

Artificial intelligence (AI) library services innovative conceptual framework for the digital transformation of university education

AI library
services 4.0
conceptual
framework

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Abstract

Purpose – Artificial intelligence (AI) is one of the latest digital transformation (DT) technological trends the university library can use to provide library users with alternative educational services. AI can foster intelligent decisions for retrieving and sharing information for learning and research. However, extant literature confirms a low adoption rate by the university libraries in using AI to provide innovative alternative services, as this is missing in their strategic plan. The research develops (AI-LSICF) an artificial intelligence library services innovative conceptual framework to provide new insight into how AI technology can be used to deliver value-added innovative library services to achieve digital transformation. It will also encourage library and information professionals to adopt AI to complement effective service delivery.

Design/methodology/approach – This study adopts a qualitative content analysis to investigate extant literature on how AI adoption fosters innovative services in various organisations. The study also used content analysis to generate possible solutions to aid AI service innovation and delivery in university libraries.

Findings – This study uses its findings to develop an Artificial Intelligence Library Services Innovative Conceptual Framework (AI-LSICF) by integrating AI applications and functions into the digital transformation framework elements and discussed using a service innovation framework.

Research limitations/implications – In research, AI-LSICF helps increase an understanding of AI by presenting new insights into how the university library can leverage technology to actualise innovation in service provision to foster DT. This trail will be valuable to scholars and academics interested in addressing the application pathways of AI library service innovation, which is still under-explored in digital transformation.

Practical implications – In practice, AI-LSICF could reform the information industry from its traditional brands into a more applied and resolutely customer-driven organisation. This reformation will awaken awareness of how librarians and information professionals can leverage technology to catch up with digital transformation in this age of the fourth industrial revolution.

Social implications – The enlightenment of AI-LSICF will motivate library professionals to take advantage of AI's potential to enhance their current business model and achieve a unique competitive advantage within their community.

Originality/value – AI-LSICF development serves as a revelation, motivating university libraries and information professionals to consider AI in their strategic plan to enable technology to support university education. This act will enable alternative service delivery in the face of unforeseen circumstances like technological disruption and the present global COVID-19 pandemic that requires non-physical interaction.

Keywords Artificial intelligence, Digital transformation, Digital transformation technology, University library services transformation, Service innovation framework, Digital transformation framework, Fourth industrial revolution (4IR), COVID-19 pandemic

Paper type Research paper



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1. Introduction

There is a rapid technological change in the present world. The Fourth Industrial Revolution (4IR) is making business organisational operations unstable. 4IR is the transformation of the

traditional productive processes by digitising the real world, towards total interconnectivity of suppliers and customers, to obtain an intelligent product (Velasquez *et al.*, 2019). A revolution in the general adoption of digital technologies to create value is known as digital transformation. The concept of digital transformation includes implementing and incorporating a range of novel information and communication technologies to develop a more sustainable and responsive solution (Agrawal *et al.*, 2019). Digital transformation (DT), which is the modification of business processes, procedures and capabilities, has taken advantage of disruptive changes by influencing society. DT has achieved worldwide consideration in numerous service establishments owing to the ubiquitous characteristics and explosion of modern digital technologies.

Consequential to the arrival of new digital transformation technologies, institutions of higher learning must find novel means to get a competitive advantage (Hamidi and Jahanshaheefard, 2019). Today's universities are increasing their efforts to influence their students to gain more strategic improvement (Al-Shihi *et al.*, 2018). One of these strategies is the awakening of university libraries, which is the core of higher education establishments to emphasise its significance to their institution's mission and goals towards quality teaching and research (Yeh and Ramirez, 2016). Thus, university libraries are encouraged to improve their strategic response by adopting DT technology-based services (Yeh and Walter, 2016). One of these technologies is artificial intelligence (AI). In recent years, the development of AI in disciplines different from the traditional sciences has been directing the technology discussion. AI is an all-inclusive discipline established in computer science, linguistics, information science, neurophysiology, neuroscience, cognitive science, psychology control science, and other disciplines (Yu *et al.*, 2019).

Although there is a perception that AI is a computer program intended to imitate human intelligence (Zhang *et al.*, 2015), the reality is that it is more than that. Through the support of AI, learning can be personalized. It can satisfy the specific wants of all of the student's categories (Wheatley and Hervieux, 2019). AI, strengthened by a vast amount of data, establishes patterns and gives meaning (Claudé and Combe, 2018), making it logical that information services provider like the university library is a good environment where AI can add value to upcoming university education. AI adoption will allow each library patron to have an opportunity of receiving a wholly novel and exclusive educational approach designed to satisfy the student's specific needs. This assumption is supported by Cox *et al.* (2019). He opines that library driven by AI can aid better learning skill through a personalized individual learning approach.

Traditionally, the library has been indisposed to change, repeatedly waiting for a specific technology to attain market satiety before responding to a new trend (Wheatley and Hervieux, 2019). In the constantly changing environment where new digital technologies are rebuilding the organization's characteristics and interactions, the digital transformation of business has significant implications for our society and business organisations at large (Chernov and Chernova, 2019). AI is an adequate means to enable library users to access library resources without restrictions in the face of any disruption. AI technology usage in the library can allow library resources to be virtually reimagined. This reimagination can help the library explore new ways to meet customer needs and support academic activities to anyone from anywhere. AI can provide continued access to an increasing domain of full-text online resources, enabling the libraries to provide services beyond traditional (Folorunso and Momoh, 2020).

Several scholars identify AI as a core element of the ongoing digital transformation of enterprises (Zimmermann *et al.*, 2018). As a 4IR accelerator (Brynjolfsson *et al.*, 2019) AI will challenge the organization's management systems. Only the ability to confirm the accurate and apt valuation of this challenge and the capability to modify management systems in line with new conditions and prospects could be vital accomplishments for present organizations,

including the library. Research has been carried out on the use of AI in providing library services. The research of [Mei et al. \(2017\)](#) proposed a framework for dynamic movement simple library for a mobile robot planning in a strange environment while ([Asemi et al., 2020](#)), on the other hand, did a review of previous studies showing how useable intelligent system can be in the library. The outcome of his research shows that the current library and information systems have a high possibility to be enhanced by incorporating it with AI technologies.

Even though the literature shows that several institutions are found to be participating in the establishment of their own AI centres, the recent findings of [Wheatley and Hervieux \(2019\)](#) affirm that incorporating the usage of AI into library services strategic plans of future is yet to be visible. An AI model that shows how AI techniques and applications can be used to provide innovative library services to support a 4IR compliant university education is insufficient in the literature. This inadequacy leaves a critical gap on how university libraries can use technologies like AI to contribute to the preparation of the university community for the future; hence this research fills this gap by developing AI-LSICF. An “Artificial Intelligence Innovative Library Services Conceptual Framework”.

