

Adoption of Innovative Technologies and Services in Academic Libraries in North Central Nigeria as a Panacea to the Effects of Covid-19 and Related Pandemics

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Abstract

This study investigated the adoption of innovative technologies and services in academic libraries in North Central Nigeria (NCN) as a panacea to the effects of COVID-19 and related pandemics. The study adopted the descriptive survey research design guided by five specific objectives and a null hypothesis. The population was 216 librarians and 9505 teaching staff at Federal Universities and Polytechnics in NCN. The multi-stage sampling technique was applied to draw samples for the study. Two sets of self-developed and face-validated questionnaires were used to collect data. The internal consistency of the instruments was assessed using Cronbach's Alpha. Data collected were analysed using the percentage, mean and standard deviation, while the Chi-Square was used to test the hypothesis. Findings in the study show that technologies and services provided in academic libraries in NCN before the COVID-19 pandemic were: the computer, circulation service, reference service, and selective dissemination of information. Only digital resources were the innovative technology and service adopted in academic libraries in NCN as a panacea to the effects of COVID-19 and related pandemics. The study further revealed a low extent of adoption of innovative technologies and services in academic libraries in NCN as a panacea to the effects of COVID-19 and related pandemics. Additionally, the study indicated that the research output of academics in NCN is positively impacted by the adopted technology and service. The innovative technologies and services agreed for possible adoption in academic libraries in NCN as a panacea to the effects of COVID-19 and related pandemics include: online databases, social media technologies, information alert service, QR Code, natural language processing, blockchain technology, intelligent virtual assistant, among others. A recommendation made in the study, among others, was

that academic library managements in NCN should, as a matter of deliberate policy, address the poor adoption of innovative technologies and services, which has revealed the weaknesses of the libraries to cater to the needs of researchers in periods of pandemics like COVID-19.

Keywords: Innovative Technologies, Services, Academic Libraries, Panacea, COVID- 19, Pandemics

Introduction

Academic libraries globally play a vital role in higher education and learning by supporting the objectives of their respective institutions. Through research, teaching, and community service, higher education aims to generate, advance, and share knowledge (Anyagugu & Iyabo, 2014). Libraries connected to universities, polytechnics, and colleges are collectively referred to as academic libraries. They carry out vital tasks that help the institutions accomplish their goals, such as providing current information resources to enhance academic programmes, preserving and disseminating knowledge through bibliographical instruction, properly organising collections, and offering reference services with the aid of pertinent technologies (Line, 2021). Academic libraries are considered the "heart" or "live wire" of their parent institutions because of these and numerous other roles. Academic libraries use a variety of technologies, including innovative technologies, to improve service delivery.

Depending on the context and point of view, the term "technology" can mean several things. According to Lane (2006), technology is concerned with comprehending how information is creatively applied to structured tasks involving humans and machines that achieve sustainable goals. Technology and innovation are fundamental to society's growth and progress. The word "innovation" comes from the Latin *innovare*, which means "into new." With a variety of definitions that frequently overlap, the idea is somewhat complex.

According to Jantz, cited in Mafungwa (2017), innovation is the introduction of a new technology, product, service, or administrative procedure into an organisation, or as a major enhancement of any, some, or all of these. According to Hudson (2014), innovation is the development and application of novel procedures, goods, services, and delivery methods that lead to appreciable gains in results, efficacy, efficiency, or quality. The goal of innovation is to develop new concepts and technologies that boost output while requiring the same amount of input (Bamberger & Nanse, 2019). According to Simisaye et al. (2018), being creative for librarians entails using their creativity and intelligence to reinvent and improve their profession in order to boost user services and maintain their collections.

Technologies that are either newly created or being used in novel ways are considered innovative. Every day, government laboratories, businesses, and academic institutions produce new technologies. These include developments in fields like biotechnology, mobile communications, sensor networks, artificial intelligence, and so forth. Innovative technologies, as used in this study, refer to technology methods and equipment used to improve and streamline academic library services as a cure-all for COVID-19 and related pandemics. Innovative technologies enable innovative services.

