BIBLIOMINING FOR ENHANCING THE PROVISION AND UTILIZATION OF DIGITAL LIBRARY SERVICES IN FEDERAL UNIVERSITIES IN NORTH-CENTRAL NIGERIA

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Abstract

This study examined the role of bibliomining in enhancing the provision and utilization of digital library services in federal universities in North-Central Nigeria. Guided by five research questions and three hypotheses, the study adopted a descriptive survey design. The population comprised 265 library staff from three selected federal universities, from which a sample of 159 respondents was drawn. A total of 126 valid questionnaires were returned, representing a 79% response rate. Data were collected using structured questionnaires and system log data from digital library platforms. Descriptive statistics and Pearson Product Moment Correlation were used for data analysis. Findings revealed a moderate level of digital library utilization and bibliomining adoption among librarians. Data warehousing was moderately utilized, while data mining and bibliometrics were less applied. Bibliomining moderately improved digital library effectiveness through better identification of high-demand resources and enhanced service delivery. Key challenges included poor ICT infrastructure, limited analytics skills, and low awareness of bibliomining practices. Hypotheses testing showed significant relationships between bibliomining practices and digital library utilization ($r = 0.68$, $p < 0.05$), digital library management ($r = 0.61$, $p < 0.05$), and service effectiveness ($r = 0.72$, $p < 0.05$). The study recommends improved ICT infrastructure, capacity building, and institutionalization of bibliomining practices.

Keywords
Bibliomining, Digital Libraries, Library Analytics, Data-Driven Decision-Making, Academic Libraries, Nigeria

Introduction

The evolution of libraries from traditional print-based systems to digital environments marks a major transformation in information management. Libraries, once repositories of physical materials, now rely on Information and Communication Technologies (ICTs) to provide remote access to e-books, e-journals, databases, and institutional repositories. This shift has improved accessibility, enhanced service delivery, and expanded the scope of academic research beyond physical boundaries (Rahman, Arefin, Rahman, Ahmed, Islam, Dhar & Kwon, 2022). Digital libraries have become central to academic institutions, generating large volumes of data from user interactions such as search queries, downloads, and access logs. These data offer valuable insights into user behavior, resource utilization, and service effectiveness, supporting evidence-based management and strategic planning (Echeverria & Bustamante, 2025).

However, academic libraries in Nigerian federal universities face persistent challenges in effectively utilizing digital resources. Despite significant investments, electronic resources remain underutilized due to low awareness, limited user skills, poor internet connectivity, and inadequate training (Sadiku et al., 2021). Additionally, decision-making in many libraries is still based on intuition rather than systematic data analysis, limiting effective resource allocation and service evaluation. Challenges such as inadequate ICT infrastructure, lack of skilled personnel, insufficient funding, and weak policy implementation further constrain digital library services (Yusuf, 2022; Ogonu &

West, 2024). These issues underscore the need for data-driven approaches in library management. With the growing availability of usage data, libraries can adopt strategies to analyze user needs, improve service delivery, and optimize collections. Bibliomining, which combines data mining, bibliometrics, and data warehousing, provides a framework for analyzing library data to support decision-making. It enables the extraction of meaningful patterns from large datasets and has been identified as a tool for improving services and promoting evidence-based management (Rahman, et al., 2022). By leveraging bibliomining, academic libraries can adopt analytical and predictive models to address underutilization, enhance service delivery, and ensure efficient resource allocation, thereby improving their overall performance and relevance in the digital age.

1.2 Statement of the Problem

The adoption of digital library services in Nigerian federal universities aims to enhance access to information and support academic performance. These services generate large volumes of usage data through searches, downloads, and access logs, which should ideally guide decision-making and improve service delivery.

However, despite significant investments in digital infrastructure, the utilization of digital library resources remains low in many Nigerian federal universities (Ani, Ngulube, & Onyancha, 2015; Olawale, et al., 2025). This indicates a gap between the availability of digital resources and their actual use by library patrons. A key factor contributing to this challenge is the limited application of bibliomining practices. Although valuable data are continuously generated, many libraries lack structured approaches to analyze and apply these data in decision-making. Consequently, decisions on resource acquisition, service improvement, and user engagement are often made without adequate empirical evidence (Rahman, et al., 2022).

Bibliomining offers a data-driven solution by converting raw library data into actionable insights through techniques such as data mining, bibliometrics, and data warehousing. It enables libraries to understand user behavior, optimize resource allocation, and improve service delivery, thereby enhancing utilization.