2. Problem statement

Various organisations experience digital technology’s transformative effects as technological and digital developments bring disruption and transformation to our world. Academia, government, and business struggle to envision how these advances will change the way they work, recognise the prospects they will bring and confront the challenges. Public institutions such as libraries can incorporate novel technologies to take the edge to disruption. For example, as an enabling technology, AI can support the university library to provide transformative services that complement quality education, learning and research. Still, there is a clear indication that library service providers do not know how technology like AI can contribute as an alternative innovative means of service delivery in the face of disruption.

Technology adoption is a topical research area in the information systems (IS) domain ([Rad et al., 2018](#)). However, in the recent findings of [Wheatley and Hervieux \(2019\)](#), where he researched 25 university libraries on AI engagement, he concludes that incorporating AI into libraries strategic plans of rendering future-ready library services is missing. His findings show a lack of the library’s consciousness on the significance of the present-day AI trend, which leaves a critical gap. This study develops an Artificial Intelligence Innovative Library Services Conceptual Framework (AI-LSICF) that can motivate librarians to consider AI a technology that can foster an alternative innovative service delivery in the face of technology disruption and unforeseen circumstances like the Coronavirus pandemic. To survive and thrive in this era, it is paramount for university libraries to take adequate measures to remain relevant in the university community. AI-LSICF will give an insight.

3. Literature review

3.1 Artificial intelligence (AI)

Developments in digital technologies and computer sciences are leading us towards a technological society where machines are gradually designed and developed to meet human needs while simultaneously becoming smarter. One of them is artificial intelligence AI ([Moreno-Guerrero et al., 2020](#)). AI is the capability a system has to correct and interpret external data, learn from such data, and use it to achieve specific goals and responsibilities through supple adaptation ([Kaplan and Haenlein, 2018](#)). AI has advanced speedily in recent times ([Ma et al., 2019](#)); hence it is likely to be one of the most valuable technologies for the coming years ([Chai et al., 2020](#)). AI has become indispensable because the rapid development

of AI has substantially made some practical and significant advances. Its potentiality has become promising and has interfered in the developmental activities of society (Majumdar and Chattopadhyay, 2020).

The prominence and use of AI, a leading disruptive technology of our time that imitates the behaviours commonly associated with human intelligence, are increasing fast worldwide (Yigitcanlar and Cugurullo, 2020). AI has penetrated medical science, education, finance, agriculture, industry, security and many other sectors (Jha *et al.*, 2019). Knowing AI techniques and applications can help management reduce the time in taking a decision (Bojorque and Pesántez-Avilés, 2020). AI has an expansive series of tasks it can accomplish (Dejoux and Léon, 2018). Figure 1 illustrates this.

3.2 AI in organisations

AI is proposed to have a transformational effect on many previous general-purpose technologies as AI organisational impact will increase in the future. Brynjolfsson *et al.* (2019) conducted a study on how helpful AI is to the organisation. This study concludes that almost every industry converts its fundamental processes and business models to benefit from AI. AI's capability in business is increasing. Its main principles related to the digital transformation progression allow establishments to get ready for, repel, and swiftly recuperate from the damaging effects of disrupting measures (Camarinha-Matos *et al.*, 2019). AI talk about a programmed system's ability to execute responsibilities generally linked with human beings, like the capacity to reason, realise the meaning, take an all-encompassing view or learn from previous experience (Van Dyk and Van Belle, 2019). Scenarios of AI adoption in the food industry has begun (Barth *et al.*, 2017). In more detail, Di Vaio *et al.* (2020) observe that AI technologies in the food industry can gather and process data from hundreds of different ingredients as they transfer on a conveyor belt. This action helps to reduce labour, costs and food waste. The reduction in the production process helps conserve food, increase the cleanness of production sites, and freshen up more processing tools fast.

AI has shown abundant prospects to transform the manufacturing field through innovative analytics tools for processing the enormous volumes of manufacturing data produced. For instance, AI has been used to forecast material properties and experimental outcomes in a bit of spent through conventional approaches (Ulas, 2019; Arinez *et al.*, 2020). AI

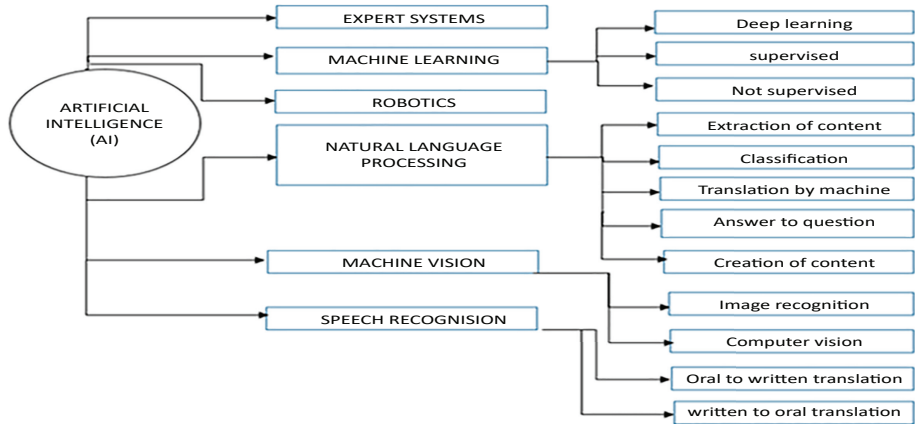


Figure 1.
AI application and
functions

Source(s): Dejoux and Léon (2018)

in this context facilitates a better acceptance of material properties as used in monitoring and modelling in the manufacturing process.

AI has become an integral part of the city. It helps to build intelligent buildings and smart cities (Cugurullo, 2020). Regarding the economy of smart cities, AI helps automate data, manage processes analysis and increase existing resources by reducing additional costs (Yigitcanlar *et al.*, 2020). AI aids smart mobility, predictive maintenance, intelligent traffic management and parking management (Paiva *et al.*, 2021). In medicine, AI can support patient's care remotely by observing and comparing their medical information through a wearable device with sensors to other data that has already been collected using AI. This allows for constant monitoring of a patient and detecting changes that may be less obvious to humans (Hwang *et al.*, 2021). AI in e-business is recommended and suggested by Malapane (2019) to be transformational by design and simplify processes. AI systems have become a crucial factor in each aspect of the e-commerce business process. AI has allowed the industry to increase productivity, performance and persistence.

The e-commerce industry has grasped a high degree of digitisation and automation concurrently. A study by Singh (2021) on AI and e-commerce ecosystem perspective observe a high implementation rate of AI by leaders such as Amazon, Walmart, Flipkart (Walmart-Flipkart) and eBay. Even at trim scale levels, he notes a similar adaption pattern by regionalised (Indian) e-commerce platforms such as Bewakoof, Grofers and Liscious. His study opines that such systems have proven to be a valuable additional parameter for the e-commerce industry and e-commerce customers. Similarly (Soni, 2020), posits that the diversified roles that artificial intelligence can undertake in an organisation include business processes such as sales, customer relationship management, product content management. AI can help sales forecasting by helping people and experts examine vast volumes of customer data to get valuable and proper insights from it. For illustration, Nandal *et al.* (2020) carried out a study on the facet of Sentiment Analysis of Amazon's Review; the study underlined how AI-based sentiment analysis could be structured to act as backed support in consumer behavioural patterns. The study underlined secondary usage of AI algorithm to produce a better review system capable of filtering process to extract false reviews that are sarcastic, refuting or similar.

