



OPEN SCIENCE: REDEFINING THE ROLE OF LIBRARIES AS HUBS FOR KNOWLEDGE JUSTICE AND INNOVATION IN THE 5TH INDUSTRIAL REVOLUTION

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Abstract

The 5th industrial revolution era focus on human-centered advancements driven by the unification of artificial intelligence and machine learning. Libraries are situated to lead this transformation by promoting equitable access to information and support the innovation and open knowledge. There are extant literature on the benefit of open science but no much attention on the disparity among the underrepresented communities in accessing and contribution to scholarly communication. Libraries as the custodian of knowledge are expected to redefine their roles in this era for proper positioning in ensuring inclusion, fair use, technology, service oriented, and dismantle knowledge supremacy through open science. The study explored how libraries can transform and adapt their roles in this era by ensuring human-centered innovation and technology integration, targeting the principle of knowledge, justice and equitable participation into their operations. Bridging the gaps and guaranteeing equitable access to open science, the study aimed at exploring how open science would be empowered in the 5IR through librarians in ensuring knowledge, justice and innovation. The study used qualitative research method and semi-structured interviews were used as the instrument to gather data from respondents. The population for this study were heads of

library in universities in south-west Nigeria. A purposive sampling technique was used to select 10 heads of library with direct experience or expertise in open science practices, knowledge equity initiatives, and library innovation strategies. The result showed that there are benefits of open science but the disparity between the developed and under-represented can better be bridged by innovative approach of the library. It was suggested that there should be collaboration among stakeholders and supportive policies to ensure knowledge justice.

Keywords: knowledge justice, library, open science, innovation, 5th industrial revolution,

Introduction

The emergence of the Fifth Industrial Revolution (5IR) gave way to a transformative era that is characterised by the interactive connection of advanced technologies such as artificial intelligence, biotechnology, and quantum computing with human ingenuity and ethical considerations. According to Xun, et al. (2021), the harmonious integration of diverse technological domains of 5IR was instituted based on the assumption that 4IR focuses less on the original principles of social fairness and sustainability but more on digitalisation and AI-driven technologies for increasing the efficiency and flexibility of production. Open science is a movement reshaping the environment of scholarly communication and has gotten global recognition. This is the unrestricted availability of high-quality data, publications, and innovations, as well as the establishment of a strong scientific community that transcends traditional boundaries to make effective decisions. The paradigm shifts in essence advocate for unlimited access to research outputs and data in order to promote reproducibility, transparency, innovation and collaboration among disciplines (Onyebinama, et al, 2024).

Knowledge justice applies the concept of social justice in information spaces. The concept was developed to advocate for libraries to be active agents in disrupting white supremacy and promoting racial justice within information access and knowledge creation (Feldman, 2019). Knowledge justice therefore is a concept, advocating for equitable access to information, inclusive participation in knowledge creation, and the dismantling of systemic barriers that perpetuate information inequities (Cornelius-Hernandez & Clarke, 2024). Traditionally, libraries are the custodians of physical information resources however, the transformation has been adapted to by librarians. This therefore, reveals a dynamic interplay between technological advancements, the principles of knowledge justice, and the evolving role of libraries. The practice could be envisioned in libraries, where users experience the same in a paperless society. This development positions libraries in promoting knowledge justice through equitable access to information for all segments of the society. The transitioning from conventional repositories of physical media to dynamic hubs that facilitate digital access, data literacy, and participatory learning is visible both in library collections and spaces (Isiaka, et al, 2024).

Statement of problem

Open science such as open data, open book, open journal and open publishing is expected to make scholarly communication available without restriction in research publishing ecosystem. Open science awareness has increased in the last decade and researchers are exploring this opportunity to make their work visible to the global world since the result of any research work is meant to address thematic issues in the society. However, there are limit to publication and access within certain geographical areas such as Africa, and Asia, where

they are struggling to gain traction. The emergence of publishing by the British colonial administration was borne out of their interest in the supply of agricultural raw materials from the region. As a result, they set up agricultural research stations in various cities in Africa. Also, most research result from developed world are funded, allowing authors to publish and communicate the result freely in most recognised commercial publishers' sites, most especially where they positioned themselves as facilitators of scholarly communication. In accessing open access most especially researchers in developing world, pay either through subscription or paywalls since these renowned publishers like Elsevier, Wiley, Springer Nature, Taylor & Francis and SAGE have consolidated themselves as gatekeepers of knowledge. Universities pay heavily annually to access research produced by their faculty members and are published by these publishing houses. It is therefore important that knowledge needs to be reclaimed in global north regions (Sheikh & Richardson (2023); Taubert, et al (2021); Ann (2013); & Dominique, Xiya & Hloni (2021).

