
A framework for aligning librarians' roles and skills with 4IR technologies at the Durban University of Technology, South Africa

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Abstract

The Fourth Industrial Revolution (4IR) has introduced transformative technologies such as artificial intelligence, robotics, the Internet of Things, big data, and blockchain that are reshaping various sectors, including libraries. This article recommends a framework to align librarian roles and skills with these 4IR technologies, focusing on the Durban University of Technology (DUT). The framework ensures that DUT librarians can effectively use these technologies to enhance services and meet evolving and diverse user needs. By examining the connection between librarian competencies and 4IR technologies, the article provides a roadmap for DUT libraries to navigate the challenges and opportunities of this technological revolution.

Keywords: Fourth Industrial Revolution, 4IR, academic libraries, librarian roles

Introduction

The Fourth Industrial Revolution (4IR) is characterised by a merging of technologies, blurring the lines between physical, digital, and biological spheres and presenting unique opportunities and challenges for libraries (Schwab 2017: 8; Maynard 2015: 1005). Librarians, traditionally seen as custodians of knowledge and information, need to adapt to these changes by developing new skills and roles. This study focused on librarians at the Durban University of Technology (DUT), exploring how they can align their roles and skills with 4IR technologies to enhance service delivery. The study aimed to identify key 4IR technologies relevant to libraries, analyse their impact on DUT librarians' roles

and skills and propose a framework for aligning librarian competencies with these technologies.

Objectives

- To ascertain the critical 4IR technologies pertinent to library operations and services.
- To analyse the impact of these technologies on the roles and skills of DUT librarians
- To propose a framework for aligning DUT librarian competencies with 4IR technologies.

Research methodology

The DUT is a multi-campus institution, which includes six site libraries dispersed across the KwaZulu-Natal Province. This study used a mixed-method research design, integrating qualitative and quantitative research approaches. Data were collected using a self-administered online questionnaire, followed by interviews. Many researchers employ both questionnaires and interviews to collect data for their studies (Hilton, Fawson, Sullivan and DeJong 2020: 187). The combination of quantitative and qualitative research approaches improves the credibility of the research findings. A quantitative research approach provides statistical information, while a qualitative approach explores intricate and detailed data, offering the researcher a deep understanding of the interactions of study participants. In adopting a mixed-method research design, the findings were triangulated by cross-referencing various data sources to authenticate and support the conclusions (Creswell and Creswell 2018: 15; Maree 2016: 82).

The researcher employed an online questionnaire for the quantitative data collection and a semi-structured interview for the qualitative insights. The latter enabled flexible probing and a deeper understanding of the participant responses. The questionnaire was developed using QuestionPro, an online survey tool subscribed to by the DUT used for data collection and analysis. Thematic analysis was applied to analyse, identify, and transcribe common patterns within the qualitative interview data.

The population (and sample) for the quantitative dimension of the study comprised the 70 library staff members employed at the DUT Library. Follow-up interviews were conducted with 10 of these staff members. Purposive sampling was employed to select the 10 interviewees, providing the researcher with the flexibility to use their informed judgement in selecting the sample from

the participants (Blackstone 2018: 80). Purposive sampling was chosen as it aligned well with the study's goal of gathering in-depth, targeted insights from specific individuals who have relevant knowledge or experience with the subject matter. This method allowed the researcher to deliberately select participants who were most likely to provide rich and detailed information related to the research objectives, such as library staff who interact with 4IR technologies. The 10 librarians interviewed were selected based on their availability, location and, importantly, their interest in the effects of new technology and innovations on the library environment, as well as their effect on the evolving roles and capabilities of librarians.

Key 4IR technologies relevant to libraries

Several 4IR technologies are relevant and can be useful in improving functionality, efficiency, and user experience in libraries. These technologies include artificial intelligence (AI), robotics, the Internet of Things (IoT), big data, cloud computing, and blockchain.

Artificial Intelligence

AI technologies, such as machine learning and natural language processing, can significantly enhance library services at the DUT. Applications include automated cataloguing, personalised recommendations, chatbots, and virtual reference services. AI can also assist in managing large volumes of data, making it easier for librarians to curate and organise information (Harisanty, Anna, Putri, Firdaus and Noor Azizi 2022).

Robotics

Robotics in libraries involves the use of robotic technology to improve services, engage patrons, and offer innovative learning experiences. This emerging field leverages automation and advanced technologies for better library services, operational efficiency, and unique user experiences (Harisanty et al. 2022). AI-driven robotics includes designing and using robots to assist with book shelving and information retrieval. These robots mimic human thinking and actions (Harisanty et al. 2022).

Internet of Things

The IoT is a network of interconnected computing devices and software that enables data transfer across systems and networks without the need for human-to-human or human-to-computer interaction (Wortmann and Flüchter 2015:

221). The IoT can transform physical library spaces into smart environments. IoT-enabled devices can monitor and manage resources such as lighting, heating, and security systems. Additionally, the IoT can facilitate efficient asset tracking, ensuring that books and other resources are easily locatable. The IoT is transforming libraries, marking a significant step toward creating smart libraries and has the potential to enhance the security and efficiency of academic libraries (Gupta and Singh 2018: 71). Gupta and Singh (2018: 72) highlight the use of radio frequency identification (RFID) tags, which are embedded sensor chips placed in library resources, allowing these items to be linked to library systems. With these RFID tags, academic libraries can connect their resources to various devices. This initiative is part of the broader movement towards smart libraries in a technologically innovative environment. The IoT enables libraries to offer virtual tours of the academic space and to continue online library orientation. Most academic libraries have online catalogues to assist users in finding information. RFID tagging facilitates self-check-in or check-out of library materials, with the additional benefit of tracing lost or misfiled items within the library collection.

Big data

The advent of big data has transformed how academic librarians handle data within academic libraries. These librarians are now responsible for reassessing their operational methods to ensure they are prepared to manage and collaborate with researchers and their datasets. Additionally, they must provide researchers with assurances that their datasets are secure and well-managed under the librarians' supervision. To effectively handle big data, it is crucial for academic librarians to receive comprehensive training. Such training will equip them with the necessary skills to understand data-related analytics and preservation techniques (Ahmad, JianMing, and Rafi 2019: 204).

