2021

Augmenting Traditional Library Services: Role of Smart Library Technologies and Big Data

Adebowale Jeremy Adetayo
Department of Library and Information Science, Adeleke University, Ede, Osun State, adebowale.adetayo@adelekeuniversity.edu.ng

Pauline Oghenekaro Adeniran
omedop2006@yahoo.com

Arinola oluwatoyin Gbotosho
Federal college of Agriculture Akure,Ondo State, arinolaoluwatoyingbotosho@gmail.com

Augmenting Traditional Library Services: Role of Smart Library Technologies and Big Data

Adebowale Jeremy Adetayo
Adeleke University Ede, Osun State, Nigeria
E-mail address: adebowale.adetayo@adelekeuniversity.edu.ng

ORCID: https://orcid.org/0000-0001-7869-5613

Pauline Oghenekaro Adeniran
Tekena Tamuno Library, Redeemer's University
Email: omedop2006@yahoo.com

Arinola Oluwatoyin Gbotosho
Federal college of Agriculture Akure,Ondo State.
Email: arinolaoluwatoyingbotosho@gmail.com

Abstract

Intrusive and disruptive technologies have given rise to information explosion, which is increasingly influencing traditional libraries. The predicament of traditional libraries is evident, based on the decreasing usage. In the face of this predicament, to maintain their position, librarians answer has to be swift. Librarians cannot plan or position themselves effectively until they grasp the existence of big data and manage it. To remain relevant, traditional libraries must reshape their services using big data and smart technologies. The article explores the practical application of big data to traditional libraries. It identifies strategies to augment library services with big data and smart library technologies. The article also identifies possible reasons to apply big data to augment library services and make recommendations.

Keywords: Smart library, smart technologies, big data, traditional library services, Librarian

INTRODUCTION

Traditional libraries have used the same service model for many decades. This paradigm is distinguished by its concentration on material collections such as books, journals, periodicals, manuscripts, and research papers. The unconventional method of presenting these materials entails arranging them on multiple shelves at high levels rather than the details. As a result, the search for information are based on the indexed authors and subjects and the physical proximity of relevant content (Bamgbade et al., 2015). In this traditional library context, there are two kinds of services. This includes both technical and reader services. The term "technical service" relates to library activities involved with knowledge acquisition and organisation. Technical services often entail actual mobility to buy items from vendors and categorise materials using cataloguing tools accessible in the library. On the other hand, readers' services are library operations that are concerned with providing direct library services to customers.

Furthermore, in traditional library settings, the library services involve both library personnel and library users. Interactions between the two are often characterised by users seeking the information at the reference or circulation desk. Users also access materials by physically

approaching the shelves and sitting in the library seats to read. In terms of governance, strategic choices are often made by the university librarian or Chief librarian. These choices are tactically implemented by unit leaders, who guarantee that the library personnel's daily activities in each unit run well. In addition, the library building is usually fixed at a location in the community. Therefore, library users need to come physically to the library to access collections.

However, the computerisation of the world is developing rapidly, which has resulted into generation of large amount of data, which cannot be managed effectively with the traditional approach. Furthermore, Hoy (2014) noted that modern living generates data at an astonishing rate that shows no indications of stopping. This situation provides genuine reasons to evaluate these factors, as it is described that the growth of data on such a large scale is referred to as "Big Data" (Djafri et al., 2018)

According to Zhan and Widen (2019), big data refers to data sets of massive size and rapid growth in various file formats, which can complicate data handling approaches and accelerate the development of technical solutions. The relationship of billions of people using electronic devices generates a flood of data every day, according to Cisco and the World Economic Forum, and those virtual financial transactions, social media traffic, and GPS coordinates now produce over 2.5 quintillion bytes of so-called "big data" every day (Moulding, 2016). The characteristics and variety of data sets make it challenging to use data and organise it. Data scientists or commercial organisations can arrange data that has been acquired consistently in the appropriate format. However, some data kinds are present in an unstructured form acquired from various resources such as e-mails and internet collected data (Wang et al., 2016). For modern libraries, big data generation, collection, storage, and movement provide specific problems and opportunities. In this context, big data librarianship prospects are becoming more widely recognised among library professionals (Zhan & Widén, 2019). However, the advent of big data is driving libraries to reinvent the service patterns that they previously used to carry out their operations (Affelt, 2015). Libraries' current shape can be augmented or changed into a smart library to adapt to the changes in this digital era.

A smart library can be conceptualised either electronically or physically. According to (Padhi & Nahak, 2019), a smart library does not have a single physical loan item on the shelves, no books in print, and on shelves, instead, it relies on enormous cooling servers, whirring digital archives, and equipment for duplicating and distribution. Base on this concept, a smart library is a transportable library that can transcend space constraints and be seen by people (Cook, 2018). Smart library can also be referred to as a library fitted with technology and is available to the public but is not staffed. The technology allows for remote management of library facilities, such as automated doors, lighting, self-service kiosks, and public computers. This allows us to considerably expand library hours, allowing more individuals to utilise the library when convenient for them (Cao et al., 2018). In addition, the library may achieve transparent user service management, mine users' functional information demands, and intelligently forecast user customised service trends by adequately combining the value density of library management, scientific services, and librarian decision-making.