Result of research in developing countries are being swamped by research from developed country. Harle & Warne (2020) note that subscribing as an institution or as an individual is difficult mostly in the global north as high cost has created academic and global inequalities in education and research thereby limiting access to what they want to read. All these are making research from the global south region invisible and less regard than those from the global north. Knowledge injustice in open science most especially open access is prevalent and there should be equitable justice in accessing, publishing and communicating scholarly output. Onyebinama, et al (2024) noted that countries outside of North America and Europe are not as prominently represented in open science. This suggests that open knowledge systems may not adequately reflect the diverse knowledge and needs of a global audience, thereby strengthening the existing power disparities in knowledge creation and dissemination.

This framework, as introduced in Egert & Allen (2017) emphasised throughout the discussion of the book Knowledge Justice, Leung & López-McKnight (2021) provides a crucial lens for examining the social justice implications of knowledge production and distribution. It emphasises that knowledge and its creation should be seen as a good to be distributed, including all voices for whom the science will matter. This paper explores the redefined role of libraries in the 5IR, emphasizing their critical function as enablers of open access and as catalysts for knowledge justice and innovation. By examining contemporary case studies and strategic initiatives, the study elucidate how libraries can harness emerging technologies to empower communities, bridge knowledge disparities, and cultivate an ecosystem conducive to sustainable progress.

Objectives of the Study

1. To identify the most critical principle to open science relevant to the 5IR,
2. To explore the benefit of open science in the 5th Industrial Revolution,
3. To identify the challenges of adopting open access in the 5th Industrial Revolution,
4. To explain how knowledge justice and innovative approaches of librarians is crucial to open science in the 5IR

Theoretical framework

Critical Race Theory (CRT) is the foundational theory underpinning Knowledge Justice. CRT highlights the importance of conceptualizing race, racism, power dynamics and structural inequalities. It offers essential concepts for understanding how race, racism, and power operate within information systems and institutions. The critical race theory started with the movement of collection of activists and scholars interested in studying and transforming the relationship among race, racism, and power. The movement focused on issues bothering on conventional civil rights and ethnic studies discourses take up, but places them in a broader perspective that includes economics, history, context, group- and self-interest, and even feelings and the unconscious (Ekwueme, et al, 2024).

The theory was used by Leung & López-McKnight (2021) to analyse and challenge the relationship between race, and power within library and information studies and advocating for dismantling white supremacy in order to achieve more just offers a powerful background for appraising the development of equitable and inclusive library and information practices (Egert & Allen (2017). This can be applied to critically examine existing open science practices and infrastructures, identify potential biases and inequalities that might perpetuate or exacerbate existing knowledge injustices. Furthermore, CRT's commitment to social justice and transformative action aligns with the study's aim of empowering open science and redefining the role of libraries McCoy & Rodricks (2015). Understanding these dynamics through frameworks like CRT and the concept of knowledge justice is crucial for developing truly equitable and inclusive open knowledge initiatives.

Intersection of Open Science and Knowledge Justice in the 5IR

The convergence of open science, technological advancements, and knowledge justice principles is a fundamental area within library and information profession. Though open science and technological advancements offer prospects for broader access to information and knowledge, knowledge justice provides a critical lens to ensure these developments are equitable and address existing power imbalances within open science (Ogungbeni et al, 2016). The principles of open science are assumed to align with the objectives of knowledge justice within the framework of the 5IR. It is characterised by extraordinary technological advancements and societal transformations driven by the integration of digital technologies such as; artificial intelligence (AI), the Internet of Things (IoT), cloud computing, big data, robotics, biotechnology, nanotechnology, blockchain, and quantum computing, characterised the technological advancement and reinforced by the increasing importance of data and advanced communication technologies (Ajani & Oladokun, 2024; Enakrire et al, 2024).

One of the main objectives of open science is promoting access to scientific research across all fields to the advantage of scientists and society (Onyebinama, et al, 2024). This support perfectly the 5th Industrial Revolution's emphasis on inclusivity and access to information for all individuals (Enakrire, Oladokun, Ignatius, Gaitanou, 2024). By eliminating obstacles to research and promoting collaborative scientific endeavors, open science can guarantee that the vast amounts of data and knowledge generated during the 5th Revolution are not locked behind paywalls or restricted by exclusive access (Ogungbeni, et al 2016; Onyebinama, et al, 2024). It was therefore suggested that the synergy between open science and knowledge justice should make result of research and knowledge freely available and break down every barriers to access especially for the marginalized communities (Feldman, 2019).