In the 4IR era, data collection has become a central asset for most businesses. Discussions around data collection and usage are prominent in the 4IR, as both businesses and libraries can extract valuable insights, patterns, and trends from data to better understand user behaviour and make informed decisions for service improvement. Librarians, with their extensive experience in managing data and information, play a pivotal role in these processes (Balashova and Gromova 2018: 1). It is clear that big data analytics allows libraries to gain insights into user behaviour and preferences. By analysing data from various sources, libraries can tailor services to meet user needs more effectively. Big data can also support collection development and resource allocation decisions.

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Blockchain

Blockchain is a decentralised digital ledger that is used to record transactions and transfer information securely and automatically (Tella 2020: 4). As explained by Tella (2020: 4), a transaction begins when one party creates a block, which is then verified by numerous computers. Once verified, the block is added to a chain, creating a unique record with its own history, and is stored online. Each block is “bound and secured to each other using cryptographic principles” (Tella 2020: 4). Libraries are now adopting blockchain technology to store their information securely. By leveraging blockchain, libraries can enhance the security, transparency, and accessibility of their services. For example, blockchain can be used to create permanent records for the digital preservation of important historical documents and research publications, ensuring long-term preservation and easy access. Furthermore, blockchain supports decentralised platforms for open-access publishing, reducing costs, and increasing accessibility by facilitating direct transactions between authors and readers, bypassing traditional publishing intermediaries. Furthermore, blockchain can be utilised to create secure digital identities for library users, thereby protecting user information (Tella 2020: 4).

Blockchain technology offers potential benefits for libraries in terms of data security and provenance tracking. It can provide a transparent and complete record of transactions, ensuring the integrity of digital archives and rare collections (Tella 2020: 4). Blockchain technology offers potential benefits to academic libraries in terms of data security and provenance tracking. It can provide a transparent and immutable record of transactions, ensuring the integrity of digital archives and rare collections.

Cloud computing

Cloud computing has significantly impacted academic libraries and provides a range of benefits that transform traditional library services. Cloud computing involves using a network of remote servers worldwide to offer faster internet access and greater storage capacity for libraries and organisations (Wada 2018: 17). Libraries are turning to cloud computing to cut down on the costs associated with maintaining individual servers and energy consumption. By using cloud services, libraries can avoid the high costs associated with purchasing and maintaining physical servers and other IT infrastructure. Libraries can integrate various services, such as cataloguing, digital repositories,

and electronic resource management, into a single cloud-based system, improving efficiency and user experience. Cloud computing also enhances the speed of the internet and improves the search capabilities of the Web for users (Wada 2018: 18). Adapting to technological advancements, many libraries, including the DUT Library, transitioned to a cloud computing environment, upgrading from a server-based library system to a cloud-based integrated management system.

Impact of 4IR technologies on librarian roles and skills

The integration of 4IR technologies into academic libraries is reshaping the landscape, requiring librarians to continuously update their knowledge and skills to adapt to these changes.

Evolving roles of academic librarians

The roles of academic librarians are constantly transforming to meet the growing needs of users and the demand for information. Librarians are expected to be experts in the way information is managed and retrieved by users. Data curation is an important aspect within libraries and involves the management, organisation, and preservation of data collected and used within academic libraries. Data curators ensure that data are properly documented, accessible, and reusable for future research (Chiwara 2020: 403). Academic libraries often use platforms to support data curation activities, such as DSpace and Fedora for their institutional repositories, and other specialised platforms for data repositories. Librarians are expected to manage, maintain, and curate the data for future use and ensure that users have seamless access to the information (Chiwara 2020: 402). Academic librarians need to develop expertise in managing and curating large datasets. This role involves ensuring data quality, accessibility, and interoperability. Academic librarians are expected to understand and become adept at integrating new technologies into library systems and services. This includes knowledge and understanding of the various library management systems available within the library sectors. It is important that DUT librarians become skilled at integrating new technologies into library systems and services.

As the information landscapes become more complex, librarians teach users to navigate digital resources and use new technologies effectively (Ayinde and Kirkwood 2020: 144). They must understand digital tools and platforms to educate and assist users. With increasing plagiarism issues, librarians need to understand copyright, intellectual property, and privacy. They ensure compliance with institutional policies and promote ethical use of information and resources.

Academic librarians face increasing pressure to align their roles with the institution's mission, fully engaging in collaboration and partnerships within the institution. As Shupe and Pung (2011: 409) observe, the role of the academic librarian has undergone significant transformation in recent times. This shift is attributed to technological advances and changes in instructional models and institutional requirements (Shupe and Pung 2011: 409). Today, librarians are more involved with academics and researchers, acting as research partners. Borrego, Ardanuy, and Urbano (2018: 663) suggest that managing research enhances librarians' problem-solving and decision-making skills, contributing to their professional development. Maponya (2005: 1) emphasises that the evolving technological environment and information landscape have impacted all institutions, affecting academic librarians' ability to provide competitive and effective services to their institutions and users. Consequently, librarians are now more involved in improving the research impact ratings of their institutions and affiliated researchers.

Atkins, as cited in Force and Wiles (2020: 196), emphasises that academic librarians must act as advocates within their institutions and aim to be on equal footing with academics. Traditional roles of academic librarians, which once focused on collection development, bibliographic instruction, and referencing, have expanded to include teaching, learning, and information literacy (IL) education. Academic librarians now prioritise scholarly communication through open access and open educational repositories, collaborating and utilising technology to connect users with the information they need (Force and Wiles 2020: 197). Their role has evolved from being custodians of books to becoming online system gatekeepers.

In the current context, especially during the COVID-19 pandemic, online teaching and providing online help have become common practices. Force and Wiles (2020: 199) note that online interactions have equipped academic librarians with additional skills such as copyright knowledge, subject-specific expertise, and advanced courseware knowledge. However, it remains challenging to meet the diverse needs of all users, each with unique requirements.

The changing landscape of librarianship has led to the creation of new specialities within libraries. Positions such as systems librarian, digital librarian, research data manager, and institutional repository librarian have emerged over time (Cox and Corral 2013: 1526). Many academic librarians have had to adapt their methods of accessing information for users, as much of the information is now available online, requiring advanced skills to identify accurate information.