As a result, in the age of big data, smart technology plays a critical role in the growth of libraries. It can extract hidden and potentially useful knowledge from a wide range of disorganised and ambiguous practical application data, and it can be utilised to support a wide range of smart business applications, such as directed marketing (Lee et al., 2016; Liikkanen & Aman, 2016). The smart library strives to deliver more helpful and high-quality services to users, create a more dazzling information interconnection environment, and create a more diverse information-sharing space. The mature application scenarios of the smart library

include a 24-hour self-borrowing and returning system, mobile phone/network self-renewal system, intelligent inventory/positioning system, intelligent seat reservation system, and 3D/AR/VR navigation system (Tingting, 2017).

Libraries have always been expected to offer access to information, including gathering, organising, and making collections available. However, due to the big data deluge, there has been a paradigm change in emphasis away from collection management toward outreach and engagement. In January 2016, it was predicted that a combination of big data and new technologies would gradually merge to create a new reality with the potential to revolutionise our way of life (Frederick, 2016), which anticipated the possibility of changing the role of libraries and pondered what role libraries could play in this revolution and how libraries could be involved in this revolution. With this trend, the pressure for libraries, especially those in developing countries, to keep up with big data deluge but more profoundly with new expectations is immense. Therefore, this article advocates that traditional libraries can augment their services through big data and smart library technologies.

Objectives of the Study

This study's general objective is to conceptualise the application of big data and smart library technologies to traditional library services.

The particular objectives of the study are to:

1. examine the concept of big data and smart library;
2. explore the characteristics of big data and smart library;
3. highlight reasons to apply Big data to augment traditional libraries services;
4. describe strategies to augment library services with Big data and smart library;
5. Explore the Big Data tools in libraries.

THEORETICAL FRAMEWORK

Schöpel's multidimensional model

Schöpel's multidimensional model aims to combine technology, people, and infrastructure. It is a method that has brought uniformity to the construction of several recent "modern" libraries. However, libraries and their technology providers are primarily concerned with technology rather than with persons. Such a "smart strategy" expresses a double error. It not only ignores the essential essence of smartness, namely that "smartness is centred on a user perspective" (Nam & Pardo, 2011), but it also practically marginalises soft domains that are vital and significant to library users and their quality of life. The smart library solves this gap by including user perspectives. Although some may disagree with its application as a theory, it provides a good framework for augmenting library services.

The model works well with library services. Because the model's components complement library service offers. The multidimensional model can be implemented and adapted by libraries. The use of big data in all aspects of the model (smart services, smart people, smart governance, and smart place) will provide value to all library services.

Threats to traditional Library services

The major issue with traditional libraries is the inability to trace the whereabouts of materials taken off or misplaced on shelves, maintaining a vast number of book records, and dealing with

late arrivals (Tarique & Rani, 2017). The information industry is highly competitive. Traditional libraries can no longer provide their services old-fashioned because they are overburdened with everyday operations. Preater (2014) defines information as a commercial commodity, and there are various actors in the information economy fighting for patrons' attention. They are known as alternative information providers (Kenney et al., 2003). Independent of the libraries, their job is to provide a private route of information at the request of individuals/organisations. They provide users with both physical and intangible information products (Yaya et al., 2014). Alternative information brokers such as mega-bookstores, online book dealers, publishers and aggregators, and even the internet are considered rivals (Tait et al., 2016). They have a repository of content and give access to it. They provide readers' advice as well as a path to resource discovery. Aside from external competitors, institutions' leadership priorities have changed to departments inside the institution that directly and quantifiable influence student achievement, competitive research, and worldwide reputation. Libraries are thus competing with other departments within their university for their share of attention, recognition, personnel resources, technology, cooperation, collaborations, opportunities, and so on (Cox, 2018). Individuals may now access and locate the information they need independently, thanks to advancements in information and communication technology enabled by the internet (Immonen & Sintonen, 2015). Regardless of these threats, librarians must foresee the factors that will impact their professional services in the future.

Emerging technologies to address these threats

The emerging technologies that can be adapted to address these threats are called smart technology. Smart technology refers to new technologies that can be used to combat these dangers. These technologies have been combined into a new library concept known as the smart library. However, to enable smartness in libraries, a large quantity of data must be collected and processed by smart technology. This massive volume of data is referred to as big data. The concepts of big data and smart libraries and their functions in libraries will be discussed further below.

Big Data Concept

Strong (2014) stated that big data is a "broader cultural phenomenon" rather than an abstract concept. According to Bumblauskas et al. (2017), big data is a vague and loosely defined phrase frequently linked with the collecting and analysis of 'large' datasets. This description may be misleading since it may lead one to believe that big data is all about massive amounts of data. For the first time in 2013, the Oxford English Dictionary introduced the phrase "big data" in its online update to refer to enormous data collections that may be computationally analysed to uncover patterns, trends, and correlations, particularly human behaviour and interactions (OED, 2013). De Mauro et al. (2016) used four concepts to describe big data. According to the study, big data is a data asset with a large volume, velocity, and variety that necessitates new technology and analytical methodologies for its translation to value. This definition excludes the veracity of data, which is a crucial feature. The veracity of the underlying data determines the correctness of the analysis (Ishwarappa & Anuradha, 2015). According to Kitchin and McArdle (2015), the defining features of big data are velocity and exhaustivity; yet, it has taken the library almost ten years for 22 per cent of the collection to be available in digital format.

