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Academic libraries readiness in the Fourth Industrial Revolution: a comparative study between Ghana and South Africa

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Abstract

Purpose – This study compares the Fourth Industrial Revolution (4IR) preparedness of two advanced academic libraries each in Ghana and South Africa.

Design/methodology/approach – The study utilized a conceptual framework that emanated from the Socio-Technical Theory (STT) and Global Competitiveness Index (GCI) models. Employing convergent parallel mixed methods, including questionnaires and interviews, 167 respondents, comprising librarians, IT staff and directors, shared insights on challenges faced by academic libraries in adapting to 4IR.

Findings – Findings highlight a deficiency in Lib 4.0 skills crucial for survival in the 4IR, with South Africa showing better readiness. Both countries lack Lib 4.0 policies and face budget constraints, inadequate ICT infrastructure and limited support. The findings underscore the impact of relevant training on staff embracing Lib 4.0 technologies.

Originality/value – The study then proposes a comprehensive model, highlighting the significance of librarians adopting a growth mindset and priori V Btizing continuous learning, relearning, reskilling and upskilling to effectively navigate the complexities posed by the 4IR.

Keywords Library 4.0, Fourth Industrial Revolution, Global Competitive Index (GCI), Socio-Technical Theory (STT), Artificial intelligence (AI), Academic library in Africa

Paper type Research paper

1. Introduction

The evolution from the First Industrial Revolution to the Fourth Industrial Revolution (4IR) has given rise to Lib 4.0 in library and information science, profoundly impacting libraries (Ahmat and Hanipah, 2018).

The 4IR is characterized by a fusion of technologies that blur the lines between the physical, digital, and biological spheres (Schwab, 2016). Building on the digital revolution of the Third Industrial Revolution, 4IR introduces novel technologies such as artificial intelligence, complex sensors, the Internet of Things (IoT), cognitive computing, virtual reality, big data, 3D printing, cloud computing, and advanced robotics (Labangon and Manabat 2018). Correspondingly, the concept of Library 4.0 (Lib 4.0) aligns with the stages of the industrial revolutions, evolving from Lib 1.0 to Lib 4.0 (Schwab, 2016). Lib 4.0 is marked

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by the integration of 4IR technologies into library services to create smart libraries, including the use of artificial intelligence, big data tools, virtual reality, IoT, and other advanced technologies to enhance information provision and library services (Kamble *et al.*, 2018; Ayinde and Kirkwood (2020). Recent studies have highlighted the importance of Lib 4.0 in preparing libraries for the challenges of the 4IR and the need for librarians to develop new skills to effectively utilize emerging technologies (Band, 2024). Coined by Noh (2015), Lib 4.0 reflects the changing nature of the internet and attributes unique to libraries. Lib 4.0 involves technological environments creating virtual spaces for intelligent libraries, where machines analyze users' information needs. In the 4IR era, librarians must acquire critical thinking and creativity skills to meet evolving patron demands (Ahmat and Hanipah, 2018; Mauro *et al.*, 2017). While concerns about potential redundancy arise with 4IR technologies like AI and robotics, Manda and Dhaou (2019) view it as an opportunity for substantial library growth, noting a disparity in 4IR adoption between Western and developing countries (Moyo, 2019).

2. Problem statement

Studies such as Manda and Dhaou (2019), as well as Petrillo *et al.* (2018), reflect on the future, challenges, and opportunities of Lib 4.0 focusing mostly on advanced countries. Limited studies on the readiness of African academic libraries for 4IR exist. As this transition is critical for Ghanaian and South African academic libraries, it would be important to know the level of their preparedness. If readiness (or lack thereof) towards the digital transformation in the 4IR can be determined and a holistic picture of the current situation can be projected, necessary actions to be taken might be identified. This will enable academic libraries to prepare adequately in diverse ways to face the disruptive changes of the 4IR otherwise they will be in danger of becoming redundant. At the World Economic Forum in Davos, Switzerland, Klaus Schwab explicitly divulged that the impact of 4IR will hit research and libraries (Ocholla and Ocholla, 2020). Despite this assertion, limited research has been done to reflect the true picture of how academic libraries are coping and preparing for the disruption in Africa.

The selection of countries and cases in this comparative study was deliberate. Ghana and South Africa were chosen as they are among the two most technologically advanced countries in West and Southern Africa, respectively. This selection allows for exploration of the impact of technological advancements on academic libraries in these regions.