The technological environment has significantly transformed academic library services and daily operations. These changes have influenced the roles of academic librarians, creating a growing need to understand and manage the digital environment and its evolving challenges (Hamad, Al-Fadel and Fakhouri 2020: 4). Peiffer (2015: 6) notes that employees have undergone numerous changes due to the digitisation and automation processes. They have faced and adapted to many disruptive technological changes and, with the 4IR, the transformation is ongoing. As the digital environment expands and becomes increasingly important for libraries, the demand for different types of librarians and information professionals has also increased. Academic libraries have recognised that their focus areas have changed, necessitating the skills of record managers, archivists, data curators, and other emerging roles for which librarians must collaborate and acquire new competencies (Robinson 2021: 151).

One of the main focuses in academic libraries is research data services and data management. Many libraries have had to reorganise their workflows to incorporate librarians' specialised skills in handling research data. The roles and responsibilities of cataloguing librarians have evolved to align with changes in both cataloguing systems and the resources provided by libraries. These librarians are required to work with repositories and various open-source databases, using standards that are compatible with these repositories. Consequently, cataloguers must continually update their knowledge and stay current with new international standards that impact their work (Han and Hswe 2011: 129).

Publishing in academic libraries has also become an increasingly important aspect of the librarian's role in supporting research and scholarship. Many libraries have established their own publishing programmes to produce scholarly journals and publications. Academic libraries are using digital publishing platforms to disseminate scholarly works (Lippincott 2016: 187).

Skills requirements for librarians

Academic librarians are expected to evolve with the transformation and adapt to the environment by learning new skills and knowledge to help them embrace new ways of working (Moonasar 2024: 227). According to Maphoto and Matlala (2023: 24), academic librarians need to reinvent themselves to deliver relevant and excellent services to users. The onslaught of COVID-19 altered the way academic institutions communicated with and provided services to users. Librarians adapted by providing more online services through the use of online tools and platforms (Maphoto and Matlala 2023: 37).

Academic librarians must attend training and workshops to remain relevant and provide adequate services amidst evolving technical innovations (Maphoto and Matlala 2023: 39; Moonasar 2024: 235). As Aslam (2021: 55) explains, user satisfaction is one of the main priorities of librarians and they are forced to acquire new skills and abilities to meet the needs of the users in a changing information landscape. The higher education landscape is changing, and this means that academic libraries need to evolve and adapt to the changes within this sector. Libraries are usually the leaders in creating neutral spaces and providing an environment that drives change and ensures that user needs are met with respect to acquiring the information that is required (Marwala 2022: 5). Librarians are consistently at the forefront of innovation and are usually the first to adapt to changes within the higher education landscape (Marwala 2022: 5). They respond to changes within the research environment and integrate new research changes within the library environment. Academic librarians have grasped research data management (RDM) policies, and the implementation of these policies has been integrated into the library workflow. Librarians are actively involved in assisting researchers with bibliometrics and metric information requirements (Moyo 2022: 87). Librarians are now engaging in research publishing and assisting researchers with training and workshops on how to publish and choose the right journals to publish their work (Moyo 2022: 88).

According to Marwala (2022: 5), the set of skills that are fundamental for librarians to adapt to the 4IR, includes agility, resilience, responsiveness, and adaptability. According to the study conducted by Moonasar and Ngoepe (2023: 20), communication, complex problem-solving, critical thinking, analytical, and technology skills are essential for librarians to navigate the 4IR landscape. With the focus on open science initiatives, librarians are expected to be the leaders in adopting these policies and providing a framework for the academic institution to follow and implement the initiatives (Moonasar and Ngoepe 2023: 24).

Academic librarians need to both acquire and retain diverse skills to thrive in the 4IR era. Digital literacy is essential and requires proficiency in digital tools and online platforms. With the rise of online resources, librarians remain crucial in ensuring users access the right information (Ayinde and Kirkwood 2020: 144). Research data services are vital, and librarians must support and manage such data, developing skills in curating large datasets for institutions and researchers (Ahmad, JianMing and Rafi 2019: 204). They need to understand various library management systems and information technology infrastructures (Moonasar 2022: 2).

Academic librarians working with data and institutional repositories need excellent metadata skills for creating and managing digital resources (Ahmad, JianMing and Rafi 2019: 204). Besides teaching IL, they must be proficient in digital literacy and impart navigation and access skills to users (Ayinde and Kirkwood 2020: 148). New technical abilities include using AI to improve library services and being aware of data security and privacy issues. Project management skills are also essential for coordinating projects with various teams and stakeholders. Understanding user needs and ensuring a positive user experience is crucial. Librarians should conduct surveys to design user-friendly interfaces and enhance user experience (Cao, Liang and Li 2018: 817). Ongoing professional development and staying updated with technological advancements are imperative (Moonasar 2024: 227).

Participant demographics

Forty-one of the 70 library staff members who were approached completed the questionnaire (a 58.6% response rate), allowing for a sufficient representation of the population to draw meaningful insights. The job designations of the 41 librarians are provided in Table 1. As noted, 10 were individually interviewed to enhance the quantitative data.

Table 1: Participants' designation

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

Findings

This study focused on DUT librarians examining how they could align their roles and skills with the 4IR technologies to enhance service delivery. To ensure the anonymity of the participants, those who were interviewed are numbered IP1-IP10 (IP= interview participant) while those who completed the online questionnaire, are numbered R1-R41 (R= respondent)

Assessment of current skills and roles

The 4IR impacts all of society, compelling academic librarians to develop diverse skills to navigate emerging technologies. The findings revealed that rapid fluctuations in innovations have affected librarians and have evolved their service to users.

IP8 shared the following:

“The roles have evolved as every year we experience less and less circulation of print material as users are drawn to online resources.”

Similarly, IP9 stated:

“The purchasing of less print resources affected cataloguers and processing staff, as they now have less print resources to work with. More cataloguing work is done online on the institutional repository and in e-books.”

Their views are supported by Ayinde and Kirkwood (2020: 143) who contend that the 4IR reshapes jobs and introduces both risks and opportunities, necessitating new skills development for librarians. Indeed, the 4IR transforms traditional working methods.

When asked if the traditional roles of working in the library had changed, 76% (31) of the 41 respondents agreed, 17% (7) were uncertain, and 7% (3) believed that there were no changes in their work (see Figure 1). Librarians were increasingly assisting users virtually through online chats and the library’s LibChat platform. LibChat is a communication tool that is used in libraries for real-time interactions between staff and users. It allows libraries to provide virtual reference services, support research inquiries, and address general questions or concerns, enhancing the accessibility and convenience of library services by enabling remote connections through instant messaging or live chat features (Goss and Decker 2022: 423). There were fewer face-to-face interactions on site. Wong and Chan (2018: 109) emphasise that the traditional roles of librarians as collection gatekeepers and information mediators are

rapidly changing, being replaced by internet-connected devices for information searching.