Keerthana *et al.* (2020) research confirms that AI can use user profile information to create a recommendation matrix on defined parameters of users interest. In simple terms, the machine learning-based system tracks a user's patterns such as browsing, wishlist, a past purchase, and review and creates a matching index with patterns similar to the user's. As AI is being employed in more and more fields, education is not left out. Applying AI in education opens up powerfully (Fahimirad and Shakib Kotamjani, 2018). From the education point of view, AI technologies have changed the tools for carrying out research. Generally, AI has an essential effect on education and personalised learning in research institutions (Chen *et al.*, 2020). These include using AI to collect data, visualise data, represent models, present and disseminate informal means of communicating such as wikis, institutional repositories, blogs and open access materials that help democratise the intellectual discussions. AI usage in education also relates to teaching and evaluation, and personalisation of education (González-Calatayud *et al.*, 2021).

Concerning the academic areas where AI is of utmost influence, studies show that higher education is where AI is being implemented the most (Hinojo-Lucena *et al.*, 2019). Contemporary literature in the educational field identifies that AI offers a more critical contribution in the evaluation and training process par excellence where it impacts promoting more changes. An example is AI intelligent tutoring systems that aid in exploring texts on student's writing and analysis (Cope *et al.*, 2020). From this viewpoint, AI offers added value to teaching platforms, permitting establishing a personalised teaching-learning setting by

recognising and assessing patterns for decision-making. It permits for making decisions and readdressing the educational processes proposing active student learning.

Correspondingly, the study by [Mirchi et al. \(2020\)](#) confirms the usefulness of AI in educational practices by developing an objective assessment tool “The Virtual Operative Assistant”. This tool permits self-guided and similar medical or surgical training among learners imitating real-life training centred on the well-recognised apprenticeship model used to train surgeons and medical apprentices. This imitation mimic is a real-life scenario where the surgeon will carry out surgeries and consequently outline to the learner the actual bimanual psychomotor skills required for safe operative results. The system offers a related feedback model presently utilised by expert tutors to less skilled learners during clinical operation. It also offers auditory feedback with a human voice to reinforce the correctly done task components and explain other components that require improvements. This educational system establishes the potential to integrate AI into surgical educational teaching. The potential of linking expertise classification instructor input and objective feedback based on proficiency benchmark produces a novel educational tool into the educational paradigm.

AI independently acquires knowledge, comprehends and makes a decision by itself through the support of intelligent software systems, which can perform tasks through continual learning and improvement ([Adadi and Berrada, 2018](#)). [Magistretti et al. \(2019\)](#) emphasise how AI resolution exposes its prospects to information organisations by establishing how machine learning algorithms can search an enormous database to find solutions to common inquiries.

3.3 AI in libraries

Organisations like the universities are changing their teaching, learning and research models to influence student’s strategic improvement in response to the disruption ([Al-Shihi et al., 2018](#)). As a result, the university libraries are encouraged to facilitate this strategic response by adopting DT technology-based services ([Yeh and Walter, 2016](#)) to boost online education standards and quality. One of these technologies is Artificial Intelligence (AI). AI is software that spans an extensive range of technologies that aim to emulate human’s intellectual tasks and intelligent activities ([Zhang et al., 2015](#)). It establishes patterns and gives meaning from a vast amount of data, strengthening it ([Claudé and Combe, 2018](#)). [Lund et al. \(2020\)](#) observe that as AI is advanced, its adoption can improve the transfer of information in multiple environments. Consequentially, the university library is the right environment where AI can add value to upcoming university education. A few scholarly research are available on the use of AI in providing library services. For instance, [R-Moreno et al. \(2014\)](#) proposed using radio frequency identification (RFID) in libraries to assist users in locating new and existing library resources. AI can provide continued access to an increasing domain of full-text online resources, enabling the libraries to provide services beyond traditional ([Folorunso and Momoh, 2020](#)).

[Sherwani et al. \(2020\)](#) exemplify the use of AI with the emergent occurrence of service robots which he equates with collaborative robots. University libraries can give research support services to the university community by using AI to annex information resources. The library can make resources available to students, faculty and the academic community to support digital scholarship and promote research. [Schrettenbrunner \(2020\)](#) submits that organisations that fast track emerging technology’s usage will flourish, while establishments that do not accelerate their product and process virtualisation with AI integration have no future. The research of [Mei et al. \(2017\)](#) proposes a framework for dynamic movement simple library for a mobile robot preparation in an unknown location.

[Asemi et al. \(2020\)](#), on the other hand, did a review of previous studies showing how useable intelligent systems can be in the library; he submits that expert systems are useable intelligent systems that mimic librarian expert’s behaviours to aid decision making and

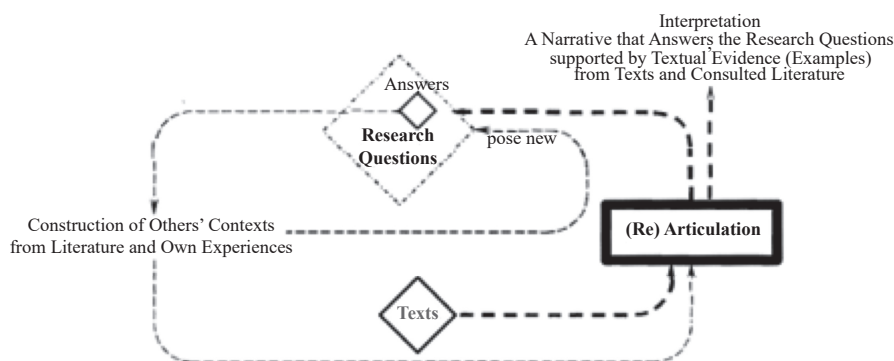
control. The outcome of this research indicates that incorporating AI technology can enhance the service delivery of library and information systems. Cox *et al.* (2018) observed from the survey of librarians from all divisions in the USA, which Wood and Evans carried out in 2018, indicates that 44% of librarians still believed that AI would not transform librarianship. To this end, this research comes up with a conceptual framework that explains how AI can enhance library services delivery that will help foster quality university's education, research and global ranking despite any level of disruption.

4. Methodology

This study adopts a qualitative content analysis methodology (Krippendorff, 2018) for this research (see Figure 2). Content analysis is a research technique for making replicable and valid inferences. Its addresses the application of analytical constructs that give meanings to data. This study adopts content analysis to investigate extant literature for a possible solution to develop an AI service innovation framework that can aid services provision and delivery in the university library.

