Disruptive changes in the role of academic libraries and librarians: a case study of a university of technology in South Africa

Anushie Moonasar and Mpho Ngoepe

Anushie Moonasar
Library, Durban University of Technology
anushiem@dut.ac.za
ORCID: 0000-0001-7885-3597

Mpho Ngoepe
Department of Information Science, University of South Africa
ngoepms@unisa.ac.za
ORCID : https://orcid.org/0000-0002-6241-161X

Abstract

Due to the proliferation of disruptive technologies that drive the Fourth Industrial Revolution (4IR), academic libraries have experienced a transformation that has altered the responsibilities of academic librarians. With disruptive technologies, library services can be accessed from anywhere in the world, provided that there is Internet access. Digital libraries, online databases, and electronic resources have enabled users to access a wide range of information. For academic librarians to not be left behind, they need to skill themselves to be relevant in the 4IR. This study, which utilised an explanatory mixed-method approach, aimed to explore how the evolving role of academic librarians can be shaped through continuous professional development at the Durban University of Technology (DUT). Quantitative data was collected first through online questionnaires due to the COVID-19 pandemic, followed by qualitative data through face-to-face interviews with selected participants. Parallel sampling was used in terms of which all librarians at the DUT were chosen for the quantitative phase of the study, while for the qualitative phase to augment the quantitative data, participants were interviewed to the level of saturation. Due to disruptive technologies, the key findings suggest a move towards open access, revitalisation of library spaces, makerspace equipped with the latest technologies such as virtual reality, changing the circulation desk into an information desk, using self-checkout machines, RFID, chutes, and creating neutral spaces to enhance inclusiveness. To counter the disruption,

academic librarians at DUT have embraced continuous professional development to update their knowledge and skills to allow them to evolve and adapt to changes within their profession.

Keywords: Academic libraries, disruptive technologies, Fourth Industrial Revolution, 4IR, South Africa, Durban University of Technology

Introduction

Due to the proliferation of disruptive technologies that drive the Fourth Industrial Revolution (4IR), academic libraries have undergone an evolution that has also changed the role of academic librarians. The new technological innovations have left a mark on every profession with their impact on changes in the way people work. Unsurprisingly, academic institutions and libraries are also affected by these innovations, such as various library automation and integrated management software, digital libraries and electronic resources, open-source software, and radio frequency identification (RFID) technology. The 4IR has impacted and transformed the way academic librarians interact and serve their users, resulting in new roles and responsibilities (Chigwada and Chisita 2021: 3). With the transformation and changes in jobs, different sets of knowledge and skills are required to ensure that productivity levels and services to the users are not affected. According to Llewellyn (2019: 133), librarians have always been proactive in terms of technological changes and early adopters of new ways of working within the library.

Academic libraries and librarians' responsibilities in institutions are to provide resources to support university teaching and learning efforts and to improve the university research agenda. As a result, academic librarians must ensure that they can meet their institution's ever-changing needs (Llewellyn 2019: 132). As suggested by Tella, Akande and Bamidele (2018: 4), academic librarians need to ensure that they can provide, organise, manage, and disseminate library resources to satisfy the user needs and assist in supporting the academic faculties. There is no doubt that librarians are resilient and able to accommodate changes within their environment. This is supported by Wong and Chan (2018: 108), who point out that librarians have witnessed the changes brought about by technology since the days of card catalogues and, over time, the automation of library services, which have, for example, led to the implementation of new methods for enhancing the discoverability of information resources through the application of international metadata standards. In the current environment, librarians face more changes as 80% of library resources are now digitised and available online. The digital sphere has significantly transformed the mode of interaction between the library and its users, making it imperative for libraries

to adapt to digital advancements in their services and engagement strategies.

This study explored the changing role of academic librarians at the Durban University of Technology (DUT) Library in South Africa. The DUT Library is a multi-campus library with six campus sites in the KwaZulu-Natal province. It was established in 2002 as a result of the merger of the former Technikon Natal and the ML Sultan Technikon. During the state-imposed lockdown caused by COVID-19, access to online resources at the DUT Library increased rapidly. Librarians had to quickly adapt to online methods of reaching out to users. Face-to-face interaction ceased, and librarians were forced to adapt to new ways of working while still providing services to users. This meant new ways of operating, and librarians needed to learn new skills to provide a competent service to users. The DUT library incorporated RFID tags and technology, prompting circulation staff to adapt to its integration into their daily operations. Additionally, the implementation of the integrated library system called FOLIO (Future of Libraries is Open) necessitated several adjustments to the staff's current workflows. These new systems are part of the library's strategic transformation within the information, communication, and technology (ICT) domain. The establishment of a makerspace at one of the site libraries demonstrates the DUT Library's commitment to evolving with technological advancements. Makerspaces serve as a creative and collaborative environment where users can engage with technology, fostering a conducive space for learning and entrepreneurial exploration (Ahmat and Hanipah 2018: 59).

Problem statement

The evolving technological changes and the forced COVID-19 lockdowns imposed by the state compelled the DUT librarians to adopt new ways of working. Librarians were used to face-to-face interactions with users but with the pandemic, they were forced to resort to online interactions. This was a change in the usual way of working that needed adapting to new ways of service provision to users. Limited information exists regarding the direct influence of disruptive 4IR technologies on academic librarians within the context of South Africa. The roles and responsibilities of librarians have changed as a result of ongoing technological innovations and changes, and it is essential that librarians continue to develop and maintain their skills and competencies in responding to the changing needs of users and the environment. Hence, librarians are expected to be flexible and adaptive to changes in the library sector. The study objectives address the transformation of the DUT library in the context of technological advancements associated with the 4IR and attempt to provide insights into how the DUT librarians effectively navigate around these changes to continue providing valuable services to the users. The research objectives explored in this study were to:

- Determine how the roles and responsibilities of academic librarians have evolved in view of disruptive technologies that drive 4IR.
- Identify skills and competencies that may help academic librarians transform with the impact of innovation and technologies.
- Establish the effects of the 4IR on the roles of academic librarians in the changing information environment.
- Suggest a framework for aligning the roles of academic librarians to the 4IR.

Literature review

This section reviews the scholarly literature in terms of the themes emanating from the objectives of the study.

Evolving roles of academic librarians

With the increase in digitisation and online resources, the impact on how librarians interact and disseminate information to users underwent a complete transformation (Llewellyn 2019: 140). The increase in online resources led to various changes within the librarians' usual workflow. Academic librarians found themselves more involved with scholarly activities such as open educational resources and datasets, and the management of research data. They are now directly involved with researchers from the beginning of the research process, and libraries are encouraged to promote publishing initiatives. Academic librarians are now expected to curate digital content from physical resources to make the resources discoverable and accessible to users. They provide various bibliometric services to users and ensure that past information resources are digitised and accessible online for users (Llewellyn 2019: 140).