According to Begum and Noor (2014), an innovative service is any process or service product that is built on a technology or methodical approach. Innovative services in the context of this study can be defined as organised, scientific, and technological activities and procedures to develop, market, and implement new or improved academic library resources and services as a cure-all for COVID-19 and similar pandemics. Given the deadly and contagious nature of COVID-19 and related pandemics, academic libraries must implement innovative technologies and services to provide smooth support for researchers trying to contain the pandemic.

Pandemics are huge-scale infectious disease outbreaks with catastrophic potential to significantly disrupt the social, political, and economic spheres, as well as significantly increase morbidity and mortality over a huge geographic area. The most recent pandemic is COVID-19, or the Coronavirus Disease of 2019. It began in Wuhan, China's Hubei province in December 2019. On January 30, 2020, the World Health Organisation (WHO) designated it a public health emergency of global concern. Sports, religious, commercial, cultural, and other events were cancelled or postponed as a result of the pandemic, which also caused significant worldwide socioeconomic disruptions. Additionally, human activity was partially shut down in all of the world's nations. As countries were ready to breathe a sigh of relief due to flattened transmission curve and decreased mortality towards the end of 2020, new viral strains were discovered in the United States and the United Kingdom, which caused more deaths and spread more quickly (Centres for Disease Control and Prevention, 2021). In Brazil and South Africa, another variation also surfaced. In fact, scientists discovered a number of variations between January and February 2021, raising concerns about vaccine resistance. Sub-variants of the variant species, such as the Omicron sub-variants, were reported in the US in January 2023 (Business Day, 2023). To stop the spread of these variants and sub-variants, public health officials were putting a lot of effort into studying them. Strict and improved adherence to public health mitigation techniques, including vaccination, physical separation, face mask use, hand cleanliness, isolation, and quarantine, was advised by the WHO.

Scientists warned that the future imposed by the coronavirus is yet unclear and that it will be with us for the foreseeable future. As anticipated, pockets of infections continue to be reported around the world, including Nigeria, where on December 13, 2023, 25 cases were reported in the North-Central state of Benue (Ileyemi, 2023). However, between February 27, 2020, when the first index case was reported in Nigeria, and April 28, 2023, a total of 266,675 cases and 3,155 deaths were documented throughout the 36 states of the country (Nigeria Centre for Disease Control, 2023). In May 2023, Tedros Adhanom Ghebreyesus, the Director-General of the World Health Organisation, proclaimed COVID-19 to be no longer a global public emergency. He however added that it does not mean COVID-19 was over as a global health threat as the virus had established itself as an ongoing health issue (Murez, 2023). He noted further that “the threat of another variant emerging that can cause a new surge of diseases and death remains, and that the threat of another pathogen emerging with even deadlier potentials remains” (Pandey, 2023, p. 2).

After three years of the COVID-19 pandemic, which caused suffering and loss for people worldwide, the Director-General warned in his end-of-year 2023 message that the world must get ready for future pandemics (WHO, 2023). This is just as Rajiv Shah, President of the Rockefeller Foundation, a global organisation dedicated to advancing human well-being worldwide, advocates for strong partnerships across sectors and borders to share knowledge, tools, and practices to ensure that pandemic prevention and response are creative and robust in the future (WHO, 2023).

It is crucial to pay attention to the concerns voiced by experts. Against this background, libraries, particularly academic libraries, need to adopt innovative technologies and services as a panacea to the effects of COVID-19 and any pandemic that may affect the world in future. This research, therefore, seeks to investigate the adoption of innovative technologies and services by academic libraries in North Central Nigeria (NCN) as a panacea to the effects of COVID-19 and related future pandemics.