This study embarked on a literature review to collect relevant publications on AI. The study used keywords like *Digital Transformation*, *Artificial Intelligence*, *University Education* and *Library Services* to look for articles from databases such as Science Direct, Scopus, Wiley online library, Web of Science and Association of information systems library. This study imports selected papers into NVivo 12. NVivo is a computer-aided text analysis (CATA) software where categorisation is possible using codes. Content extracted from articles was categorised into themes, and second-level codes were allocated to enhance a category's opportunity in different contexts. Themes emerged from different AI tools and application categories (Dejou and Léon, 2018) (see Figure 1). The classification aided the familiarity with the meanings of contents that characterise AI's domain.

Patterns and trends emerged, which facilitated the deduction of themes that helped establish a gap in university library services. There is no framework on how the university library can provide service using AI tools and applications hence necessitating this research. This study considers the theoretical understanding of the elements that make up the components of the business models presented in the theoretical framework in Figure 5. This study highlights the components of the theoretical framework and defines its key constructs. This definition guides the determination of the conceptual framework elements of the proposed AI-LSICF.



Source(s): Krippendorff (2018)

Figure 2.
Qualitative content
analysis framework

A conceptual framework “enlightens, in narrative form or graphically, the key factors, constructs or variables to be considered and the supposed relationships among them” (Miles and Huberman, 1994). To project awareness and understanding of how AI adoption can help library services. This research integrates the AI application and functions of Dejoux and Léon (2018) (see Figure 1) into the elements of Digital Transformation Framework (DT) as suggested by Matt *et al.* (2015) (see Figure 3). This study considers the various components of the digital transformation framework (Matt *et al.*, 2015) and contextualises it by emphasising the current setting required of an organisation’s digital transformation. This DT framework’s components were used to structure essential AI techniques and applications that characterise current fourth industrial revolution (4IR) digital transformation thoughts. The emphasis on the 4th industrial revolution enables a deeper reflection of the organisations’ role in creating value and where the organisation should focus its value creation. Afterwards, this research considers constructs in AI techniques and proposed applications (Dejoux and Léon, 2018). These constructs were used as keywords to carry out a wide-ranging literature review in the domain of AI from a far-reaching to the specific viewpoint related to service delivery in general practice. This consideration seeks to understand how AI has been helpful in service delivery in other service domains.

The literature search helped clarify and outline the phenomena perceived to comprehend general and precise information that would connect practical experiences that establish AI implementations in various service contexts. Although, in general, all practices are fundamentally unique and function in many diverse practice models (financial, organisational, environmental and human resource). This study develops AI-LSICF with the assumption that professional practices are unique; hence, the framework attributed to the library must be practice-specific in agreement with all the peculiarities of library practice. This assumption inspired this research to further search into extant literature in library services to identify constructs that March relevant AI techniques and applications in services delivery. This decision assisted this research in discovering relevant constructs that measure up as broader building blocks that populate the dimensions of the developed AI-LSICF. The insights taken from extant literature suggests valuable knowledge on how library practitioners can navigate through the uncertain adoption of AI in the library to provide services that can enhance the university’s digital transformation at this challenging time.

The service innovation framework helped describe and explain how leveraging on AI supports a service innovation that helps to enable a shift in the current service model in library and information science practice. The framework recommends how prevailing practices in other areas within the service industry show alternative ways the library can transform general practice. The framework provides new insight into capturing, generating,

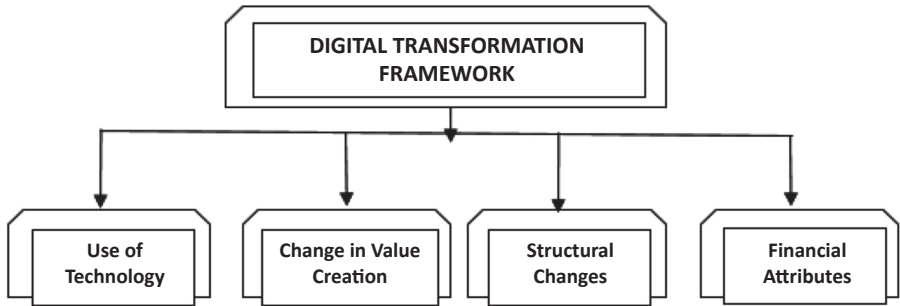
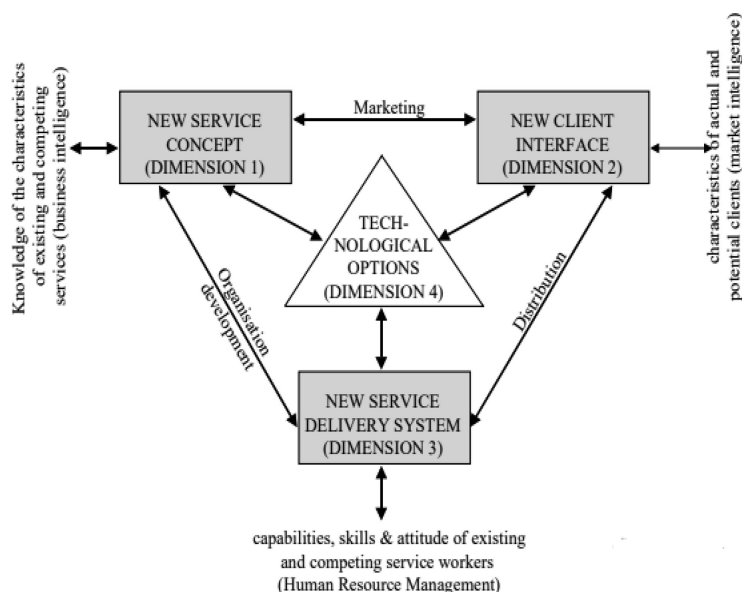


Figure 3.
Digital transformation
framework

Source(s): Matt *et al.* (2015)



Source(s): Hertog (2000)

Figure 4.
Service
innovation model

and delivering value by looking at application methods from a socio-technical approach; instead of purely technologically driven approaches. This research further populates the dimension of the service innovation framework with corresponding constructs collected from previously reviewed factors, elements and influences that makes up innovative phenomenon in organisational practice. The above process informs an emergent information system framework that contributes to service innovation implementation in research and practice. The framework is an artificial intelligence innovative library services conceptual framework (AI-LSICF).

5. Theoretical model

A theoretical framework consists of abstract and theoretical elements that shape the decisions made during the research (Lindsay, 1995). “AI application and functions” of Dejoux and Léon (2018); “Digital transformation framework” (DT) of Matt *et al.* (2015) and “Service innovation framework” of Hertog (2000); were integrated to form a framework that guides the development of an “Artificial intelligent library service innovative conceptual model” (AI-LSICF) proposed for this research. The illustration of the theoretical framework is in Figure 5.

