Asian Journal of Information Science and Technology
ISSN: 2231-6108 (P); 3049-2661 (E)
Vol.15 No.1, 2025, pp.20-24

www.crijournals.org
DOI: https://doi.org/10.70112/ajist-2025.15.1.4307

Empirical Analysis of Barcode Technology: Utility and Advantages in Nigerian Academic Libraries

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(Received 20 November 2024; Revised 31 December 2024; Accepted 25 January 2025; Available online 6 February 2025)

***Abstract* - The study focused on barcode technology, its utility, and its advantages in libraries, providing an empirical analysis from a Nigerian academic library. The research was guided by four objectives and four research questions. A descriptive survey design was employed. The research population consisted of 11 librarians from the Dame Patience Jonathan Automated Library, Ignatius Ajuru University of Education, Port Harcourt. Given the small population size, all members were selected using a total enumeration sampling technique, resulting in a sample size of 11 librarians. Data were collected using a standardized questionnaire titled *Barcode Technology,* Utility, and Advantages in Libraries Questionnaire (BTUALQ). Means were used to analyze the research questions. The findings revealed that data migration issues, reliance on internet and electricity, setup costs, and a lack of technical expertise were among the technical, financial, and human resource challenges to successfully implementing barcode technology in libraries. The study recommended that Nigerian libraries ensure their staff receive adequate training and retraining to effectively adopt and operate technical tools-particularly barcode technology-to thrive in the current technological era.**
Keywords: **Barcode Technology, Academic Libraries, Nigeria, Implementation Challenges, Staff Training.**

I. INTRODUCTION

Libraries have undergone significant changes in recent years due to the explosive growth of ICT, rendering traditional distribution techniques obsolete. The automation of libraries in the current ICT era has increased the demand for better facilities for users. Library materials are increasingly transitioning from traditional print media to various technological formats. In this context, barcode technology plays a crucial role in automating library operations (Mehendale, 2018).

Barcode technology is an automatic data-gathering and identification method that represents information using a series of parallel lines or patterns with varying widths and spacing. It is commonly used for pricing, inventory control, product tracking, and other applications requiring precise and rapid identification. According to Akanbi *et al.,* (2018), the fundamental concept of barcode technology is to encode alphanumeric data into a machine-readable visual pattern, typically printed directly on items or labels. A barcode scanner or reader equipped with sensors and a light source is used to decode and analyze the data. Barcodes increase operational speed and accuracy by offering a simple and cost-effective method of encoding text data that can be read by affordable electronic readers. Fatima and Ansari (2017) described barcodes as a visual, machine-readable format representing data through a series of bars and spaces that devices can scan and interpret. Barcode technology has revolutionized library operations by enabling more effective collection management, streamlining processes, and improving patron services. Shahwar and Mehtab (2017) noted that barcode technology has enhanced the accuracy and efficiency of library services.

Libraries using barcode systems benefit from improved operational efficiency, better patron experiences, and accurate inventory management, enabling them to adapt to technological advancements and enhance services (Yuanshang *et al.,* 2019). Kolhe *et al.,* (2016) emphasized that barcode technology has transformed library management systems, while Chanda (2019) highlighted several specific applications of barcode technology in libraries:

1. *Accessioning:* Newly acquired books are assigned accession numbers encoded as barcodes, which facilitate easy retrieval of bibliographic details such as title, author, and subject.
2. *Membership identification:* Barcodes on library membership cards enable librarians to quickly verify a user's membership status, with scanned data retrieved via library management software.
3. *Circulation:* Barcodes streamline the issuance and return of library materials by replacing manual entries with accurate scanned data.
4. *Library attendance systems:* Barcodes on membership cards can record patrons' arrival and departure times when scanned at entry points.
5. *Inventory and periodical control:* Barcodes encode detailed information about periodicals and journals, aiding in efficient management.
6. *Stock verification:* Barcode systems simplify stock verification by allowing staff to scan book barcodes and generate lists of missing items.