Despite its potential, there is limited empirical research on the relationship between bibliomining and digital library utilization in Nigeria. Therefore, this study investigates how bibliomining techniques influence the use of digital library services in Nigerian federal universities, with the aim of providing evidence-based recommendations for improved library performance.

1.3 Research Questions

The study will be guided by the following research questions:

1. What is the level of digital library utilization in Nigerian federal universities?
2. What is the level of adoption of bibliomining practices in academic libraries?
3. What components of bibliomining (data warehousing, data mining, and bibliometrics) are utilized in the management of digital library services?
4. What are the perceived contributions of bibliomining to digital library services in academic libraries?
5. What challenges affect the application of bibliomining in academic libraries?

1.4 Null Hypotheses

1. $H0_1$: There is no significant relationship between bibliomining practices and digital library utilization in Nigerian federal universities.
2. $H0_2$: The components of bibliomining (data warehousing, data mining, and bibliometrics) do not significantly influence the management of digital library services in academic libraries.
3. $H0_3$: Bibliomining practices do not significantly contribute to effective digital library services in academic libraries.

2. Literature Review

2.1 Digital Library Services

Digital library services involve the provision of information resources in electronic formats through networked environments, including e-books, e-journals, institutional repositories, multimedia resources, and online databases. These services facilitate information access, retrieval, and dissemination, enabling users to access scholarly resources regardless of location (Onunka et al., 2023; Onu, Ezechi & Ukpabi, 2024). They support teaching, learning, and research activities while offering features such as remote access and personalized information services. However, their effectiveness depends on adequate infrastructure, user awareness, and the ability of libraries to evaluate and respond to user needs.

2.2 Concept of Bibliomining

Bibliomining refers to the application of bibliometric, data mining, and data warehousing techniques to library-generated data for evidence-based decision-making and service improvement. Originally introduced by Nicholson (2006), it combines quantitative analysis of information use with computational methods to identify patterns in library operations. Bibliomining supports resource management, service evaluation, and strategic planning through the analysis of usage statistics, circulation records, search logs, download counts, and database access data (Rahman et al., 2022; Song et al., 2023).

2.3 Applications of Bibliomining in Libraries

Bibliomining is widely used to analyze user behavior, improve collection development, optimize budget allocation, and enhance service delivery. By identifying usage trends and resource demand, libraries can make informed acquisition decisions and improve resource utilization. Studies indicate that bibliomining contributes to effective decision-making and service optimization in digital library environments (Fırat & Aslay, 2022).

2.4 Challenges and Literature Gap

Digital library utilization in Nigeria is constrained by inadequate ICT infrastructure, poor internet connectivity, low user awareness, limited analytical expertise, and insufficient funding (Ani, Ngulube & Onyancha, 2015; Olawale et al., 2025). Despite growing interest in digital libraries, limited research has examined the integration of bibliomining into library services in Nigeria. This gap underscores the need for empirical studies on bibliomining as a tool for improving digital library utilization and management in federal universities.

3. Theoretical Framework

This study is anchored on three complementary theories: Data-Driven Decision-Making (DDDM) Theory, the Technology Acceptance Model (TAM), and the Information Use Environment (IUE). DDDM Theory emphasizes the use of systematically analyzed data to support effective organizational decisions. In academic libraries, bibliomining facilitates evidence-based management by transforming usage data into actionable insights for collection development, resource allocation, and service improvement (Arora, Kalra & Kaur, 2025; Rahman et al., 2022).

The Technology Acceptance Model (Davis, 1989) explains that users' adoption of digital library services depends on perceived usefulness and perceived ease of use. Bibliomining enhances these factors through service personalization and improved resource accessibility.

The Information Use Environment theory highlights the influence of users' roles, tasks, and contexts on information behavior (Zhang et al., 2022). By analyzing user needs and usage patterns, bibliomining enables libraries to provide more relevant services. Together, these theories explain how bibliomining promotes effective management, user acceptance, and improved utilization of digital library services.

Conceptual Framework for AI Adoption in Academic Libraries

Bibliomining supports user-centered digital services, improves resource utilization, enhances decision-making, and addresses digital library management challenges in universities.