According to Jantz (2012: 3), libraries cannot remain static, and librarians must embrace new innovations that allow them to evolve and respond to changing user needs. Apriliyanti and Ilham (2022: 5) allude to the fact that libraries have transformed from providing conventional face-to-face information to users in the library to providing them with online accessibility to most of the information resources. Users no longer need to physically visit the library for information as the information and library resources are now available online and can be accessed remotely. The transformation of librarians' roles began when technology and the automation of libraries started. The emergence of the Internet and the development of online databases in the 1980s and 1990s revolutionised the way information was accessed and shared, leading to the start of the digitisation of many library resources. The entire process and functioning of libraries have evolved in terms of how the library collection is procured,

processed, catalogued, and organised for user retrieval. Apriliyanti and Ilham (2022: 15) describe how the focus in libraries changed from the mere provision of information to users to now becoming collaborative and creative spaces that encourage users to discuss and collaborate within these spaces. This shift in focus within libraries from the traditional role of providing information to fostering collaboration and creativity can be attributed to many factors, including the transformation in technology, changing user expectations, and the evolving role of librarians in the digital age (Apriliyanti and Ilham 2022: 15). Libraries are no longer silent hubs, but rather a place that now provides various services that promote digital initiatives and scholarly publishing. In addition, the 4IR has introduced new ways of working within libraries and information sectors. Libraries have embraced various technologies and innovative tools to enhance user experiences and collaborative learning, including interactive learning technologies, makerspaces, and multimedia production facilities (Ahmat and Hanipah 2018: 59). The inception of the Internet of Things (IoT) has allowed machines, humans, and data to connect and interlink with each other. Machines can now operate independently or coordinate with human interaction and libraries have significantly transformed using these technologies (Apriliyanti and Ilham 2022: 8). Gupta and Singh (2018: 72) refer to the RFID technology used in libraries for automated tracking and management of library materials. Libraries often use digital signage and interactive displays to provide real-time information about library promotions and events. Machines can now operate autonomously or in collaboration with humans (Mohideen, Sheikh, Kaur and Sukmawatid 2022: 522). Furthermore, libraries are now using robots to shelve books, interact with users to obtain information, and users use self-check stations without the assistance of librarians. The University of Pretoria was the first university in South Africa to pioneer the use of a robot to assist users in finding information in a library setting (Olivier 2019).

With the influx of information from various digital sources, academic librarians play an essential role in teaching users information literacy (IL) and digital literacy (Ayinde and Kirkwood 2020: 148). They are actively involved in ensuring that the users and researchers always have easy access to the library resources and they empower users with the skills and knowledge to effectively navigate, evaluate, and use information. Academic librarians collaborate with faculties to integrate IL skills into the academic curriculum, ensuring that the users are equipped with the necessary research skills and competencies to succeed in their academic pursuits. Therefore, it is important that library collections are available online for easy retrieval. In addition to teaching IL, librarians are involved in assisting researchers in citation management and research and imparting the necessary skills required to navigate the digital and research landscape effectively (Mohideen et al 2022: 523).

Although the 4IR arrived with many positive impacts on the library environment, many challenges accompanied its arrival. Apriliyanti and Ilham (2022: 6) found that apart from the development of technology-based systems that allow the smooth operations of workflow and the quick turnaround time in accessing information, the 4IR exposes personal data and threatens intellectual property rights. With the increased availability of information and e-resources comes an increase in illegal copying and theft cases, as users can easily access and download information from various pirated sites. One example is the downloading and printing of e-books from various free websites (Hussain 2020: 4). The challenges of online transactions are often complex and include digital rights management restrictions, technical issues that users may encounter with slow download speeds, server errors, and compatibility issues with specific devices or e-reader applications. Additionally, users might have concerns about privacy and security issues when providing personal information online and this can impact their access to information from various sites. With the ease of access to information, many challenges have emerged, such as an increase in plagiarism cases, as it is now much easier to copy and paste work belonging to others and pass it as your own creation. The abundance of information has resulted in an information overload, making it difficult for users and people to distinguish between true and false information (Jantz 2012: 4). Librarians are crucial in helping users extract key information from the abundance of information available, as they use their expertise in employing various strategies and techniques to guide users in accessing reliable and relevant information. By actively listening and asking targeted questions, librarians can provide personalised guidance and recommend appropriate resources based on the unique and specific information needs of users.

Skills and competencies

Librarians are expected to be skilled in and knowledgeable of new innovations, and libraries are usually significantly impacted by the changes brought about by these innovations. Apriliyanti and Ilham (2022: 8-9) emphasise that to adequately respond to users' needs, librarians need to possess a wide range of skills and competencies, including digital awareness, strong leadership and communication abilities, and effective problem-solving skills. These skills are required to work with technology and users in a cohesive environment. According to Ghislieri, Molino, and Cortese (2018: 4), while robots and librarians can collaborate, robots and technology lack the interpersonal and soft skills that only a librarian can provide to users. It is essential that librarians have basic information technology skills to be able to understand emerging technology and high-speed Internet searches. Hamad, Al-Fadel and Fakhouri (2020: 3) maintain that librarians need technical skills to understand and

navigate their way through electronic sites and databases to search and retrieve reliable information. Pfeiffer (2015: 7) supports the notion that the qualifications and skills of employees are important and that the willingness to engage in continuous learning development must be encouraged for all librarians. Academic librarians must ensure that they are up-to-date with the relevant knowledge and skills to satisfy user needs, such as staying informed about emerging research trends, mastering information retrieval technologies, providing expert research assistance, and facilitating access to diverse and up-to-date scholarly resources. Users' needs change as new technology emerges (Llewellyn 2019: 131), and librarians are required to adapt to these changes, understand them, and transfer the knowledge gained to users (Jantz 2012: 3). Librarians need to be one step ahead of users and anticipate user requirements by engaging in professional development and keeping abreast of emerging trends. Technology allows the librarian to provide relevant and timely support to users while ensuring that the library remains an essential resource for the evolving needs of the academic community. Technology, searching, problem-solving and critical thinking skills are necessary for librarians to navigate their way through the deluge of data and information that exists. As Chanetsa and Ngulube (2017: 195) explain, librarians need to be resourceful and innovative in their work and their engagement with users. They are required to assist researchers in managing the research process and data conception (Shao, Li, Wu, Guo, Feng, Hui, F., Niu, Y. and Zheng 2018: 805). These are all new skills that librarians are required to acquire and engage in to provide a good service to researchers (Tella, Akande and Bamidele 2018: 6).

In Table 1, Despardes (2020), illustrates the various skills set required in 2018, 2020, and 2025. The latter are in line with what the World Economic Forum (2020: 104-108) predicted in 2020. The skill set requirements of 2020 mirror the transition towards the 4IR and align with the evolving demands made of librarians. There is a gradual shift in automation and artificial intelligence (AI) that is captivating the workplace. The table demonstrates how skill requirements change and how important it is for librarians to ensure that their skills align with what is required in the information environment. Wong and Chan (2018: 111) state that academic librarians need to be adaptive, creative, and innovative to meet the challenges that impact librarians' competence and the skills gap. Cao, Liang and Li (2018: 820) argue that academic librarians are required to possess characteristics that enable them to be smart librarians and to remain relevant in the profession. The newly qualified library and information studies graduates need to be exposed to the emerging skills set through their formal in-service training. This will enable new graduates to understand the requirements of the continually evolving profession. The skills essential for the year 2025, reflect the anticipated new emerging innovations and areas of expertise that are expected to be in demand. These skills are particularly pertinent for the

continuous development of academic librarians. The new areas of expertise and skills required in the 4IR require the academic librarian to be creative in his or her approach to the profession and to provide a satisfactory service to users.