The literature indicates five characteristics of big data: volume, velocity, variety, value, and veracity. The term volume refers to the size of a data collection (typically terabytes and petabytes). The data might be so enormous that it cannot be analysed on a single machine. However, megabytes of data can be processed by computer software. Terabyte and petabyte data analysis necessitates the use of big data analysis technologies. The second most important

feature of large data is “velocity” (Lycett, 2013). It refers to the frequency with which this data is created. Blogs and microblogs create data at a faster rate in the present electronic and digital world. Twitter is a microblog that exemplifies big data velocity. It creates around 6,000 tweets every second, in addition to over 350,000 tweets transmitted per minute, 500 million tweets per day, and approximately 200 billion tweets per year. Textual data (e.g., blogs and text messages) and non-textual data (e.g., videos, pictures, and audio recordings) are examples of data types (Erevelles et al., 2016). Ordinary data can be input into Microsoft Excel sheets, but big data contains data extensions (such as blogs, tweets, visited websites, short messages, chat conversations, and e-mails) that cannot be placed into an MS Excel sheet. To preserve and analyse big data, a range of data analysis sources and measurement patterns are necessary. Another essential aspect of big data is its value. Ishwarappa and Anuradha (2015) defined two big data values: the cost of processing and the IT infrastructure required to handle it and the turnover value. Companies invest heavily in developing IT infrastructures for big data storage and processing — the first form of value. They profit from data processing — the second form of value. The accuracy and relevance of big data are connected to its veracity. There is irrelevant data in volume, velocity, and variety, which raises processing and infrastructure costs while lowering turnover value. The veracity of data is its correctness and objectivity.

Big data sources may be generally split into three groups. First and foremost is data streams. Data streams are created or processed by computer, and mobile-mediated data such as log files, sensor data, position tracking, and processor generated data. Second, there are Library Social Networks such as. Google+, Facebook, YouTube, Twitter, Linked In, blogs, WhatsApp, Instagram, and Pinterest, are examples of social media platforms. Third, there are Public Domains, which include data that is publicly available on the internet.

Reasons to apply big data to augment libraries services

Big data has been managed in a variety of sectors, including corporate decision making (Kościelniak & Puto, 2015), forecasting future healthcare trends (Chang, 2016), and assessing customer service satisfaction (Xiang et al., 2015). Big data is a prospective arena for future improvements in economic and societal value, as well as a potential source of competitive advantage for organisations in the medium and long run (Grover et al., 2018). According to Lu et al. (2017), librarians are highly aware of Big Data and are developing data-related activities. Big data is included in the NMC Horizon Report Library Edition 2017 as one of the six critical technological developments for libraries, although with a one-year implementation time frame. Nonetheless, user demand for such new big-data-based services remains low.

After gathering data from many sources, integrating it is a difficult task. Furthermore, the types of data in the library fluctuate drastically, and varied quantities of data must be organised and maintained to enable the library’s services (Goldberg et al., 2014). Also, library users’ requirements will continue to rise in the future due to the digital environment (Showers, 2014). Therefore, librarians should be able to relate to data production, administration, and preservation (Semeler et al., 2019). The role that librarians can play in Big Data analytics is an essential one, and there is a need to increase librarians’ skills and expertise for Big Data analytics deployments. However, Xie and Fox (2017) noted that library personnel lack the competence to deliver new value-added services when it comes to Big Data analytics. In this regard, Atkinson (2018) study indicates a need for library personnel to be better integrated into the educational process and understand and assist different stages of research-based requirements of library users.

The following are specific reasons to apply big data to library services:

1. Nowadays, vast amounts of data are generated in nearly every field, including satellites in Earth's orbit, genetic engineering, the health sector, and market research surveys. However, big data may also be found in libraries. More and more academics are trying to use the collections to analyse data and organise information properly. As a result, many libraries have already been in the big data industry for some time — albeit sometimes unknowingly. Because of their digitised holdings, extensive libraries, in particular, contain an almost unmanageable amount of data.

2. Big data affects libraries directly as they could use big data tools to analyse their extensive data holdings, such as understanding their users better and thus offering new or improved services.

3. Big data indirectly affects libraries as academics at universities will increasingly rely on big data in their research (Metzler et al., 2016).

4. For economic reasons, big data can also lead to cost reductions, automation, and faster and better decisions.

5. Examining big data is essential and harbours opportunities. Currently, only 0.5% of all the data worldwide has been analysed, i.e., there are still plenty of prospects to get involved in big data projects (Regalado, 2013).

All of these factors should compel libraries to confront the topic of big data precisely in reality, mainly because pure information science appears to have moved away from this subject as institutes for information science, big data are sprouting up all over. In this regard, information science is rapidly increasing - only current information scientists can compete in this environment.

Smart Library

The term "smart" has several connotations, including efficient, sustainable, equitable, habitable, instrumented, and networked. Smart library is the application of smart computing technology to make a city's essential infrastructure processes and services more intelligent, interconnected, and efficient. Markus Aittola, a Finnish library researcher, presented the notion of a "smart library" for the first time in 2003 (Aittola et al., 2003). The properties of other new technologies are incorporated into smart libraries to complement library services innovatively. (1) overall perception from technologies such as RFID, IoT, picture recognition, speech recognition, PDA, and artificial intelligence. This contributes to the natural integration of readers and libraries. (2) People-oriented- The smart library allows readers to engage on the same platform, track and acquire users' personalised requirements and information, and offer them genuine, all-around humanised services. (3) Low cost- The smart library can lower the cost of human and material resources by developing and utilising resources more reasonably. (4) It adheres to the notion of sustainable development. The smart library may achieve energy saving and environmental protection and the rational use of diverse natural resources and the promotion of coordinated cultural and ecological building (Younis, 2012).