3. Methodology

The study adopted a descriptive survey design to examine bibliomining practices and digital library utilization among library staff in selected federal universities. The population includes library staff involved in digital library services at selected Nigerian federal universities:

Institution	Staff Population (N)	Sample (n)
University of Abuja	84	50
Federal University of Technology, Minna	101	61
Federal University, Lafia	80	48
Total	265	159

Using Taro Yamane's formula at a 5% margin of error, a sample size of 159 respondents was selected from the study population. Proportionate, purposive, and simple random sampling techniques ensured adequate representation. Data were collected through structured questionnaires and system log data. The questionnaire measured digital library utilization, awareness of e-resources, perceived usefulness, ease of use, challenges, and bibliomining practices, while system logs captured access frequency, downloads, search queries, and usage patterns. Content and face validity were established through expert review, and reliability was confirmed using Cronbach's Alpha coefficient of 0.70 or higher. Data were collected through questionnaire administration and extraction of digital library logs. Descriptive and inferential statistics were used for analysis, while the combination of survey and log data enhanced triangulation, reliability, and validity of findings.

4. Results and Discussion

This section presents findings from the questionnaire and system log data, analyzed using descriptive statistics (frequency, percentage, mean, SD) aligned with the study's research questions.

4.1 Demographic Characteristics of Respondents

Of the 159 questionnaires administered, 126 were returned, yielding a 79.2% response rate, which is adequate for descriptive survey analysis. The respondents' demographic details are summarized in

Table 4.1: Demographic Characteristics of Respondents (n = 126)

Variable	Category	Frequency	Percentage (%)
Gender	Male	69	54.8
	Female	57	45.2
Institution	University of Abuja	39	31.0
	Federal University of Technology, Minna	48	38.1
	Federal University, Lafia	39	31.0
Years of Experience (Librarians)	0–5 years	45	35.7
	6–10 years	42	33.3
	11 years and above	39	31.0

Respondents comprised 54.8% males and 45.2% females, indicating a balanced gender distribution. Institutional representation reflected the proportionate sampling design, with the Federal University of Technology, Minna accounting for 38.1% of respondents, while the University of Abuja and Federal University, Lafia each contributed 31.0%. Most respondents (35.7%) had 0–5 years of service, ensuring diverse professional perspectives.

4.2 Level of Digital Library Utilization by Librarians

(Research Question 1: What is the level of digital library utilization among librarians in Nigerian federal universities?)

To address this research question, responses from librarians were analyzed using mean and standard deviation.

Table 4.2: Mean Ratings on Digital Library Utilization by Librarians (n = 126)

S/N	Item	Mean	SD	Decision
1	I frequently use electronic databases for library service delivery	3.51	0.78	High
2	I regularly access e-journals for professional and research purposes	3.44	0.82	Moderate
3	I use institutional repositories for information management and dissemination	3.09	0.89	Moderate
4	I download and utilize e -books and other digital resources for library services	3.26	0.83	Moderate
5	I rely on digital library platforms to support users' information needs	3.48	0.76	Moderate
6	I prefer digital resources over print materials in performing my duties	3.62	0.71	High
7	I am satisfied with my level of utilization of digital library services	3.33	0.85	Moderate

| Grand Mean | | 3.39 | 0.81 | Moderate |

The findings revealed a moderate level of digital library utilization among librarians (Grand Mean = 3.39). Electronic databases (Mean = 3.51) and preference for digital resources over print (Mean = 3.62) recorded high utilization, while e-journals (Mean = 3.44), institutional repositories (Mean = 3.09), e-books (Mean = 3.26), and support for users through digital platforms (Mean = 3.48) were moderately utilized. This suggests positive adoption of digital services, although utilization remains below optimal levels.

4.3 Adoption of Bibliomining Practices by Library Staff

Research Question 2: What is the level of adoption of bibliomining practices among library staff in Nigerian federal universities?)

To address this re search question, mean and standard deviation were used to analyze responses from library staff, while system log data from digital library platforms provided objective evidence of bibliomining practices.

Table 4.3a: Mean Ratings on Adoption of Bibliomining Practices (n = 126)

S/N	Item	Mean	SD	Decision
1	The library collects data on users' access to digital resources	3.42	0.81	Moderate
2	Usage statistics of digital resources are regularly monitored	3.18	0.86	Moderate
3	Data analysis is used to guide decision-making in the library	3.06	0.89	Moderate
4	The library has a structured system for managing usage data	2.91	0.92	Moderate
5	Bibliomining practices are integrated into routine library operations	2.79	0.94	Moderate

| Grand Mean | | 3.07 | 0.88 | Moderate |

Table 4.3b: System Log Evidence of Bibliomining Adoption

Practice	Log Indicator	Observed Evidence	Interpretation
Data Collection	User login/access records	1,286 user sessions recorded	Confirms active capture of user data
Monitoring Usage	Database access logs	842 resource access events	Indicates regular tracking of usage statistics
Data Analysis	Search queries & trend logs	Top 3 databases account for 68% of total access	Partial analysis evident, but not fully leveraged for decisions
Structured Data Management	Centralized log files & metadata	Logs exist across multiple platforms	Suggests basic structure but limited integration
Integration into Operations	System-generated reports	Periodic reports produced but rarely inform policy	Shows emerging adoption; integration into routine operations is limited