Table 1: Top 10 skills requirements

2018	**2020**	**2025**
Complex problem solving	Complex problem-solving	Analytical thinking and innovation
Coordinating with others	Critical thinking	Active learning and learning strategies
People management skills	Creativity	Complex problem solving
Critical thinking	People management skills	Critical thinking and analysis
Negotiation	Coordinating with others	Creativity, originality, and initiative

(Despardes 2020)

Impact of the 4IR on the roles of academic librarians

ICTs in the 4IR have, without a doubt, impacted the library and information sector. New innovations have changed the way information is transferred and retrieved. Oke and Fernandes (2020: 2) point to higher education being impacted by ICT innovations, such as online platforms, that change the way institutions in the sector teach and engage with students. The impact of the 4IR has transformed the way that libraries and librarians interact with users and the services they provide. Libraries have undergone a digital transformation, integrating advanced technologies, online resources, and digital collections. This ensures that information is more accessible and convenient for users, irrespective of their physical location. Libraries are using various technologies to reach and engage with the users. The use of robots and technology in the 4IR allows academic librarians to connect with their users, and they need to make the most of this interconnectivity to reach out to more users and disseminate the right information to satisfy user requests (Hussain 2020: 4). There is a shift from knowing the library collection to now knowing and understanding the needs of the users. Librarians are emphasising the importance of designing and delivering user-centred services that align with the unique information needs and preferences of library users, thereby improving the overall user experience and engagement. Academic librarians are focusing on providing targeted IL instruction and guidance to empower users with the necessary skills to navigate, evaluate and use information resources effectively in various academic contexts. Technology has allowed libraries to progress and develop, and librarians are required to evolve with the changes to address the needs of the users within

their institutions. It is imperative that librarians are flexible and open to continuously developing their knowledge and skill base in response to the changing trends within the profession (Fernandez 2020: 25). With the 4IR, many new applications have been introduced and libraries are embracing trends such as big data, the IoT, cloud computing, embedded systems, robotics, and AI (Ocholla and Ocholla 2020: 363).

Research methodology

The study adopted an explanatory design using the mixed-method research approach. Data were collected from participants to explore the evolving roles of the librarians at the DUT Library. An online questionnaire was used for the collection of quantitative data and follow-up interviews were used for the qualitative data. To select participants, parallel sampling was used, that is, while different samples for the quantitative and qualitative phases were used, participants were drawn from the same population. The study population comprised librarians (70) employed by the DUT. In terms of the quantitative phase of the study, all 70 librarians were e-mailed the link to the questionnaire in February 2022. The questionnaire was developed online using the DUT subscribed software called QuestionPro, which is an online survey tool used for collecting data for research purposes. Participant anonymity and confidentiality were maintained throughout the research process. To augment the quantitative data, interviews were conducted (the qualitative phase) with participants who met certain criteria that included their experience, availability, and willingness to participate in the interviews. The researchers have in-depth knowledge about the population and, therefore, were able to make informed selections of the latter group of participants (those who were interviewed). Thematic analysis was used to analyse, identify, and transcribe similar patterns within the data collected. Findings are presented in tables, figures, and text, and sometimes participants are quoted verbatim.

Participant demographics

The study's target population comprised, as noted, 70 library staff members. All were full-time employees. The study specifically focused on full-time staff employed at the DUT Library, irrespective of their professional qualifications or designations. This approach facilitated the researchers' comprehensive engagement with the participants, enabling an examination of the evolution of their roles and the influence the 4IR has on their responsibilities. The number of participants by designation is reflected in Table 2.

Table 2: Participant demographics

Designation	**No of participants**
Coordinators	2
Assistant librarians	4
Library assistants	16
Librarians	12
Managers	3
Training librarian	1
Marketing librarian	1
Postgraduate librarians	1
Digital librarian	1

Findings and discussion

A total of 41 completed questionnaires were received and 10 interviews were conducted. The findings revealed that the participants agreed that the 4IR has impacted the library environment and, as a consequence, their roles and responsibilities have changed. These changes required librarians to be proactive in upgrading their skills to continue serving users adequately. To ensure the anonymity of the participants, those who completed the online questionnaire, are numbered R1 – R41 (R= respondent) while those participants who were interviewed are numbered IP1– IP10 (IP = interview participant)

Evolving roles and responsibilities of the academic librarians

The first objective was to determine how the roles and responsibilities of academic librarians have evolved with the introduction of the new disruptive technologies that drive the 4IR. Findings reveal that the roles and responsibilities of the DUT librarians have evolved. The digitisation of library resources and online services provided at the DUT Library have allowed users remote access to a wide range of information resources and services. The librarians are expected to manage these digital collections and enhance user services by employing emerging technologies to improve the services. Participants, as illustrated in Figure 1, were unanimous in their understanding that their roles and responsibilities within the DUT Library had changed. Among the respondents, 29% (12) were certain that technological advancements exerted an influence on the operational techniques of librarians. Thirty-two percent (13) concurred that librarians now participate in a more substantial volume of online tasks and have significantly increased their virtual interactions, especially compared to previous years. Furthermore, 24% (10) of

the respondents perceived that the changes in the technological landscape of libraries had a discernible effect on the services provided to users. The overarching consensus was that conventional modes of operation have been transformed. The librarians noted that the integration of novel technologies and systems triggered numerous changes. As elucidated by Wong and Chan (2018: 109), these contemporary technological shifts challenge the established paradigms of librarian's work.

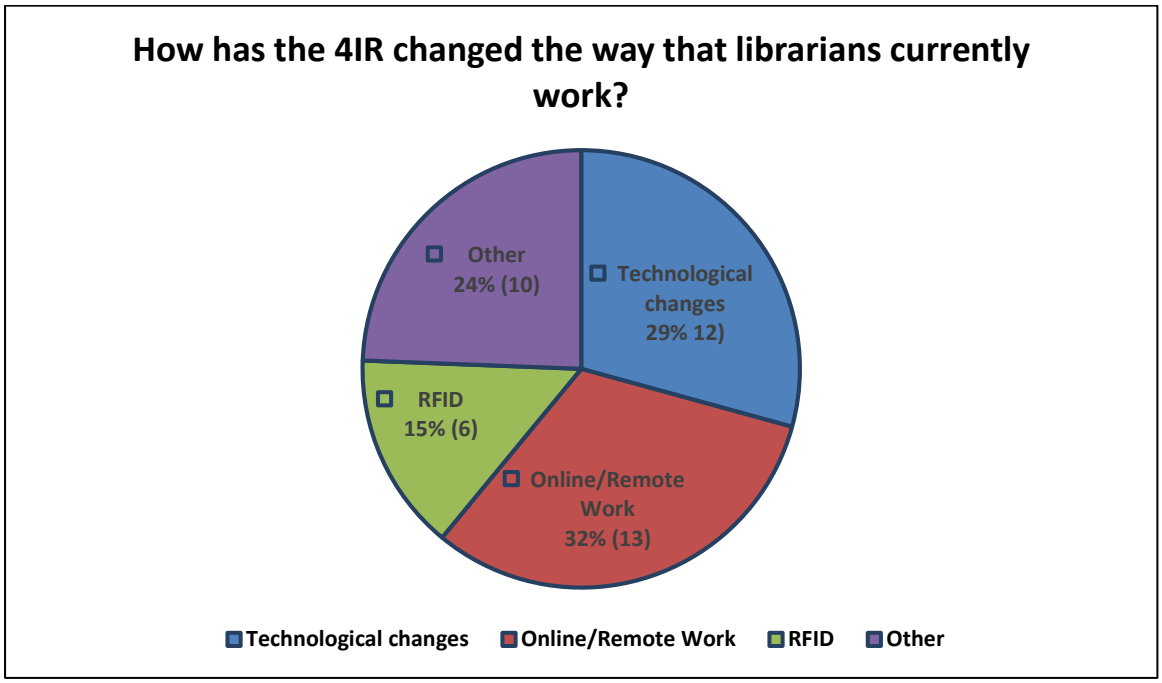

Figure 1: Changes in librarians work (N=41)