The University of Ghana and the University of Cape Coast in Ghana, the University of Johannesburg, and the University of Cape Town in South Africa were selected due to their strong technological infrastructure and innovative library services. This selection enables examination of the experiences of librarians in institutions at the forefront of technological adoption.

This study stands out by conducting cutting-edge research, directly engaging professional academic library staff for practical insights distinguishing it from prevalent desktop research in the literature. Addressing a gap in mixed-method approaches for African academic libraries, the study provides detailed empirical evidence. It caters to academic library management, information practitioners, policymakers, governments, and stakeholders, aiming to inform them about the Fourth Industrial Revolution's impact. Beyond assessing 4IR readiness, the study lays the groundwork for investigating the potential 5th Industrial Revolution, emphasizing staying relevant in the digital transformation era.

3. Research questions

The study was based on the following research questions.

(1) What Lib 4.0 skills and competencies are possessed by academic librarians in Ghana and South Africa for the 4IR?

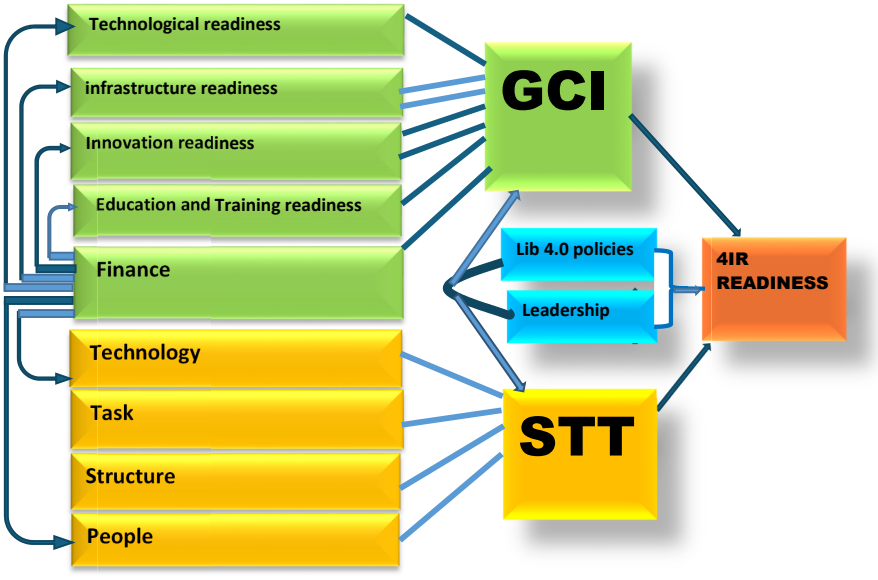
(2) Which policies are in place for disruptive changes in academic libraries in Ghana and South Africa?

(3) What challenges are faced by Ghanaian and South African academic libraries in incorporating the 4IR technologies?

4. Theoretical perspectives

The study's conceptual model (Figure 1) integrates two theoretical frameworks: the Global Competitive Index (GCI) and Socio-Technical Theory (STT). The GCI, developed by the World Economic Forum, assesses a country's competitiveness based on 12 pillars, however, based on the research objectives and the present focus of this research on academic libraries, the researcher chose to consider the following four constructs of Innovation which include Infrastructure, Technological Readiness, and Higher Education and Training as critical to this study which are grouped into three subindexes: Basic Requirements, Efficiency Enhancers, and Innovation and Sophistication Factors (Schwab, 2019). For this study, five constructs from the GCI are relevant: technological readiness, infrastructure readiness, innovation readiness, education and training readiness, and finance (Chan and Chan, 2018; Taskinsoy, 2019; Babalola and Raji, 2018). These constructs represent the foundational elements necessary for academic libraries to thrive 4IR.

The Socio-Technical Theory (STT) complements the GCI by examining the interplay between technological, social, and organizational factors. STT posits that successful technological adoption depends on the alignment of four variables: technology, task, structure, and people (Mumford, 2006; Carbone and Burgess, 2008; Manda and Dhaou, 2019). In the context of academic libraries, this means that librarians, library administrators, and stakeholders must work together to ensure that technological innovations are effectively integrated into library operations, services, and policies.