The intersection of open science, knowledge justice and 5IR will tripod equity, fairness and inclusive knowledge landscape between global north and south, will accurately reflects the key themes and potential interactions to consider how the principles of open science and knowledge justice can be brought together within the context of the technological transformations of the 5th industrial revolution to create a more equitable and inclusive knowledge landscape. The connection of these ideas within the 5th IR suggests a need for innovative open science approaches that actively integrate diverse knowledge and challenge traditional knowledge hierarchies. These concepts are synergised where knowledge is co-created, openly shared, ethically managed, and used to empower all segments of society, not just the privileged few.

Innovative approaches to open science within 5th Revolution

In the context of the 5IR and open science, it implies that libraries have a crucial role to play in ensuring that the advancements in open science are guided by the principles of knowledge justice thereby, promoting equitable access and participation in the emerging knowledge ecosystem. The redefined role of libraries as active agents in this landscape is crucial for ensuring that open science in the 5th Revolution is not only technologically advanced but also contributes to a more just and equitable knowledge ecosystem for all. Power dynamics and social inequities deeply influence who can access, contribute to, and benefit from open knowledge systems. Libraries, in their evolving roles, have the potential to be key actors in challenging these imbalances and fostering a more just and participatory knowledge landscape.

CRT inspires a move towards transformative librarianship, which involves understanding how information shapes self-awareness and community awareness, while also recognising epistemic supremacy and institutional harms faced by marginalised communities (Ogungbeni, et al 2016; Onyebinama, et al, 2024). This approach encourages libraries to become active agents in creating conditions for radical change towards racial justice (Leung & López-McKnight, 2021). Critical race theory encourages a re-evaluation of the core tenets of open science, such as neutrality and vocational awe, arguing that these concepts can inadvertently uphold white supremacy (Ogungbeni et al, 2016; Egert & Allen, 2017). It calls for a paradigm shift in how librarians understand their roles and responsibilities in shaping a more just information landscape. Libraries need to become the dynamic and intelligent hubs developing new services and expertise that actively facilitate open science grounded in knowledge justice. This includes and start with acquiring new skills in data science, digital curation, and technology management (Ann, 2013).

The use of advanced technologies like AI in libraries raises ethical and privacy concerns that can impact knowledge justice principles such as inclusivity, transparency, and intellectual freedom. Therefore, libraries can develop ethical guidelines to ensure these technologies are used responsibly and equitably. Libraries as a hub can build institutional repositories and open access infrastructure for open access to research and data (Ajani and Oladokun, 2024). Innovation in this area could involve developing more user-friendly, accessible, and community-driven platforms that prioritise the needs of diverse knowledge producers and users which can foster scientific collaboration and knowledge sharing among researchers. For communities, and policymakers to advance open science and address societal challenges.

Innovative approaches could involve leveraging 5IR technologies to create virtual collaboration spaces and platforms that intentionally center marginalised voices. Furthermore, libraries should actively work to enhance digital literacy and technology skills among library patrons and staff, particularly in marginalised communities, focusing on different digital literacy programs on promoting inclusive open science engagement. Training, resources, and advocacy, especially for marginalized communities who might otherwise be excluded can be facilitated. To allow users embrace and explore technologies like AI, blockchain, AR/VR, and 5th generation wireless to enhance services and accessibility while remaining mindful of ethical implications and equity. The sources afore mentioned collectively argue that the 5th Industrial Revolution presents a unique opportunity for libraries to redefine their roles. By embracing digital technologies and the principles of Open Science, libraries can become more accessible, inclusive, and collaborative hubs. By actively engaging with the concepts of Knowledge Justice and challenging systemic inequities, libraries can move beyond traditional roles to become powerful agents for social change and innovation in the 21st century. They are not just repositories of information but dynamic centers that empower individuals and communities through equitable access to and engagement with knowledge.