IP4, in the follow-up interview, explained the effect of the 4IR on the library:

> *It is changing how academic libraries offer their services and libraries will need to move from the traditional way of doing things to the new ways which involve more information technology.*

IP10 agreed:

> *Definitely, the librarians' roles have changed from physically engaging with users to online interaction.*

The traditional way of working and engaging users had evolved, and it was mainly due to new innovations and the increased digitisation of resources within the library. Librarians have had to adapt and engage with users through virtual platforms. This is in line with Rahmah's (2020: 358) view that librarians are transforming with smart thoughts and actions to meet new innovations that impact the library environment. Smart thoughts among the DUT librarians range from the ability to recognise the importance of technology in libraries and

explore innovative ways to integrate tools and resources to improve the user experience. The librarians are actively involved in cultivating collaborative partnerships with other libraries, academic institutions, and departments within the DUT to foster a culture of knowledge sharing, resource exchange, and research. Participants are aware that the new technological changes affect the way they work and that new innovations such as robots and various AI-enabled technologies are being introduced to help users find and locate information. As Fernandez (2020: 23-24) mentions, new technologies are replacing humans in some areas, thus changing the customary way of working. AI technology is replacing traditional ways of interacting and engaging with users to access and retrieve information. As earlier noted, one such example is the University of Pretoria Library which, in May 2019, introduced a robot librarian named Libby to help users in the library (Oliver 2019).

As IP3 explained:

> *Academic libraries will have to continue to move with the trend of 4IR and implement services that can be available online and be accessible anywhere in the world without one physically having to walk into the library to get resources.*

The participants concurred that COVID-19 was one of the main drivers in accelerating the 4IR changes at the DUT Library. The pandemic prompted a rapid shift towards digitisation and remote access, which led to the adoption of various technological strategies within the library. The state-imposed lockdowns forced librarians to embrace working and engaging with users through various online platforms. Connell, Wallis, and Comeaux (2021: 5) agree, pointing out that the pandemic forced librarians to embrace online interactions with patrons. Librarians benefit from the use of online platforms in that they enable faster access to the information that users require, and they facilitate successful interactions between users and librarians in the digital environment. Online platforms have no restrictions with numbers, as face-to-face interactions can only accommodate a certain number of users at a time. This allows librarians to reach and teach IL classes to more users. Librarians indicated that they were comfortable with conducting online chats and interacting virtually with users. As illustrated in Figure 2, while some librarians attributed the shift to remote work to new technologies, others observed that the shift began earnestly during the pandemic and the imposed lockdowns. A substantial 82% (34) of the librarians acknowledged that the changes within the DUT Library were propelled by the rapid onset of the COVID-19 pandemic and subsequent governmental lockdown measures. On the contrary, 17% (7) expressed uncertainty about this phenomenon. Kosciejew (2020: 307) highlights the substantial role that libraries played in disseminating accurate information

about the pandemic, providing users with reliable health-related data. Libraries needed to enhance their capacity and adapt to the changes brought about by the pandemic to ensure seamless virtual access to information. The responses of the participants depicted in Figure 2 align with Kosciejew (2020: 307), who claimed that the transformations prompted by the lockdown accelerated the changes within university libraries.

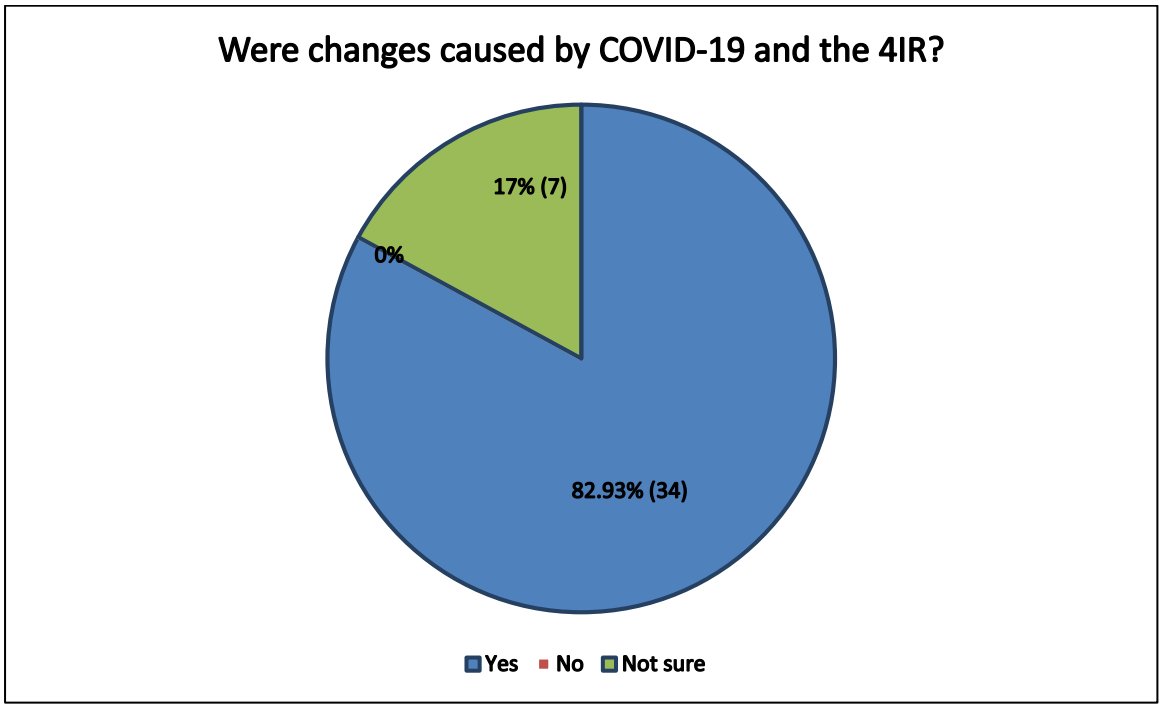

Figure 2: Changes caused by COVID-19 and the 4IR (N=41)

In the interviews, several participants agreed that COVID-19 and the forced lockdowns taught librarians that remote work was possible with the availability of 4IR technologies. These findings are in line with the viewpoints put forth by Connell, Wallis, and Comeaux (2021: 5) who contend that remote work can be viably undertaken while simultaneously delivering services to library users. The following are views expressed by two of the participants:

IP1 indicated:

> *Librarians, specifically information services librarians or subject librarians, must adjust to working virtually using online tools to engage with library users to offer support for research, teaching, and learning.*

IP2 stated:

> *We (librarians) were also surprised to find that we could work remotely and produce good results, if not better in some cases. With the availability of new, better, and faster technology, we are able to provide content effectively and timeously to the users.*

The DUT librarians underwent a transformation in their responsibilities within the institution, assuming a more participatory role in the research and instructional activities at the university. This observation aligns with the perspectives presented by Otike and Barát (2021: 19) that academic librarians are currently expected to play a supportive role in fostering teaching and learning initiatives within the institutional setting. The participants revealed that their roles evolved to that of engaging directly with researchers from the beginning of the research process. Librarians were now more involved in helping researchers manage their research data in terms of preservation and making the data accessible for reuse. There is a growing effort to promote and support the development of open-access initiatives. This is in line with Force and Wiles (2020: 197) in making scholarly research publications freely accessible to the research community. The DUT library was investigating ways in which to pursue the digitisation of library materials to allow online access. The first items identified to be digitised are from the DUT archives.