Smart libraries have four dimensions, according to Schöpfel (2018). This encompasses smart services, smart people, smart governance, and smart places. The first dimension is smart services, which may be defined as bringing smart cities' "spirit of innovation" to current library services. RFID, mobile and wireless access, semantic web, machine learning, IoT, natural language processing, augmented reality, and virtual reality is examples of developing technologies in this model. They are, however, empty values if they do not presuppose connectivity or the user is in the centre of the action. Mobile crowdsensing to enable smart

mobility, library space utilisation, access to library services (Stojanovic et al., 2016), agile management UX design, and personalised information discovery based on suggestions may all be part of the real usage evaluation. The second dimension is smart people. Because smart libraries are designed for, and by smart people, this notion of smart people may be interpreted on two levels in the context of libraries: smart community and knowledge creation (Schöpfel, 2018). This level includes library users and employees as a single community that collaborates to create knowledge. Possibly tomorrow, the library will be a centre of life, encounter, liberation, artistic and scientific instruction, as well as space for reading, music, theatre, exhibits, cafeterias, and fab laboratories.

The third dimension is smart place. This dimension connects services, users, and the environment to increase the library's smartness. The term "smart place" combines new qualities from the green library and the "third place library" to represent the transformation of the traditional library building and operation into a smart place that contributes as much to the city's viability as it does to its smartness. The final aspect is smart governance: This aspect of the smart library is institutional and political. It includes all library features related to the city's notion of "smart governance," such as collaboration, cooperation, partnership, public involvement, and participation (Coe et al., 2001).

Applying Big Data to Smart Libraries

Big data-driven library technologies provide library users with personalised, remote, real-time, and virtualised services. The rapid increase in the volume, veracity, velocity and variety of library data created by various library instruments provides novel approaches to studying interactions with library users (Nicholson & Bennett, 2016). By delivering personalised and intelligent services, big data helps the library to be smart and user-friendly. Catalogue and process/transactional data are two types of library big data. Catalogue data is the inherent data and knowledge of library files, whereas process data is created by library and service administration or given by library users. The first category of data consists mainly of documental, bibliographical, and financing data, whereas the second group consists primarily of log, user, and record data. Library big data analytics enable exceptional digital library innovations such as customised recommendation services and library user behaviour/habit analysis, which provide significant value and insights for a librarian, user, and services. Values for librarians are shown in the changes and advantages offered to librarians by intelligent big data analytical tools and digital management processes that enable the library to produce competitive products and services at a low cost. Improving library user experience and pleasure is infused with user value. By analysing library big data in its many forms, service value may be improved in service and process quality and efficiency. Because of the large volume, variety, velocity, and veracity of big data, developing a library management system necessitates creating novel architecture and digital technology applications to handle library big data, such as data acquisition, preservation, and processing. Thus, digital library management and digital library innovation form a transition closed-loop system in which library innovation drives library management while management tools and essential support for library innovation are provided (Liu & Shen, 2018).

Yin suggested a four-layer model for smart cities: data capture and transmission, data vitalisation, common data and service layer, and applications layer (Yin et al., 2015). Regardless of the number of layers, these models seek to project the data journey from birth in raw form to extracting valuable information, benefiting end-users, citizens, and decision-makers. It is simple to recognise the similarity (or even congruence) between Smart library models and the big data value chain. This comparison exemplifies the intersection of big data and smart libraries. This is equally true for big data and smart libraries.

The application of schöpel's multidimensional model requires the transition of a traditional library to smart services, smart people, smart place and smart governance through the help of big data.

Smart services: A smart library's objective is to provide smarter services. The key to success is innovation. As a result, big data technology may be used to provide smart services. In addition, big data may be used to create improvements. Therefore, it has become essential for libraries to leverage big data to incorporate knowledge and enhance services. According to Ferran et al. (2005), libraries play a critical role in public social service systems. To continue to serve library patrons, libraries must adapt to technological advances by utilising big data. The potential of big data and smart library can be harness into technical and readers' services.

Technical Services: The Radio Frequency Identification Device (RFID) is a device that assists in the identification and tracking of data from things (Pujar & Satyanarayana, 2015). RFID can be used in libraries to manage their collections. This is accomplished by attaching an RFID tag carrying bibliographic information, transaction logs, and virtual representations to each item in the acquisition department. This will allow each collection, like the accession number, to be unique. Cloud computing may be utilised to help in cataloguing. Cloud computing is a form of Internet-based computing that delivers on-demand computational services and data to computers and other equipment. It is a paradigm for gaining joint, on-demand access to a shared pool of customisable computer resources (Khuntia et al., 2016). Libraries may use cloud computing to store all of their catalogue entries, which can then be harvested automatically by other libraries, similar to how Mendeley harvests citations.

Readers' services: The circulating unit may utilise RFID to charge and discharge books. Integrating the library card with RFID tags makes it feasible to correlate catalogue circulation, overdue, and fines. Consequently, libraries will be able to use smart technologies to alert customers about overdue goods and allow them to pay fines online (Addepalli & Addepalli, 2014). Furthermore, libraries will be able to efficiently market library holdings by using smart shelves based on user behaviours in the library and transaction data. This can be accomplished by informing the client during prior visits to the library about new arrivals in a topic field that they were looking for (Pujar & Satyanarayana, 2015). If a library user discovers a book in the collection, but its status is indicated as borrowed by another user, it may be reserved by the second user. When a reserved book is returned via the automated station, it is placed in a separate container designated for reserved books. At this point, the gadget would send the consumer a message or an e-mail to confirm the book's availability (Purnik, 2019). Users can utilise library smartphone apps to locate resources, reserve books and research spaces, follow library events, and participate in user education initiatives (Guo et al., 2018; Kerr & Pennington, 2018).

