

## **A Strategic Evaluation of Artificial Intelligence for Innovative Libraries in the 21<sup>st</sup> Century: The Components and Applications**

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**Abstract:** *Advances in technology have changed things globally, especially in the area of information management, business and governance, so much that the effective use of information technology makes a difference between success and failure. There exist some levels of uncertainty about the future of libraries, occasioned by the competition poised by Google, Amazon, Wikipedia, Myspace etc., which are veritable sources of information. The aim of this study is to evaluate strategically the component and application of Artificial Intelligence (AI) for Innovative Libraries in the 21st Century. From the study it is then concluded that The application of artificial intelligence and machine learning in libraries is an emerging trend that has captured the attention of relevant practitioners and academics. Some advanced AI and ML techniques like pattern recognition and MAS are also being used to ensure library security; user identification; book title recognition; RFID management, and other administration activities. Deep learning, neural network algorithms, convolutional neural networks have also been proved as powerful tools for scholarship, collections discovery, search and analysis. One of the recommendations drawn from the study is that appropriate training should be given to librarians concerning the technical knowhow of the adoption of AI in the library.*

**Keywords:** *Artificial Intelligence (AI) and Innovative Libraries.*

### **Introduction**

Machines that mimic and exhibit "human" cognitive abilities associated with the human mind, such as "learning" and "problem-solving," have been referred to as "artificial intelligence." Major AI researchers have subsequently rejected this definition and now speak of AI in terms of rationality and acting rationally, which does not place any restrictions on the definition of intelligence (Wikipedia, 2022). Artificial intelligence is founded on the idea that human intelligence can be described in a way that makes it simple for a computer to imitate it and carry out tasks of any complexity. Artificial intelligence aims to emulate cognitive processes in humans. When it comes to concretely defining processes like learning, reasoning, and perception, researchers and developers in the field are making unexpectedly quick progress. Some people think that soon inventors might be able to create systems that are better than what humans are currently capable of learning or understanding. Others, however, continue to be dubious because all cognitive processes involve value judgements that are influenced by human experience (Frankenfield, 2022). Artificial intelligence has a plethora of uses. The technique can be used in a wide range of industries and areas. AI is being tested and deployed in the healthcare sector to provide medication dosages, disperse various treatments suited to individual patients, and support surgical procedures in the operating room.

Advances in technology have changed things globally, especially in the area of information management, business and governance, so much that the effective use of information technology makes a difference between success and failure. There exist some levels of uncertainty about the future of libraries, occasioned by the competition poised by Google, Amazon, Wikipedia, Myspace etc., which are veritable sources of information. Understandably, libraries in Nigeria should be worried about their roles in the dynamics landscape of information provision/delivery that is shifting away from the traditional enterprise. The emergence of Information Communication Technology (ICT) also bring changes to library and information services. As a response to the adoption and application to the new technology, libraries are shifting from the old traditional role as a social agency for information generation, storage, retrieval and dissemination to the modern electronic information systems (Simisaye, Salisu and Awodoyin, 2018).

### **Concept of artificial intelligence (AI)**

Frankenfield (2022) defines artificial intelligence (AI) as the simulation of human intelligence in devices that have been trained to think and act like people. The phrase can also be used to refer to any computer that demonstrates characteristics of the human intellect, like learning and problem-solving. Artificial intelligence (AI) is intelligence expressed by robots as opposed to intelligence displayed by animals and humans, according to Wikipedia (2022). Artificial intelligence is the idea and creation of computer systems that can carry out tasks that would typically require human intelligence, including as speech recognition, visual perception, decision-making, and language translation, according to the Oxford English Dictionary (2022).

One of the hottest buzzwords in technology right now is artificial intelligence (AI), and for good reason. Several inventions and developments that were previously only found in science fiction have steadily become actual during the last several years (Kelley, 2022). Artificial intelligence is viewed by experts as a factor of production with the ability to open up new avenues for growth and transform how work is carried out across industries. For instance, according to this PWC report, AI might by 2035 help the world economy grow by \$15.7 trillion. With roughly 70% of the worldwide effect, China and the United States are well-positioned to gain the most from the impending AI boom (Kelley, 2022).