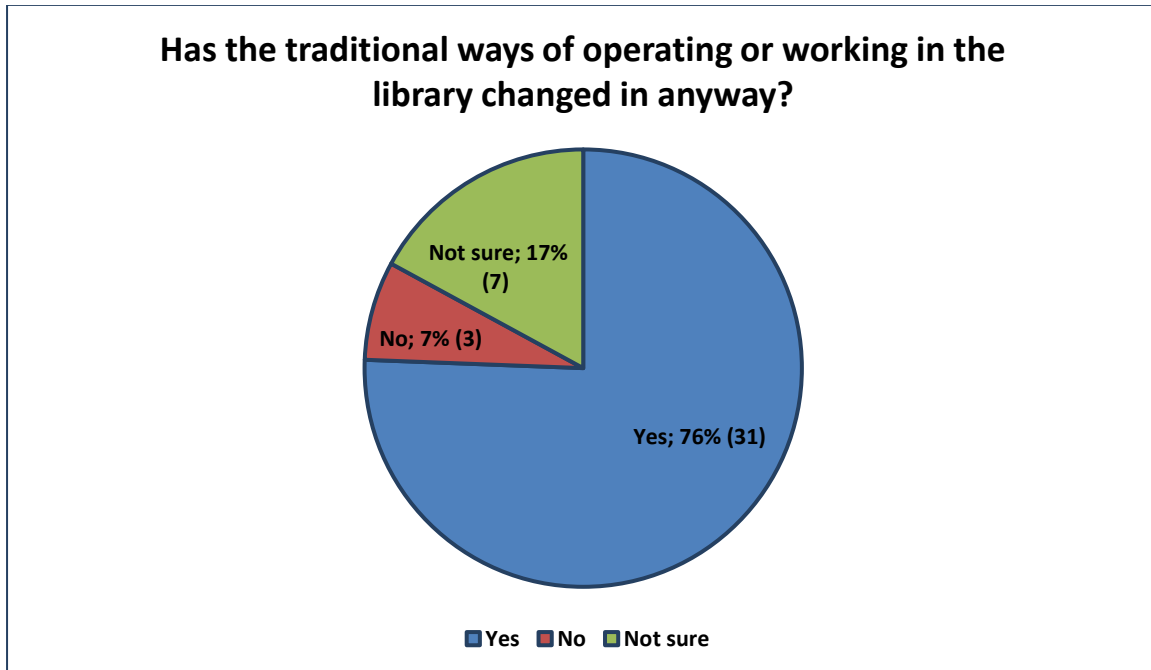


Figure 1: Changes in library functions (N=41)

Acquiring new skills

When asked about the new skills required due to changes in their library, the responses from the DUT librarians were diverse. In Figure 2, it can be observed that 36% (15) of the 41 respondents highlighted the need for librarians to acquire proficiency in searching and working on the two newly introduced platforms within the library. Furthermore, 32% (13) of the respondents reported the requirement to learn various IT-related skills. This finding aligns with Ayinde and Kirkwood (2020: 144), who emphasise the librarian's role in coordinating and implementing new technologies within libraries. Five percent (2) of the respondents indicated the need to acquire research skills, while 7% (3) pointed to the need for developing digital skills. These findings demonstrate that librarians had to acquire a wide range of new skills to effectively assist users and researchers in their respective endeavours. The librarians were aware that they had to be familiar and proficient with various AI tools and platforms that drove the 4IR landscape.

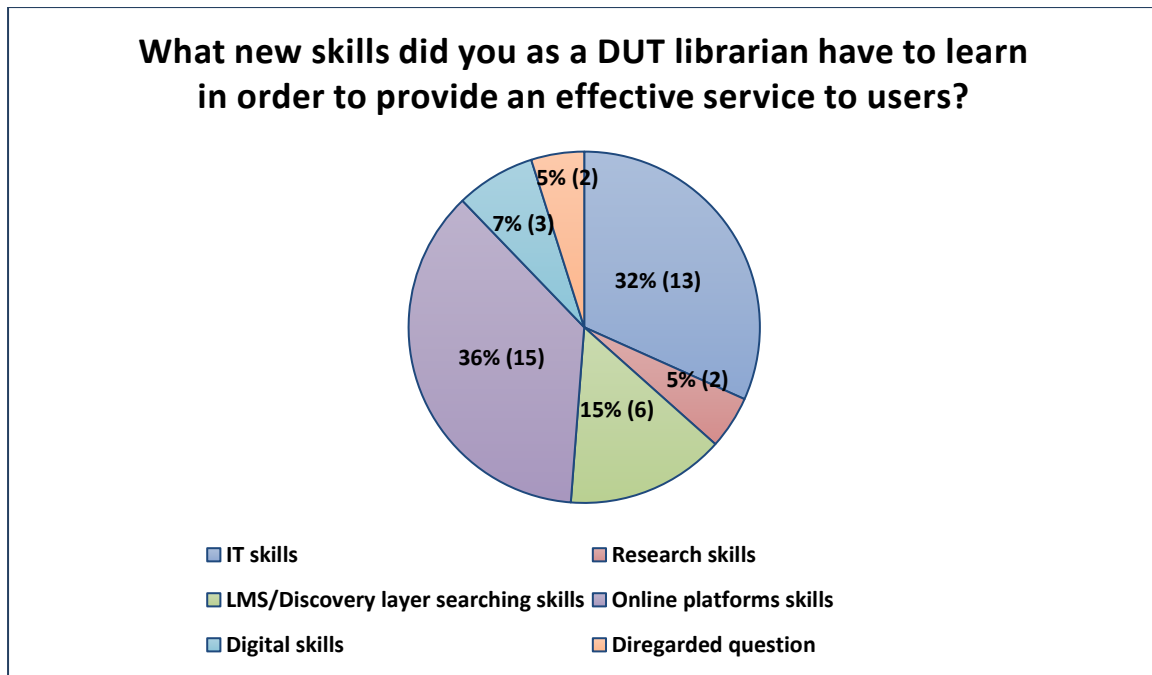


Figure 2: New skills required as DUT librarians (N =41)

Information technology skills

Librarians can effectively harness the new technologies introduced in libraries by acquiring IT skills. These skills encompass proficiency in software applications, database management, troubleshooting technical issues, understanding network infrastructure, and keeping abreast of IT trends (Shilenge and Telukdarie 2021: 459). Developing these skills enhances librarians’ support for users and researchers in accessing and utilising digital resources. The systems and IT librarians provide support for the IoT devices used within the DUT Library and they are required to understand how to troubleshoot and maintain these systems.