5.1 Digital transformation framework (DTF)

This research adopts “The Digital Transformation Framework” (Matt *et al.*, 2015) that defines transformation along four dimensions. It consists of four elements: *use of technologies*, *change in value creation*, *structural changes* and *financial aspects*. The *use of the technologies* component deals with embracing technologies and achieving their strategic goals. The *changes in value creation* concern the digital transformation strategies effect on the value chains of an organisation. The value chain’s notion of an organisation builds on the organisation’s

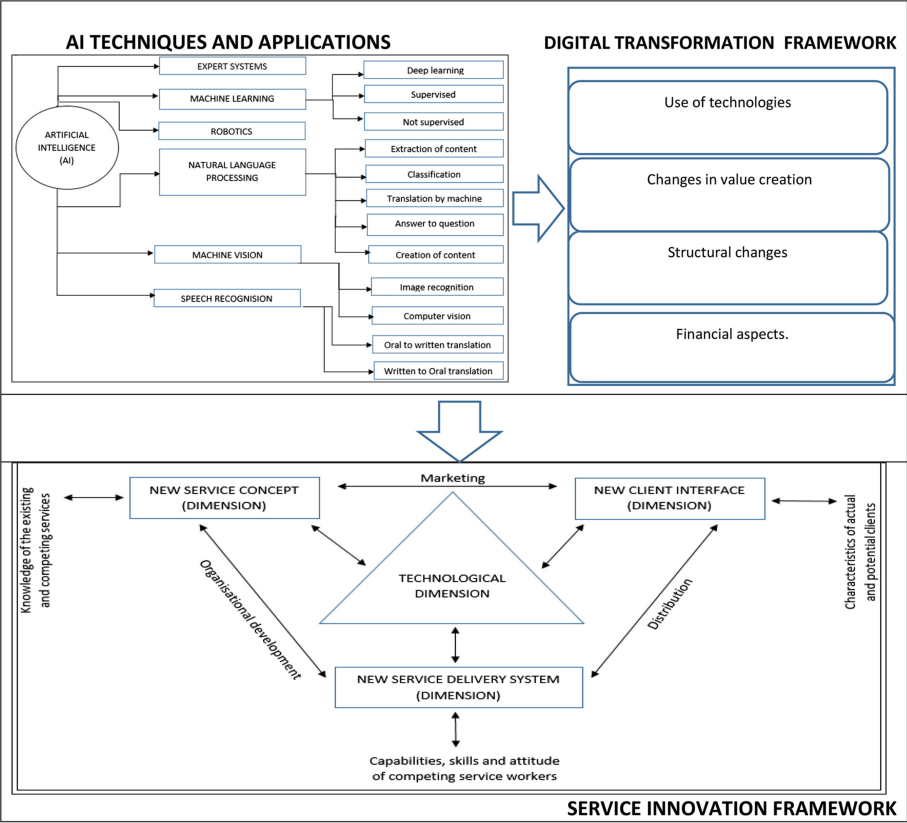


Figure 5.
Theoretical framework

Note(s): Author's design

progression as a system comprising subsystems. *Structural changes* require the firm to allow for innovative value-creating accomplishments that new technologies enable. Structural changes consist of disparities in a firm's organisational structure, particularly relating to the novel digital undertaking's location within the business structures.

Financial aspects drive all three other dimensions. It is also a driver of an abounding force of transformation. It captures the urgency to change within the firm evaluated by its financial Sustainability. To guarantee the fruitful outcome of a digital transformation strategy projected for the university's aims and objectives, establishments like the university library need to align the four different dimensions. The use of technologies, value creation, structural changes and financial aspects is beneficial for the library's digital transformation endeavour complementing university activities. The illustration of the digital transformation framework is in Figure 3.

5.1.1 AI and the "use of technologies" in a library setting. The application of AI technology into the library setting fosters digital transformation. For instance, the expert's system's application to library resource management can promote the evolution of library resource classification and storage methods. *Machine vision and biometrics* technology can replace the guard system of the library's entrance. This replacement will make a change from its

traditional security system. Furthermore, the library can use RFID sensors and electronic tags to facilitate real-time data communication, intelligent access to services, borrow physical resources and monitor library users. This submission supports the position of [Chhetri and Thakur \(2019\)](#), who opines that RFID is the newest technology used in libraries to handle automated library and theft discovery. According to [Chhetri and Thakur \(2019\)](#), RFID in libraries is an artificial intelligence system that can help discover the actual location of any library resources. This action promotes an intelligent library that can serve users without human interaction. [Table 1](#) shows the literature excerpts that support this.

5.1.2 AI and “changes in value creation” in a library setting. AI technology encourages the library’s digital transformation, thus changing how university library creates value for their services. For instance, AI algorithms can influence users to borrow records to enhance and add value to library services ([Almaghrabi and Chetty, 2017](#)). This influence promotes the information access pattern and the learning behaviour traits of an individual ([Kumar, 2019](#)), which can serve as a more effective means for enhancing scholarly engagement. For library user’s identification, the library can apply AI technology to simplify the library registration. The image recognition provided by AI can provide biometric recognition of users. As a result, students would enjoy receiving a completely new and unique educational approach tailored to their specific needs ([Chatterjee and Bhattacharjee, 2020](#)). This approach is a change in value creation. [Table 2](#) shows an excerpt on how AI can create value for library services to support university education.

5.1.3 AI and “structural changes” in the library setting. The structural dimension of the Digital transformation framework is concerned with whom will be in charge of the transformation endeavour. These changes develop innovative hierarchies, new business processes and new skills or competencies. For instance, the library’s adoption of an artificial intelligence system can replace the function of a library assistant that leads the patrons to the reading rooms to quest the book’s precise position. The submission of [Litsey and Mauldin \(2018\)](#) supports this claim. He concludes that the library can use machine learning predictive

AI as a digital transformation technology
AI applications and
functions

(Excerpt)

Source

Expert system	“... <i>The expert system</i> is a program system with a think tank of expert-level knowledge and experience and can simulate human experts to solve problems ...”	Chunmeng et al. (2019)
Radio frequency identification(RFID)	“... RFID is the latest technology used in libraries for managing the automated library and also for theft detection ...” “... RFID in libraries is an artificial intelligence system that can help in knowing the actual destination of any library resources ...”	Chhetri and Thakur (2019) Tim et al. (2018)
Sensors	“... intelligent retrieval technology like AI can optimise the retrieval method of library resources. ...”	Kassab et al. (2018)
Electronic tags	“... through the identification of electronic tags and real-time communication of data, intelligent services can be provided to users”	Chunmeng et al. (2019)
Robotics	“... robotised, 24-h registration implies that borrowed library items can be restored after open hours thereby keeping library users away from lateness or fines ...”	Sammeta and Madara (2018)
Machine vision	“... <i>Machine vision technology and biometrics</i> technology can be applied to the library entrance guard system ...”	Chunmeng et al. (2019)

Table 1.
Literature excerpts on
the use of AI as a
digital transformation
technology

Table 2.
Literature excerpts on
the use of AI for
changes in value
creations

AI for changes in value creations AI applications and functions	(Excerpt)	Source
Algorithms	"... novel data mining algorithms influence the relationship between users and borrowing records to improve the library services ..."	Almaghrabi and Chetty (2017)
Learning analytics	"... data analytics assess information pattern of the users. ..."	Kumar (2019)
Machine vision	"... AI can also be applied to library identification like the 'intelligent facial recognition' to simplify library registration ..."	Chatterjee and Bhattacharjee (2020)
Robotics	"... AI-powered chatbots can help in answering reference queries ..."	Chrisinger (2019)
Natural language processing	"... AI technology may also help prepare 'innovative content' ..."	Kumar (2019)

analytic tools to analyse various data points to predict services and actions that can help user's services.