Statement of the Problem

Seamless academic library services are crucial for all times and seasons as a cornerstone of research and development, as well as teaching and learning. It is even more critical in periods of social dislocation induced by pandemics. This is especially true because libraries should assist in providing information services to facilitate research to curb the pandemic and for enhanced community recovery. Innovative technologies and services are the means to establish and sustain viable information services at this period. Innovative technologies in academic libraries ensure limitless access to information from any location and by multiple users at the same time. As attested to in the literature, the adoption of innovative technologies and services in

the post-COVID-19 era would be strategic in breaking the information service barrier and reaching a wider audience simultaneously (Oduwale et al., 2023). It is also critical as a proactive measure against pandemics of a similar nature. These qualities could make the academic library both indispensable and safe during periods of a pandemic like COVID-19. However, it has been observed that most academic libraries in Nigeria are bereft of innovative technologies to power innovative services for research during times of pandemics like COVID-19. The consequences of such a lacuna are grievous, but to say that it could result in greater casualties and delay in flattening the virus transmission curve. This may be the reason why libraries are shut down along with other institutions considered not of essential service during pandemics. The rationale for this study, therefore, is to investigate the adoption of innovative technologies and services in academic libraries as a panacea to the effects of COVID-19 and related pandemics.

Objectives of the Study

The general objective of this study is to investigate the adoption of innovative technologies and services in academic libraries as a panacea to the effects of COVID-19 and related pandemics in NCN. In this regard, the study was specifically designed to:

1. Identify the technologies and services provided in academic libraries in NCN before the COVID-19 pandemic.
2. Identify the innovative technologies and services adopted in academic libraries in NCN as a panacea to the effects of COVID-19 and related pandemics.
3. Ascertain the extent of adoption of innovative technologies and services in academic libraries in NCN as a panacea to the effects of COVID-19 and related pandemics.
4. Determine the effectiveness of innovative technologies and services in academic libraries in NCN as a panacea to the effects of COVID-19 and related pandemics.
5. Propose innovative technologies and services in academic libraries in NCN as a panacea to the effects of COVID-19 and related pandemics.

Hypothesis

A null hypothesis will be tested at a 0.05 level of significance. It is stated as:

H₀₁: There is no significant difference in the technologies and services adopted in academic libraries in NCN before and after the COVID-19 pandemic.

Literature Review

Academic libraries are vibrant social institutions and essential sources of trustworthy knowledge at higher education institutions. According to the University

of Staffordshire (2025), an academic library is a specialised library connected to an educational institution that caters to the information needs of its staff, faculty, and students. The Federal Ministry of Education (2019) defines the roles of Nigerian universities, polytechnics, and colleges in the country's education policy. These roles include, among other things, developing high and middle-level human resources within the framework of the country's needs and making the best possible contribution to national development by intensifying and diversifying their programmes. A dynamic library system must be maintained in order to fulfil these functions, which are accomplished through research, teaching, and learning initiatives (Akpan-Atata et al., 2015). To complement the institutions' courses, the libraries' materials must be adequate in terms of quality, depth, diversity, and currency.

Academic libraries have always offered a wide range of services to cater to their sizable and diverse clientele. These services include circulation, serials, reference, user education, current awareness, selective information dissemination, compilation of reading lists, reprographic, computerised interactive search, and more (Eze & Uzoigwe, 2013; Adebayo, et al., 2018). However, by their very nature, the majority of these conventional services rely on manual labour. They are ineffective during pandemics such as COVID-19.

