DIGITAL TECHNOLOGIES FOR INCLUSIVE PUBLIC LIBRARY SERVICES DELIVERY FOR THE PHYSICALLY CHALLENGED USER

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ABSTRACT

This paper reviews innovative 4th industrial revolution digital technologies for inclusive public library services for the physically challenged user. Using literature and observed trends, the paper indicates that public libraries are the best positioned social institutions to provide the needed information services to the physically challenged using digital technologies such as artificial intelligence and machine learning, robots and cobots, high internet connectivity, autonomous vehicles, audio aids, visual aids, physical aids, text to speech software, speech recognition software, reading digital and audio libraries, etc. This helps improve access to digital literacy and devices in order to bridge the digital divide existing between the information privileged and the digitally excluded physically challenged, thereby enhancing an evenly developed society occasioned by the participation and contribution of every member. Despite having a prospect like the emergence of COVID-19 which necessitates the need for more virtual approaches to information services to limit the risks associated with physical contacts, challenges like financial limitations, equipment inadequacy, limited professionals and skills, absence of inclusive library services policies, faulty library designs, and sometimes, utter absence of public libraries affect the delivery of inclusive information services to the physically challenged using digital technologies. The implication of these is an imminent imbalance in societal development. The paper recommends preparation of policies on inclusive library services, training of librarians in handling 4IR digital technologies for inclusive library services, awareness and advocacy programmes, adequate provision funding for digital technologies acquisition, and establishment of more provincial libraries to address the challenges identified.

***Keywords*:** 4th Industrial Revolution, Digital Technologies, Inclusive Public Library Services, Physically Challenged

INTRODUCTION

The present era is largely regarded as a knowledge-driven society, the knowledge economy, where the access to and use of information and knowledge give competitive advantage to individuals and groups, while the lack of such access and use cause imbalances in societal development. This means that knowledge is needed in areas of industry, commerce, defence and security, health, education, etc, in equal measures for all members of the society. The role information plays in the development organizations, institutions and the nation has positioned it as a very vital commodity for societal development (Abdusalami, & Esievo, 2019). While information is increasingly being recognised as a major factor of production, its use depends on several factors, especially availability and accessibility to the individuals who need it to address their individual and/or group needs. These individuals have varying degrees of needs and requirements based on their physical, physiological, mental and socio-economic status.

The World Health Organisation (WHO) estimates that over a billion people; representing about 15% of the world's population have some form of disability (WHO, 2013). Out of this number, roughly 80% live in poor and developing countries (Mensah, Williams, Atta-Ankomah, & Mjomba, 2008). Of this number, 25 million are in Nigeria, and as such suffer exclusion (Uduu, 2020). This means they lack access to basic social amenities and factors of production including adequate information and knowledge, which altogether make it difficult for them to participate actively in societal development. One of the major social amenities that have the potentials of driving the needed social development through the empowerment and education of the members of the society is the public library, which is established to provide information services for the entire member of the public regardless of age, gender, religion, ethnicity, physiological status, education or political leanings.

Global information systems targeted at providing information services to the immediate and general communities have exponentially expanded. The concept of global village, occasioned by the emergence of disruptive technologies of the present era has created innovative concepts and challenges to information services delivery. The 4th Industrial Revolution (4IR) is known as knowledge society which built upon the digital revolution (Bamigbola, 2020). As a result, Bamigbola further explains, all human systems have adjusted and adapted to the new

normal, in particular, the educational system has been highly transformed and it has affected libraries as well.

Modern libraries in developing societies have not been left out of these innovations and evolutionary trends. The disruptive changes of the 4th Industrial Revolution era to the libraries come from many aspects and the common discussion is about managing the technology innovation. There are general propositions on how to handle disruptive changes but the specific description for the library to take comprehensive strategic actions are still unexplained (Ahmat, & Abu Hanipah, 2018). It is expected that the potentials of these disruptive innovative digital technologies are properly harnessed by libraries to enhance the provision of information services that covers all members of the society, thereby facilitating inclusion and inclusiveness.

Ensuring an evenly developed society requires that all hands must be on deck. Adequate and equitable access to opportunities and resources to compete favourable and contribute to human social and capital development must be guaranteed. Yet, the dire situation presented by the exclusion of the individuals who are physically challenged threatens the attainment of an evenly developed and balanced society. Therefore, this article intends to assess, using literature, recorded and observed experiences, innovative 4^{th} industrial revolution digital technologies for inclusive public library services delivery for the physically challenged user.