Source(s): Figure courtesy of Bostrom and Heinen (1977) and Sala-I-Martin *et al*. (2015)

Figure 1.
Proposed model to measure the readiness of the 4IR

The conceptual model suggests that academic libraries must achieve a high score in the GCI constructs, adequately prepare the STT factors, and develop Lib 4.0 policies (Ahmadian, 2019; Ahmat and Hanipah, 2018) to successfully navigate the 4IR. Additionally, innovative leadership is crucial to drive this transformation (Tella, 2020a). By integrating these theoretical perspectives, the study provides a comprehensive framework for understanding the complex factors that influence academic libraries' readiness for the 4IR.

5. Literature review

The literature review was based on the following sub-themes:

5.1 Academic librarian's IT skills and competencies for 4IR technologies

The Fourth Industrial Revolution (4IR) necessitates librarians to acquire new skills for evolving information needs (Hussain, 2019; Tait *et al.*, 2016). The University of Calgary (2020) and Schwab (2016) recommend curricular reviews. Manda and Backhouse (2017) emphasize innovation and technological proficiency, while Ahmat and Hanipah (2018) stress librarians' analytical skills with large data. Gleason (2018) identifies essential 4IR skills: cognitive flexibility, emotional intelligence, problem-solving, critical thinking, creativity, and people management. Ocholla and Ocholla (2020) concur, highlighting problem-solving, critical thinking, creativity, collaboration, emotional intelligence, and decision-making for information professionals in the 4IR.

Raju's (2017) study on library competency in Cape Town concluded that information professionals need new skills for the Fourth Industrial Revolution (4IR). Saunders (2020) identifies high-demand skills in US academic libraries amidst digital transformation, emphasizing the need for preparation. Tella (2020a) stresses continuous training for library professionals and patrons to master 4IR skills, as highlighted by Chang's (2019) prediction that 77% of future jobs will require new technology skills. Ocholla and Ocholla's (2020) study on South African academic libraries echoes the importance of acquiring 4IR skills for teaching, research, and learning support, aligning with similar findings by Adetunla and Chowdhury (2023), Hussain (2019), Tembe and Mkhathali (2021), Butler-Adam (2018), and Tella (2020b).

5.2 Challenges faced by academic libraries in incorporating the (4IR)

Although the 4IR is bringing tremendous opportunities, several challenges might be experienced, and, to minimize the disruptive changes, these challenges need to be addressed. The challenges are as follows:

5.2.1 Inadequate funds. Studies by Opele (2018), Anyim (2018), and Acheampong (2016) highlight insufficient funding as a primary hurdle hindering the adoption of modern technologies in Nigerian and Ghanaian academic libraries. Ahenkora-Marfo and Osei-Bonsu (2013), along with Abban (2018), reveal financial constraints in Ghanaian academic libraries, impeding their readiness for the Fourth Industrial Revolution (4IR). In South Africa's KwaZulu-Natal, Mugwisi *et al.* (2018) find limited funding as a critical obstacle for embracing 4IR technologies. Cronje (2018) and Oke and Fernandes (2020) further emphasize the challenge of limited funding in South Africa, impacting the integration of 4IR in teaching and learning.

5.2.2 Insufficient ICT infrastructure. Mphidi's (2016) work on South African public libraries emphasizes the need for strategic approaches to bridge the digital divide, revealing a lack of attention and limited ICT infrastructure hindering library development. Similarly, Mashiyane *et al.*'s (2020) study at North-West University highlights insufficient ICT infrastructure as a barrier for academic libraries in South Africa, especially during events like COVID-19. Ocholla and Ocholla (2019) and Manda and Backhouse (2017) found that a

lack of ICTs, low broadband connectivity, and inadequate hi-tech devices impede the transition to smart societies, particularly in libraries. Khan and Bhatti's (2017) study in Pakistan and Ghanaian studies by Antwi *et al.* (2020) and Ankrah and Atuase (2018) corroborate these findings, linking inadequate ICT infrastructure to challenges in implementing new digital library services.

5.2.3 Inadequate training. Zervoudi's (2020) and Gleason's (2018) studies emphasize the inadequacy of advanced IT skills among African academic library professionals during the Fourth Industrial Revolution (4IR). Training is identified as crucial for upskilling and reskilling. Butler-Adam (2018) highlights the importance of human factor development in utilizing 4IR technologies effectively. Ankrah and Atuase (2018) stress the responsibility of academic libraries to keep pace with technological advancements but note financial constraints hindering staff training. Ocholla and Ocholla (2019) and Manda and Dhaou (2019) underscore the necessity for continuous training among South African academic librarians to navigate disruptive technologies in library services.