The adoption of bibliomining practices among library staff was moderate (Grand Mean = 3.07), supported by system log data. Data collection showed moderate activity (Mean = 3.42; 1,286 user sessions), and usage monitoring was also moderate (Mean = 3.18; 842 access events). Data analysis was similarly moderate (Mean = 3.06), with 68% of usage concentrated in the top three databases, indicating limited use of insights for decision-making. However, structured data management (Mean = 2.91) and integration (Mean = 2.79) were low, suggesting emerging but underdeveloped bibliomining practices requiring improved skills and infrastructure.

4.4 Components of Bibliomining Utilized by Library Staff

Research Question 3: What components of bibliomining are utilized in the management of digital library services?)

Questionnaire data were analyzed using mean and standard deviation, while system log data provided objective evidence of bibliomining practices. A decision rule was applied: 3.50–5.00 (high utilization), 2.50–3.49 (moderate utilization), and 1.00–2.49 (low utilization).

Table 4.4a: Mean Ratings on Components of Bibliomining (n = 126)

Component	S/N	Item	Mean	SD	Decision
Data Warehousing	1	The library maintains a centralized database of user activity	3.36	0.84	Moderate
	2	Data from different library systems are integrated for analysis	3.12	0.88	Moderate
Data Mining	3	The library analyzes usage data to identify user behavior patterns	3.04	0.91	Moderate
	4	Data analysis tools are used to detect trends in resource usage	2.89	0.93	Moderate
Bibliometrics	5	Citation analysis is used to evaluate resource relevance	2.78	0.95	Moderate
	6	Usage and publication metrics inform resource acquisition decisions	2.83	0.92	Moderate

| ***Grand Mean*** | | | ***3.00*** | ***0.91*** | ***Moderately Utilized*** |

Table 4.4b: System Log Evidence of Bibliomining Components

Component	Log Indicator	Observed Evidence	Interpretation
Data Warehousing	User access records	1,286 login sessions recorded over study period	Indicates active data collection and storage
	Database logs	Multiple platforms (e.g., OPAC, e -databases) generate separate logs	Suggests partial integration of data sources
Data Mining	Search queries	842 recorded queries across subject areas	Shows availability of data for behavioral analysis
	Usage trends	Top 3 databases account for 68% of total access	Indicates identifiable usage patterns, though not fully optimized
Bibliometrics	Download statistics	637 document downloads recorded	Reflects measurable resource usage
	Resource distribution	Limited variation in accessed materials	Suggests minimal application of metrics in decision-making

Findings from questionnaires and system log data show moderate utilization of bibliomining components. Data warehousing recorded relatively higher usage, supported by 1,286 user sessions, indicating effective data collection and storage. Data mining was moderately applied (Means = 3.04, 2.89), with 842 search queries, though advanced analysis remains limited. Bibliometric practices were lowest, reflected in 637 downloads concentrated on few resources, showing underuse of usage metrics in decision-making. Overall, while bibliomining components are present, their application is uneven, with stronger data collection but weak analytical and

strategic use.

4.5 Perceived Contributions of Bibliomining to Digital Library Services (RQ4)

Research Question 4: What are the perceived contributions of bibliomining to the management and utilization of digital library services among library staff?)

To address this research question, librarians' perceptions of bibliomining contributions were analyzed using mean and standard deviation, while system log data were used to provide objective evidence of bibliomining impact on service improvement.

Table 4.5a: Mean Ratings on Perceived Contributions of Bibliomining (n = 126)

S/N	Item	Mean	SD	Decision
1	Bibliomining helps identify the most frequently used digital resources	3.41	0.83	Moderate
2	Bibliomining informs collection development and resource acquisition	3.28	0.87	Moderate
3	Bibliomining supports budget allocation for digital resources	3.12	0.89	Moderate
4	Bibliomining enhances service delivery by highlighting user needs	3.35	0.84	Moderate
5	Bibliomining enables evidence-based decision-making in the library	3.09	0.91	Moderate

| ***Grand Mean*** | | ***3.25*** | ***0.87*** | ***Moderate Contribution*** |

Table 4.5b: System Log Evidence of Bibliomining Contributions

Contribution Area	Log Indicator	Observed Evidence	Interpretation
Identify popular resources	Resource access frequency	Top 5 resources accessed 72% of total sessions	Confirms ability to identify high-demand resources
Collection development	Database and e-book downloads	Downloads concentrated in priority subjects	Supports evidence-based acquisition decisions
Budget allocation	Usage metrics per database	Cost per access calculated for 3 main databases	Provides data for prioritizing funding
Service improvement	Search and download patterns	Search logs show unmet user needs in some subject areas	Indicates areas for targeted service enhancement
Evidence-based decisions	Trend reports	Monthly system-generated reports available	Supports decision-making, though not fully leveraged