IP1 explained:

“It was imperative for librarians to have strong IT skills and familiarity with the use of databases and the internet. Users expect us to know and understand all of their devices and how to troubleshoot various challenges they encounter.”

IP3 concurred:

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

This aligns with Balashova and Gromova's (2018: 1) view that IT is crucial for business transformation in the 4IR era. DUT's adoption of cloud technology ensures that librarians use these platforms daily for efficient storage and access to information.

Flexibility of librarians to adapt to changes

Academic librarians must be able to adapt to new technological advances and incorporate them into their daily tasks and services. They need to demonstrate readiness to embrace change promptly and maintain a flexible mindset in their approach to thinking and working. Lee et al. (2018: 11) highlight the importance of flexibility in effectively navigating the 4IR and responding to its dynamic shifts. Several respondents echoed this view, recognising that the ability to adapt to change is crucial for delivering successful services to users. The significance of adaptability and flexibility in the evolving landscape of the 4IR is highlighted by Eberhard et al. (2017: 54). These skills are essential to facilitate various activities within the library environment. Figure 3 offers insight into the librarians' perceptions of their flexibility to adapt to changes at the DUT Library. Of the 41 respondents, 70% (28) expressed a positive outlook toward adapting to changes, while 20% (8) felt uncertain and apprehensive. Ten percent (5) chose not to respond to the question.

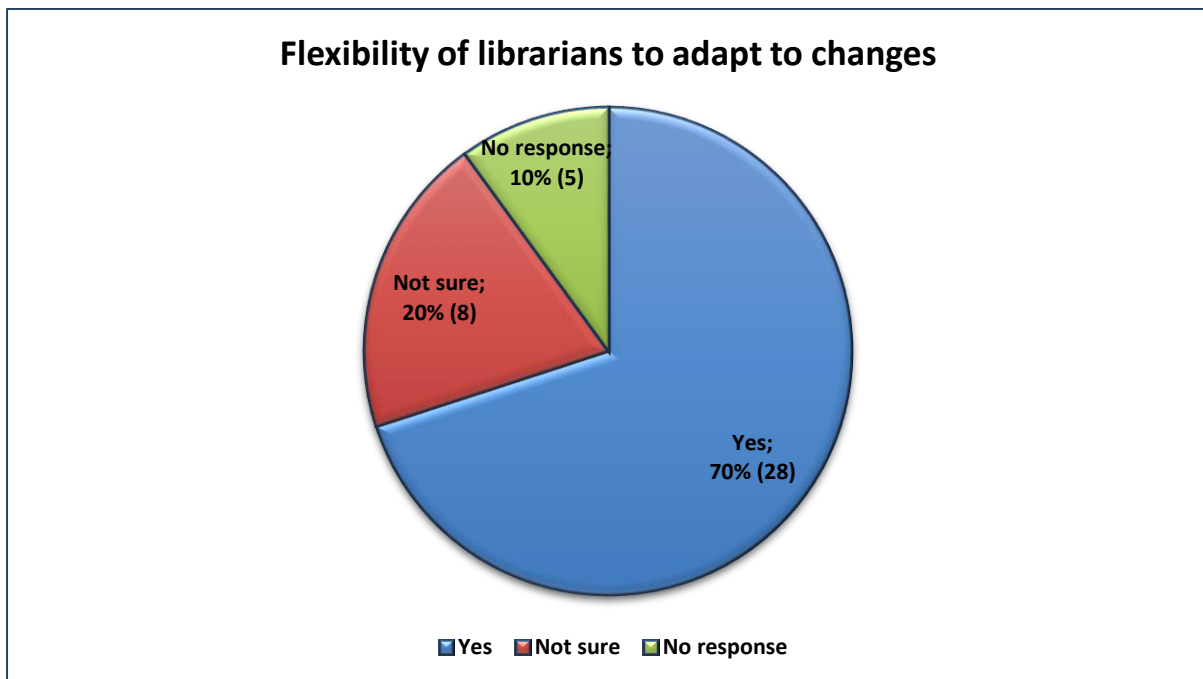


Figure 3: Flexibility of librarians to adapt to changes (N=41)

Technology has significantly reshaped academic librarians' roles, requiring new methods to meet user needs through virtual platforms. Rahmah and Marlina (2020: 358) highlight librarians' adaptation with "smart thoughts and actions" to

innovations. The researchers observed rapid user responses and robust engagement on online platforms under the 4IR, reinforcing the need for librarians to quickly adapt to dynamic demands (Rahmah and Marlini 2020: 358).

Findings revealed new roles and adjustments as the librarians adapted to changes. For example, at the DUT Library, cataloguers now manage online resources such as e-books and journals, shifting from print to electronic materials; while processing staff focus more on projects than on the preparation of physical items. A new digital librarian role was created to manage open scholarly research, aligning with Cox and Corral's (2013: 1533) emphasis on such positions. Additionally, librarians are involved in IL education and research instruction through platforms such as Moodle and Microsoft Teams, consistent with Cox and Corral (2013: 1534). Subject librarians played a pivotal role in online teaching and learning during the pandemic, improving both user and librarian experiences.

Tenopir et al. (2014: 85) note that librarians are essential for implementing research data services and supporting researchers with data management and preservation. They engage researchers in RDM plans and address data security and benefits, in line with Wong and Chan's (2018: 111) view on the growing importance of RDM and digital scholarship.

These efforts underscore a university's responsibility to adapt and support evolving academic and research needs amidst technological advancements (Tenopir et al. 2014: 85).

Changes in librarians' work in the context of the 4IR

The 4IR presents both challenges and opportunities for libraries and librarians. Aligning librarian roles and skills with 4IR technologies can enhance services and better meet user needs. Momoh and Folorunso (2019: 2) note that librarians' roles have evolved alongside rapid technological advancements and that these roles have transformed in response to disruptive technologies.