Challenges of innovative library roles for knowledge justice in 5th revolution

Libraries need to address challenges such as limited funding and infrastructure, a shortage of skilled professionals, and the need for supportive policies to effectively promote open science and knowledge justice in a technologically advanced landscape, particularly in regions like Africa (Ann, 2013) lack of infrastructure directly impacts access to open knowledge systems, This is particularly relevant to the Global South, where infrastructure limitations and the high cost of internet bandwidth can hinder the adoption of open science practices. Identifying and analyzing innovative approaches to open science in the 5th Revolution requires considering how the unique characteristics of this era intersect with the goals of open science and the principles of knowledge justice. The sources suggest several areas where innovation is emerging or necessary. Also, technological advancement plays a key role in open science with its innovative opportunities like internet, open access publishing platform and digital repository, (Xun, et al, 2021). However, the challenge of data security, privacy, digital infrastructure and interoperability are likely to emanate. Although the intersectional relationship gives hope to the marginalised community yet, the risk of intensifying inequalities can occur if marginalised communities lack the necessary resources, infrastructure, or digital literacy to fully participate in the system. The study of Egert & Allen (2017) does not delve into this holistically therefore calling for expert-centered approaches to inclusive knowledge ecosystem (Ogungbeni, et al 2016; Redkina 2021; Ajani & Oladokun 2024). However, the digital divide unequal access to technology and internet connectivity remains a significant obstacle to achieving knowledge justice in a technologically driven environment (Enakrire, et al, 2024).

Research Methodology

Qualitative research approach was used in this study to explore the role of libraries in empowering open science and promoting knowledge justice and innovation in the 5th industrial revolution. Semi-structured interviews were used as the instrument to gather data because of the explorative nature of the research which allows deeper probe into emerging themes while ensuring that key research objectives are systematically addressed. The

Population for the study are the heads of libraries in South West Nigeria. A non-probability sampling technique was used to select heads of library in academic institutions that has been in existence for twenty (20) years. A total of 10 (ten) respondents (heads of library) who have direct experience or expertise in open science practices, policy makers and research were selected and interviewed. To ensure diverse insights into the variables, an interview guide was developed based on the key themes of the study; Libraries and open science facilitation, knowledge justice principles in library services, innovation roles of libraries in the 5th Industrial Revolution and challenges and opportunities in redefining libraries' functions. The interviews were conducted via virtual platforms (WhatsApp) based on participant's availability and convenience after which the responses were transcribed for analysis.

Discussion of Findings

This study examines open science in the 5th revolution, and the role of libraries as hubs for knowledge justice and innovation. Thematic content analysis was done to achieve the study objectives. These findings were summarized as follows based on the questions asked during the interview.

Objective 1: How well do you understand the most critical principle to open science relevant to the 5IR

This section provides a foundational understanding of the key principles driving open science in the 5thIR. Open access emerges as the most critical principle in promoting open science within the context of the 5IR, as it directly influences research accessibility and knowledge sharing. Collaboration is consistently highlighted as crucial for fostering interdisciplinary approaches and accelerating innovation. Reproducibility and transparency are seen as foundational principles for ensuring the credibility and trustworthiness of research in the open science framework. Open data and open methods also receive significant attention, highlighting their importance in ensuring that research processes are transparent, accessible, and usable by others. Open peer review, while mentioned less frequently, remains an important principle for ensuring the quality and integrity of research in an open science environment. This finding implies that open science can foster innovation and ensure trust in research by focusing on the principles of collaboration, reproducibility, and transparency, all of which are critical to keeping pace with the rapid technological advancements in the 5IR.

Objective 2: The benefits of adopting open science practices in the 5th revolution

Insights from the analysis revealed that the benefits of open access, particularly increased accessibility, transparency, innovation, and collaboration are central to its value in advancing research. The findings showed that the benefits of open access in the library include increased accessibility. Equitable access to information remains the most frequently mentioned theme. Open access provides a platform for research to be freely available, ensuring that knowledge is accessible to researchers globally. One of the participants emphasized the *importance of making research findings available on public platforms to verify and validate research results.*

The finding also showed that open access increases transparency and accountability. Open access enhances transparency in research processes, allowing for better validation and verification of findings. This also encourages greater accountability in research. Participant 3 highlighted this as a key benefit, *helping researchers ensure that their open access increases transparency.* In addition, open access accelerates innovation by making new research findings available faster to the global research community. Participants 3 and 6 emphasized:

that when research is openly shared, it enables quicker application and further innovation, especially in interdisciplinary work. This finding is in line with the submission of Harle & Warne (2020). Improved collaboration was also identified as a major benefit. Open access enables increased collaboration among researchers, particularly across disciplines and geographical boundaries. Participants 3, 5, 7 highlighted that the global sharing of information allows researchers from various fields to collaborate more effectively and drive forward knowledge creation. Empowerment of citizen science also emerged as benefit. Participant 6 pointed out that *citizen science can thrive with open access, enabling individuals who are not professional researchers to contribute valuable data and insights to scientific research.* Open access was also perceived as improving research quality. Open access contributes to enhanced research quality by ensuring that research is available for peer review and validation.