Furthermore, Frankenfield (2022) claimed that the ability to reason and take actions that have the best likelihood of reaching a particular goal is the ideal quality of artificial intelligence. Machine learning (ML), a subtype of artificial intelligence, is the idea that computer programmes can automatically learn from and adapt to new data without human assistance. Deep learning algorithms make it possible for this autonomous learning by ingesting vast quantities of unstructured data, including text, photos, and video. AI, which stands for artificial intelligence, is a general term for systems or robots that accomplish tasks by mimicking human intelligence and are capable of continuously improving themselves based on the data they gather. AI can appear in a variety of ways (Oracle, 2022). A few examples are:

- Chatbots use AI to understand customer problems faster and provide more efficient answers.
- Intelligent assistants use AI to parse critical information from large free-text datasets to improve scheduling.
- Recommendation engines can provide automated recommendations for TV shows based on users' viewing habits.

AI is much more about the process and the capability for super-powered thinking and data analysis than it is about any particular format or function. Although AI brings up images of high-functioning, human-like robots taking over the world, AI isn't intended to replace humans. It's intended to significantly enhance human capabilities and contributions. That makes it a very valuable business asset (Oracle, 2022).

### **Concept of an innovative library**

The word "innovative" is the adjective for "innovation". Innovation is the practical implementation of ideas that result in the introduction of new goods or services or an

improvement in the offering of goods or services. ISO (2020) defines innovation as "a new or changed entity realising or redistributing value". Others have different definitions; a common element in the definitions is a focus on newness, improvement, and the spread of ideas or technologies. According to Thijs (2018), innovation often takes place through the development of more effective products, processes, services, technologies, artefacts, or business models that innovators make available to markets, governments, and society (Wikipedia, 2022). On the other hand, a library is a collection of information, sources, resources, and services organised for use and maintained by a public body, an institution, or a private individual. In the more traditional sense, it means a collection of books. This collection and services are used by people who choose not to or cannot afford to purchase an extensive collection themselves, who need material no individual can reasonably be expected to have, or who require professional assistance with their research (New World Encyclopaedia Contributors, 2022).

Libraries that are innovative are places where knowledge is kept in books and other artefacts and where new ideas are encouraged to be used or implemented for better information transmission. When a librarian adopts entrepreneurial abilities in the provision and management of library and information services, innovation, according to Etebu and Zacchaeus (2020), begins. Basically, the librarian must be willing to take chances, come up with new ideas, and innovate while carrying out his duties in order to improve the level of services offered to library patrons. Staff members of libraries that exhibit innovation and entrepreneurship reimagine and improve their work to improve services to patrons and preserve the resources. An entrepreneurial librarian assembles data and knowledge staff teams to analyse and improve services, physical spaces, and the digital environment. The entrepreneurial librarian questions the traditional ways of delivering services with the view of improving them. Being creative and resourceful and seeking better answers to make the library a learning organisation, one that constantly changes as it strives to be an integral component of the aspirations of library patrons (Etebu and Zacchaeus, 2020). One of the services of innovative libraries is virtual reference (VR) services relating to chat and email service, collaborative service provision, service staffing, and staff training in university libraries, as reported by Shaw & Spink (2013). They revealed that email is increasingly supported by Frequently Asked Questions (FAQ) and databases are preferred cost-effective means for providing university VR services.

An example of an innovative library in the world is the Stuttgart City Library, located in Stuttgart, Germany. It was opened in 2011. This nine-story public library designed by Yi Architects is characterised by its stunning white-on-white colour scheme (lit by blue light at night), its bold cubic shape, and its cavernous interior. This cultural centre for the city, designed to feel open and full of light, can be entered from any of its four sides, and patrons can borrow artwork as well as books (Powers, 2020).