5.2.4 ICT skills gap. Oyewumi *et al.* (2018) highlighted the ICT skills gap in selected universities in Kwara state, Nigeria, underscoring the broader challenge faced by academic libraries in Africa. Building on this, various authors (Adetunla and Chowdhury, 2023; Ocholla and Ocholla, 2019, 2020; Hussain, 2019; Manda and Dhaou, 2019; Ahmat and Hanipah, 2018) have advocated for the swift acquisition of new skills and the implementation of Lib 4.0 technologies to ensure the relevance and competitiveness of academic libraries.

Ayoku and Okafor's (2015) analysis of ICT skills in Nigerian university libraries revealed barriers to leveraging advanced technologies, including a lack of interest, fear, inadequate knowledge, and insufficient training. Mashiyane *et al.* (2020) and Anyim (2018) echoed these findings, emphasizing the absence of training in ICT technologies for digital transformation. Khan and Raad (2020) highlighted the importance of e-learning during the COVID-19 crisis but stressed that a lack of technical skills could impede success. Ali and Gatiti (2020) urged academic libraries to upgrade with innovative technologies.

5.2.5 Lack of institutional support. The library, central to academic institutions, faces challenges due to insufficient institutional support (Sassen and Wahl, 2014). This hampers the implementation of technological innovations. Saxena and Dubey's (2014) study on academic libraries in India highlights the consistent lack of financial and infrastructure support. Mashiyane *et al.* (2020) support this, emphasizing the hindrance posed by inadequate institutional support in incorporating modern technologies. Acheampong and Dei (2020) and studies by Ntlotlang (2019) and Oakleaf (2010) concur, underscoring the difficulties faced by academic libraries in realizing their goals due to a lack of support.

5.3 Available policies towards Lib 4.0 technologies and application

Manda and Dhaou (2019) emphasize the need for well-crafted policies to guide institutions in adapting to the smart industrialization era. Zervoudi (2020) concurs, underscoring the importance of innovation policies for information professionals and academic libraries to thrive in the technological revolution. Jantz (2017, p. 324) notes the insufficient attention given to library management innovations for transformation in a fast-paced environment. Regular revision of library policies, including budgets for Lib 4.0 technologies, is crucial. These policies inform university leaders, policymakers, and library users, fostering understanding and support.

6. Methodology

The study utilized a convergent parallel mixed methods approach, blending qualitative and quantitative research perspectives from post-positivism. The convergent parallel mixed

method allows the researcher to integrate both qualitative and quantitative data in a single study. Concerning this type, both qualitative data and quantitative data are gathered concurrently or simultaneously and this process is also known as triangulation. In effect, it gives the researcher the leeway to compare both data where one serves to complement the other with the original intent of obtaining an all-inclusive understanding of the research problem under investigation. Questionnaires gathered data from technologically influenced librarians, and IT staff impacting library decision-making. Out of 203, 167 respondents (82% response rate) were obtained from the University of Ghana Balme Library, Sam Jonah Library in Ghana, the University of Johannesburg Library, and the University of Cape Town Library in South Africa. Additionally, four (4) library directors, one from each university were interviewed. See Table 1 below. SPSS and Excel analyzed quantitative data, while thematic data analysis was applied to qualitative data from interviews.

7. Analysis and discussion of major findings

The analysis was based on the following themes:

7.1 IT skills and competencies

Skills in this context refer to the specific IT skills and competencies, including technical, digital, thinking, personal, and data analysis abilities, that library staff must acquire to remain relevant and adapt to the technological innovations of the 4IR. The 4IR necessitates library staff to acquire new skill sets, as projected by the World Economic Forum's Future of Jobs Report (Schwab, 2018). To stay ahead of technological innovation and remain relevant, library staff must possess specific IT skills and competencies. A summarized data is demonstrated in Tables 1 and 2 which was based on the following 4IR Skills and competencies: Technical IT skills, Digital IT skills, Thinking skills, Personal skills, and Data analysis.

Table 1.
Study population

Countries	Libraries by countries	University librarian (Head)/Director	Deputy librarians and librarians	IT staff	Total
Ghana	University of Ghana	1	41	1	43
	University of Cape Coast	1	49	9	59
South Africa	University of Cape Town	1	45	12	58
	University of Johannesburg	1	44	2	47
Total		4	179	24	*207*

Table 2.
Overall IT skills of librarians – Ghana (N = 96)

Ranking of responses	Score ranges	Freq	Percentage (100%)
Low level of IT skills and competencies	65 and below	60	62.5
Moderate level of IT skills and competencies	66–93	36	37.5
High level of IT skills and competencies	94–135	–	–
Total		*96*	*100*

Source(s): Authors' own creation

The overall librarian's knowledge, skills, and competencies for each country were put together to obtain a general result. This was done by summing up the number of items.