Objective 3: Challenges of adopting open access in the 5th Industrial Revolution

However, the challenges, including Cultural Barriers, Data Management, and Intellectual Property issues, must be addressed for open access to reach its full potential. Libraries and institutions should focus on overcoming these challenges by providing necessary training, developing supportive policies, and ensuring adequate funding and infrastructure. A participant expressed concern about tools and support from the management and that some researchers are not willing to share their data and work due to copyright and data safety. Participant 2 and 3 mention funding as a great challenge.

Objective 4: How crucial is knowledge justice and innovative approaches of librarians to open science in the 5IR

The focus under this section is understanding how libraries can facilitate equitable access to information, foster diverse perspectives, and address information inequalities. The finding revealed that libraries can become hubs for knowledge justice by prioritizing equitable access to information for all, ensuring that no group is left behind. Participant 3 explicitly stated that a library as a hub for knowledge justice means *prioritizing equitable access and addressing information inequalities.* Another role is by promoting digital literacy as essential for ensuring that individuals navigate and effectively use the digital tools available in the 5IR. Libraries must also engage with their communities to provide relevant resources and services. Libraries also play a critical role in advocating for open access to information and ensuring that their policies support inclusive access. In addition, the finding revealed that libraries should use innovative services, such as virtual reference services, to promote knowledge justice by offering faceless interactions. This can help ensure that all individuals, regardless of their identity, can access resources without bias as suggested by Isiaka, et al, (2024). Also, the finding revealed that libraries can work in partnership with other organizations and communities to improve access to resources and services. Libraries can empower communities and individuals through training and support for local initiatives. This finding showed that in the 5IR, libraries must evolve into hubs that not only provide resources but also ensure fair distribution and use of knowledge. The objective of this section is to identify emerging and innovative approaches in libraries for promoting open science and knowledge justice within the context of the 5th Industrial Revolution (5thIR). Key themes emerged from the findings. First, open data and research data management are becoming essential services in libraries, especially in the context of the 5thIR. Participant 1 highlighted the need for libraries to provide services like open data and research data management. Advocacy for Knowledge Justice emerged third. Knowledge justice is about libraries ensuring fair and

equitable access to information, and Participant 5 stressed that *"As information professionals, knowledge justice is about being fair in how we acquire, store, and share knowledge. It's essential that libraries foster inclusivity and equality in information access."*

Data privacy and ethical concerns emerged fourth. With the increased use of digital technologies in research and data collection, libraries must ensure that ethical standards are maintained and that user data is protected. Participant 6 noted: *"In the digital age, libraries must be vigilant about data privacy and ensure that ethical considerations guide how we collect and share information."* The need to bridge the digital divide was also emphasized as a key factor. Digital Divide is identified as a challenge to accessing knowledge and technology, particularly for underrepresented or disadvantaged populations. Libraries play a critical role in bridging the digital divide by offering access to technology and providing digital literacy training. This is essential for promoting knowledge justice and ensuring that everyone, regardless of background, can participate in the digital revolution. Participant 6 observed, *"The digital divide remains a major barrier to equal access to knowledge. Libraries must work to ensure that all users have the tools and training they need to engage with digital content."* This response corroborate Afzal et al (2023) where digital divide was identified as one of the major reason for lack of participation in open access. Next, AI literacy, coding, robotics, and data science skills were also identified as necessary for librarians to effectively engage with the demands of the 5thIR. Participant 9 stated, *"AI literacy and coding skills are essential for future-proofing library services. Librarians need to stay ahead of technological advancements to help users engage with these tools."*

Conclusion

In conclusion, the study gave an understanding of the transformative backdrop of the 5th revolution that is marked by digital technologies and global collaboration, open science emerges as a force in knowledge justice and libraries are no longer a passive repositories of information but driving towards a forward progress. In this paradigm, libraries are repositioning themselves as dynamic hubs for knowledge justice and innovation. By embracing open access, fostering inclusive research environments, and supporting equitable knowledge sharing, libraries can dismantle traditional barriers to scientific participation and empower underrepresented communities. This redefinition not only aligns libraries with the ethical requirements of the open science movement but also ensures their continued relevance and leadership in shaping an equitable knowledge ecosystem.

Recommendation

1. There should be an active involvement and collaboration of diverse stakeholders; researchers, government, students and libraries in developing an inclusive open science initiative that will allow a robust policy that priorities equity, accessibility and transparency.
2. Institutions should invest in open science ecosystem; open repositories, data management tools, and interoperable systems that will enable libraries to support and balance open science practices more effectively.
3. Investment in capacity building for librarians is essential to effectively navigate and use open science tools and platforms.

4. Government should encourage researchers by adopting the result of research that are openly published to address societal issues.

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