*Stuttgart City Library, Germany*

## **The Component of Artificial Intelligence**

Artificial intelligence is a field of engineering that uses highly advanced techniques and technologies for designing software and robots to think and act intelligently. It is labelled as artificial because it is the opposite of human natural intelligence. Artificial intelligence software can help businesses, schools, and healthcare facilities perform tasks more quickly and effectively than humans (ADSERVIO, 2022). As such, the five basic components of artificial intelligence include learning, reasoning, problem-solving, perception, and language understanding.

### ***1. Learning***

According to TechBlogMU (2018), learning is a very essential part of AI, and it happens in a number of different forms. The simplest form of learning is through trial and error. In this form, the programme remembers the section that has given the desired output, discards the other trial actions, and learns by itself. For example, in a chess programme, mate-in-one chess problems might try out moves at random until one is found that achieves mate. Here the programme remembers the successful move, and next time the computer is given the same problem, it is able

to produce the result instantly. The learning component of AI includes memorising individual items like different solutions to problems, vocabulary, foreign languages, etc., also known as rote learning. This learning method is later implemented using the generalisation method (Bansal, 2021). Similar to humans, computer programmes also learn in different ways. Talking of AI, learning on this platform is further segregated into a varied number of forms. One of the essential components of AI is learning, which includes the trial-and-error method. The solution keeps on solving problems until it comes across the right results. This way, the programme keeps a note of all the moves that gave positive results and stores them in its database to use the next time the computer is given the same problem.

## **2. Reasoning**

According to Bansal (2021), the art of reasoning was something that was only limited to humans until five decades ago. The ability to differentiate makes reasoning one of the essential components of artificial intelligence. AI uses the ability to make inferences when applying reasoning based on commands it is given or other information at its disposal. For example, virtual assistants will offer restaurant recommendations based on the specific orders or questions they receive. The assistant will use reasoning to decide what restaurants to suggest based on the questions it received and the nearest location of various restaurants. This type of reasoning involves drawing inferences. Inferences include two categories: deductive and inductive reasoning (ADSERVIO, 2022).

Furthermore, as stated by TechBlogMU (2018), deductive reasoning is in which the truth of the premises guarantees the truth of the conclusion, while in inductive reasoning, the truth of the premises supports the conclusion but cannot be fully dependent on the premises. In programming logic, generally, deductive inferences are used. Reasoning involves drawing inferences that are relevant to the given problem or situation.

## **3. Problem-solving**

The third major component that makes up the development of artificial intelligence programmes and systems is problem-solving. As the entire premise of artificial intelligence is the creation of computer programmes and systems that solve problems in a manner similar to that of human beings, problem-solving is perhaps the most pivotal component in terms of the development of AI (CaseGuard, 2022).

In its general form, the AI's problem-solving ability comprises data, where the solution needs to find  $x$ . AI witnesses a considerable variety of problems being addressed on the platform. The different methods of problem-solving count as essential artificial intelligence components that divide the queries into special and general purposes (Bansal, 2021).

In the case of a special-purpose method, the solution to a given problem is tailor-made, often exploiting some of the specific features provided in the case where a suggested problem is embedded. On the other hand, a general-purpose method implies a wide variety of vivid issues. Further, the problem-solving component in AI allows the programmes to include step-by-step reduction of the difference between any goal state and the current state.

## **4. Perception**

According to CaseGuard (2022), the fourth major component in the development of artificial intelligence programmes and systems is perception. In keeping with comparisons to the function of the human mind, the way in which individuals perceive the world around them is critical to the manner in which they solve problems in their respective lives. As it relates to artificial intelligence, perception is achieved through the utilisation of different sense organs, whether they are real or artificial. AI addresses a huge variety of problems. For example, finding out winning moves on the board games, planning actions in order to achieve the defined task, identifying various objects from given images, etc. Problem-solving methods are mainly divided into two types: special-purpose and general-purpose methods. General-purpose methods are applicable to a wide range of problems. One used in AI is means-end analysis, which involves the step-by-step

reduction of the difference between the current state and the goal state. Special-purpose methods are customised to solve a particular type of problem (TechBlogMU, 2018).