Libraries have transitioned from offering traditional face-to-face information to providing users with online access to all information resources (Ahmat and Hanipah 2018: 59). Figure 4 reflects this sentiment, showing that the respondents believe their roles and responsibilities within the library have evolved in the context of the 4IR. Of the 41 respondents, 29% (12) indicated that technological advances have influenced their work methods. Furthermore, 32% (13) agreed that librarians are now engaged in more online work and have

significantly increased their online interactions compared to the previous year. Additionally, 24% (10) of the respondents perceived that technological evolution has impacted library services. There is consensus that traditional methods have changed due to new technologies and systems, aligning with Wong and Chan's (2018: 109) view that technological changes challenge traditional librarian practices.

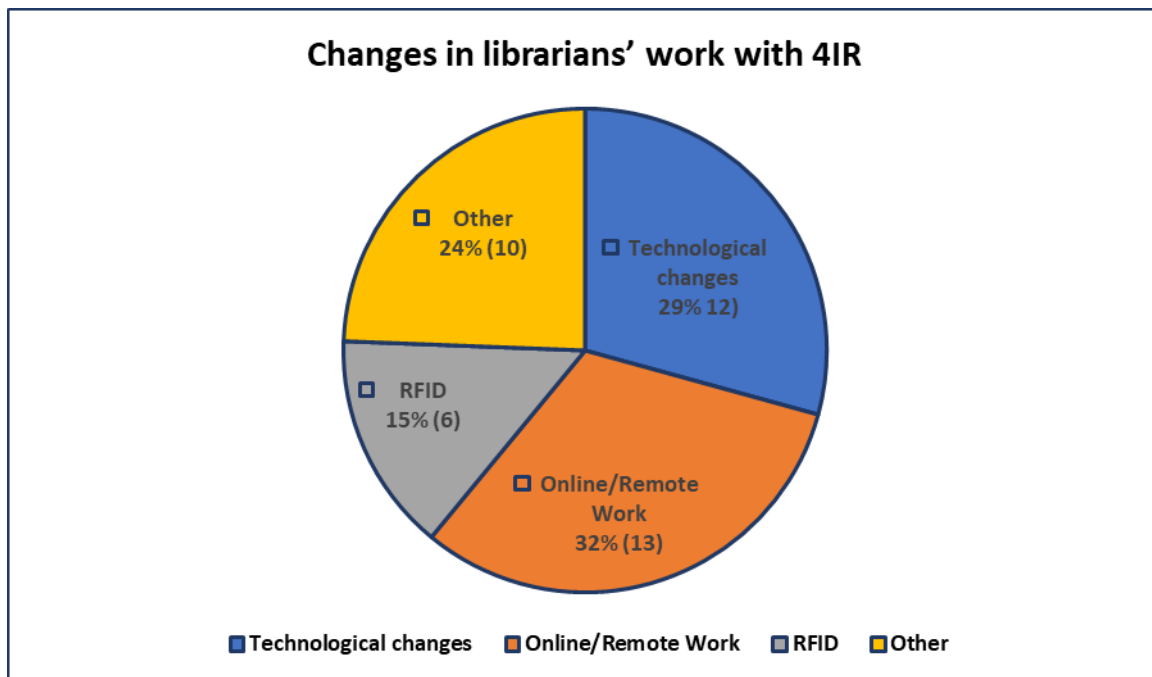


Figure 4: Changes in librarians' work (N=41)

Proposed framework for aligning librarian competencies with 4IR technologies

The ultimate objective of the study was to develop a framework aimed at aligning the competencies of the DUT librarians with the demands of 4IR. As highlighted, the 4IR has significantly influenced the field of library and information science, profoundly transforming its professional and operational landscape. The shift towards these 4IR technologies, demands a reimagining of librarian roles with a focus on new skills and competencies.

Framework components

The components of the framework were developed based on an in-depth analysis of existing literature and insights gathered from participant responses during interviews and questionnaire feedback. The proposed framework is depicted in the form of a flow chart in Figure 5 below.

Skills and competencies

The findings consistently show that participants strongly believe that librarians need to redefine their current skill sets and adopt new skills to remain effective in providing quality services to users. Communication and interpersonal skills are essential for any librarian, whether they work in technical services or public services, as these skills are necessary to interact with users and other librarians. The study revealed that skills in technology – communication, creativity, critical thinking, problem-solving, analytical thinking, and the ability to adapt to changes – are crucial for librarians to navigate the challenges of the 4IR.

IP2 emphasised the importance of communication skills:

“Good communication skills are essential for librarians to be able to identify user’s needs, discuss their issues and be able to assist with the challenges they face in retrieving information”

This is aligned with Mohideen et al. (2022: 522) who believe that librarians must possess effective communication skills to meet user needs in various formats.

Shilenge and Telukdarie (2021: 459) emphasise that IT skills are crucial for navigating 4IR challenges and integrating operational technology for optimal practices. The DUT librarians noted the need for soft skills in addition to IT skills, namely, problem-solving, creativity, and critical thinking. Critical thinking skills are essential for librarians as they navigate a variety of tasks and responsibilities within their profession. The role of academic librarians has significantly transformed due to new technological innovations, drastically changing their interactions with users (Shupe and Pung 2011: 409). Librarians need to critically assess the quality, relevance, and reliability of information sources. These skills are crucial for evaluating the development of the library’s collection and meeting user needs. Librarians now require critical thinking skills and an adaptable mindset to manage the effect of these changes on libraries. They need to evaluate new technologies, understand their implications, and make informed decisions about their adoption and integration. Eberhard et al. (2017: 54), in addition to critical thinking, emphasise the importance of problem-solving and cognitive skills as vital attributes for people in the 4IR. Many respondents highlighted the indispensability of critical thinking skills for librarians in the 4IR, a viewpoint supported by Ayinde and Kirkwood (2020: 148), who assert that these skills are highly sought after in continuously evolving libraries.

Technical proficiency

Digital technologies have transformed information management at the DUT Library. Librarians must now curate digital resources and help users navigate them. Technical proficiency is crucial in enhancing users' experiences with personalised and improved resource access and keeping them updated on new tech-driven services. The important role that technology is now playing in service delivery in academic libraries is underscored by the responses below.

IP10 believed that:

“New technology has helped to speed up the rate in which information is created, edited, disseminated and stored for future usage.”

R9 explained::

“Technology has improved service delivery and the provision, sharing and accessing of information faster and better services.”