Conceptual Definition of the Physically Challenged

Lawal-Solarin (2012), defines physical challenge as an inability to perform some or all the task of daily life, or a medically diagnosed condition that makes it difficult to engage in activities of daily life. In the opinion of Gobalakrishnan (2013) physically challenged individuals could be described as those restricted, hindered or prevented to have equal opportunities with their contemporaries due to physical deformity such as visual, hearing, mobility, cognitive, language and speech impairment. Some of them are considered physically challenged due to some natural defects from births or caused by accidents. These disabilities could either be acquired through life circumstances like accidents or natural in the sense that an individual could be born with a physical challenge (Nwahunanya, Ede, Abiamuwe, Attah, & Asogwa, 2020). These individuals are disadvantaged in several aspects of societal participation and lack of access

to adequate, relevant, accurate, current and objective information can further aggravate their situation, which may pose threats to the attainment of societal and communal goals.

Conceptual Definition of Public Libraries

Public library is an organisation established, supported and funded by the community, either through local, regional or national government or through some other form of community organization. It provides access to knowledge, information and works of the imagination through a range of services and is equally available to all members of the community regardless of race, nationality, age, gender, religion, language, physical and mental limitations, economics and employment status and educational attainment (Salman, Mostert, & Mugwisi, 2015). The public library is usually established to meet the informational, educational and recreational needs of members of the public in all spheres of life. It is an organization established, supported and funded by the government or through some other forms of community organization. It provides access to knowledge, information or works of the imagination through a range of resources and services and is equally available to all members of the community regardless of race, nationality, age, gender, religion, language, disability, economic status, employment status and educational attainment (Okojie, & Okiy, 2019).

Public libraries exist to serve the entire member of the locality, referred to as the public. They are established to serve the numerous information needs of the community to the social capital, educational and recreational development of the community members on the basis of equality regardless of age, sex, race, religion, nationality, language or social status (Sadiku, Olarongbe, & Tsafe, 2018). This unique feature of the public library places it at a very important position among all other social information system. In terms of range of accessibility and scope of services delivered, and range of users, the public library sits atop all other forms of library and information systems.

Inclusivity and Public Library Services

The Department of Economic and Social Affairs of the United Nations (2016) defines inclusion or social inclusion as the process of improving the terms of participation in society for people who are disadvantaged on the basis of age, sex, disability, race, ethnicity, origin, religion, or economic or other status, through enhanced opportunities, access to resources, voice and

respect for rights. It is as much a process as it is a goal, the objective of which is to erase its direct opposite, social exclusion. Inclusion has become an integral aspect of global development plan so much that several governmental and non-governmental organisations have factored it into their short and long term plans. For instance, it is the Goal 16 of the United Nations 17 Sustainable Development Goals, which reads to "*Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels."* (Conference of European National Librarians, 2022).

Pratiwi and Heriyanto (2022) argue that social inclusion is essential for sustainable development for equitable marginalized groups' growth. Furthermore, it is explained that social inclusion fulfils human rights through basic needs such as outreach access, services, social participation, and identity recognition. It also enhances environmental development through group involvement in societal development programmes and activities irrespective of social background, race, characteristics, religion, ethnicity, beliefs, culture, and social status (Ra'is, 2017). Inclusivity confers a unique fairness status to every society as it provides an opportunity for sense of belonging and competitiveness to individual members of the society, while at the same time, enhancing the prospects of attaining established societal goals through the empowerment of human resources irrespective of their ability or disability level.

Local public libraries can help to overcome the barriers created by exclusion by providing computer resources and Internet access, as well as assistance and support in the use of web-based information and communication technology, and the provision of assistive technology and adaptive devices can further assist those with disabilities or other limitations (Moisey, 2007). Libraries based on social inclusion are libraries that facilitate communities to develop their potential by viewing cultural diversity, willingness to accept change, and offering opportunities to strive for, protect and advocate culture and human rights (Wiyono, 2021). The author further explains that libraries can create social capital by offering diverse programmes and activities that can facilitate the plurality of society with over differences, cultural backgrounds, economic status, and interests; and connect with other institutions in the community that can improve literacy.

Marwiyah (2019) states that the library has an important role in promoting the social inclusion with its function as an institution to implement education for all. Miller (2014) also

buttress the above arguments by stating that the public library is believed to be a place with the potential for social connectivity, and the creating of social capital. This social capital is enhanced when the library offers information services to every member of the society including the physically challenged who have suffered exclusion for too long in developing societies.