### ***5. Language Understanding***

The final component that makes up the development of artificial intelligence is language understanding. Put in the simplest of terms, language understanding in the context of the development of artificial intelligence can be defined as a set of different system signs that justify their various means or methods using convention (CaseGuard, 2022). To this point, as the vast majority of artificial intelligence programmes and systems are developed within the English-speaking world, a major component of the creation of many such programmes and systems is enabling them to understand the English language. Through this language understanding, software developers are able to ensure that computer programmes are able to efficiently execute their respective functions and operations.

AI processes language in something as seemingly simple as spellcheck and autocorrect. Computer programmes use neural networks to scan large bodies of text for misspelt words and language irregularities. Another way AI uses language processing is when it weeds out spam in email systems. For example, spam filters delegate specific messages as spam when they see certain words or combinations of words (ADSERVIO, 2022).

### **Application of Artificial Intelligence in Innovative Libraries**

Because AI may be used to organise and make accessible vast informational collections, artificial intelligence is important to libraries (ALA, 2019). Artificial intelligence is the contemporary technology used to manage the digital library, according to Sridevi and Shanmugam (2017). The development of computer systems or machines that think, behave, and actually challenge human intelligence is the ultimate goal of artificial intelligence, and this certainly has significant ramifications for the field of librarianship. Artificial intelligence (AI) is a biologically inspired technology used to mimic how humans perceive and process information (Sridevi & Shanmugam, 2017). AI is not merely an intelligent system or software programme. Artificial intelligence (AI)-based technologies are used by intelligent library automation systems to deliver knowledge-based services to patrons and staff. Natural language processing (NLP), expert systems (ES), pattern recognition, robotics, etc. are some artificial intelligence disciplines that are utilised in library management systems (Sridevi and Shanmugam, 2017). The computer receives input in the form of natural language, processes it, analyses it, and then answers with the appropriate information. According to the McGraw-Hill Encyclopaedia of Science and Technology (2007), NLP has been utilised as a medium for interaction in database management systems and as an object or input for processing in automatic text translation or text summarization. Subject indexing is another real-world use of artificial intelligence in libraries. This task requires the technical expertise of the librarian or indexer and his intellectual judgement to peruse, analyses, and suggest the appropriate terms to be used as index terms or keyword of a given document. Any computer system or machine that can undertake this task can be said to be intelligent. Another major area for implementing AI is information search and retrieval. Agent technology has been used to support the information search process in DLs, including strategic search support, proactive support for query formulation, intelligent assistance for information search and retrieval, and personalized services to users (Liu, 2011). An agent-based architecture supports high-level search activity in federated DLs, combining the advantages of previous approaches (Wójcik, 2020). Depending on the interest of the user, intelligent software agents search the DLs and return the information that the user is looking for, and also through personal agents, users can customize their interfaces (Das and Ul Islam, 2020).

Artificial intelligence has gained tremendous application in library information services, which include:

#### ***Application of Expert Systems in Classification***

According to Adejo and Misau (2021), the application of the expert system in the area of classifications in libraries includes the following:

*Coal SORT*: It is a conceptual browser designed to serve either as a search or an indexing tool. Coal SORT consists primarily of a frame-based semantic network and the software needed to allow users to display portions of it and move around in the conceptual structure. The expert knowledge in the system is embodied almost entirely in the semantic network.

*EP-X*: The Environmental Pollution Expert (EP-X) has certain things in common with coal SORT in that both are concentrating on enhancing interfaces using a knowledge-based approach. The knowledge base of EP-X consists of a hierarchical frame-based semantic network of concepts and a set of templates that express the patterns called pragmatic relationships among concepts. These patterns are referred to as conceptual information.

### ***Application of Expert Systems in Indexing***

Indexing periodicals is another area where expert systems are being developed. Indexing a periodical article involves the identification of concepts and translating these concepts into verbal descriptions by selecting and assigning controlled vocabulary terms that are conceptually equivalent to verbal descriptions. The reason for automating the intellectual aspects of indexing is to improve indexing consistency and quality. Based on the information provided by the indexer, the systems can arrive at appropriate preferred terms to automatically assign relevant subdivisions. The system can make inferences, and based on those inferences, it can take appropriate action. 'Med Index' is the best example of an indexing system used in the library indexing activity. Very few library users have interacted with knowledge-based systems. Generally, users have had very little contact with these systems due to the fact that most of them are not perfect enough to be used by the everyday library patron (Adejo and Misau, 2021).