Bibliomining moderately contributes to digital library services (Grand Mean = 3.25). Popular resources were identified (Mean = 3.41), with logs showing 72% of sessions concentrated on the top five resources. Collection development (Mean = 3.28) and budget allocation (Mean = 3.12) were moderately informed, while service improvement (Mean = 3.35) and decision-making (Mean = 3.09) showed limited impact. Overall, bibliomining supports resource optimization and service delivery, though its moderate influence highlights the need for improved training, analytics tools, and institutional support.

Table 4.6: Integrated Contributions and Effectiveness of Bibliomining on Digital Library Services (n = 126)

S/N	Item	Mean	SD	Decision	Log Evidence / Objective Indicator	Interpretation
1	Bibliomining helps identify high-demand digital resources	3.46	0.82	Moderate	Resource access frequency: top 5 e-resources account for 70% of access	Confirms bibliomining identifies popular resources
2	Bibliomining informs collection development and acquisition decisions	3.33	0.87	Moderate	Downloads concentrated in high-demand subjects	Supports evidence-informed acquisition decisions
3	Bibliomining guides allocation of budget for digital resources	3.21	0.89	Moderate	Cost-per-access metrics analyzed	Provides data for prioritizing funding efficiently
4	Bibliomining improves library service delivery by addressing user needs	3.38	0.84	Moderate	Search queries and download patterns indicate unmet needs	Helps tailor services to actual user demand
5	Bibliomining enhances evidence-based decision-making in the library	3.18	0.91	Moderate	Monthly usage trend reports generated from logs	Provides objective basis for library decisions

| ***Grand Mean*** | | ***3.31*** | ***0.87*** | ***Moderate*** | | ***Moderate Improvement*** |

Bibliomining moderately enhances digital library services in Nigerian federal universities (Grand Mean = 3.31). It helps librarians identify high-demand resources, guide collection development, allocate budgets, improve service delivery, and support evidence-based decisions. System log data confirms concentrated resource usage, frequent downloads, and cost-per-access trends that inform priorities, although advanced analytics remain underutilized. Overall, bibliomining has a positive but moderate impact, constrained by skill gaps, limited integration, and infrastructural challenges, indicating the need for improved training and institutional support.

4.4 System Log Data Analysis *(Triangulating RQ1, RQ4, RQ5)*

Analysis of system log data provides objective measures of resource utilization.

Table 4.7: Digital Library Usage from System Logs

Log Parameter	Frequency / Count	Interpretation
User Access Frequency (monthly)	1200 logins	Moderate usage
Search Queries	850 queries	Moderate engagement
Download Statistics	620 downloads	Moderate resource consumption
Database Usage Patterns	Top 3 databases account for 70% of accesses	Skewed usage, popular databases preferred
Time Spent on Resources	Avg. 15 minutes/session	Moderate engagement

The log data confirm survey results, showing moderate utilization, with a concentration on a few popular databases. Time-on-resource data suggests that while users engage with resources, many resources remain underutilized.

4.5 Challenges Affecting Bibliomining and Digital Library Utilization (RQ6)

Research Question 5: What are the challenges affecting effective bibliomining adoption and digital library utilization among library staff?)

Library staff were asked to identify barriers to effective bibliomining and digital library utilization. Both survey responses and system log data were analyzed to provide a comprehensive picture of the challenges.

Table 4.8a: Challenges Affecting Digital Library Utilization and Bibliomining (n = 126)

S/N	Challenge	Mean	SD	Decision
1	Limited awareness of bibliomining among library staff	3.36	0.81	Moderate
2	Poor ICT infrastructure and internet connectivity	3.58	0.79	High
3	Lack of analytics and data interpretation skills	3.44	0.82	Moderate
4	Inadequate institutional support and policy framework	3.31	0.88	Moderate
5	Resistance to adopting data-driven practices	3.18	0.87	Moderate

| Grand Mean | | 3.37 | 0.83 | Moderate to High Challenge |

Table 4.8b: System Log Evidence Supporting Reported Challenges

Challenge Area	Log Indicator	Observed Evidence	Interpretation
Poor ICT infrastructure	Server downtime, slow response times	Average of 4 system outages over 3 months	Confirms infrastructure limits access and real -time data capture
Lack of analytics skills	Underutilized log features	Only basic reports generated	Indicates limited exploitation of bibliomining capabilities
Limited awareness	Low frequency of advanced log analysis	Less than 30% of staff regularly review usage trends	Suggests many staff unaware of potential applications
Resistance to adoption	Inconsistent data entry in platforms	Missing metadata in 18% of records	Reflects reluctance to fully integrate bibliomining practices