The increase in digitisation and online resources impacts the technical services or backroom librarians as there are fewer items to physically handle. Printed resources require physical processing and preparation for long shelf-life usage, while online resources do not. This has caused a decline in physical acquisitions of library resources, which has resulted in a decrease in work for the acquisitions and processing staff who help with the physical handling of the items. The purchasing of online resources has increased but these items still need to be catalogued and made available for retrieval. The work of cataloguing staff has now transformed and includes creating metadata for open-access resources such as institutional repositories, archival materials, e-books, and various other digital research projects. Metadata curation enhances the usability and accessibility of research and scholarly works and facilitates effective information retrieval and data integration across various platforms within an institution (Han and Hswe 2011: 129).

Skills and competencies in the 4IR

The second objective concerned identifying the skills and competencies that assisted the librarians in understanding and evolving with the changes brought about by 4IR innovations. These included the ability to adapt and understand rapidly changing technologies such as data analytics and digital tools that assist librarians in navigating advanced systems and resources. Ayinde and Kirkwood (2020: 143) remarked that the 4IR created new opportunities and new ways of working while redefining jobs and skills for librarians. These allowed faster service delivery and increased productivity for users. Continuously emerging

4IR technologies accentuate the gap in librarian skills concerning the transformation that libraries have experienced with new technological innovations. The findings in relation to the skills and competency levels of librarians in 4IR are consistent in that the participants firmly believed that they (librarians) need to redefine their current skills and develop new skills to ensure that they can continue to be competent in providing a good service to library users.

As illustrated in Figure 3, 56% (23) of respondents agreed that IT skills were crucial for academic librarians. A further 15% (6) of respondents identified basic computer and searching skills as essential, while 19% (8) believed that communication skills were just as important and 10% (4) expressed the importance of possessing advanced programming skills as essential competencies for achieving proficiency in their work.

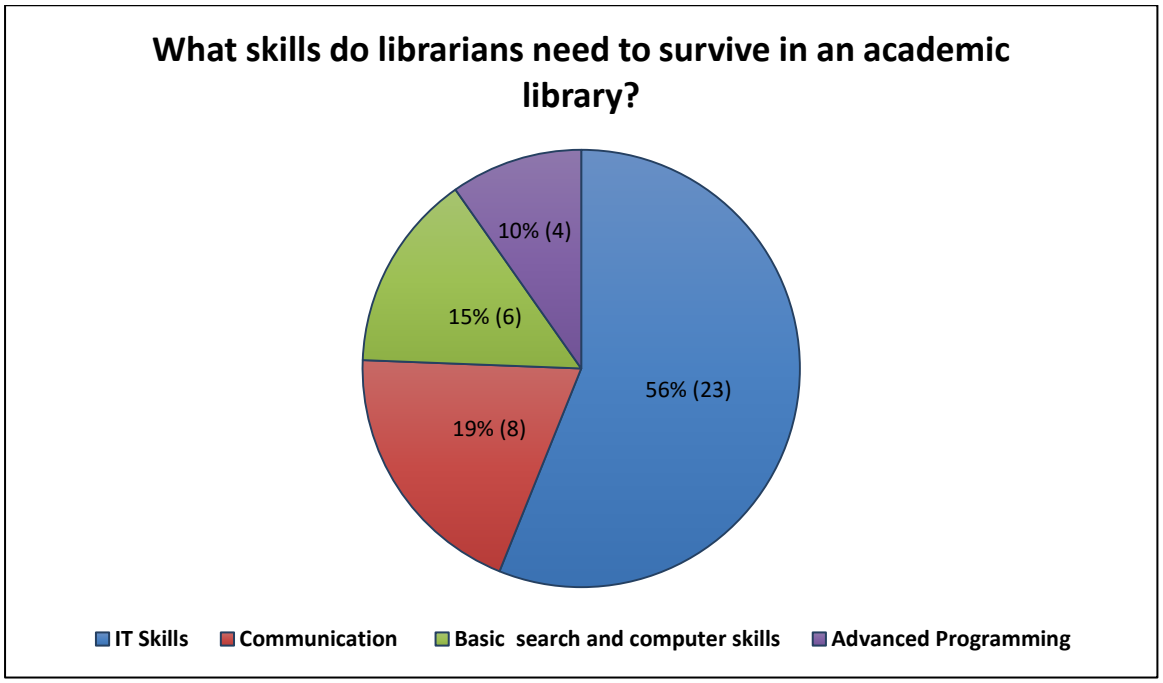

Figure 3: Academic librarian skills (N=41)

The interviewed participants agreed that technology skills, such as information retrieval techniques, digital literacy skills, knowledge of integrated library systems, database searching, and digital repositories were essential skills to possess in the current changing environment.

IP1, for example, stated:

> *It was imperative for librarians to have strong IT skills and familiarity with the use of databases and the Internet.*

IP3 explained:

> *Information technology skills have become a prerequisite for academic librarianship and it is necessary to have a knowledge of computer skills in order to keep up with the ever-changing technologies. Thinking skills in order to be open-minded enough to accept that things change in a rapid manner and be able to communicate with others.*

This concurs with the assertion made by Balashova and Gromova (2018: 1), that technology plays a significant role in shaping the future of work. Within the dynamic realm of libraries, characterised by the ongoing wave of digital transformations, librarians are compelled to nurture their technical proficiencies, in areas such as software development, data analytics, coding, research, and database management to remain attuned to prevailing trends. This shift towards research data and digitisation underpins the imperative for the DUT librarians to acquire these technical competencies, thereby effectively adapting to, and harnessing the potential of emerging technologies within the landscape of libraries. The DUT Library supports the curation and preservation of research data in compliance with best practices and data management standards to ensure data integrity, accessibility, and long-term usability for future research analysis. The librarians are involved in assisting researchers in developing comprehensive data management plans that outline strategies for data collection, organisation, documentation, and preservation throughout the research process. Through the cultivation of these skills, librarians can play an important role in facilitating the seamless assimilation of digital resources and services, ultimately improving the capacity of the DUT Library to embrace the evolving needs of its users in an increasingly digitised environment.

In addition to the widespread agreement among the librarians regarding the importance of IT skills in libraries, Table 3 presents the list of skills that librarians will require. Some of these skills that librarians needed to possess were, to an extent, aligned with the skills that appeared in the World Economic Forum (2020: 104-108) listings. The skills outlined in the table were directly provided by the participants, who recognised the significance of these competencies within the context of the 4IR. Communication, technology, and complex problem-solving skills emerged as the most crucial set of skills that librarians need to possess. Gerolimos and Konsta (2008: 696) maintain that communication and interpersonal skills are indispensable skills that librarians are required to possess. The results highlighted that creativity, critical thinking, analytical thinking, and the ability to adapt to changes were further essential skills that a librarian needed to possess to navigate the 4IR. As stated by Mohideen et al (2022: 522), possessing adept communication skills is essential for librarians to effectively address user requirements, whether through spoken,

written, or online mediums. In the context of the 4IR, communication has become more convenient, due to technological advancements that have eliminated previous challenges that hindered the smooth exchange of information. Critical thinking, creativity, and problem-solving skills are essential for librarians as they participate in a variety of tasks and responsibilities within the information landscape, including IL instruction. These vital skills are required to embrace the introduction of disruptive technologies and to be able to adapt and evolve with the necessary changes (Eberhard, Podio, Alonso, Radovica, Avotina, Peiseniece, Caamaño Sendon, Gonzales Lozano and Solé-Pla 2017: 54).