The introduction and development of information and communication technologies, especially in the areas of computing, internet networking, and storage technologies, have completely transformed the traditional and inflexible nature of library services, which are typified by in-person interactions between the librarian and the patron. In light of this, Queen's University Library (2023) asserts that COVID-19 has only quickened the rate at which digital technologies are transforming how libraries function and serve their patrons. El-Kalash et al. (2022) therefore identified innovative technologies and services that could improve library services during pandemics, such as OPAC and Web OPAC searching facilities, virtual reference services, current awareness services, robots, library mobile applications, bookmark applications, virtual reality applications, 3D technology, quick response services, and drones. In addition, Omeluzor et al. (2020) added that Frequently Asked Questions (FAQ), Online Public Access Catalogue (OPAC), text messaging, ask a Librarian, blogging, and social media are examples of innovative technologies for library education and services. In a study by Asefeh and Asemi (2018), a number of ways that innovative technologies might enhance library services were identified, such as resource cataloguing, book shelving, and circulation services.

Innovative technology has influenced library services in a number of ways. According to Mogali (2015), these include performing jobs more quickly and

effectively, lowering errors and flaws, improving access to resources both locally and internationally, and taking on challenging and difficult work, among others. Like everything else, library services have been significantly impacted by artificial intelligence (AI) in recent years. Reasoning, discovery, generalisation, object manipulation, natural language processing, and many more are the goals of artificial intelligence (Das and Islam, 2021). The authors claim that because the AI system can "think" and behave like people without human intervention, it can help create an intelligent library with latent intelligent roles that can function without human assistance. As a result, these libraries will be highly effective for providing information during pandemics like the COVID-19. Recommender systems, expert systems, agent technology, intelligent shelves, Natural Language Processing (NLP), Radio Frequency Identification (RFID), Pointer, Answer-man Online Reference Assistance (ORA), and more are examples of AI technologies used in library services. According to Xiao and Gao (2020), these recommendation systems aid in enhancing library services and offering users individualised services. Chatbots and virtual assistants are examples of AI solutions that can greatly improve user interactions and streamline library operations. AI-powered chatbots, for instance, can help with catalogue searches and provide prompt responses to customer questions (Ejiro, 2025). While advanced nations have already embraced these AI techniques, academic libraries in many developing nations, including Nigeria, seem to be just beginning to use them. Research on AI integration in Nigerian university libraries typically reveals a poor degree of readiness and adoption of AI services and technology in their operations (Moustapha & Yusuf, 2023; Aminu, 2024). However, research by Ogonu and West (2024) found that university libraries in River State, Nigeria, had a high level of adoption of innovative technologies other than artificial intelligence.

Improved information services are the main goal of innovative technologies and services in libraries. In the context of this study, this should be taken into consideration when evaluating academic research production. According to Saibakumo (as cited in Adeyeye and Oladokun, 2023), cloud computing, robots, artificial intelligence, and QR bar code technology are examples of cutting-edge technologies that are thought to have an impact on academic library users' research output. In a similar vein, Tindowen and Abella (2024) noted that new services that influence users' research include specialised databases, digital resources, and individualised research support from library staff.

This work is hinged on two theories: Ranganathan's Laws of Library Science (1931) and Everett Rogers' Diffusion of Innovations Theory (1962). Both theories would provide a context for interpreting the results. Ranganathan enunciated five laws, which are all relevant to this study. In this regard, information and

communications technologies have altered the landscape of libraries across the world, making them acquiescent to innovative technologies and services to suit the environment created by COVID-19 and related pandemics. The major tenets of Everett Rogers' Diffusion Innovation Theory are that four elements, namely innovation, communication channels, time, and social systems, influence the spread of innovation. The theory is relevant to this study because innovative technologies and services adopted by academic libraries, particularly during pandemics, must be communicated to users within a reasonable time. The social systems triggered by COVID-19 facilitate academic libraries' adoption and communication of innovative technologies and services.

The literature reviewed in this study indicates that library services are continuously changing in response to societal demands. Many core library services, such as reference assistance, research support, and teaching, for example, are being provided in new and often more accessible and inclusive ways than ever before, with the help of innovative technologies. While many of these innovative technologies and the resultant services were identified in the literature, the researchers did not encounter any earlier study that investigated the innovative technologies and services adopted by academic libraries in NCN, nor were they concerned with mitigating the effects of COVID-19 and related pandemics.