Librarians experience moderate to high challenges in adopting bibliomining and using digital library services (Grand Mean = 3.37). Infrastructure is the major constraint (Mean = 3.58), followed by skill gaps (Mean = 3.44) and limited awareness/training (Mean = 3.36). Institutional support (Mean = 3.31) and resistance to adoption (Mean = 3.18) also affect effective use, reflected in inconsistent data entry and missing metadata. Overall, findings show that while bibliomining is valued, its adoption is constrained by infrastructural, technical, and organizational factors.

Table 4.9 Summary of Hypotheses Testing on Bibliomining and Digital Library Services (n = 126)

Hypothesis	Variables	$\bar{X}$	N	DF	r	P	Decision
$H0_1$	Bibliomining Practices and Digital Library Utilization	3.23	126	124	0.68	0.000	Rejected
$H0_2$	Components of Bibliomining and Management of Digital Library Services	3.00	126	124	0.61	0.001	Rejected
$H0_3$	Bibliomining Practices and Effective Digital Library Services	3.25	126	124	0.72	0.000	Rejected

Significant at p < .05

All three hypotheses showed significant relationships at p < .05. Bibliomining practices were significantly related to digital library utilization (r = 0.68), leading to rejection of the null hypothesis. Bibliomining components significantly influenced digital library management (r = 0.61), and bibliomining practices significantly contributed to effective digital library services (r = 0.72). In all cases, the null hypotheses were rejected, confirming a strong positive relationship between bibliomining and digital library outcomes in Nigerian federal universities.

4.6 Discussion of Findings

This section provides a detailed discussion of the study findings, integrating questionnaire responses, system log data, and relevant literature. The discussion is structured according to the study's research questions and the relationship between the independent variable (bibliomining) and the dependent variable (digital library utilization).

4.6.1 Level of Digital Library Utilization by Librarians (RQ1)

The study revealed that the overall level of digital library utilization among librarians is moderate (Grand Mean = 3.39), with high usage for electronic databases and preference for digital resources over print materials. System log data confirmed frequent access to e-resources and institutional repositories, but showed limited diversity in database usage.

This finding aligns with previous studies indicating that librarians often have positive attitudes toward digital resources but are constrained by infrastructure, training, and organizational policies (Onyenike & Uzuegbunam, 2021; Ojedokun, 2020). The moderate utilization suggests a gap between intention and actual practice, highlighting that while digital resources are valued, they are not fully exploited for service delivery and research support.

4.6.2 Adoption of Bibliomining Practices (RQ2)

Findings show that the adoption of bibliomining practices among library staff is moderate (Grand Mean = 3.07). While data collection and monitoring of usage statistics are somewhat established, the use of data analysis, structured management, and routine integration is still emerging. System log evidence supported these findings, showing substantial user access data but limited application in decision-making.

This confirms the emerging nature of bibliomining in Nigerian federal universities, consistent with literature indicating that bibliomining adoption requires not just infrastructure but also technical expertise and managerial support (Rahman, et al., 2022; Bawden & Robinson, 2020). Libraries are collecting data, but the transformation of raw data into actionable insights for resource allocation, service improvement, and policy formulation remains limited.

4.6.3 Utilization of Bibliomining Components (RQ3)

The study found that data warehousing is moderately utilized, whereas data mining and bibliometrics are less integrated into library operations. System log evidence confirmed that while platforms generate extensive logs, analytical and bibliometric tools are underutilized, resulting in partial exploitation of digital library usage patterns.

This supports previous research asserting that effective bibliomining requires the integration of all three components data warehousing, mining, and bibliometrics to produce actionable insights (García et al., 2020; Malik & Mandal 2025). The moderate use of components underscores the need for staff training, analytics tools, and organizational strategies to move from basic data collection to evidence-based library management.

4.6.4 Perceived Contributions of Bibliomining (RQ4)

Respondents perceive bibliomining as moderately beneficial for identifying popular resources, informing collection development, guiding budget allocation, and enhancing service delivery (Grand Mean = 3.25). System log data corroborated these perceptions, showing that usage patterns can inform acquisition decisions and highlight service gaps.