The breakdown is shown below.

Number of items = 26

Likert scale used were; Very High = 5, High = 4, Moderate = 3, Low = 2, Very low = 1

E.g. If an individual respondent should score 5 throughout, the total score will be the number of items × 5

Therefore, = Very High = 26 × 5 = 130, High = 26 × 4 = 104, Moderate = 26 × 3 = 78, Low = 26 × 2 = 52 and Very Low = 26 × 1 = 26.

All individual results based on the Likert scale were computed and the results are shown in Tables 1 and 2.

Table 2 shows the overall responses from Ghana on the level of IT skills and competencies needed in the 4IR. The overall impression shows that (62.5%) out of the total respondents from Ghana have a low level of knowledge of IT skills and competencies needed for the 4IR and 36 (37.5%) indicated a moderate level of knowledge. As depicted in Table 3, 48 (67.6%) out of the total respondents from South Africa have a moderate level of IT skills and competencies needed for the 4IR, and 23 (32.4%) have a low level of competency. It can be inferred from these results that, there is a need for library staff to go through education training, and retraining to acquire the necessary new skillset needed for them to utilize Lib 4.0 technologies and applications.

Comparing both results, it is realized that academic libraries from both Ghana and South Africa need to organize relevant continuous intensive education and training programs for their library staff with the prime intent of helping them gain the new skills needed to stay relevant in the 4IR era. This finding supports the study by Tella (2020a) who found a mismatch of skills and the lack of required IT skills and competencies which negatively impacted the growth of the libraries. The finding is also in line with Chang (2019) indicating that most libraries lack the required skills needed for the era of 4IR, given that library staff should be exposed to new IT skills including coding skills, spreadsheets, and digital platforms. This study recognized that there is a need for an academic library to take a cognizant view of the kind of training and skills they are enrolling library staff and patrons in to secure a better position to leverage from the disruptive changes of the 4IR and to stay relevant.

The study supports Butler-Adam's (2018) and Hussain's (2019) proposal that preparing for the Fourth Industrial Revolution (4IR) requires information professionals and patrons to acquire the right skills. Consequently, there's a call to review academic curricula and integrate more 4IR skills to minimize additional training. Tembe and Mkhathali (2021) advocate for academic libraries to adopt a futuristic approach, adjusting training programs and job descriptions to meet the 4IR demands, encompassing ICTs, communication, marketing, public relations, and research skills.

8. Challenges to incorporating the 4IR technologies in academic libraries

This section sought to determine challenges experienced by academic libraries in the quest to incorporate 4IR technologies and applications.

Ranking of responses	Score ranges	Freq	Percentage (100%)
Low level of IT skills and competencies	65 and below	23	32.4
Moderate level of IT skills and competencies	66–93	48	67.6
High level of IT skills and competencies	94–135	–	–
Total		*71*	*100*

Source(s): Authors' own creation

Table 3. Overall IT skills of librarians – South Africa ($N = 71$)

8.1 Insufficient budget

Respondents were first asked about the insufficient budget for ICT infrastructure and network facilities. It was found that a total of 37.8% of Ghanaian respondents agree (23.4% Agree; 14.4 Strongly agree). The majority (21.6%) of South Africans disagreed, while 10.2 and 8.4% agreed and strongly agreed.

The finding of the study shows that both Ghanaian and South African academic libraries have insufficient and limited budgets for new ICTs. Financial handicaps have deprived academic libraries of deploying modern technologies such as robotics, Blockchain technology, Makerspace, big data, and virtual reality. Statistically, academic libraries in Ghana (37.8% out of 57.5%) are more affected than in South Africa (21.6% out of 42.6%). Also, one of the library heads acknowledged:

> We have a lot of funding issues. These new technologies are quite expensive getting money to acquire some of these latest technologies has not been easy. Budgetary allocation for such technology has been tough.