R37 stated:

“New technologies will help libraries strengthen their programmes and facilities in ways that foster better services, higher user satisfaction, and more positive perceptions.”

Academic librarians need to manage and analyse the increasing volume of academic research data to support research outcomes. They are essential in supporting the new opportunities for open access and digital resources brought about by the 4IR (Force and Wiles 2020: 197). DUT librarians recognise that new technologies enhance productivity and foster a more engaging work environment. They need to collaborate with diverse users and colleagues, solve complex problems, and connect with experts across disciplines.

Information literacy

IL is critically important in today's digital age. Academic librarians need to have the ability to guide and educate users about the location, evaluation, and use of information resources effectively. They foster critical thinking skills by teaching users how to evaluate information sources for accuracy, reliability, and relevance (Hamad et al. 2020: 3). The following two responses illustrate IL's importance.

IP5 stated:

“Information literacy is important, especially in the time of fake news and misinformation; it helps to identify false information and discern between reliable sources and fake content.”

Similarly, R2 opined:

“IL empowers users by providing them with skills to make informed decisions and enhances lifelong learning and personal growth.”

IL equips users with the skills to search and retrieve information using various tools and platforms. Librarians understand that effective IL promotes lifelong learning by instilling the ability to locate, evaluate, and use information effectively throughout life (Hamad et al. 2020: 3). IL emphasises the ethical use of information, including understanding copyright and intellectual property and respecting privacy. It also enables effective communication of information, both orally and in writing, by organising and presenting it logically.

In general, IL is crucial to navigate and prosper in an information-rich world, where effective access, evaluation, and use of information are essential to success.

Digital literacy

Digital literacy involves navigating, evaluating, and creating information using digital technologies. Users need basic skills, such as using computers, smartphones, and other devices. Librarians must share their expertise in online searches, understanding URLs, using different browsers, and evaluating source credibility. The responses below illustrate that librarians actively promote digital literacy skills among users.

According to IP10:

“It is essential that we educate our users in effectively using online communication and the challenges that are associated with social media and digital security.”

IP3 stated:

“Users need to understand the basic steps in creating digital content and the long-term impact these platforms can have on them. Awareness of the long-term implications of online actions and the concept of a digital footprint needs to be emphasised.”

IP10 explained:

“Personal information online needs to be protected, and the use of strong passwords, recognising phishing scams, and maintaining digital security, needs to be understood by users.”

Collaboration and teamwork

Collaboration among academic librarians is essential to effectively align with the 4IR, as it accentuates their ability to work collaboratively with colleagues, participate in team projects, and contribute to a positive work environment. Librarians need to work with faculty, IT staff, and researchers to integrate new technologies and digital resources, ensuring that services meet diverse academic needs. Collaboration fosters innovation by combining different perspectives (Nhede 2018: 203). Librarians can jointly develop digital repositories, online learning modules, and RDM systems, which are vital in the 4IR context.

IP3 highlighted:

“The library engages with other libraries to learn from their experiences in handling the 4IR.”

IP2 explained:

“DUT librarians are always actively involved in collaborating with counterparts at other institutions to share experiences and learn from them.”

Teamwork among librarians facilitates the sharing of experience and skills in emerging technologies such as data analytics, AI, and digital curation. This collective knowledge strengthens the library staff's ability to effectively manage and utilise these technologies. Collaborative efforts lead to comprehensive support systems for users, enabling librarians to improve IL programmes, research support services, and technology assistance for students and faculty.

Research support

Research support in academic libraries, particularly at the DUT, often involves a variety of services and resources designed to assist students, faculty, and researchers. Librarians offer consultations on research strategies, database navigation, and resource identification. Postgraduate librarians assist with literature and systematic reviews and help with institutional repository access for theses, dissertations, and research outputs. These librarians hold workshops and training sessions on citation management software such as EndNote, Mendeley, or Zotero for postgraduate users. Training in efficient information search, evaluation, and use is provided, along with access to extensive collections of academic journals, books, and databases. The DUT promotes RDM and the library provides workshops on data planning, storage, and sharing for researchers. Librarians educate users on open access and copyright issues and provide support with journal selection and understanding of the publication process.

IP9 highlighted the DUT Library's proactive approach to addressing new roles to enhance research support and to adapt to evolving needs by establishing new positions:

"The library has initiated new posts to move forward with digital scholarship, and the creation of a digital librarian, data curation, digitisation, and marketing librarian are proof that we are moving on the right track."

Recommendations and implementation strategies

To effectively adapt to the effects of 4IR technologies on DUT librarians' roles and skills, several recommendations need to be implemented.

Training and workshops

While IP1 had an extremely positive perspective concerning DUT librarian skill sets and ongoing training:

"The DUT Library has a workforce equipped with the necessary skill sets to handle the 4IR and its implications. Staff are continuously attending seminars and workshops to keep up with the current and future technologies and trends. People and technology are consistently connected to each other, ensuring that learning takes place"

it is recommended that regular workshops and seminars on emerging technologies should be held at the DUT Library sites to ensure that librarians are kept informed about trends and their impacts.

IP8 believed that continuous training and learning is critical for librarians to remain relevant in their disciplines:

"Investing in capacity-building is the best way to stay current with changes. Librarians need to be techno-savvy."

IP7 underscored the importance of keeping up-to-date:

"Librarians need to always update and upgrade skills to provide modern services to today's users."

Online learning platforms

Online platforms offer flexible learning opportunities for DUT librarians, providing courses, tutorials, and webinars on the 4IR technologies to enhance their skills. These must continue to be promoted and utilised. IP9 noted that library services improved due to these online resources:

“Staff are creatively engaging with library users off-site through Teams, Google Hangouts, social media, and WhatsApp. Moodle is used for classroom activities and assessments, while Teams and Zoom facilitate meetings and classes. Online chat tools on the library website address user queries.”

Mentorship programmes

Mentoring programmes are effective in transferring knowledge and skills from experienced librarians to the younger generation. The respondents R17 and R23 believed that succession planning and mentoring young professionals was important to keep the profession relevant:

“Mentoring ensures that the knowledge and expertise of experienced librarians is transferred and shared with librarians new to the profession.”

“Mentoring young recruits can help the library and the profession to maintain continuity and create a strong foundation for the future of the library.”