Hence, intelligent systems offer a means of knowing the statistics of user's activities in the library building at any point in time. Centred on the AI algorithm technology and intelligent platform, the AI technology on deep learning allows the application to update and optimise without the need for the automation librarian. This claim is supported by [Chunmeng et al. \(2019\)](#). His submission states that AI can deeply study library service design effectively and create a new factual service design process. [Table 3](#) illustrates the literature excerpts indicating how AI can aid structural change.

5.1.4 AI and the "financial aspect" in the library setting. Financial Sustainability evaluates a business model. The way organisational activities is carried out defines costs and consequently affects profits. Organisations need to generate returns to cover their costs. AI adoption foster cost-effectiveness to reduce the cost of acquiring university library resources. AI algorithm helps acquire open web resources containing valuable scholarly publications into the library database free. [Singha and Verma, \(2019\)](#) posit that QR codes, an AI application, can carry much more information, e.g. a URL, to a wide variety of free online resources media at a low cost. [Rodrigo et al. \(2019\)](#) opines that crowdsourcing opens the door to solving a wide variety of problems allowing us to obtain relatively low cost labelled data in a small amount of time.

Table 3.
Literature excerpts on
the use of AI for
structural change

AI for structural change AI applications and functions	(Excerpt)	Source
Natural language	"... AI can deeply study the library service design effectively create a new and factual service design process ..."	Chunmeng et al. (2019)
Machine learning	"... the use of machine learning predictive analytic tool can be used by the library to analyse a variety of disparate library data points to predict services and actions that can help user's services ..."	Litsey and Mauldin (2018)
Deep learning	"... digitised guides of textbooks can serve as customisable digital learning interfaces at all levels of education ..."	Ahmad et al. (2019)
Expert system	"... Information systems researchers could investigate and understand the implications of AI for decision making ..."	Bawack et al. (2019)

University libraries can explore the use of AI for crowdsourcing, which reduces the financial burden on its parent institution. With content crowdsourcing, libraries can also deploy AI-powered crowdfunding techniques as a financial strategy to source a fund from virtual platforms to acquire materials. [Table 4](#) shows the literature excerpts on how AI can be used in the library financially.

5.2 Service innovation framework (SIF)

AI can help provide innovative library services, which will support future-ready university activities in all situations. This research uses the service innovation framework of [Hertog \(2000\)](#) (see [Figure 4](#)) to channel its argument, filter interpretation, summarise innovative concepts and provide a lens. The service innovation framework is an innovation model that gives insight into how evolving technology can provide innovative services. The framework has four domains: “*The service concept*”, “*The client interface*”, “*The service delivery system*” and “*Technological options*”. *Service concept* speaks of services unique to its actual market. The *client interface* expresses an interface’s modernisation amidst the patron and its service provider. The *service delivery system* connects to the link between the client and the organisation providing the service. *Technological options* permit for improved efficiency and competence in the important information-processing fundamentals that are in services segments. The illustration of the service innovation framework is in [Figure 4](#).

5.2.1 AI for “new services concept” in the university library. AI can enhance new services concepts that can support the survival of university learning and research. Library and information professionals can use AI to complement the traditional reference services provided to users in the face of disruption. Expert systems can help library patrons make an intelligent decision about their search query instead of asking the reference librarian. [Kassab et al. \(2018\)](#) note that the use of AI applications improves the retrieval methods of library resources. This notation calls for more exploration of AI’s use and adoption, as mentioned by [Bawack et al. \(2019\)](#). For instance, RFID can help locate resources without human assistance as it helps in knowing the actual destinations of a book in the library ([Tim et al., 2018](#)). This capability indicates that AI adoption for library service provision can display “New Service Concepts” in an innovative way that will increase library professionals relevance. It will redeem the image of the university library as a dedicated entity in the provision of quality services that will support a future-ready university.

5.2.2 AI for “new services delivery system” in the university library. AI can help foster innovative library service delivery. Machine vision’s recognition of legitimate library users can help to link them to the information they seek. This competence can aid selective dissemination of information (SDI) as information sharing can be personalised. The statement of [Chatterjee and Bhattacharjee \(2020\)](#) indicates that library patrons registration can be done through AI “biometric registration”. The implication is that AI can match user’s research interest, thus linking them to the information they seek as they enter the library

AI for financial change

AI applications and
functions

(Excerpt)

Source

Machine vision

“... QR codes can carry much more information, e.g. a URL, to a wide variety of free online resources media at a low cost ...”

[Singha and Verma \(2019\)](#)

Machine learning

“... Crowdsourcing opens the door to solving a wide variety of problems allowing us to obtain relatively low cost labelled data in a small amount of time ...”

[Rodrigo et al. \(2019\)](#)

Table 4.
Literature excerpts on
the use of AI for
financial change

based on the user's profile. This guidance confirms the assertion of [Tim et al. \(2018\)](#) that AI "RFID" can help users know the actual destination of library books and resources. Robotics like virtual assistants can simulate human behaviours, respond to and interact with the users to answer reference queries. [Sammata and Madara \(2018\)](#) confirm this as he states that 24-h robotisation of library activities can make users return borrowed items to the library even when it is closed. The inference is that robotised AI applications can provide library services even if they are not physically accessible in a pandemic like COVID-19.

5.2.3 AI for a "new client interface" in the university library. AI can power a new service interface that will enhance learning for students. Chat-box can be an interface as virtual agents instead of a human representative of the library. Virtual agents give users a comfortable atmosphere to enjoy access to more resources or services without fearing human interaction. [Sammata and Madara \(2018\)](#) align with this claim as they conclude that robotised, 24-h registration can restore borrowed library items after the close of open hours. This ability can attract users to the library page/website. It fosters the user's interaction with the library activities, such as automated feedback. The analysis of user's feedback data helps transform traditional library services.

5.2.4 AI for "new technology options" in the university library. AI adoption in the library can provide a new technological option for library service innovation. These are biometric recognition, expert systems, machine learning, machine vision, algorithm, sensors and robotisation. In mandate to play a crucial role in the digital transformation progression of the university, AI adoption helps the university library consider solutions outside their environment, comprehend the university's digital priority and play a significant role by bringing technologies and people together irrespective of their location. Adopting AI for innovative library services is an excellent technological option to promote the library's relevance, especially during critical times. The university library can significantly transform university research activities with AI's research support services.