Smart People: The main components of smart libraries are knowledge creation and smart communities. Big data analytics may assist in assessing patrons and empowering them to become more knowledgeable in academics or library use. According to Li et al. (2019), there are several benefits to using big data in libraries, including understanding the user's reading patterns and successfully utilising resources. A smart library can provide these advantages to a larger extent.

Smart Place: The smart library connects services, people, and the environment. Big data is required for this relationship to occur since it combines many data generated by users, exposed by services, and disbursed in the environment. This huge amount of data will determine the success of a smart library. Big data will assist librarians in better managing their buildings,

equipment, and appliances. This can assist libraries in controlling electricity, lighting, air conditioning, and Wi-Fi devices within the library (Qin, 2018).

Smart governance: Decision-making is essential in a smart library. In a smart library, big data can help with decision-making. According to Jim (2018), Big Data comprises high velocity, high variety, and high volume information that is expensive and maybe exploited for innovation to improve understanding and decision-making. According to Kamupunga and Chunting (2019), the benefits of Big Data in academic libraries are intended for management planning, assisting researchers, and investing in Big Data and text-mining methodology. In practice, smart technologies may collect data and actions from users, which can then be analysed using big data analytics. The analytics results may be utilised to forecast and better control the library.

Big Data Tools in Libraries

The Computer Business Review (CBR) produced a list of the most popular Big Data tools in 2015 (Nunns, 2015). They include Cambridge semantics, Splice Machine, MarkLogic, Google charts, SAP in Memory, MongoDB, Pentaho, Talend, Tableau, Splunk. and Hadoop. Cambridge Semantics assists in collecting, integrating, and analysing Big Data to develop Unified Access solutions. The software includes a data integration machine that helps with data collecting and analytics. Splice Machine is a real-time SQL-on-Hadoop database that may assist in generating real-time actionable insights, which is an obvious advantage for those seeking rapid development. MarkLogic is designed to handle large amounts of data and provide users with real-time updates and notifications. Google Charts has various tools for displaying data from websites, such as hierarchical treemaps and basic charts.
SAP's HANA platform has several benefits over the competitors, including integrating and analysing vast amounts of data in real-time. This is highly advantageous for the developer seeking a quick time to market. MongoDB is a free and open-source documental database that is excellent for developers that desire complete control over the end product. Pentaho combines data integration and business analytics to visualise, analyse, and mix Big Data. The open and embeddable platform includes advanced analytics features such as data mining and predictive analysis. Because Talend is open source, enhancements will continue to be made as the community modifies the programme. Its technologies include data management and application integration packages for development, testing, and deployment. Tableau is a well-known name in the data visualisation industry, but it also provides several tools for developers backed by an active community. This software's primary features include an in-memory analytics database and a sophisticated query language. Splunk generally focuses on capturing machine data generated by various sources, such as websites, apps, and sensors. Hadoop is open-source software designed to manage large amounts of data. It is a framework that enables the distributed processing of enormous data sets across computer clusters using simple programming models. It is intended to expand from a single service to thousands of computers, each of which provides local processing and storage.

Challenges of augmenting library services with smart library technologies and big data

Embracing Change: Embracing change could be a problem for library workers, as many are often against change. For example, some may perceive that technology will take away their job. As a result, they may fight against such change.

Finance: Smart library and big data implementation require much financial commitment to acquire all the necessary equipment needed for implementation. However, this proposal may

be rejected. The rejection of those plans could be due to funding cuts in libraries (Nicholas et al., 2010).

Privacy: Privacy is a major concerned as smart technology functionality requires connectivity, communication, and data transfer among objects. Therefore, a visitor to a library equipped with smart technology needs to enable mobile connectivity. Unfortunately, this connectivity allows library staff to control the visitor's mobile phone and access the contents, which is considered an infringement of privacy (Welbourne et al., 2009).

Technical issues*:* Smart technology may at times be vulnerable to the issue of failure in functioning due to technical problems or human errors. The issue of system failure can be very costly, both physically and financially. For instance, sending inaccurate instruction to traffic systems, health care systems, and nutrition systems may lead to many people's death.

Technical skills: Most librarians are not trained with the technical skills to handle big data tools and smart technologies. As a result, librarians may find it challenging to use the technologies. Furthermore, the technique necessary for harnessing the power of big data and smart technologies is rare among librarians.

Conclusion

Big Data and smart library capability caught the focus of the library world. In the world of big data and smart libraries, librarians will play an essential role as they have the expertise, experience and service mindset to assist universities, companies and governments. With these powerful analytics, which big data technologies offer, librarians can look at the data in new ways, thus adding value to different services and programs. A librarian does not need to become a programmer but should know how various software tools can transform enormous data.

Recommendations

Change Management: According to Adeyoyin et al. (2012), change is vital to all in the world that it is the most acute complication to conquer in the game of survival of the fittest, and it is persistent all the time. Libraries should follow a formal, realistic method for handling change that reinforces change. It is possible to use change agents to manage resistance while it is happening.

Alternative Funding: Some financial costs will be borne by adopting technological models that will shape traditional library services. Innovative and pragmatic librarians are continually exploring new means of library finance. The new means should go beyond the traditional reliance of the parent agency or the government but more focus on infopreneurship ((Adetayo & Hamzat, 2021), loans, gifts and collaborations.