These findings are consistent with existing studies emphasizing that bibliomining supports data-driven decision-making, improves resource relevance, and enhances service efficiency (Helal et al., 2018; Ibima.org, 2020). However, the moderate level of perceived contributions suggests that libraries are not yet fully leveraging data-driven insights to optimize digital resource utilization.

4.6.5 Challenges Affecting Bibliomining and Utilization (RQ5)

The study identified moderate to high challenges affecting bibliomining adoption and digital library utilization (Grand Mean = 3.37), including poor ICT infrastructure, limited analytics skills, lack of awareness, institutional support, and resistance to change. System log data confirmed infrastructure issues (server downtime, slow platform response), underutilization of advanced analytical features, and incomplete metadata entry.

These findings align with prior studies highlighting that the successful implementation of bibliomining and digital library services in Nigerian universities is hampered by technological, human, and organizational constraints (Onyenike & Uzuegbunam, 2021; Oladejo et al., 2020). Addressing these challenges is crucial for enhancing digital resource accessibility, usage, and decision-making capacity.

4.6.6 Relationship between Bibliomining Practices and Digital Library Utilization (H1)

The study found a significant relationship between bibliomining practices and digital library utilization in Nigerian federal universities ($r = 0.68$, $p < .05$). This indicates that effective collection and analysis of library usage data improve access to digital resources and enhance service delivery. The finding agrees with García, López, and Pérez (2021), who noted that bibliomining promotes evidence-based library improvements through user behavior analysis. García, Pérez, and López (2020) also emphasized that data-driven management increases accessibility and user satisfaction. Similarly, Ani, Ngulube, and Onyancha (2015), Onyenike and Uzuegbunam (2021), Ojedokun (2020), and Davis's (1989) Technology Acceptance Model supported the positive influence of digital technologies on library utilization.

4.6.7 Influence of Bibliomining Components on the Management of Digital Library Services (H2)

The study revealed that bibliomining components data warehousing, data mining, and bibliometrics significantly influenced digital library service management in academic libraries ($r = 0.61$, $p < .05$). This suggests that analytical tools and data management techniques improve library administration, planning, and service delivery. The finding supports Rahman et al. (2022), who stated that bibliomining enhances strategic management and innovation in libraries. Han, Pei, and Tong (2022) also noted that data mining helps identify patterns for informed decision-making and service improvement.

Similarly, Fırat and Aslay (2022), Bawden and Robinson (2019), and Antonacopoulos et al. (2024) emphasized that advanced analytical systems strengthen operational efficiency and effective digital library management.

4.6.8 Contribution of Bibliomining Practices to Effective Digital Library Services (H8)

The study revealed that bibliomining practices significantly contribute to effective digital library services in academic libraries ($r = 0.72$, $p < .05$). This indicates that bibliomining improves service quality through better understanding of user needs, resource utilization, collection development, and evidence-based decision-making. The finding agrees with García, López, and Pérez (2021), who stated that bibliomining enhances library services through empirical data analysis. Malik and Mandal (2025) also noted that emerging technologies and analytics strengthen modern library systems. Similarly, Onunka et al. (2023), Ogonu and West (2024), Sadiku, Issa, and Kpakiko (2021), and Yusuf (2022) emphasized that technological and data-driven innovations improve information access, operational efficiency, and digital library service delivery.

5.2 Key Findings

The study revealed the following:

1. Digital Library Utilization: Librarians exhibited a moderate level of digital library utilization, with frequent access to electronic resources, but limited diversity and full exploitation of available databases.
2. Adoption of Bibliomining Practices: Adoption was moderate, with basic data collection and monitoring in place. However, more advanced practices such as structured data management, analytics, and routine integrationintolibrary operations remain underdeveloped.
3. Components of Bibliomining: Data warehousing was moderately applied, while data mining and bibliometrics were less utilized. System log data confirmed the availability of usage data but showed that analytical and bibliometric insights were not fully leveraged for decision-making.
4. Perceived Contributions: Bibliomining was perceived to moderately enhance collection development, service delivery, and evidence-based decision- making. Log data supported these perceptions, demonstrating that usage patterns can inform resource allocation and highlight service gaps.
5. Challenges: Significant barriers included poor ICT infrastructure, limited analytics skills, low awareness, inadequate institutional support, and resistance to change. These challenges constrain the full adoption of bibliomining and limit the effective utilization of digital library resources.
6. The study established a significant relationship between bibliomining practices and digital library utilization in Nigerian federal universities, indicating that effective analysis of library usage data enhances access to digital resources, user satisfaction, and service delivery.
7. The study found that bibliomining components data warehousing, data mining, and bibliometrics significantly influence the management of digital library services in academic l ibraries by improving administration, planning, decision-making, and operational efficiency.
8. The study further revealed that bibliomining practices significantly contribute to effective digital library services through improved user-centered ser v i ces, resource management, collection development, and evidence-based administrative decisions supported by data-driven technologies and analytical systems.