This trend is consistent with Opele (2018) as well as Abban (2018), Acheampong (2016), and Ahenkora-Marfo and Osei-Bonsu (2013) who reported inadequate funding in academic libraries in Nigeria and Ghana respectively as the fundamental obstacle to the advancement in modern technology. Cronje (2018), Hussain (2019), as well as Penprase (2018), concluded that most academic libraries are currently ill-prepared for the disruptive changes of the 4IR. Even though South Africa is known for championing the incorporation of 4IR technologies in Africa, the work of Oke and Fernandes (2020) confirmed that they are weighed down by limited funding in their effort to implement innovation strategies toward 4IR. By extension, this finding implies that as academic libraries are already saddled with financial constraints, they are also not able to implement innovative strategies that could help attract funds from stakeholders.

This finding connotes that academic libraries do not have effective mechanisms to mobilize funds to support the incorporation of 4IR technologies into library services. In effect, it will impact library staff since there will be insufficient funds to motivate them, as well as education training, and technological readiness.

8.2 Inadequate ICT infrastructure and network facilities

Regarding inadequate ICT infrastructure and network facilities, the majority (39.6%) of the respondents from Ghana either agreed or strongly agreed. Unlike Ghana, responses from South Africa show that the majority (40.9%) disagreed. It can therefore be deduced that budgets for ICT infrastructure and network facilities are inadequate in all libraries, but that it is a bigger issue in academic libraries in Ghana.

One of the library heads from South Africa lamented that:

> The second challenge is having adequate and right sort of hardware and software to be able to incorporate 4IR technologies and stable Wi-Fi connectivity with adequate bandwidth.

Another library head from Ghana underscores the necessity for support from IT suppliers by saying:

> Lack of IT support from suppliers is another issue.

These findings align with Manda and Backhouse (2017) and Khan and Bhatti (2017), who predicted challenges in implementing Lib 4.0 technologies due to inadequate ICT infrastructure. Antwi *et al.* (2020), Mashiyane *et al.* (2020), as well as Ocholla and Ocholla (2019), concur that some academic libraries in Ghana, South Africa, and Malaysia faced challenges, resorting to borrowing ICTs and devices to offer smart services to patrons.

Considering the GCI infrastructure, Noh (2015) and Adarkwah (2020) underscored that infrastructure is crucial for academic libraries to navigate 4IR disruptions, emphasizing the need for high scores in internet, telecommunication devices, computers, and accessories.

8.3 Inadequate training

Inadequate training in ICT applications and emerging technology is a big issue facing academic libraries. Respondents were asked to respond to the statement about inadequate training. The majority of the Ghanaian respondents (39%) were in agreement. Likewise, 31.2% of respondents from South Africa agreed and strongly agreed. These results are indications that all libraries in both countries need more training on new ICT applications and technologies. This finding is consistent with Ankrah and Atuase (2018) who concluded that numerous academic libraries in Africa, due to inadequate funds, do not prioritize training and retraining of library staff to attain the necessary skillsets demanded by the 4IR.

This finding aligns with Ocholla and Ocholla (2019), Manda and Dhaou (2019), and Gleason (2018), who all highlight the detrimental impact of the lack of continuous training on academic libraries in the Fourth Industrial Revolution (4IR). To address this challenge, academic libraries should explore alternative, cost-effective methods like online conferences, webinars, information literacy programs, and workshops for training initiatives. From the Global Competitiveness Index (GCI) standpoint, it implies that academic libraries face financial constraints in organizing sufficient 4IR training programs. It also suggests a lack of innovation or interest in 4IR technologies among library leaders, coupled with disinterest from individual libraries in utilizing available 4IR-related training programs.

8.4 Lack of ICT skillset

Data was solicited on the issue of the lack of an ICT skillset needed to utilize Lib 4.0 technologies. The findings show that the majority (38.3%) of respondents from Ghana agreed and strongly agreed. In contrast, only 22.5% of respondents from South Africa agreed, while nobody agreed strongly. This depicts that there is more room for improvement in ICT skills needed by academic librarians in Ghana to utilize Lib 4.0 technologies as compared to their counterparts from South Africa.

One of the library heads from South Africa said:

> There is a skillset gap and if we want to function in this environment, then librarians need to increase their technical skills in areas such as information systems and programming skills because it is a natural progression. If we are going to be embracing these new tools in this environment, we need to have a new skill set.

Another library head from South Africa confirmed this by stating:

> We definitely have a lack of skills because people lack the underlying skills. Very often, skills of the third industrial revolution. It makes it more difficult to upskill people to be able to use 4IR technologies.