Methodology

The descriptive survey research design was adopted for this study. The design entails collecting and analysing data about people or phenomena by comparing existing and required standards and identifying the means to improve their current state (Shona, 2020). The NCN, made up of six states, including the Federal Capital Territory (FCT), Abuja, is the area for this study. Seven federal universities with a population of 118 librarians and 6,872 teaching staff, and four federal polytechnics with a population of 98 librarians and 2,633 teaching staff were studied. A multi-stage sampling technique, involving complete enumeration, proportionate stratified random sampling, and accidental sampling techniques, was applied in the study. All 216 librarians shall be drawn by complete enumeration, while 950 or 10% shall be drawn by proportionate stratified random sampling from among the academics in the universities and polytechnics. Two sets of self-developed and structured questionnaires were used to collect data. They were titled: Innovative Technologies and Services in Academic Libraries Questionnaire (ITSALQ) and Effectiveness of Innovative Technologies and Services in Academic Libraries Questionnaire (EITSALQ). The first set of questionnaires, which has 42 items, addressed the first three objectives of the study and was administered to the librarians, while the second set, with 28 items, addressed the fourth and fifth objectives and was administered to

the academics. The instruments were face-validated by three experts: two in the field of Library and Information Science and one in the field of Measurement and Evaluation. The Internal consistency of the Instruments was ensured using Cronbach's Alpha. The overall reliability indexes were .892 and .941 for Questionnaire I and Questionnaire II, respectively. They were thus judged reliable. Data collected from respondents were coded and analysed using the percentage, mean and standard deviation. Percentage scores of 50 per cent and above were considered positive and accepted, while scores below 50 per cent were considered negative and rejected. The criterion mean for this study was 2.50. Hence, a mean score equal to or above the criterion mean indicates the agreed region, whereas a mean response below the criterion score denotes the disagreed region. A null hypothesis was tested at a 0.05 level of significance using the Chi-Square test.

Results

In line with the research questions and the null hypothesis that guided the study, the summary of the analysis of data collected are presented in the tables below:

Research Question 1: What are the technologies and services provided in academic libraries in NCN before the COVID-19 pandemic.

Table 1: Percentage scores of technologies and services provided in academic libraries in NCN before the COVID-19 pandemic (N = 168)

S/N	Items	Provided	Not Provided
1	Circulation Service	60%	40%
2	Reference Service	75%	25%
3	Virtual Reference Service	25%	75%
4	User Instruction	40%	60%
5	Selective Dissemination of Information	55%	45%
6	Computer	60%	40%
7	Online Database	50%	50%
8	Institutional Repository	20%	80%
9	Integrated Library System	25%	75%
10	Subject Gateway	10%	90%
11	Open Source Repository	55%	45%
12	Digital Resources	25%	75%
13	Electronic Mail Service	25%	75%
14	Social Media Technologies	25%	75%

From table 1 above, six items, namely, circulation, reference service, selective dissemination of information, computer, online database and open source repository, have scores of 50 per cent or above. These technologies and services are considered to be provided in academic libraries in NCN before the COVID-19 pandemic.

Research Question 2: What are the innovative technologies and services adopted in academic libraries in NCN as a panacea to the effects of COVID-19 and related pandemics?

Table 2: Percentage scores of innovative technologies and services adopted in academic libraries in NCN as a panacea to the effects of COVID-19 and related pandemics. (N = 168)

S/N	Items	Adopted	Not Adopted
1	Online Database	27%	73%
2	Subject Gateway	28%	72%
3	Web OPAC	38%	62%
4	Digital Resources	55%	45%
5	Social Media Technologies and Services	36%	64%
6	Block Chain	11%	89%
7	Natural Language Processing	11%	89%
8	Intelligent Virtual Assistant	38%	62%
9	Face Recognition	21%	79%
10	Shelf-Reading Robots	10%	90%
11	Book Delivery Drones	5%	95%
12	Radio Frequency Identification	38%	62%
13	Information Alert Service	16%	84%
14	Quick Response (QR) Code Access	5%	95%

None of the items listed in Table 2 above has a percentage score up to 50, except digital resources, which scored 55%. This shows that it is the only innovative service adopted in academic libraries in NCN as a panacea to the effects of COVID-19 and related pandemics.