Table 3: Basic and cross-functional skills

Cognitive skills	**Process skills**	**Technical skills**	**Interpersonal skills**
Creativity skills	Critical thinking	Quality control	Communication
Analytical skills	Active listening	New technology	Flexibility
Problem-solving	Pedagogic competency	Online platforms	Customer service
Organisational skills	Teaching skills	System skills	Teamwork
Research skills	Planning and executing skills	Software skills	People skills
Publishing skills	Strategic marketing skills	Data analysis skills	Liaison skills
Ethical skills	Collection development	Digital literacy skills	Emotional intelligence

Effects of the 4IR on the roles of academic librarians

The third objective sought to establish the effects of 4IR on the roles of librarians in the changing landscape of academic libraries. Change is difficult for many individuals, and it takes a while for an individual to conform and accept the change. Ahmat and Hanipah (2018: 57) explain that it takes about two years or more to change an individual's behaviour and mindset to embrace new ways of working. Lee, Yun, Pyka, Won, Kodama, Schiuma, Park, Jeon, Park, Jung, and Yan (2018: 3) emphasise the importance of flexibility in effectively embracing the 4IR and adequately navigating its evolving dynamic shifts. Several participants echoed this sentiment, acknowledging that the ability to adapt to changes is a valuable competence that greatly contributes to the successful provision of services to users. The critical role of adaptability and flexibility within the evolving landscape of the 4IR environment is highlighted by Eberhard et al (2017: 54). These proficiencies are indispensable for facilitating a diverse array of activities within the library setting. Insights into

the librarians' adaptability to changes within the DUT Library are furnished in Figure 4. Among the respondents, a substantial 70% (28) expressed a positive stance toward embracing changes, whereas 20% (8) exhibited uncertainty and apprehension. Additionally, 10% (5) opted not to respond to the question.

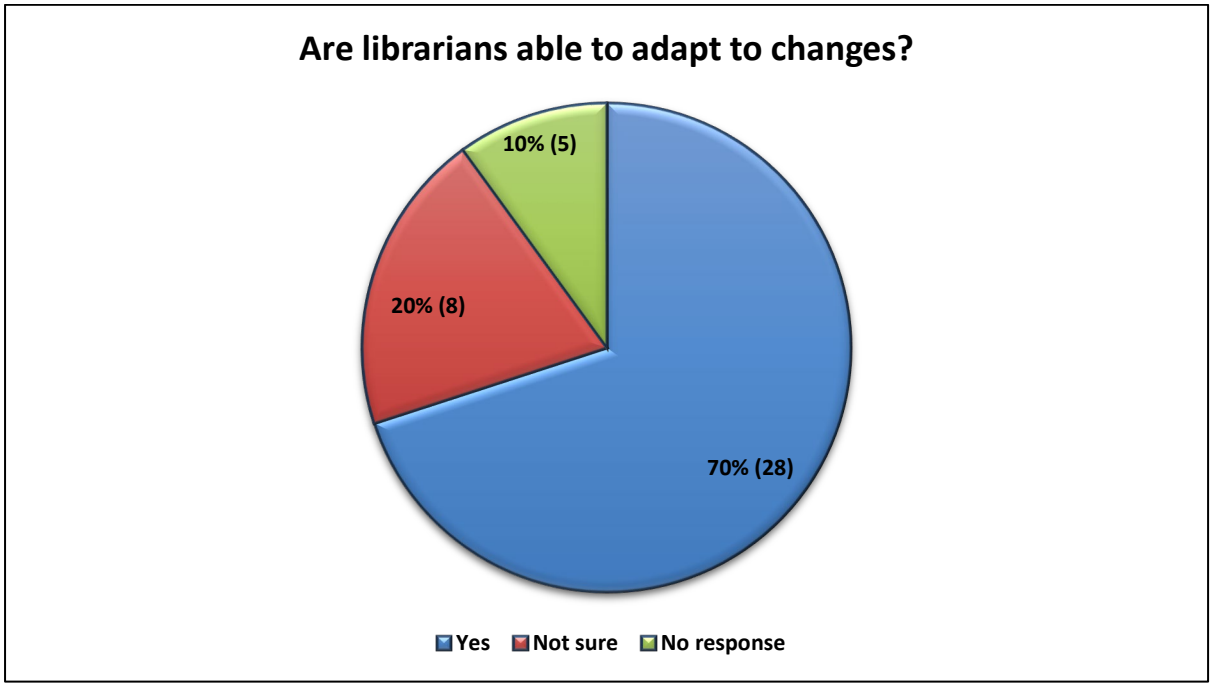

Figure 4: Flexibility of librarians to adapt to changes (N=41)

It was found that although librarians understood the need to evolve with the new changes, this could be difficult for those who fear or resist change.

R40 indicated:

> *Not all librarians are willing to change their "set" ways. Staff in general are resistant to change.*

R41 succinctly expressed what many of the DUT librarians felt about the changes they were experiencing:

> *There are mixed responses. Some librarians adapt easily and embrace the changing technologies whilst some are concerned that it will negatively affect their jobs.*

The interviewed participants recognised that librarians needed to display adaptability and resilience when faced with changes in their work environment. Some individuals shared their personal feelings and viewpoints concerning these changes.

IP9 attempted to explain why it is important for librarians to adapt to the changes:

> *To avoid being obsolete and feeling unwanted in the library sector and also to be able to adapt will mean that there is still a place for us in the library.*

IP8 explained:

> *Most of us are intimidated by the changes and cannot adapt to them, as we fear that our services will be outdated and redundant.*

IP4 shared their experience of acquiring and mastering new working methods to effectively reach and engage with users:

> *I had to attend workshops on how to use MS Teams, Moodle and other learning platforms*.

The librarians were cognisant of the fact that the physical library spaces needed a change. The pandemic accelerated the revitalisation and rejuvenation of the physical layout, resources, and services within the library. The DUT Library undertook to redesign the spaces in the library to meet the COVID-19 regulations and to make the library as inviting as possible to encourage users to visit the library. The aim was to transform the library into a dynamic, welcoming, and adaptable hub that accommodated various learning styles and activities, thereby fostering a more engaging and productive experience for the users.

The findings further revealed that while the DUT librarians embraced the new innovations endorsed by the library, there was a sense of fear and scepticism toward the unknown aspects that the new technologies unveiled. Librarians were apprehensive and unsure of their job security in light of the new innovations. Figure 5 reflects the areas that the librarians believed would be the most affected by the 4IR. Circulation emerged as the sector deemed most susceptible, as indicated by 34% (14) of respondents. Processing was the other area that received a high response, 29% (12), while acquisitions and periodicals shared the same response rate of 12% (5). Cataloguing trailed behind, with three responses, making up 8% of the total, and a smaller proportion of 5% (2) expressed uncertainty about the potential impact across these areas.