6. Findings

The general notion that we are at the commencement of a "4th industrial revolution" (4IR) has appealed to extensive responsiveness from academia and business. [Camarinha-Matos et al. \(2019\)](#) and [Schwab \(2016\)](#) contend that subsequently, we are entering the 4IR. The first industrial revolution commenced with steam. The second industrial revolution came with the advent of electricity, mass production and division of labour. The third was with semiconductors and electronics but ended with the Internet and computer applications ([Nadkarni and Prügl, 2021](#)). The drive of 4IR is to progress the efficacy and usefulness of the organisation's value chain. However, the 4IR is fuzzy by digital technology intersections and their usefulness in providing value to work and our way of life. Extant literature confirms this with the study of [Lipsmeier et al. \(2018\)](#) on the framework for the identification and demand-orientated classification of digital technologies. His study emphasises that it is a significant challenge for organisations to categorise, structure, and evaluate digital technologies.

Although the reputation of 4IR has made several people attribute it to DT, information systems in the context of a 4IR DT do not entirely epitomise a "technology". Authors like [Oertwig et al. \(2019\)](#) refer to DT in the 4IR context as an ultimate revolution of an entire novel form, purpose or structure creating new value with digital technologies. For illustration, technology has been significantly helpful during global lockdowns for certifying business continuousness through remote operation, healthcare delivery, amusement and upholding social interactions and was an essential part of recovery arrangement. Technology like AI will increase digital transformation efforts in preparation for unforeseen circumstances ([Coombs, 2020](#)).

Occurrences like the COVID-19 pandemic has stimulated and fast-tracked digital transformation inventiveness against preceding resistance to change (Papagiannidis *et al.*, 2020). This statement supports advocacy that it is the precise time for industries to accept Industry 4.0 and DT initiatives using technology (Kumar *et al.*, 2020). The saying equally affirms the conclusion of Pflaum and Gölzer (2018) that technology will possibly push all industries to experience DT. Contrary to their growing significance, various establishments hesitate to acquaint themselves with digital technologies in their value creation systems because most do not adequately approach digital transformation (Lipsmeier *et al.*, 2018). This assertion is confirmed by Assar and Hafsi (2019) who opines in his exploratory Analysis of Enterprise Architecture Management Support that most modern-day enterprises have a challenge dealing with digital transformations.

Research has shown that the current information systems are highly likely to be enhanced with AI technologies. In the library context, Cox *et al.* (2019) look at the impacts of AI on search and retrieval methods and resources delivery in academic libraries in the US. His findings reveal that AI is useful in academic libraries. Furthermore, the research findings of Azimi *et al.* (2021) compared the rate of recurrence of AI application in the concepts mined from the extant literature specified that AI is significant in library service processes. However, his study concluded that the functions of AI mainly affect the library's circulation department. Similarly, Asemi *et al.* (2020) carried out a study on intelligent libraries reviewing how expert systems, artificial intelligence, and robot can be used in the library. His finding concludes that current information systems have a high potential to be improved by integration with AI technologies.

On the other hand, an investigation of (AI) awareness and perception by the management of university libraries in Nigeria (Abayomi *et al.*, 2021) reveals that academic librarians are aware of AI usage in university libraries. Nevertheless, the fear of job loss is the primary constriction they face in AI technology adoption. Librarians fear that the use of robots in libraries will create job loss. Contrarily, the robots will complement the librarian's efforts. The survey by Winkler and Kiszl (2021) shows that AI is an additional opportunity for academic libraries instead of a threat. It could be helpful in all parts of the library procedure. Even though the literature has shown that AI is useful in service delivery, there is no provision of an innovative DT model to show a holistic implementation of AI application and functions in the library context considering this age of the fourth industrial revolution. This research uses the "Digital Transformation Framework" elements to map out and categorise the literature findings (see Tables 1–4). These elements are the *use of technology*, *changes in value creation*, *structural change* and *financial aspects*. With them, this research show evidences of how AI can be beneficial in providing library services, which will support the activities of a future-ready university in all situations.

6.1 Discussion of findings

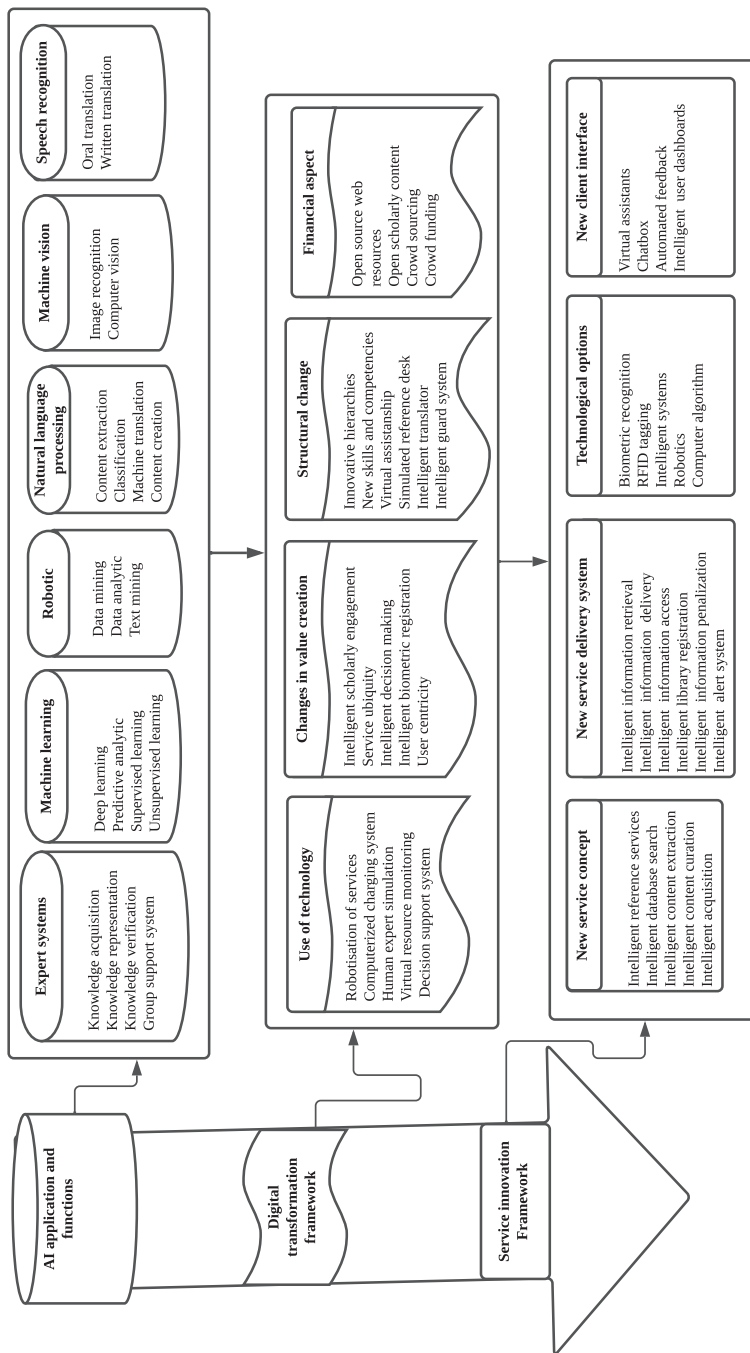
In recent years, the rapid growth of digital technologies has steered the DT business processes. If an organisation wants to remain competitive, it should stimulate innovation. To ensure this, organisations need to strategise a way to design their future actively. Any firm on the lookout for digital upgrade must prepare to adapt its approaches and competencies to give room for novel ways of identifying and creating value. DT necessitates a central re-invention of the mode people do things in organisations and society. At the preliminary stage, firms must understand that DT is not a homogeneous concept. DT is progressively changing the organisation's way do business, making it one of the most significant advancements of our time. DT is a process of innovation that leverages technology. These digital innovations are accomplished by merging a novel digital business model and innovative technology.