Research Question 3: What is the extent of adoption of innovative technologies and services in academic libraries in NCN as a panacea to the effects of COVID-19 and related pandemics?

Table 3: Mean ratings and standard deviations on extent of adoption of innovative technologies and services in academic libraries in NCN as a panacea to the effects of COVID-19 and related pandemics

N = 168

S/N	Items	Mean	St.D	Decision
1	Online Database	1.93	.770	Disagreed
2	Subject Gateway	1.86	.784	Disagreed
3	Web OPAC	2.21	.903	Disagreed
4	Digital Resources	2.85	.734	Agreed
5	Social Media Technologies and Services	2.18	.918	Disagreed
6	Block Chain	1.46	.673	Disagreed
7	Natural Language Processing	1.51	.675	Disagreed
8	Intelligent Virtual Assistant	1.70	.894	Disagreed
9	Face Recognition	2.00	1.116	Disagreed
10	Shelf-Reading Robots	1.70	1.012	Disagreed
11	Book Delivery Drones	1.55	.887	Disagreed
12	Radio Frequency Identification	1.67	.663	Disagreed
13	Information Alert Service	1.60	.727	Disagreed
14	Quick Response (QR) Code Access	1.64	.815	Disagreed
	Aggregate Scores	1.85	.826	Disagreed

Results in table 3 shows a low extent of adoption of innovative technologies and services in academic libraries in NCN as a panacea to the effects of COVID-19 and related pandemics. Only one item i.e. digital resources with means score of 2.85 have score above the criterion mean of 2.50.

Research Question 4: What is the level of effectiveness of adopted innovative technologies and services on research output of academics in NCN as a panacea to the effects of COVID-19 and related pandemics?

Table 4: Mean ratings and standard deviations on level of effectiveness of adopted innovative technologies and services on research output of academics in NCN as a panacea to the effects of COVID-19 and related pandemics? (N = 722)

S/N	Items	Mean	St.D	Decision
1	Online Database	2.95	.865	Agreed
2	Subject Gateway	2.65	.654	Agreed

3	Web OPAC	2.75	.769	Agreed
4	Digital Resources	2.95	.743	Agreed
5	Social Media Technologies and Services	3.10	.700	Agreed
6	Block Chain	2.55	.801	Agreed
7	Natural Language Processing	2.56	.801	Agreed
8	Intelligent Virtual Assistant	2.80	.751	Agreed
9	Face Recognition	2.55	.922	Agreed
10	Shelf-Reading Robots	2.10	.768	Disagreed
11	Book Delivery Drones	2.00	.705	Disagreed
12	Radio Frequency Identification	2.25	.888	Disagreed
13	Information Alert Service	2.70	.842	Agreed
14	Quick Response (QR) Code Access	2.45	.863	Disagreed
	Aggregate Scores	2.60	.791	Agreed

Table 4 above indicates that the research output of academic in NCN are positively impacted by the adopted innovative technologies and services. The results of analysis shows that respondents are agreed that online database, subject gateway, web OPAC, digital resources, social media technologies and services, block chain, natural language processing, intelligent virtual assistant, face recognition and information alert services have high level of effectiveness on their research output.

Research Question 5: What are the innovative technologies and services for possible adoption by academic libraries in NCN as a panacea to the effects of COVID-19 and related pandemics?