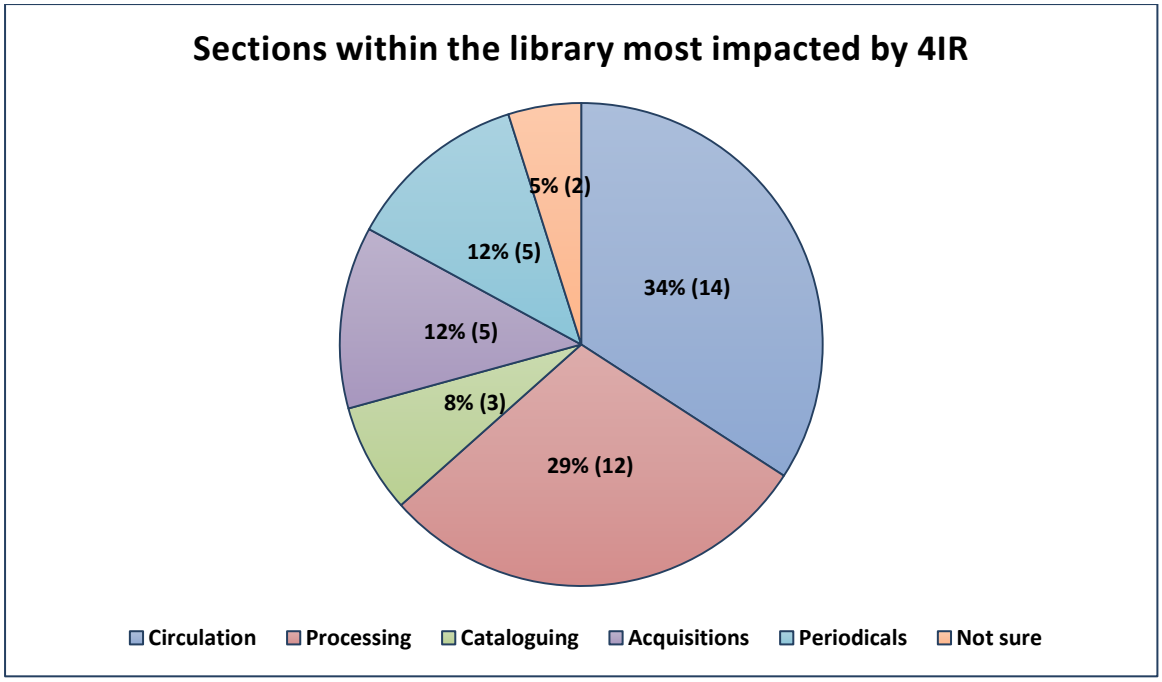

Figure 5: Impact of the 4IR on sections within the library (N =41)

When interviewees were asked about the impact of the 4IR on the library, IP2 stated:

> *The whole academic library sector is impacted. Academic librarians need to adapt and become flexible. Academic libraries need to explore and investigate new forms of digital services within their institutions. Should they not be forward-thinking, jobs run the risk of becoming obsolete. The reduced need for staff managing physical items would impact most jobs, from stack to cataloguing and librarians, who would have less need to maintain a physical collection.*

IP6 agreed:

> *4IR definitely has an impact on academic libraries. Libraries are now shifting paradigms from traditional ways to modern ways. People and machines are connecting to each other at high speed. A certain group of people and their jobs will become redundant. Replacing them with new workers with the needed skills or with machines that do the job cheaper.*

The findings revealed that technology was the main driver of change in the library environment. The use of new online and virtual learning platforms encouraged more online engagements, which in turn improved service delivery and response time to meet user needs. The online chat groups with the relevant faculty librarians allowed users the opportunity to communicate and engage with the librarians when required. The participants were satisfied that the DUT Library was proactive in sourcing new innovations to increase productivity and

address user needs. The library was also encouraging staff to continuously develop their skills and stay abreast of the latest trends. As noted, the library introduced RFID tags and, as part of their daily routines, the circulation staff had to learn and adapt to using RFID and understand the way the self-check kiosks worked. The integrated library system called FOLIO was implemented within the library in July 2021 and this introduced many changes in the current workflows that staff had to adjust to. These new systems were introduced as part of the library's transformation in the ICT sphere. The findings revealed that the participants were satisfied with the new innovative systems that had been introduced in the library. The participants also believed that the DUT library management was proactive in aligning the library with the evolving technological systems.

Framework to align the roles of academic libraries to the 4IR

It is clear that the impact of technological innovations and digitisation has influenced how academic librarians provide services to users. Figure 5 illustrates a framework to align the roles of academic libraries to the 4IR. The revitalisation of library spaces, virtual realities, and the emergence of open-access initiatives reflect the changes that have taken place in academic libraries and influence how academic libraries and librarians function. The roles and responsibilities of academic librarians in the context of embracing open-access initiatives are:

- Open access initiatives: Academic librarians promote open access initiatives by assisting researchers and the university in understanding the benefits of making research outputs freely available to the public.
- Institutional repository management: Academic librarians oversee and manage the institutional repositories where scholarly works and research outputs are archived and made accessible. This includes the organisation and curation of scholarly works.
- Copyright and licensing: Academic librarians are actively involved in advising on copyright issues, as well as engaging in licensing agreements to ensure compliance with open access principles.
- Data management: Academic librarians assist researchers in data management, curation, and storage of their research data.
- Bibliometrics: Academic librarians play an important role in promoting bibliometrics to researchers to enable them to promote their research outputs and assess their impact. Researchers' work must be visible and accessible beyond the institutional landscape.

The roles and responsibilities of academic librarians in the context of the revitalisation of library spaces are:

- Space design: Academic librarians are actively involved in redesigning library space that fosters and promotes collaboration, innovation, and learning. This includes configuring physical spaces and incorporating technology at the DUT Library.
- User experience: Academic librarians are focused on enhancing the overall user experience by curating relevant collections, providing accessible resources, and creating comfortable study environments.
- Community engagement: Academic librarians are actively involved in organising events, workshops, and training sessions within the academic community and in the external community by providing resources to disadvantaged communities.

The roles and responsibilities of the academic librarians in the context of embracing virtual realities are:

- Digital resources: Academic librarians manage and promote digital collections, e-books, and e-journals, ensuring their accessibility and usability.
- Virtual reference services: Academic librarians offer virtual reference and research assistance through online chats, email, or video conferencing.
- Digital literacy: Academic librarians are actively engaged in teaching digital literacy skills, information retrieval, evaluation, and citation skills in virtual environments.

The skills and competencies that academic librarians require in the context of the 4IR are:

- Cognitive skills: Academic librarians need to possess strong creativity, analytical, problem-solving, organising, research and publishing skills to assess information needs, identify trends and the ability to make data-driven decisions to assist the users.
- Process skills: The librarians need to have critical thinking, active listening, teaching, and strategic marketing skills. They should also have a deep understanding of library processes, cataloguing, metadata management and information management skills.
- Technical skills: The librarians are required to be proficient in library management systems and digital repository platforms, and keep abreast with emerging technologies. Digital literacy, data analysis, and system and software skills are essential skills for the DUT librarians.
- Interpersonal skills: The librarians must excel in communication, customer service, and collaboration to engage with a diverse group of users. They need to be flexible and adapt seamlessly to the constantly

changing library landscape.