Mentoring helps to maintain the continuity of library services. By preparing the next generation of librarians, libraries can ensure that there is no major disruption in services as experienced librarians retire or resign. Succession planning through mentoring helps identify and prepare future leaders. Young information professionals are groomed to take on leadership roles while ensuring that the library remains dynamic and forward-thinking.

The proposed framework

The framework, depicted as a flowchart in Figure 5, illustrates how the academic librarians' skills align with the 4IR through various implementation strategies. The central focus is on identifying the skills needed to develop and enhance librarians' abilities. The proposed framework identifies the specific digital, technical, information, research, and teamwork skills needed. These skills encompass a broad range of competencies required in a modern library. These include being adept at using library management systems, databases, and emerging technologies. The ability to effectively find, evaluate, and use digital information resources is essential and combined with the ability to guide users in effectively retrieving the right information to satisfy their needs and transfer lifelong learning capabilities. Teamwork and working well with others internally and externally build better collaboration among peers to achieve common goals. Providing research support to academics and users is important in creating visibility and encouraging scholarly output. The implementation strategy ensures that the core areas are identified and the specific strategies are followed to achieve the results required to make the framework successful. The framework recommends strategies such as online learning platforms, training

workshops, and mentorship programmes. To successfully adapt to 4IR innovations, libraries must invest in continuous professional development, modernise their technological infrastructure, engage and educate users, foster innovation, formulate comprehensive policies, and regularly monitor and evaluate the progress of the librarians and the users' experiences. These checkpoints or steps can help ensure that librarians are well-equipped to navigate the evolving landscape and continue to provide valuable services amid 4IR innovations and the digital age. The proposed framework aims to keep librarian competencies aligned with evolving technological advances and to foster adaptability and growth.

This framework provides a strategic roadmap for academic librarians to adapt to the 4IR through targeted skills development, evaluation, and continuous refinement. It emphasises a dynamic approach that ensures librarians remain relevant in a rapidly changing technological environment.

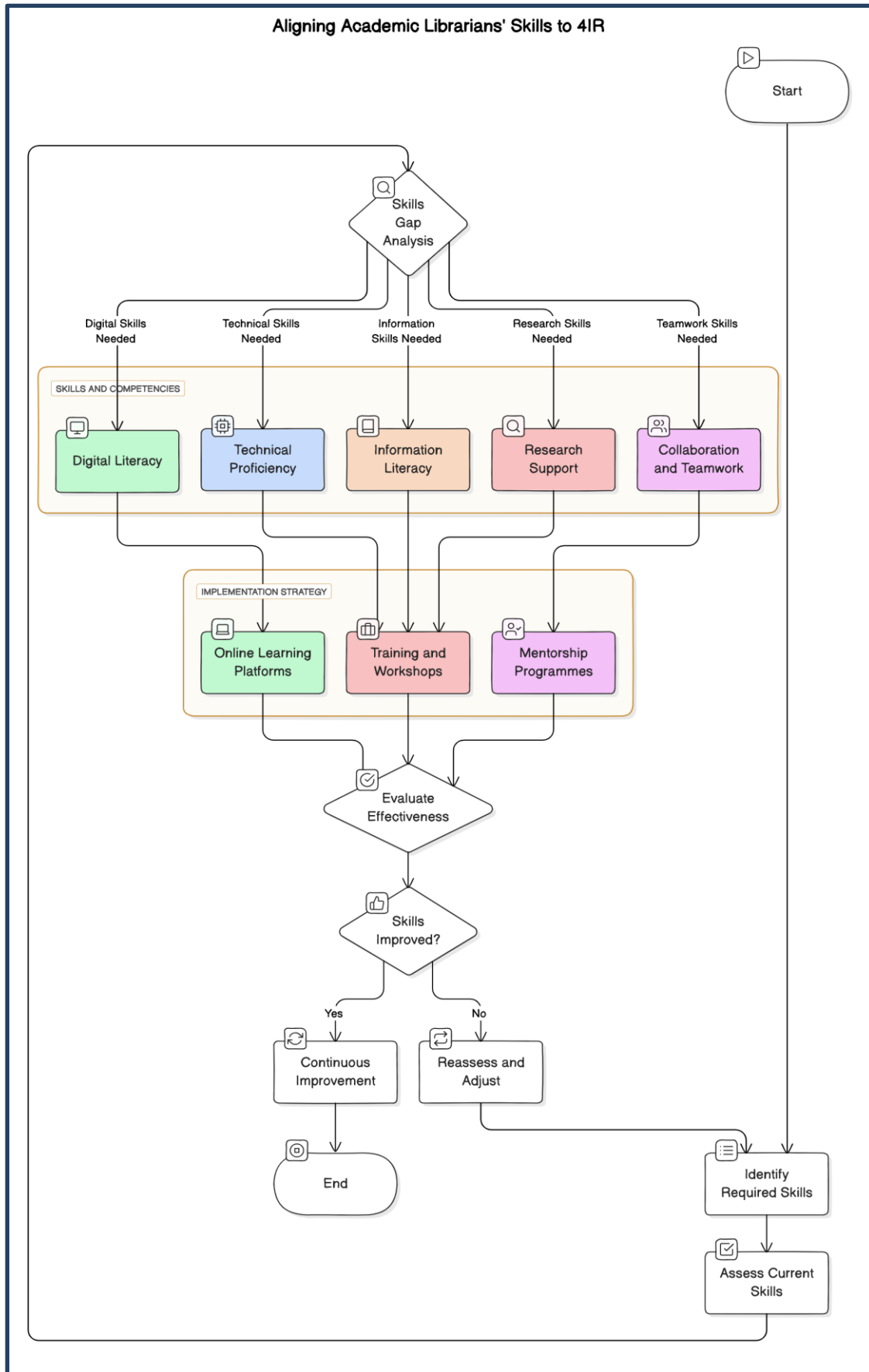


Figure 5: Proposed framework for aligning librarian skills with 4IR technologies

Conclusion

The 4IR presents both challenges and opportunities for the DUT Library. By aligning librarian roles and skills with emerging 4IR technologies, DUT can enhance its library services and better meet the needs of its users. The proposed framework provides a structured approach to achieving this alignment, ensuring that DUT librarians are well-equipped to navigate the rapidly changing technological landscape. Through targeted training, collaborative partnerships, and continuous evaluation, DUT libraries can harness the power of 4IR technologies to drive innovation and excellence in service delivery, ensuring that the library remains a vital and innovative resource for its users.

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