Table 5: Mean ratings and standard deviations on innovative technologies and services for possible adoption by university libraries in NCN as a panacea to the effects of COVID-19 and related pandemics. (N = 722)

S/N	Item Statements	Mean	St.D	Decision
1	Adoption of Online Database	3.50	.500	Agreed
2	Adoption of Subject Gateway	3.05	.497	Agreed
3	Adoption of Web OPAC	3.20	.601	Agreed
4	Adoption of Digital Resources	3.40	.490	Agreed
5	Adoption of Social Media Technologies and Services	3.45	.592	Agreed
6	Adoption of Blockchain	2.80	.815	Agreed
7	Adoption of Natural Language Processing	2.95	.669	Agreed
8	Adoption of Intelligent Virtual Assistant	2.70	.843	Agreed
9	Adoption of Face Recognition	2.65	1.015	Agreed
10	Adoption of Shelf-Reading Robots	2.50	.866	Agreed
11	Adoption of Book Delivery Drones	2.64	.673	Agreed
12	Adoption of Radio Frequency Identification	2.70	.843	Agreed
13	Adoption of Information Alert Service	3.15	.654	Agreed
14	Adoption of Quick Response (QR) Code Access	3.05	.590	Agreed
	Aggregate Scores	2.98	.624	Agreed

Table 5 above shows that respondents are agreed on all the items listed as innovative technologies and services for possible adoption by academic libraries in NCN as a panacea to the effects of COVID-19 and related pandemics. The aggregate mean score of 2.98 is higher than the mean score benchmark of 2.50.

Null Hypothesis: There is no significant difference in the technologies and services adopted in academic libraries in NCN before and after the COVID-19 pandemic.

Data testing the null hypothesis is contained in Table 6 below:

Table 6: Summary of Chi-square analysis of differences in the technologies and services adopted in academic libraries in NCN before and after the COVID-19 pandemic.

Variable	Adopted O(E)	Not Adopted O(E)	Chi- Square value	Df	P- value	Decision
Technologies and Services Adopted before COVID-19	41(16.4)	26(50.6)	81.759 ^a	1	0.000	Significant
Technologies and Services Adopted after COVID-19	41(41)	101(76.4)				

P>0.05

The table above shows the calculated Chi-square values and the corresponding p-values of technologies and services adopted in academic libraries in NCN before and after the COVID-19 pandemic. The p-values are less than 0.05. This implies that there is a significant difference in the technologies and services adopted in academic libraries in NCN before and after the COVID-19 pandemic. The null hypothesis that there is no significant difference in the technologies and services adopted in academic libraries in NCN before and after the COVID-19 pandemic is therefore rejected.

Discussion

Results of findings in Table 1 indicate that circulation service, reference service, selective dissemination of information, computer, online database and open source repository are the technologies and services provided in university libraries in NCN before the COVID-19 pandemic. This finding aligns with those of Eze and Uzoigwe (2013) and Adebayo et al. (2018), who identified circulation service, serials service, reference service, user education, current awareness service, selective dissemination of information, compilation of reading lists, reprographic service, and computerized interactive search technologies and services provided in academic libraries. This finding implies that technology application in academic libraries in Nigeria is low.

Findings in Table 2 shows that the only service provided up to an acceptable degree in academic libraries in NCN as a panacea to the effects of COVID-19 and related pandemics is digital resources. This finding is not consistent with those of El-Kalash et al. (2022) which identified innovative technologies and services in libraries to include; OPAC and Web OPAC searching facilities, virtual reference service, current awareness service, robots, library mobile application, library bookmark application, virtual reality application, 3D technology, drones, and quick response services. The finding is also contrary to those of Omeluzor et al. (2020) which noted that Frequently Ask Questions (FAQ), Online Public Access Catalogue

(OPAC), Text Messaging, Ask a Librarian, blogging, and Social Media are innovative technologies and services in libraries, especially at the post-COVID-19 era. The adoption of only digital resources as the panacea for the effects of COVID-19 and related pandemics is extremely inadequate. Academic libraries cannot stand the test of pandemics without the deployment of adequate, innovative and cutting-edge technologies. By virtue of the environments and users of academic libraries, they tend to be more sophisticated than other libraries. It is expected that the other libraries should take a cue from them. However, they have not lived up to their expectations in the deployment of innovative technologies and services. Libraries must be ready for disaster of any kind; natural, human or health-related. It is in the deployment of innovative technologies and services that academic libraries would contain the disaster associated with pandemics.