4th Industrial Revolution Digital Technologies for Inclusive Public Library Services for the Physically Challenged

The present era is considered the industrial revolution era. An era characterised by the emergence of technologies blurring of boundaries and fusion of bridges between the physical, digital, and biological worlds (human resources). It is considered a fusion of advances in artificial intelligence (AI), robotics, the Internet of Things (IoT), 3D (Three Dimensional) printing, genetic engineering, quantum computing, and other technologies (McGinnis, 2021). It is characterized by the convergence and complementarity of emerging technology domains, including nanotechnology, biotechnology, new materials and advanced digital production (ADP) technologies. The latter includes 3D printing, human-machine interfaces (HMIs) and artificial intelligence, and is already transforming the global industrial landscape (Lavopa, & Delera, 2021).

Ayandokun and Nworu (2022) summarise that the 4th Industrial Revolution technologies and advancements revolve around a more sophisticated, speedy, vibrant, robust, and advanced approach to data and information management for the benefit of man. It offers better opportunities for the management of data, information and knowledge for the rapid development of the society at individual and communal levels.

Digital technologies and tools are technologies relating to computers or the "Computer Age" (Gökçearslan, Solmaz, & Coşkun, 2017). The denote a wide range of technologies, tools, services and applications using various types of hardware and software used to facilitate services or activities by electronic means to create, store, process, transmit and display information. Broadly, digital technologies include the use of personal computers, digital television, radio, mobile phones, robots etc (Tulinayo, Ssentume, & Najjuma, 2018). They are electronic tools, systems, devices, and resources that generate and store data from teaching and learning. They include learning materials that use technology across curriculum learning areas with examples

such as online games, multimedia, cloud computing, 3D printing, and mobile computing (Kumi-Yeboah, Sallar, Kiramba, and Kim, 2020).

Marr (2020) explains the major components of the 4th Industrial Revolution as:

i. Artificial Intelligence and Machine Learning: Artificial intelligence (AI) and machine learning refer to the ability of machines to learn and act intelligently—meaning they can make decisions, carry out tasks and even predict future outcomes based on what they learn from the data.

ii. Internet of Things (IoT): The Internet of Things (IoT) refers to the increasing number of everyday devices and objects that are connected to the internet and gather and transmit data.

iii. Big Data: This refers to the exponential explosion in the amount of data being generated in the increasingly digital age.

iv. Blockchains: A blockchain or distributed ledger is, in simplistic terms, a kind of highly secure database, a way of storing information.

v. Cloud and Edge Computing: Cloud computing means storing and processing data on other people's computers in a data center via a network that gives companies the ability to store massive amounts of data and process it in nearly real-time. Edge computing refers to the processing of data on devices such as smartphones. Edge sits at the other end of the scale—rather than far away in remote data centers, edge computing happens up-close-and-personal on the frontline of business operations. Rather than send every piece of information collected by cameras, scanners, handheld terminals or sensors to the cloud to be processed, edge devices carry out some or all of the processing themselves, at the source where the data is collected.

vi. Robots and Cobots: Robots can be defined as intelligent machines that can understand and respond to their environment and perform routine or complex tasks autonomously. In this data-driven age, it's the intelligence and ability to act autonomously that defines robots and separates them from other machines. The rise of collaborative robots, or cobots, is the latest generation of robotic systems designed to work alongside humans as robotic colleagues. Cobots enhance the work that

humans do and interact safely and easily with the human workforce—extra robotic muscle in the workplace.

vii. Autonomous vehicles: An autonomous vehicle—be it a car, truck, ship, or other vehicle—is one that can sense what's going on around it and operate without human involvement.

viii. 4G and 5G technologies: 5G is the fifth generation of cellular network technology, which, together with other network innovations, will give us much faster and more stable wireless networking, as well as the ability to connect more and more devices and enabling richer, more varied streams of data.

Apart from their general advantages to the general public, these technologies offer adaptive and assistive prospects to the physically challenged in particular. They can be adapted in the following ways:

- **Speech-Recognition software**: Library users dealing with blindness/visual impairment, or with physical limitations that prevent them from typing on a keyboard, can use text-to-speech devices (mobile and otherwise) to compose their assignments. When using these programmes, users speak into a microphone, which then translates their words into typed documents. The most well-known of the software programs that perform this task is *Dragon Naturally Speaking*, which also recognizes voice commands such as "insert exclamation point." This is enabled by Artificial Intelligence technologies.
- **Text-to-Speech software**: This kind of assistive technology helps users with visual impairments by allowing them to listen to the text that appears on a computer screen. This is a huge improvement over Braille because once the programme is installed on the computer, it can read anything on the screen, no matter what format it is in (e.g. .pdf or website) with no waiting for a Braille translation. This enables library users to participate in online activities, use email and text, and have immediate access to course materials. There are many free versions of this software available online, such as *Natural Readers.*
- **Visual Aids**: This broad category of assistive technology includes screen magnification software that enlarges portions of the screen where the reader directs the mouse; screen reader software that translates screen text to Braille, text-to-speech programs; audio texts. All of these can be used by students of many different kinds of visual disabilities.