Data encryption: Privacy can be resolved by adopting encryption technology to personnel and users sensitive data. However, this encryption should not cover data necessary for data analytics that is vital for decision making.

Training: The curriculum of library professionals should be adjusted to accommodate big data and smart technologies. Librarians should be trained on the different techniques in harnessing big data technologies (Adetayo, 2021).

REFERENCES

Addepalli, S. L., & Addepalli, S. G. (2014). Library management system using RFID technology. *International Journal of Computer Science and Information Technologies*, *5*(6), 6932–6935. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.657.7931&rep=rep1&type=pdf

Adetayo, A. J. (2021). Leveraging Bring Your Own Device for Mobility of Library Reference Services: The Nigerian Perspective. *The Reference Librarian*, 1-20. https://doi.org/10.1080/02763877.2021.1936342.

Adetayo, A. J., & Hamzat, S. A. (2021). Infopreneurship and Financial Satisfaction among Library Professionals in Tertiary Institutions in Ede , Osun , Nigeria. *Library Philosophy and Practice (e-Journal)*, *4749*, 1–15. https://digitalcommons.unl.edu/libphilprac/4749/

Adeyoyin, S., Imam, A., & Bello, T. (2012). Management of Change in the 21st Century Libraries and Information Centres. *Library Philosophy and Practice (e-Journal)*, *695*. https://digitalcommons.unl.edu/libphilprac/695

Affelt, A. (2015). *The accidental data scientist: big data applications and opportunities for librarians and information professionals*. Information Today.

Aittola, M., Ryhänen, T., & Ojala, T. (2003). SmartLibrary - Location-aware mobile library service. *International Conference on Mobile Human-Computer Interaction*, *2795*, 411–416. https://doi.org/10.1007/978-3-540-45233-1_38

Atkinson, J. (2018). Reflections on Collaboration and Academic Libraries. In *Collaboration and the Academic Library: Internal and External, Local and Regional, National and International* (pp. 221–232). Elsevier. https://doi.org/10.1016/B978-0-08-102084-5.00020-1

Bamgbade, B. J., Akintola, B. A., Agbenu, D. O., Ayeni, C. O., Fagbami, O. O., & Abubakar, H. O. (2015). Comparative analysis and benefits of digital library over traditional library. *World Scientific News*, *24*, 1–7. http://psjd.icm.edu.pl/psjd/element/bwmeta1.element.psjd-12f68008-735d-4b63-af6f-9748f444c5d4/c/WSN_24__2015__1-7.pdf

Bumblauskas, D., Nold, H., Bumblauskas, P., & Igou, A. (2017). Big data analytics: transforming data to action. *Business Process Management Journal*, *23*(3), 703–720. https://doi.org/10.1108/BPMJ-03-2016-0056

Cao, G., Liang, M., & Li, X. (2018). How to make the library smart? The conceptualization of the smart library. *Electronic Library*, *36*(5), 811–825. https://doi.org/10.1108/EL-11-2017-0248

Chang, A. C. (2016). Big data in medicine: The upcoming artificial intelligence. *Progress in Pediatric Cardiology*, *100*(43), 91–94. https://www.infona.pl/resource/bwmeta1.element.elsevier-88d9ca39-ebb9-3567-80b3-387f45aa131d

Coe, A., Paquet, G., & Roy, J. (2001). E-governance and smart communities: A social learning challenge. *Social Science Computer Review*, *19*(1), 80–93. https://doi.org/10.1177/089443930101900107

Cook, M. (2018). Virtual Serendipity: Preserving Embodied Browsing Activity in the 21st

Century Research Library. *Journal of Academic Librarianship*, *44*(1), 145–149. https://doi.org/10.1016/j.acalib.2017.09.003

Cox, J. (2018). Positioning the Academic Library within the Institution: A Literature Review. *New Review of Academic Librarianship*, *24*(3–4), 219–243. https://doi.org/10.1080/13614533.2018.1466342

De Mauro, A., Greco, M., & Grimaldi, M. (2016). A formal definition of Big Data based on its essential features. *Library Review*, *65*(3), 122–135. https://doi.org/10.1108/LR-06-2015-0061

Djafri, L., Bensaber, D. A., & Adjoudj, R. (2018). Big Data analytics for prediction: parallel processing of the big learning base with the possibility of improving the final result of the prediction. *Information Discovery and Delivery*, *46*(3), 147–160. https://doi.org/10.1108/IDD-02-2018-0002

Erevelles, S., Fukawa, N., & Swayne, L. (2016). Big Data consumer analytics and the transformation of marketing. *Journal of Business Research*, *69*(2), 897–904. https://doi.org/10.1016/j.jbusres.2015.07.001

Ferran, N., Mor, E., & Minguillón, J. (2005). Towards personalization in digital libraries through ontologies. *Library Management*, *26*(4–5), 206–217. https://doi.org/10.1108/01435120510596062

Frederick, D. E. (2016). Data, Open Science and libraries – The Data Deluge Column. *Library Hi Tech News*, *33*(8), 11–16. https://doi.org/10.1108/LHTN-09-2016-0040

Goldberg, D., Olivares, M., Li, Z., & Klein, A. G. (2014). Maps & GIS data libraries in the era of big data and cloud computing. *Journal of Map and Geography Libraries*, *10*(1), 100–122. https://doi.org/10.1080/15420353.2014.893944