Reducing these issues is crucial as competitors like Google may take over professional librarians' roles. This aligns with Ayinde and Kirkwood's (2020) finding of a skill mismatch in the Fourth Industrial Revolution (4IR). Mashiyane *et al.* (2020), Khan and Raad (2020), and Anyim (2018) identify insufficient skills as a critical challenge hindering academic libraries from adapting to Lib 4.0 disruptive technologies. Despite innovative strategies and management readiness, academic libraries must address this by training and retraining staff in 4IR-relevant skills (Ocholla and Ocholla, 2020; Hussain, 2019; Manda and Dhaou, 2019; Ahmat and Hanipah, 2018). Additionally, conducting library staff skills audits, as advocated

by Ntlotlang (2019), is crucial to identify strengths, abilities, and skills gaps for a comprehensive understanding of library staff competencies.

The 4.0 skills gap poses a significant challenge to academic libraries' success in the 4IR. The STT and GCI frameworks highlight the importance of librarians possessing the right skill sets to effectively adopt and utilize Lib 4.0 technologies, even with adequate technological, infrastructural, and financial resources. Therefore, academic libraries must prioritize training and upskilling their staff to meet the demands of the 4IR.

8.5 Lack of support from authorities

Data gathered shows the results gathered regarding the lack of support from authorities for implementing ICT applications in the library. The majority of the respondents from Ghana (66) agreed and strongly agreed, while only twenty from South Africa agreed and strongly agreed.

One of the directors from Ghana said:

> Management support is another challenge. Some of the management thinks these 4IR technologies are a waste of money. They do not understand the value. Given constant training and alignment of these emerging 4IR technologies will be relevant.

This finding suggests that academic libraries in Ghana need support to implement Lib 4.0 technologies and applications.

This aligns with Mashiyane *et al.*'s (2020) study, revealing that insufficient institutional support is a major challenge for academic libraries. Acheampong and Dei (2020) echo this sentiment, emphasizing the hindrance caused by a lack of institutional support in achieving 4IR goals. Ntlotlang (2019) suggests proactive lobbying by academic librarians to secure backing from top management and other potential funding sources. This highlights the need for improved structures, policies, negotiation skills, and effective fundraising strategies in academic libraries to garner support for 4IR initiatives.

9. Available Lib 4.0 policies

The study underscores the significance of library policies in guiding academic libraries, particularly regarding the adoption of Lib 4.0 technologies. It reveals that not all participating academic libraries have comprehensive policies addressing Lib 4.0 technologies and applications, indicating a potential gap in strategic guidance for investing in these technologies. This was also confirmed by the library director from South Africa stating:

> . . . we don't have a particular policy on 4.0 but we've got policies around. Only policy in line with Lib 4.0 is in line with circulating policies. We used to take cash. Now we do not take any cash. Everything is on the app, so in that way, our policy has changed.

With the future possibility of the inclusion of Lib 4.0 technologies in mind, the extent of the review of the general policy was further assessed. The study found that academic libraries have attempted to periodically review their general policies to include 4IR. This was also confirmed by one of the directors from Ghana who said:

> Fortunately, we have the opportunity to develop a library policy or say revised policy for the library. We are trying to incorporate some of these technologies into the library policies and let the library board and academic board understand the need to adapt and spend on these 4IR technologies. We are waiting for approval and one advantage is that when we have 4IR technologies incorporated into the library policies, it is easy to get support from the management.

The data signals a positive inclination towards Lib 4.0 technologies, yet academic libraries are urged to integrate these technologies to ensure relevance and productivity during the 4IR. The study recommends the reconstruction of policies to align with the skills required in the digital era, along with allocating sufficient financial resources for 4IR technologies, adopting new business models, and updating job descriptions.

10. Conclusion

World Economic Forum in Davos, Switzerland, in 2016, where the concept of the Fourth Industrial Revolution (4IR) was coined by Klaus Schwab, with the reference that it would be building on "the Third, the digital revolution" and would be "characterized by a fusion of technologies that is blurring the lines between the physical, digital, and biological spheres".

The 4IR involves a convergence of technologies, urging academic libraries to undergo digital transformation for continued relevance. The study identified a 4.0 skills gap among library staff, emphasizing the necessity of acquiring these skills to thrive in the 4IR. The study revealed that training programs influence library staff's interest in and utilization of newly adopted technology, aligning with the digital transformation agenda.

Efforts to integrate Lib 4.0 technologies in response to 4IR disruptions face significant obstacles, primarily stemming from insufficient budget allocation, inadequate ICT infrastructure, lack of necessary skills and training, absence of support from authorities, and the absence of Lib 4.0 policies.