Barcoding is an identification technique that supports complex management systems by providing accurate data rapidly (Mehendale, 2018). Its implementation enhances efficiency, reduces operational costs, and promotes accuracy in library workflows. According to Echem et al. (2024), barcoding reduces errors, boosts productivity at circulation desks, and saves staff time. Islam and Shuva (2013) further noted that barcodes improve performance and efficiency in library operations compared to manual systems.

Benefits of barcode technology in libraries include:

1. Improving data entry accuracy
2. Enhancing service quality and staff efficiency
3. Boosting patron satisfaction and the library's reputation
4. Providing reliable data for management information systems
5. Enabling real-time data collection
6. Saving time and reducing human error in circulation processes

Barcode technology, combined with computer applications and library software, has become indispensable for modern libraries, streamlining operations and enabling more advanced service delivery.

II. RESEARCH PROBLEM

The goal of implementing barcode technology in today's libraries and information centers is to enhance operations by improving transaction efficiency, reducing staff workload, and enhancing user services. Barcode-derived data are precise and quickly accessible, supporting improved decision-making while minimizing the likelihood of human error. Additionally, barcodes are inexpensive to design and print.

Although barcodes offer numerous advantages, their presence alone does not guarantee effective and efficient service delivery. For optimal results, barcode systems must be properly implemented and actively maintained.

Therefore, this study aims to examine barcode technology, its benefits, and its applications in libraries through an empirical investigation conducted in an academic library in Nigeria.

III. OBJECTIVES OF THE STUDY

1. To explore the specific functions of barcode technology in library processes.
2. To identify the advantages of barcode technology in enhancing library workflows.
3. To examine the impact of barcode technology on the efficiency of library services.
4. To investigate the technical, financial, and human resource barriers to the effective utilization of barcode technology in libraries.

IV. RESEARCH QUESTIONS

1. What are the specific functions of barcode technology in library processes?
2. What are the advantages of barcode technology in enhancing library workflows?
3. What is the impact of barcode technology on the efficiency of library services?
4. What are the technical, financial, and human resource barriers to the effective utilization of barcode technology in libraries?

V. METHODOLOGY

A descriptive survey design was used in the study. The study population comprised 11 librarians from the Dame Patience Jonathan Automated Library, Ignatius Ajuru University of Education, Port Harcourt. Personnel data from 2024 confirmed that the library had 11 librarians at the time of the research. A total enumeration sampling technique was employed to include the entire population, given its small size, resulting in a sample size of 11 librarians.

Data were collected using a standardized instrument titled *Barcode Technology, Utility, and Advantages in Libraries Questionnaire* (BTUALQ). All 11 copies of the questionnaire distributed to the librarians were returned, yielding a 100% response rate. The research questions were analyzed using mean scores. Items with a criterion mean below 2.50 were excluded, while those with a criterion mean of 2.50 or higher were accepted.

VI. RESULTS AND DISCUSSION

TABLE I THE RESPONDENTS' BIO-DATA

Variables	Frequency	Percentage (%)
Sex		
Male	4	36
Female	7	64
Age		
20-30	1	9
31-50	2	18
51 and above	8	73
Program		
BLS	3	28
MLS	4	36
Ph.D.	4	36

According to Table I, four respondents (36%) were men, while seven respondents (64%) were women, indicating that the majority of respondents were women. Additionally, the results showed that eight respondents (73%) were aged 51 years or older, two respondents (18%) were between the ages of 31 and 50, and one respondent (9%) was between

the ages of 20 and 30. This suggests that most respondents were aged 51 years or older.

Furthermore, the respondents' educational qualifications revealed that three respondents (28%) held a bachelor's degree in library science, four respondents (36%) had a master's degree, and four respondents (36%) had a doctorate in library science.