Grover, V., Chiang, R. H. L., Liang, T. P., & Zhang, D. (2018). Creating Strategic Business Value from Big Data Analytics: A Research Framework. *Journal of Management Information Systems*, *35*(2), 388–423. https://doi.org/10.1080/07421222.2018.1451951

Guo, Y. J., Liu, Y. Q., & Bielefield, A. (2018). The provision of mobile services in US urban libraries. *Information Technology and Libraries*, *37*(2), 78–93. https://doi.org/10.6017/ital.v37i2.10170

Hoy, M. B. (2014). Big Data: An Introduction for Librarians. *Medical Reference Services Quarterly*, *33*(3), 320–326. https://doi.org/10.1080/02763869.2014.925709

Immonen, M., & Sintonen, S. (2015). Evolution of technology perceptions over time. *Information Technology and People*, *28*(3), 589–606. https://doi.org/10.1108/ITP-12-2013-0219

Ishwarappa, & Anuradha, J. (2015). A brief introduction on big data 5Vs characteristics and hadoop technology. *International Conference on Computer, Communication and Convergence (ICCC 2015)*, *48*(C), 319–324. https://doi.org/10.1016/j.procs.2015.04.188

Kamupunga, W., & Chunting, Y. (2019). Application of Big Data in Libraries. *International Journal of Computer Applications*, *178*(16), 975–8887. https://doi.org/10.5120/ijca2019918955

Kenney, A. R., McGovern, N. Y., Martinez, I. T., & Heidig, L. J. (2003). Google meets eBay: What academic librarians can learn from alternative information providers. *D-Lib*

Magazine, *9*(6). https://doi.org/10.1045/june2003-kenney

Kerr, A., & Pennington, D. R. (2018). Public library mobile apps in Scotland: views from the local authorities and the public. *Library Hi Tech*, *36*(2), 237–251. https://doi.org/10.1108/LHT-05-2017-0091

Khuntia, S. K., Mishra, M., Ramesh, D. B., Librarian, J., librarian, A., & Librarian, C. (2016). Applicability of information technology in libraries with a step ahead to smart library in 21st century. *Indian Journal of Library Science and Information Technology*, *1*(1), 22–25. https://www.ipinnovative.com/media/journals/IJLSIT_1(1)_22-25.pdf

Kitchin, R., & McArdle, G. (2015). The Diverse Nature of Big Data. *SSRN Electronic Journal*, *3*, 1–10. https://doi.org/10.2139/ssrn.2662462

Košcielniak, H., & Puto, A. (2015). BIG DATA in Decision Making Processes of Enterprises. *Part of Special Issue: International Conference on Communications, Management, and Information Technology (ICCMIT'2015)*, *65*, 1052–1058. https://doi.org/10.1016/j.procs.2015.09.053

Lee, C. H., Ryu, J., Lee, S. H., Kim, H., & Lee, I. (2016). Functional cross-hemispheric shift between object-place paired associate memory and spatial memory in the human hippocampus. *Hippocampus*, *26*(8), 1061–1077. https://doi.org/10.1002/hipo.22587

Li, S., Hao, Z., Ding, L., & Xu, X. (2019). Research on the application of information technology of Big Data in Chinese digital library. *Library Management*, *40*(8–9), 518–531. https://doi.org/10.1108/LM-04-2019-0021

Liikkanen, L. A., & Aman, P. (2016). Shuffling services: Current trends in interacting with digital music. *Interacting with Computers*, *28*(3), 352–371. https://doi.org/10.1093/iwc/iwv004

Liu, S., & Shen, X. L. (2018). Library management and innovation in the Big Data Era. *Library Hi Tech*, *36*(3), 374–377. https://doi.org/10.1108/LHT-09-2018-272

Lu, N., Song, R., Heng, D., Gottipati, S., & Tay, A. (2017). Using data analytics for discovering library resource insights – Case from Singapore Management University. *Proceedings of the 25th International Conference on Computers in Education ICCE 2017*, 280–287. https://ink.library.smu.edu.sg/sis_research/3835

Lycett, M. (2013). "Datafication": Making sense of (big) data in a complex world. In *European Journal of Information Systems* (Vol. 22, Issue 4, pp. 381–386). Palgrave Macmillan Ltd. https://doi.org/10.1057/ejis.2013.10

Metzler, K., Kim, D. A., Allum, N., & Denman, A. (2016). *Who Is Doing Computational Social Science? Trends in Big Data Research A SAGE White Paper*. https://doi.org/10.4135/wp160926

Moulding, J. (2016, February 29). *Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2015-2020*. https://www.v-net.tv/2016/02/29/cisco-visual-networking-index-global-mobile-data-traffic-forecast-update-2015–2020/

Nam, T., & Pardo, T. A. (2011). Conceptualizing smart city with dimensions of technology, people, and institutions. *ACM International Conference Proceeding Series*, 282–291. https://doi.org/10.1145/2037556.2037602

Nicholas, D., Rowlands, I., Jubb, M., & Jamali, H. R. (2010). The impact of the economic

downturn on libraries: With special reference to university libraries. *Journal of Academic Librarianship*, *36*(5), 376–382. https://doi.org/10.1016/j.acalib.2010.06.001

Nicholson, S. W., & Bennett, T. B. (2016). Dissemination and Discovery of Diverse Data: Do Libraries Promote Their Unique Research Data Collections? *International Information and Library Review*, *48*(2), 85–93. https://doi.org/10.1080/10572317.2016.1176448