- **Audio Aids**: Another broad category of assistive technology, these user aids include sound amplification tools; alerting devices that use flashing lights or icons on the computer screen rather than sounds to signal users; close-captioning for videos; TTY (TDD) also known as Telecommunication for the Deaf; phones enabled with *Voice Carry-Over (VCO) technologies* that allow library users with hearing difficulties to communicate over the phone with their own voice.
- **Physical Aids**: For users with physical mobility, stability, motor coordination, and range of motion challenges, several technologies are available to assist them in completing their schoolwork, including audio books for students who cannot physically handle books; keyboard adapters such as keyguards to prevent mistyping from tremors or loss of control; voice recognition software for students who cannot type.

(Briggs, 2012).

Importance of Adapting 4th Industrial Revolution Digital Technologies for Inclusive Public Library Services for the Physically Challenged

Ng'etich (2017) assessed the availability and use of adaptive technology devices for visually impaired student teachers in primary teacher training colleges in Kenya, and noted that adaptive technology devices improve the quality of education and remove learning barriers for the Visually Impaired learners. They improve access to quality education, enable the learner to address individual and collective temporary social problems and be able to reach responsible judgment in seeking solutions to these problems. This is done e by using them in their original form e.g. Braille clocks and watches, materials manufactured specifically for visually impaired information users.

Furthermore, Eid (2013) opine that Information and communications technology (ICT) has been identified as an important aspect of the wider strategy for the social inclusion of users with disabilities. The following are some of the common approaches utilized:

i. Distance e-Learning: The distance learning home is accessible to students with disabilities. Distance courses allow users with disabilities to continue living at home while they are studying, to share documents, lessons, exchange ideas and make presentations. Using a computer is a common component of the training and studying process.

ii. Reading digital and audio libraries: Users with intellectual, hearing or reading disabilities, impaired sight, dyslexia and other disabilities are now able to follow educational courses via digital and audio libraries, accessing their material, content and resources via the Internet. Users can connect from home and read or hear the relevant books, without having to go to the local library.

iii. Internet, broadband for persons with disabilities: People with disabilities are today using the Internet, which builds their capacity to communicate with each other at a distance. Using the Internet helps them to gather and understand public information and news, to participate in leisure interests with others, to chat, shop, manage their finances, and write to authorities and friends. A computer with a broadband connection provides opportunities for improved participation in everyday life and independent living.

iv. Winning communication: Persons with disabilities are now able to communicate with others online, taking e- learning courses and interacting with the instructor and other users through online discussion forums. In online discussion for learners with mobility impairments; they can can make use of an alternative keyboard or speech input software to access the online course and participate in written communication.

The disabilities associated with physical challenges pose threats to the attainment of academic goals and lifelong learning of the physically challenged, especially students. However many technological tools could increase, as much as possible, the possibilities for students with disabilities to overcome these challenges with fewer difficulties (Alnahdi, 2014). According to Eid (2013), the use of digital assistive technologies can increase disabled persons' capabilities and independence. The technologies can be used for communication and productivity ends, or to provide an individual with an opportunity to experience recreational opportunities. This is because the use of ICT and AT (assistive technology) improves their social skills, learning and ultimately their employment opportunities, by providing the best education possible, building their capacities and developing important life skills.

Digital technologies can be used to facilitate digital inclusion for the physically challenged. Digital inclusion is a strategy pursued to foster social inclusion of those who have been sidelined from the mainstream of information society due to lack of access to digital technologies and the skills to use them (Beyene, 2018). According to Onyemachi and Ayandokun (2022) the rural community library and information centres can help provide the

access to digital literacy and digital devices in order to bridge the digital divide existing between the information privileged and the digitally excluded. Teaching of digital literacy is expected to be part of this project because even with access to resources, only the digitally literate can maximize the potentials of the digital economy and be fully integrated into the digital economy as active participants.

Access is an essential library service; at the core of all libraries is the ability to provide equitable access to information for users in physical and electronic formats (Frank, Salsbury, McKelvey, & Mclain, 2021). The American Library Association (2019) states that "all information resources that are provided directly or indirectly by the library… should be readily, equally, and equitably accessible to all library users". The Australian Library and Information Association (ALIA) state, 'public libraries are safe and trusted and inclusive public spaces where everyone is welcome' (Australian Library and Information Association [ALIA], 2016, p. 13).