TABLE II MEAN SCORES OF SPECIFIC FUNCTIONS OF BARCODE TECHNOLOGY IN LIBRARY PROCESSES

Sl. No.	Item	$\bar{x}$	Remark
1	Resource check-out	2.96	Agree
2	Inventory management	2.78	Agree
3	Patron identification	2.76	Agree
4	Security and anti-theft	2.87	Agree
5	Resource tracking	2.51	Agree
6	Collection management	2.93	Agree
7	Patron registration	2.71	Agree
8	Resource verification	2.54	Agree
	Grand Mean ($\bar{x}$)	2.71	Agree

Table II illustrates the specific functions of barcode technology in library processes. The respondents identified these functions as follows: resource check-out (M = 2.96), inventory management (M = 2.78), patron identification (M = 2.76), security and anti-theft (M = 2.87), resource tracking (M = 2.51), collection management (M = 2.93), patron registration (M = 2.71), and resource verification (M = 2.54).

These findings suggest that the specific functions of barcode technology in library processes include resource check-out, inventory management, patron identification, security and anti-theft, resource tracking, collection management, patron registration, and resource verification.

The findings of the current study align with those of Islam and Shuva (2013), who confirmed that barcodes are used for patron identification, resource tracking, and patron registration. Similarly, Patel (2016) noted that barcodes enhance the speed and accuracy of check-out procedures. Patrons can present their barcoded library cards, which are scanned along with the barcode of the item being checked out, ensuring effective transaction recording.

Rahaman (2016) further emphasized that barcodes facilitate efficient check-in and return procedures, enabling library staff to promptly update the catalog with the status of returned items and reshelve them. Barcodes are closely associated with library material cataloging records, as these unique identifiers support inventory management, item tracking, and status updates.

TABLE III MEAN SCORES OF THE ADVANTAGES OF BARCODE TECHNOLOGY IN ENHANCING LIBRARY WORKFLOW

Sl. No.	Item	$\bar{x}$	Remark
1	It encodes a significant amount of information in a relatively small space	2.67	Agree
2	It enables automation of various library house-keeping processes	2.98	Agree
3	Minimizes human errors	2.65	Agree
4	Streamline data entry and retrieval processes	2.53	Agree
5	Accurate data recording and information storage	2.61	Agree
	Grand Mean ($\bar{x}$)	2.69	Agree

Table III highlights the advantages of barcode technology in enhancing library workflow. The respondents identified these advantages as follows: it encodes a significant amount of information in a relatively small space (M = 2.67), enables the automation of various library housekeeping processes (M = 2.98), minimizes human errors (M = 2.65), streamlines data entry and retrieval processes (M = 2.53), and facilitates accurate data recording and information storage (M = 2.61).

These findings suggest that the advantages of barcode technology in enhancing library workflow include:

1. Encoding a significant amount of information in a relatively small space.
2. Enabling the automation of various library housekeeping processes.
3. Minimizing human errors.
4. Streamlining data entry and retrieval processes.
5. Ensuring accurate data recording and information storage.

The findings of this study align with Mehendale's (2018) assertion that barcodes facilitate data entry, promote the automation of many library housekeeping procedures, and store a substantial amount of information in a compact space.

Similarly, Singh and Sharma (2016) noted that barcodes enable libraries to automate processes such as inventory control and resource tracking. They further emphasized that barcodes ensure consistency in data entry and significantly reduce the likelihood of human errors.

Table IV illustrates the impact of barcode technology on the efficiency of library services. The respondents identified the following impacts: faster circulation processes (M = 2.93), real-time tracking of resources (M = 2.73), reduction in

staff workload (M = 2.82), enhanced user experience (M = 2.62), and integration with digital systems (M = 2.98). These findings suggest that barcode technology improves the efficiency of library services by:

1. Facilitating faster circulation processes.
2. Enabling real-time tracking of resources.
3. Reducing staff workload.
4. Enhancing the user experience.
5. Supporting integration with digital systems.