The impact of the 4IR on academic librarians and the changing landscape of academic libraries are reflected in the following:

- Digital initiatives: Academic librarians are involved in implementing digital initiatives such as digital preservation, virtual searches, promotion of open-access resources and online learning platforms.
- Publishing: The DUT Library is actively involved in promoting an online publishing space, facilitating open-access journals, and supporting institutional publishing initiatives.
- New skills: Academic librarians need to acquire new skills in data science, data analytics, machine learning, and AI that reflect the changing landscape of academic libraries and exploit the full potential of 4IR technologies.
- New ways of working: With the 4IR academic librarians increasingly work remotely, collaborate virtually, and adapt to agile workflows to meet the evolving needs of library users.

In a 4IR academic library landscape, librarians are at the forefront of embracing technology, advocating for open access, and enhancing the library experience for users while continually acquiring new skills to adapt to the rapidly changing information environment. They are key players in ensuring that academic libraries remain vital hubs of knowledge and research in the digital age.

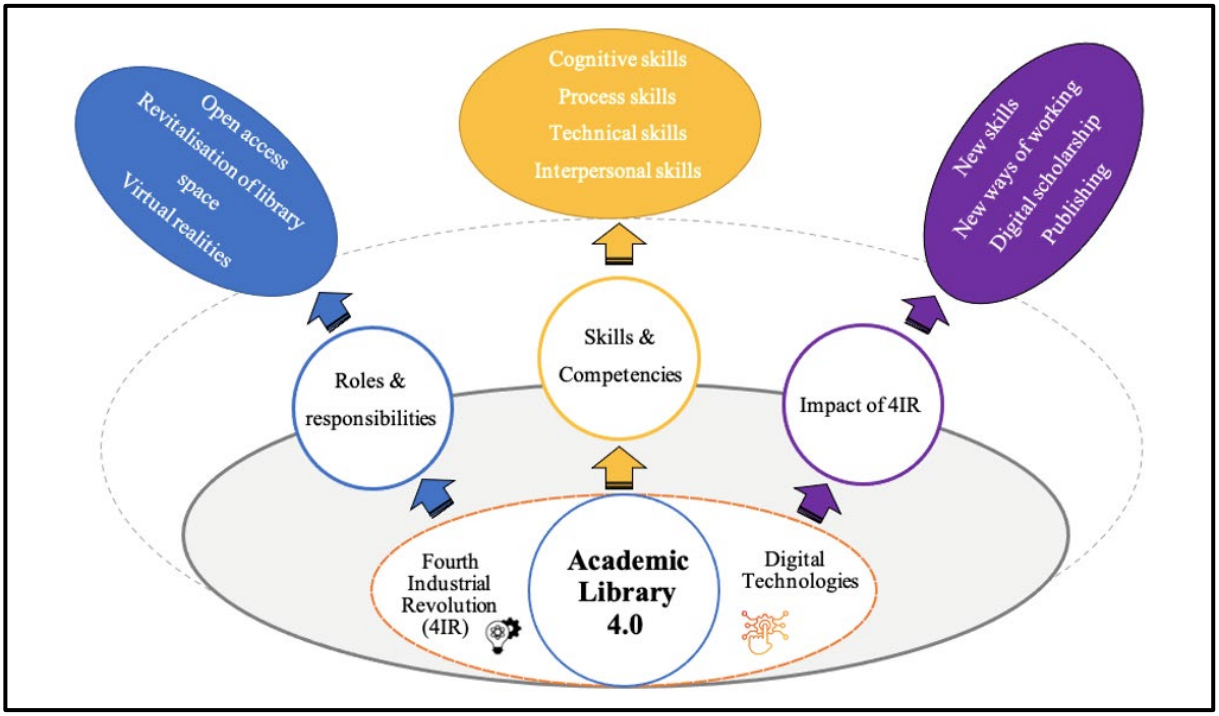

Figure 5: Framework aligning the roles of academic libraries to the 4IR

Conclusion and recommendations

With the evolving technological advancements and the disruptive technologies accompanying the 4IR, along with their impact on libraries and users, it is essential that academic libraries be prepared to adapt to these changes. Libraries are living organisms that provide a neutral space for conversation, user participation, and the evolution of thinking; they should not be afraid of evolving and transforming. As new technologies and innovations increase productivity levels and provide faster services, they create new opportunities to form new alliances in a variety of disciplines. Most 4IR innovations require the use of technical skills, so librarians must consider upgrading their technical skills.

These new innovations will necessitate human intervention, and librarians can be trained to assist users in learning how to use the new technologies. When a new technology is introduced to users, there are usually many glitches and issues, and librarians will be required to assist users in this regard. With each new revolution (such as the 4IR), there is widespread concern about job losses. However, people evolve by learning new skills and working in new ways responding to the changes being brought about by the 4IR. Furthermore, there will always be a need for people. Human beings are the only ones who can provide the necessary soft skills and emotional intelligence to empathise with technology users. The amount of data retrieved from individuals and users increases with the 4IR. This personal data must be managed and secured because it can endanger individuals and library users. The cybersecurity risks of handling users' personal data may be a topic for future research. User data management is essential because it can affect many ethical issues and put users at risk.

Disruptive technology has altered the methods by which information is created, stored, and retrieved. In addition, technology has introduced flexibility and eliminated the rigidity of information access. To retrieve information, a user no longer needs to physically visit a library. Librarians must evolve and adapt to meet the new and exciting challenges of the 4IR and to meet the growing needs and demands of next-generation users. Librarians must be able to respond and adapt to the rapidly changing technology in their environment, rather than resisting it. They need to be innovative and creative thinkers to keep up with these changes. New-generation users are adaptable and require creative workspaces. As a result, libraries must provide these opportunities for those who are willing to embrace 4IR transformations. The DUT Library recognises the impact of disruptive technologies on information access and changing user needs. The library understands that traditional methods of information retrieval

are no longer sufficient in the digital age. With this in mind, the work of many librarians has shifted to prioritise user needs. DUT library users now expect flexibility and convenience when accessing information and physical visits to the site library are no longer the primary choice. The establishment of a makerspace at the Indumiso Campus Library (of the DUT) is a clear sign of the library's commitment to embracing innovation. Makerspaces provide creative and collaborative spaces for users to explore and experiment with technology, fostering an environment conducive to learning and entrepreneurial endeavours. By offering such facilities, the library ensures that it remains relevant in providing excellent service to its users.

In the context of the 4IR, which is characterised by the rapid integration of advanced technologies such as AI, automation, machine learning, and digital transformation, the importance of human interaction remains an essential and enduring component. Despite the advancements in technology that have significantly transformed various industries and sectors, the human element continues to play a vital role, particularly in sectors that require emotional intelligence, empathy, and nuanced understanding. Elaborating on the significance of human interaction, it is crucial to recognise that certain aspects of communication, collaboration, and service delivery inherently require human involvement. People remain essential in providing emotional support and exhibiting soft skills that machines are incapable of offering. AI is not equipped to comprehend or respond to the emotional needs of users in the same way that humans can. While AI and automation can efficiently process data, perform repetitive tasks, and provide quick solutions, they often lack the capacity to understand complex human emotions, interpret non-verbal cues and empathise with users on a personal level. Therefore, while the 4IR continues to drive innovation and efficiency through technological advancements, acknowledging the perpetual necessity for human interaction underscores the irreplaceable role of human skills, empathy, and interpersonal connections in fostering meaningful and sustainable interactions within various professional and social contexts.

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