The requisite to leverage digital technology to advance and apply novel business models compel firms to re-assess current structures, capabilities and culture to ascertain appropriate technologies to carry out organisational processes and deliver business offerings. However, the key challenges contemporary businesses face to achieve their DT subsists. Despite this, the danger connected with failure to act maybe even more significant, as history has shown that digital technologies mainly can collapse giants of the business industry who refuse to change with the times. This treat emphasises the need for an organisation like the university libraries to re-position itself to take advantage of technology to refine the value of library services in this time of the information age. AI, a digital technology used for advanced service and digital offerings, especially during the COVID-19 pandemic, which required remote assistance and physical distancing, can deploy DT initiatives in the library. As companies are considering rewriting their business models, trying out digital technologies and building a digital service strategy, there is a need to design a model that can make academic librarians realise AI technologies as partners-in-progress and change opinions against them. This change in perception will make academic librarians relevant in the fourth industrial revolution era.

Creating justifiable structures in prevailing service environments without displacing people's sight necessitates Industry 4.0 way out that is efficient and useful as needed. An organisation like the academic library should improve its ability to formulate and use a suitable DT pathway to increase the delivery of advanced library services. Therefore, this research comes up with a DT innovative AI library services conceptual model that aims to assist academic librarians in understanding the functions and application of AI and how it can foster value-adding digital transformation.

6.2 Development of (AI-LSICF)

In this research, we initially proposed a theoretical framework (see [Figure 5](#)) as a prerequisite requirement to guide creating an innovative conceptual framework (AI-LSICF) that targets library services. This theoretical framework establishes that information systems applications positively affect innovative service delivery in general practice. This study requires existing field experience to re-invent central constructs required to support AI adoption in the library and information science domain. This study inferred from the literature review; experiences that appeared to support developing an emerging information systems framework that shows the AI innovation viability. This study maps out the findings into various categories contained in the theoretical framework in (see [Figure 5](#)). The theoretical framework is applied to develop AI-LSICF (see [Figure 6](#)) by substituting the dimensions of "DT framework" in [Figure 3](#) and "AI applications and functions" in [Figure 1](#) to match library and information science constructs identified from the literature concerning practical implementation experiences in the library and information science domain. This method enabled this study to understand the innovative activities in university library settings with AI. It helps to show how the application of AI to the library setting is achievable. This research then uses the service innovation framework to give an insight into how there can be a synergy in integrating AI techniques and applications in library service provision to actualise digital transformation. It further establishes that the library can achieve innovative service delivery that fosters value-added services. The development of AI-LSICF contributes to the business model and digital transformation literature by providing a rich context for AI research in library and information science. The AI-LSICF also contributes to the general information system body of knowledge. Its design process can offer a valuable platform for other IS professionals to introduce AI successfully in their service settings. For example, practitioners could use this framework to discover an alternative space for improved digital customer interaction. The methodology and process used to develop this framework allow interpretation of theoretical constructs, further adding strength and providing some light and



Note(s): Author's design

Figure 6.
AI library service
innovation conceptual
framework

inspiration to model development paradigms in information systems research. Figure 6 shows a graphical representation to demonstrate a flow process of a viable AI-LSICF framework. The flow process points out where the relationships between constructs in each dimension are represented and describe how they connect.

AI-LSICF helps increase an understanding of AI by presenting new insights into how the university library can leverage technology to actualise innovation in service provision to foster DT. This trail will be valuable to scholars and academics interested in addressing the application pathways of AI library service innovation, which is still under-explored in digital transformation. In practice, AI-LSICF could reform the information industry from its traditional brands into a more applied and resolutely customer-driven organisation. This reformation will awaken awareness of how librarians and information professionals can leverage technology to catch up with digital transformation in the fourth industrial revolution age. The enlightenment of AI-LSICF will motivate library professionals to take advantage of AI's potential to enhance their current business model and achieve a unique competitive advantage.

The technological progression that digital disruption carries with it infiltrates higher education institutions. Similarly, the current global pandemic calls for alternative social distancing compliant solutions by forcing various organisations, including the university, to align with a digital transformation in all dimensions. Consequently, the university's library adoption of AI technology can enhance an alternative university education and learning.

Based on the findings, the library can use AI to discover new insights in innovative service delivery, saving time and efforts to collect and promote university research accomplishments. A university library that can look further than the automation of the library would be able to safeguard its relevance to its institutions in the future. The AI-LSICF of this research satisfies a call to make the university library understand how AI can support the digital transformation of the university academic and research activities. Therefore this study recommends AI-LSICF as a pacesetter for AI consideration in library strategic plans and adoption for library service provision. Future research should endeavour to test this framework's practicability in an organisational setting through exploratory and survey research, as this will aid empirical confirmation and improvement of the prosed framework.

7. Limitation

This research has a limitation, as the framework proposed is solely based on literature findings. There is a need to test AI-LSICF in practice. In addition, the framework is not trying to choose typical examples to oversimplify AI adoption in other practices by developing a rigid standard but taking a broad understanding of the framework as an alternative to the traditional service delivery model.

8. Conclusion

Digital transformation is a ground-breaking ongoing revolution that uses technology to improve an organisation's business models. Technology brings endless opportunities, but it also challenges individuals and organisations that navigate digital transformations. This study contributes to the discourse of digital transformation by AI-LSICF for library service innovation. AI-LSICF establishes that organisations like the university library can foster innovative change, supporting the digital transformation of university research and learning with digital technologies like AI. The findings of this research could inspire library and information professionals to start premeditating AI technology inclusion in their policies. AI-LSICF framework will help the library and information professionals understand new skills that allow them to use technology like AI to re-invent themselves to satisfy user's

current and future needs. Re-invention of skills and competencies will foster the realisation of a value-adding digital transformation. This submission fills a significant knowledge gap in the academic literature. AI-LSICF is essential, as it will increase the library's significance as an entity that adds value to the university community in preparation for digital disruption and unforeseen circumstances like the COVID-19 pandemic. Overall, the outcome of this study can influence the planning of new information services provision and evaluation of existing library services for further improvement.

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