TABLE IV MEAN SCORES OF THE IMPACT OF BARCODE TECHNOLOGY ON THE EFFICIENCY OF LIBRARY SERVICES

Sl. No.	Item	$\bar{x}$	Remark
1	Faster Circulation Processes	2.93	Agree
2	Real-Time Tracking of Resources	2.73	Agree
3	Reduction in Staff Workload	2.82	Agree
4	Enhanced User Experience	2.62	Agree
5	Integration with Digital Systems	2.98	Agree
	Grand Mean ($\bar{x}$)	2.81	Agree

The results of this study align with the findings of Singh and Sharma (2016), who reported that barcode systems allow for quicker circulation operations. Real-time tracking of library resources ensures accurate inventory management and reduces the number of lost items. Ansari (2017) further highlighted that barcode technology reduces staff workload, allowing librarians to focus on specialized tasks such as collection development and user support. Additionally, the technology enhances the user experience by providing smoother access to resources and faster service.

TABLE V MEAN SCORES OF THE TECHNICAL, FINANCIAL AND HUMAN RESOURCE BARRIERS TO THE EFFECTIVE UTILIZATION OF BARCODE TECHNOLOGY IN THE LIBRARY

Sl. No.	Item	$\bar{x}$	Remark
1	Data Migration Issues	2.93	Agree
2	Internet and Power Dependence	2.73	Agree
3	Security and Privacy concern	2.42	Disagree
4	Setup Costs	2.62	Agree
5	Poor User Education	2.21	Disagree
6	Poor Technical Expertise	2.81	Agree
	Grand Mean ($\bar{x}$)	2.62	Agree

Table V outlines the technical, financial, and human resource barriers to the effective utilization of barcode technology in the library. The respondents identified the following barriers: data migration issues (M = 2.93), dependence on internet and power (M = 2.73), setup costs (M = 2.62), and limited technical expertise (M = 2.81). These findings indicate that the primary barriers to the effective use of barcode technology in libraries include:

1. Data migration issues.
2. Dependence on internet and power.
3. Setup costs.
4. Limited technical expertise.

The results of this study are consistent with the findings of Fatima and Ansari (2017), who identified setup costs and lack of awareness as significant challenges in implementing barcode technology in libraries. They also noted that users sometimes fail to scan items properly due to insufficient awareness. Similarly, Islam and Shuva (2010) highlighted data migration concerns, power outages, and financial constraints as critical technical and human resource barriers to the effective utilization of barcode technology in libraries.

VII. CONCLUSION AND RECOMMENDATIONS

This paper examined barcode technology, its utility, and its advantages in libraries, presenting an empirical analysis from a Nigerian academic library. It concludes by emphasizing how barcode technology has revolutionized operational efficiency and service delivery in libraries. The findings demonstrate its usefulness in streamlining resource management, reducing staff workloads, and enhancing user experiences by enabling faster and more accurate procedures. Barcode technology has proven to be an essential tool for modernizing library operations in an increasingly digital environment by supporting real-time tracking and integration with digital systems. The benefits identified in this empirical investigation highlight its potential to address persistent challenges in academic libraries, paving the way for improved resource management and accessibility. As Nigerian libraries continue to evolve, the adoption and optimization of barcode technology will remain crucial in meeting the needs of modern library patrons. Based on the study's conclusions, the following recommendations are proposed:

1. Nigerian libraries should ensure that their staff receive adequate training and retraining to effectively implement and manage technological tools-particularly barcode technology-to remain relevant in this digital age.
2. Library management should address power supply challenges by providing reliable power sources and related infrastructure, as functional library services depend on the availability of essential infrastructure.
3. Nigerian academic libraries should be sufficiently funded to undertake projects and initiatives aimed at improving their services.

Declaration of Conflicting Interests
The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding
The authors received no financial support for the research, authorship, and/or publication of this article.

Use of Artificial Intelligence (AI)-Assisted Technology for Manuscript Preparation
The authors confirm that no AI-assisted technologies were used in the preparation or writing of the manuscript, and no images were altered using AI.

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