Nunns, J. (2015, May 6). *10 of the most popular Big Data tools for developers*. Tech Monitor. https://techmonitor.ai/technology/data/10-of-the-most-popular-big-data-tools-for-developers-4570483

OED. (2013). *big, adj. and adv.* Oxford English Dictionary. https://www.oed.com/view/Entry/18833

Padhi, S., & Nahak, B. (2019, October). The Role of Smart Library and Smart Librarian for E-Library Services. *12th International CALIBER-2019 KIIT*. https://ir.inflibnet.ac.in/handle/1944/2338

Preater, A. (2014). *Information as a commodity*. https://www.preater.com/2014/06/03/information-as-a-commodity/

Pujar, S. M., & Satyanarayana, K. V. (2015). Internet of Things and libraries. *Annals of Library and Information Studies (ALIS)*, *62*(3), 186–190. http://op.niscair.res.in/index.php/ALIS/article/view/9800

Purnik, A. (2019). *The Internet of Things Serving Libraries*. IFLA. https://www.ifla.org/node/92356

Qin, J. (2018). The Research of the Library Services Based on Internet of Things. *Proceedings of the 4th International Symposium on Social Science (ISSS 2018)*, 399–407. https://doi.org/10.2991/isss-18.2018.83

Regalado, A. (2013). *The Data Made Me Do It*. MIT Technology Review. https://www.technologyreview.com/2013/05/03/16109/the-data-made-me-do-it/

Schöpfel, J. (2018). Smart Libraries. *Infrastructures*, *3*(4), 43. https://doi.org/10.3390/infrastructures3040043

Semeler, A. R., Pinto, A. L., & Rozados, H. B. F. (2019). Data science in data librarianship: Core competencies of a data librarian. *Journal of Librarianship and Information Science*, *51*(3), 771–780. https://doi.org/10.1177/0961000617742465

Showers, B. (2014). Developing a shared analytics service for academic libraries. *Insights: The UKSG Journal*, *27*(2), 139–146. https://doi.org/10.1629/2048-7754.149

Simo, H. (2015). Big Data: Opportunities and Privacy Challenges. In *Privatheit, Öffentlichkeit und demokratische Willensbildung in Zeiten von Big Data* (pp. 13–44). Nomos. https://doi.org/10.5771/9783845264165-13

Stojanovic, D., Predic, B., & Stojanovic, N. (2016). Mobile crowd sensing for smart urban mobility. In *European Handbook of Crowdsourced Geographic Information* (p. 371). Ubiquity Press. https://doi.org/10.5334/bax

Sulistialie, E. (2015). New roles for the librarian of Bosscha Observatory: Review of tasks in library over two decades. *Open Science at the Frontiers of Librarianship*, *492*, 232–236. http://adsabs.harvard.edu/pdf/2015ASPC..492..232S

Tait, E., Martzoukou, K., & Reid, P. (2016). Libraries for the future: The role of IT utilities in the transformation of academic libraries. *Palgrave Communications*, *2*(1), 1–9. https://doi.org/10.1057/palcomms.2016.70

Tarique, M., & Rani, V. P. (2017). Implementation of RFID in library management system based on Internet of Things (IOT). *International Journal of Scientific Research in Computer Science, Engineering and Information Technology*, *2*(3), 315–321.

Tingting, L. (2017). From Smart Library to Intelligent Library: The Turn of Library Development in the Age of Artificial Intelligence. *Library and Information*, *3*, 98–101.

Wang, C., Xu, S., Chen, L., & Chen, X. (2016). Exposing library data with big data technology: A review. *2016 IEEE/ACIS 15th International Conference on Computer and Information Science, ICIS 2016 - Proceedings*, 1–6. https://doi.org/10.1109/ICIS.2016.7550937

Welbourne, E., Battle, L., Cole, G., Gould, K., Rector, K., Raymer, S., Balazinska, M., & Borriello, G. (2009). Building the internet of things using RFID: The RFID ecosystem experience. *IEEE Internet Computing*, *13*(3), 48–55. https://doi.org/10.1109/MIC.2009.52

Xiang, Z., Schwartz, Z., Gerdes, J. H., & Uysal, M. (2015). What can big data and text analytics tell us about hotel guest experience and satisfaction? *International Journal of Hospitality Management*, *44*, 120–130. https://doi.org/10.1016/j.ijhm.2014.10.013

Xie, Z., & Fox, E. A. (2017). Advancing library cyberinfrastructure for big data sharing and reuse. *Information Services and Use*, *37*(3), 319–323. https://doi.org/10.3233/ISU-170853

Yaya, J., Achonna, A. U., & Osisanwo, T. (2014). Competitive intelligence: A tool for effective job performance in academic library. *Sky Journal of Educational Research*, *2*(4), 20–27. http://www.isihome.ir/freearticle/ISIHome.ir-21096.pdf

Yin, C. T., Xiong, Z., Chen, H., Wang, J. Y., Cooper, D., & David, B. (2015). A literature survey on smart cities. *Science China Information Sciences*, *58*(10), 1–18. https://doi.org/10.1007/s11432-015-5397-4

Younis, M. I. (2012). SLMS: A smart library management system based on an RFID technology. *International Journal of Reasoning-Based Intelligent Systems*, *4*(4), 186–191. https://doi.org/10.1504/IJRIS.2012.051717

Zhan, M., & Widén, G. (2019). Understanding big data in librarianship. *Journal of Librarianship and Information Science*, *51*(2), 561–576. https://doi.org/10.1177/0961000617742451