The issues of internet access and device ownership are central to digital equity and inclusion, and libraries can support users by offering a technology checkout programme to lend devices such as laptops, tablets, and even internet hotspots. As libraries work to support remote access to subscription resources and offer devices for checkout that enable access to the internet, they can also offer traditional in-person services virtually, such as research consultations to increase the ways that users can receive assistance from the library to further support inclusion (Frank, Salsbury, McKelvey, & McLain, 2021, 188).

Challenges and Prospects of Innovative 4th Industrial Revolution Digital Technologies for Inclusive Public Library Services for the Physically Challenged

Barriers to the provision of assistive technology for the physically challenged include fiscal restraints, equipment barriers, teacher barriers, and the individual as a barrier. Funding assistive technology devices can be an issue, especially with the ongoing costs of many assistive technology devices and services (Jacobsen, 2012). Most of the libraries battle with inadequate resources for the delivery of inclusive library services for the physically challenged. Babalola and Haliso (2011) observe that none of the libraries they surveyed in their study of library and information services to the visually impaired has Braille book, talking books, talking newspaper and assistive technologies were not available in the libraries. The only materials that were available were a few audio books.

One of the major prospects for the digital inclusion of the physically challenged by public libraries is the outbreak of COVID-19 which has increased the need for and use of digital information services delivery. Frank, Salsbury, McKelvey and McLain (2021) assert that the COVID-19 pandemic exposed remote access and digital accessibility as critical and ongoing issues. Serholt, Eriksson, Dalsgaard, Bats, and Ducros, (2018) state that although there are many challenges coupled to the shift towards media and technology literacy and the changing role of libraries and librarians, there are also many positive experiences and opportunities. This implies that with new technology, it is possible to reach those who are otherwise unable to come the library.

Conclusion and Recommendations

The capacity of every human society to attain communal goals is hinged upon the aggregate capacity of the group members to contribute and participate in societal development. Different group of individuals exist in the society with different capacities and capabilities. Ideally, some of these capacities are artificially acquired through education, learning and training. However, the acquisition of these capacities among some individuals is affected by physiological and psychological barriers that hinder them from acquiring the needed information, knowledge, skills, to enhance their capacities. Some of these challenges affect their natural ability to engage and participate in societal development. Meanwhile, in an era when information has become the tool for such development, adequate attention must be given to the information systems, information architecture and infrastructure to deliver the information services aimed at enhancing the needed capacities for development. The public library is one of those institutions properly and naturally positioned to deliver information services to every member of the society without any form of societal barriers. These services are referred to as inclusive services because they are specifically tailored towards meeting the special needs of these special users with the sole aim of improving their ability and potentials to contribute to societal development. The public library is expected to achieve this noble objective by harnessing the potentials of the 4th Industrial Revolution digital technologies adapted to deliver information services to this group of users. Such technologies include artificial intelligence and machine learning, robots and cobots, high internet connectivity, autonomous vehicles, audio aids, visual aids, physical aids, text to speech software, speech recognition software, reading digital and audio libraries, internet broadband for persons with disabilities. However, despite the presence of prospects such as the

emergence of COVID-19 which has necessitated the need for more digital and virtual approach to information services to limit the risks associated with physical contacts, there are notable barriers to effective use of digital technologies to deliver inclusive public library services. Such barriers include financial challenges, equipment and tools inadequacy, limited professionals and skills for inclusive library services delivery, absence of inclusive policies in public libraries, faulty designs of libraries, and sometimes, utter absence of public libraries in several communities. The implications of these challenges, if they persist is an unevenly developed society where the physically challenged are left behind in the scheme of things, making it difficult to attain a truly developed society. The following recommendations are hereby put forward to address the challenges identified:

. Preparation of a library policy that takes into cognizance, the need for inclusive information services delivery. This should be well provided in the objectives and mission of every public library as part of the core objectives of the library.

. Training of practicing and prospective librarians in the delivery of inclusive information services for the physically challenged using digital technologies of the modern era. This will help facilitate an efficient inclusive information services delivery.

. Establishment of more provincial/ community libraries and information centres to support the central libraries in the delivery of information services to the physically challenged in remote communities.

. Acquisition of adequate digital adaptive technologies to provide special information services for the users with special needs.

. Regular outreach and awareness programmes to notify the members of the society on the existence of inclusive public library services. The existence of such services is not enough if they are not being used.

. Regular provision of funds for public library inclusive services by government. The Ministry of Humanitarian Affairs and the Ministry of Information at the federal and state levels should adopt synergies to facilitate adequate provision of funds to support public libraries in states with little or no wherewithal to achieve this.

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