The study initially proposed that the Global Competitiveness Index (GCI) and Socio-Technical Theory (STT) can be used to determine academic libraries' readiness for the Fourth Industrial Revolution (4IR). The findings highlight the relevance of GCI and STT in assessing 4IR readiness. However, the study emphasizes that Lib 4.0 policies and innovative leadership significantly contribute to this readiness. Academic libraries must, therefore, cultivate innovative leaders with an interest in 4IR technologies and formulate Lib 4.0 policies to attract financial support and align library focus with 4IR demands for successful adaptation amid digital disruptions.

11. Contributions and originality of the study

The 4IR in academic libraries seeks to create an intelligent library and respond to disruptive changes. Study results and literature emphasize the crucial integration of **Technoware** (4IR technologies, applications, and innovation), **Financeware** (funding source and allocation for 4IR), Humanware (staff skills, knowledge, attitude, and innovative leadership), **Patronware** (digital literacy programs and 4IR curriculum), **Orgaware** (structure, tasks, Lib 4.0 policies, procedures, collaboration, network, and change management), and **Infoware** (information access, usage, and interconnectivity) for holistic 4IR preparation. Figure 2 provides a guide and outlines proposed strategies by the researcher for academic libraries to navigate 4IR complexities and anticipate advancement.

12. Recommendations

To navigate the challenges of 4IR, management, and stakeholders should prioritize ongoing training in 4IR technologies, establish Library 4.0 policies, and focus on fundraising through lobbying, advocacy, collaboration, and innovative leadership. Additional strategies include investing in new ICT, developing Curriculum 4.0, fostering digital literacy for patrons, promoting Library 4.0 services, creating journals for 4IR researchers, and establishing a center for research and innovation in 4IR.

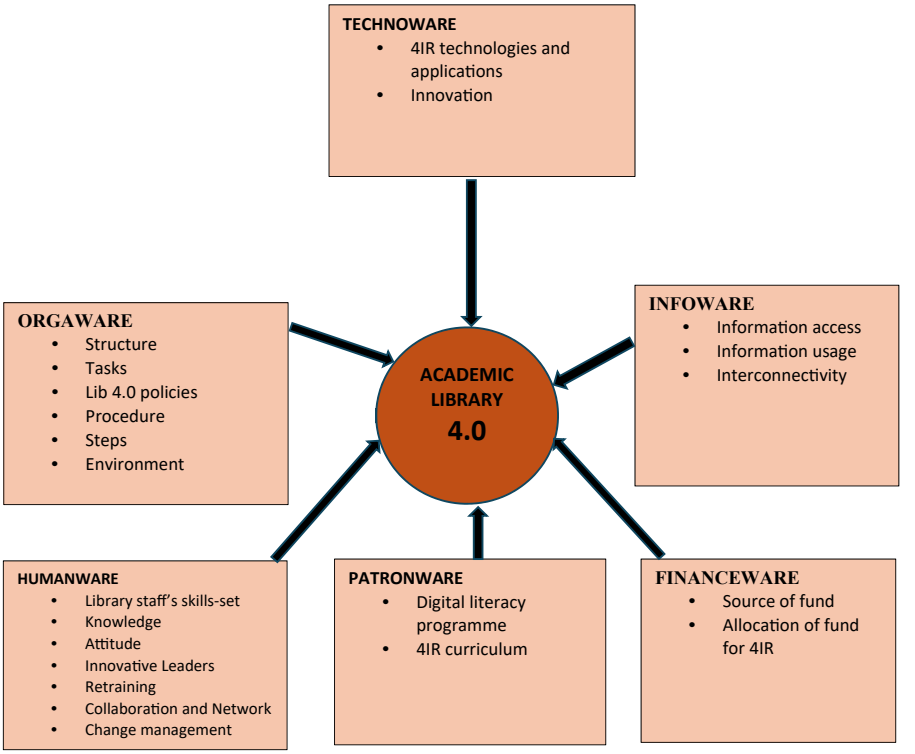


Figure 2.
Guidelines to assess the readiness of academic libraries for 4IR disruption world economic forum in Davos, Switzerland, in 2016, where the concept of the Fourth Industrial Revolution (4IR) was coined by Klaus Schwab, with the reference that it would be building on "the third, the digital revolution" and would be "characterized by a fusion of technologies that is blurring the lines between the physical, digital, and biological spheres"

Source(s): Authors' own creation

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