The third research question was answered in table three. It shows that only digital resources is the innovative technology and service adopted to a large extent in academic libraries in NCN as a panacea to the effects of COVID-19 and related pandemics. This finding is consistent with those of Moustapha and Yusuf (2023), and Aminu (2024) whose findings showed a low level of adoption and utilization of innovative technologies, including AI tools in Nigerian academic libraries. However, the findings are opposed to those of Oduwole et al. (2023) which revealed a high level of adoption of innovative services among academic libraries in Nigeria.

Table 4 shows the analysis of data on research question four. Findings indicate that even though the extent of adoption of innovative technologies and services are poor in academic libraries in NCN, they have positive impact on researches of academics. Consequently, online database, subject gateway, Web OPAC, digital resources, social media technologies, block chain, Natural Language Processing, intelligent virtual assistant, and face recognition, and information alert service despite their low adoption have high level of effectiveness on research output of academics in NCN as a panacea to the effects of COVID-19 and related pandemics.

Findings on the fifth research question and shown on table 5 reveals the innovative technologies and services to be proposed for possible adoption by university libraries in NCN as a panacea to the effects of COVID19 and related pandemics. Results show that all 14 items were accepted for adoption in academic libraries. For example, adoption of artificial intelligence-related technologies and services such as blockchain, natural language processing, intelligent virtual assistant, face recognition, shelf-reading robots, information alert service, etc., were all accepted for possible adoption by academic libraries. These findings agree with

studies by Nwobu et al. (2024), Xiao and Gao (2020), Tella (2020), and Cox (2022). All the studies pointed out that AI-related technologies and services are critical for enhanced and personalised library services in the current information age.

Insight from the null hypothesis tested shows a significant difference between the innovative technologies and services adopted in academic libraries in NCN before and after the COVID-19 pandemic. This difference could be attributed to the variation in technologies and services provided for analysis. It is likely that if the same set of items were presented and analysed, the result would show no significant difference. This could be considered as a limitation of this study.

Recommendations

The following recommendations are made based on the findings and conclusion arrived at in the study:

1. Academic library managements should review their policies with the view to broaden their disaster management strategies, particularly with regards to COVID-19 and related pandemics.
2. Academic library managements in NCN, should, as a matter of deliberate policy address the poor adoption of innovative technologies and services which has revealed the weaknesses of the libraries to cater to the needs of researchers in periods of pandemics like the COVID-19.
3. Managements of tertiary academic institutions should equip their libraries to install and implement innovative technologies and services proposed in this research as a panacea to the effects of COVID-19 and related pandemics.

Conclusion

This study was critical by virtue of the perception of the library as an essential social infrastructure that should provide information services for researches, including those aimed at curbing the menace of pandemics. This expectation is particularly of academic libraries, given their relative sophistication, environments and functions. However, results in this study indicates that academic libraries despite their obvious inadequacies to meet up with essential information services at the period of the COVID-19 pandemic have not done much to improve on their services by leveraging innovative technologies and services as a panacea to the effects of COVID-19 and related pandemics. Though the findings in the study indicate a low extent of adoption of innovative technologies and services, it was also found that they still positively impacted the research output of academics. The rate of diffusion of innovation as propounded in Everret Rogers diffusion innovative theory is abysmally slow in

academic libraries in NCN. The same is the rate of growth of the libraries as a living organism according to Ranganathan's laws of library science. This research provides a framework for the adoption of innovative technologies and services as a panacea to the effects of COVID-19 and related pandemics.

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