5.3 Conclusion

In conclusion, bibliomining represents a viable and strategic approach for enhancing digital library utilization in Nigerian federal universities. The study revealed that although academic libraries are actively collecting and monitoring library usage data, the analysis, interpretation, and practical application of such data remain relatively limited. The findings further showed that the adoption of bibliomining practices is gradually emerging, with moderate implementation of

mining, and bibliometric analysis.

The study also established that system log evidence provides objective confirmation of existing bibliomining practices while identifying areas requiring improvement for more effective digital library management. It was further observed that challenges relating to infrastructure, technical skills, and institutional support continue to hinder the full integration and utilization of bibliomining practices in academic libraries.

Overall, the study confirmed that bibliomining practices significantly enhance digital library utilization and improve the management and effectiveness of digital library services. The application of bibliomining techniques supports evidence-based decision-making, efficient resource management, improved service delivery, and better understanding of users' information needs. Therefore, bibliomining remains an essential tool for strengthening digital library management, improving resource relevance, and ensuring sustainable and user-centered library services in Nigerian federal university libraries, provided that technical, human, and organizational challenges are adequately addressed.

5.4 Recommendations

Based on the findings of this study, several recommendations are proposed to enhance the adoption of bibliomining and optimize digital library utilization in Nigerian federal universities:

5.4.1 Recommendations for Practice

1. *Strengthen ICT Infrastructure:* Universities should invest in reliable servers, high-speed internet, and robust digital library platforms to ensure uninterrupted access, efficient data collection, and effective bibliomining. Improved infrastructure will facilitate optimal use of digital library resources and enable more advanced bibliomining practices.

2. *Capacity Building and Staff Training:* Library staff should receive training in data analytics, bibliometrics, and evidence-based decision-making. Workshops, seminars, and continuous professional development programs can enhance staff competence in interpreting system log data and leveraging insights for resource management.

3. *Institutional Policies and Support:* Universities should develop formal policies and guidelines to institutionalize bibliomining practices. Policies should include mandates for routine data analysis, integration of insights into decision-making, and incentives for data-driven initiatives to ensure sustainability.

4. *Integration of Bibliomining into Routine Operations:* Libraries should embed bibliomining practices into daily workflows, using log data to guide collection development, budget allocation, and service improvement. Establishing standard operating procedures for data management and analysis will ensure consistency and long-term adoption.

5. *Awareness and Advocacy:* University management and library leadership should raise awareness about the benefits of bibliomining among staff. Highlighting successful applications can motivate adoption and reduce resistance to data-driven library practices.

6. Academic libraries should strengthen the adoption of bibliomining practices to improve the utilization of digital library resources and services through effective analysis of users' information needs and usage patterns.

7. University libraries should integrate bibliomining components such as data warehousing, data mining, and bibliometric tools into digital library management systems to enhance planning, administration, and evidence-based decision-making.

8. Library management should encourage the use of data-driven and analytical practices to improve digital library service delivery, resource management, collection development, and user satisfaction in academic libraries.

5.4.2 Recommendations for Future Research

1. *Longitudinal Studies on Bibliomining Impact:* Future research should examine the long-term effects of bibliomining on digital library utilization, service quality, and user satisfaction. Tracking usage trends over time

will provide valuable insights into the effectiveness of data-driven decision-making in library management.

2. *Comparative Studies Across Universities:* Researchers can conduct comparative studies across federal, state, and private universities to evaluate differences in bibliomining adoption and digital library utilization. Such studies will help identify best practices and institutional factors that influence effective implementation of bibliomining practices.

3. *Exploration of Advanced Analytical Techniques:* Future studies could investigate the use of predictive analytics, machine learning, and AI-based bibliomining to enhance digital library management. These approaches can provide more sophisticated insights into user behavior, resource demand, and service optimization.

4. *User-Centric Studies:* Research should explore the perceptions and experiences of library users, including students and academic staff, regarding the impact of bibliomining on resource accessibility and service quality. Such studies will offer a holistic perspective, linking staff practices to actual user outcomes and satisfaction.

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