Some other applications of AI include:

- Automatic cataloguing and classification using optical character recognition (OCR)
- Automatic translation of foreign language materials using natural language processing (NLP)
- Interactive bibliographic instruction using various media
- Intelligent gateways to online sources,
- User-structured information environment
- Portable computer reader services for the handicapped
- Intelligent Document Delivery Services (DDS) (Omame and Alex-Nmecha, 2020)

### **Artificial Intelligence in the Cataloguing Operation**

Cataloguing, cataloguing, or library Cataloguing is the process of creating and maintaining bibliographic and authority records in the library catalogue, the database of books, serials, sound recordings, moving images, cartographic materials, computer files, e-resources, etc. that are owned by a library (Haider, 2020). The catalogue may be in tangible form, such as a card catalogue, or in electronic form, such as an online public access catalogue (OPAC). In libraries, metadata creation is often called cataloguing (Young and Joudrey, 2020). Cataloguing is a subset of the larger field of information organization. It can be defined as "the process of creating metadata for resources by describing a resource, choosing name and title access points, conducting subject analysis, assigning subject headings and classification numbers, and maintaining the system through which the cataloguing data is made available. Joudrey, Taylor, and Miller (2015) are cited in Haider (2020).

Descriptive cataloguing or descriptive cataloguing includes recording the attributes of a library item, such as the name of the author(s), contributor(s), title, edition, publisher, distributor, date, the number of pages, its size, the name of the series, etc. Descriptive cataloguing enables the user to find and identify a book by the name of the author, the title, variant titles, etc. Two popular standards for descriptive cataloguing are the Anglo-American Cataloguing Rules (AACR) and its successor, Resource Description and Access (RDA).

Subject cataloguing (or subject cataloguing) involves the subject analysis of the resource and providing corresponding subject headings from a controlled vocabulary or subject heading list, such as Library of Congress Subject Headings (LCSH), Medical Subject Headings (MESH), and the assignment of classification numbers using schemes such as Library of Congress Classification (LCC) or Dewey Decimal Classification (DDC). A subject heading is defined as the most specific word or group of words that capture the essence of the subject or one of the subjects of a book or other library material and is selected from a subject heading list containing the preferred subject access terms (controlled vocabulary) and assigned as an added entry in the bibliographic record, which works as an access point and enables the work to be searched and retrieved by subject from the library catalogue database. Cataloguing has become very important for keeping all the materials in the library in order. Indeed, cataloguing has provided regularity within the library. People who do research in the library can easily find the material that they are looking for. No time is consumed in obtaining the information that you need. There's ease of use whenever you search for files or information.

Cataloguing is known as the oldest library craft. Recent attempts to automate cataloguing through expert systems have focused on descriptive cataloguing because it is considered rule-based (AACR2). There are two approaches to applying artificial intelligence techniques to cataloguing. One of which is a human-machine interface, where the intellectual effort is divided between the intermediary and the support system; and the other is an expert system with full cataloguing capability linked into an electronic publishing system so that as a text is generated online, it can be passed through knowledge-based systems and the cataloguing process done without any intellectual input from an intermediary. In an era of mounting volumes and varieties of data, keeping an enterprise data catalogue -to-date h has become increasingly difficult. But technologies like artificial intelligence, however, could transform the data catalogue market. Machine learning programmes can sift through enterprise data catalogues and file systems to collect metadata tags automatically. This process is similar to the ways in which Google scours the internet for websites to catalogue and index. Applying this technology to a data catalogue allows enterprises to populate and update it automatically, without the need for human intervention. This could solve the critical and longstanding problem that's held enterprise data catalogues back: the need for humans to be diligent. And it could help the data catalogue market flourish (Hayler, 2019).

### **New Trends in Digital Information**

The latest trends in library and information science (LIS) include advances in collection management (ERM, IoT, FS), user engagement (augmented reality, makerspaces), and security (SSO). For decades now, libraries have been attuned to new developments in information technology and adopted them to enhance their collections and serve their communities. If you've already decided to make a career in librarianship, then staying abreast of emerging trends in library science is not only a subject of interest; it's also one of the crucial skills you'll need to function effectively as a librarian in the modern age (Beschler, 2022). There are many trends in digital information, which include:

#### ***Robotics in the Library***

In the modern era, libraries are going to create new beginnings with the help of technology. One of the latest technologies used in libraries is robotics. Robotics and artificial intelligence (AI) developments are having an impact on library operations and facilities. Scrambling, rolling, flying, and climbing are all tasks that the robots engage in (Vonkova et al., 2021). Libraries, as well as the wider knowledge (and social) world in which we all work, are affected by robotics. Libraries can integrate robotics with other AI technologies, like a drone being controlled by a robot, to make sure that the library is always under surveillance. Talking robots can be placed in various sections of the library as a user aid and guide. Shanghai Library has put up a humanoid robot at the entrance, which will interact with the users and clarify their doubts. The applications of robotics in libraries are widespread, and in the present day, there is no doubt that robots will dominate libraries, signalling the future of staff-less libraries. The needed books and their

numbers are given as input to the robot first. The robot will identify the books by detecting the RFID tags on the books on the shelf. If the RFID matches the saved book details, a notification will be sent to the shelf unit. The corresponding tray will come forward, and the book will be deposited into the robot's basket (Gupta et al., 2022). Further, the book will be headed to the collection centre, from where the users can collect it (Nepali and Tamang, 2022).

### ***Cloud Computing***

One of the biggest trends that have emerged during the past year is cloud computing. More and more industries are realising that it is important for a company to have a designated place for all of its digital information and resources. Having a well-protected place that can take care of everything and keep the information safe has almost become a necessity. Cloud computing is the go-to solution for brands who want to improve their work and make it more efficient digitally (Team Linchpin, 2022).

### ***Big Data Analytics***

Big data analytics is a trend that has grown over the past few years. This is now being implemented in almost every industry using large-scale production processes, manufacturing, and supply. Big data analytics allows brands to process their information better and reach a much better understanding of the areas they need to develop (Team Linchpin, 2022).

### ***Growth of IoT networks***

The Internet of Things is the concept that all digital devices are connected by a single medium through which one can control everything within their home. More and more brands realise that this is indeed the way of the future and is within technological reach. More brands are beginning to incorporate this concept, and the statistics showcasing this are prevalent enough to attest to positive growth (Team Linchpin, 2022).

### ***Rise of chatbots***

While most technological advancements help us move towards the greater good, some aren't as beneficial as we might think. Chatbots aren't always bad because, in some situations, they have improved the customer service that we have access to. Chatbots are programs that respond to certain queries in certain ways and are designed to help customers with some of the more basic functions they would need. These are, of course, still not in a position wherein they are a complete substitute for real-life customer service, which has helped them stay in development (Team Linchpin, 2022).

### **Conclusion**

The application of artificial intelligence and machine learning in libraries is an emerging trend that has captured the attention of relevant practitioners and academics. Some advanced AI and ML techniques like pattern recognition and MAS are also being used to ensure library security, user identification, book title recognition, RFID management, and other administration activities. Deep learning, neural network algorithms, and convolutional neural networks have also been proven to be powerful tools for scholarship, collection discovery, search, and analysis. Besides, an artificially intelligent conversational agent, or chatbot, works as a virtual reference librarian. It enhances face-to-face human interaction for library web site tour guides, automated virtual reference assistants, readers' advisory librarians, and virtual storytellers. In any case, as a systematic review study, this research also has some limitations.

### **Recommendations**

From the study, it is therefore recommended that:

1. Appropriate training should be given to librarians concerning the technical know-how as regards the adoption of artificial intelligence (AI) in the library.
2. The use of cataloguing in analysis in the library should be encouraged for better analytic results.



3. The use of artificial intelligence (AI) in libraries should be encouraged due to its numerous advantages in the application of library services.

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