

Original Article

Factors Affecting the Adoption of Metaverse Technology Among Librarians in Federal Universities of Technology in Nigeria

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Abstract**Introduction**

Librarians' readiness for metaverse technology in Nigerian universities of technology is not well documented. This study aimed to assess librarians' awareness, digital skills, perceived infrastructure, organizational support, and challenges regarding metaverse technology in Federal Universities of Technology in Nigeria, and to examine the relationships between awareness and digital skills and between infrastructure and organizational support.

Methods

This cross-sectional survey was conducted between April and July 2026 in six Federal Universities of Technology in Nigeria. Academic librarians in these universities who agreed to participate were included, and incomplete questionnaires were excluded. Data were collected with a validated online questionnaire using four-point scales. Descriptive statistics were used with a criterion mean of 2.50, and Pearson correlation was used to test the hypotheses at a 0.05 significance level.

Results

A total of 103 librarians were included. Overall, 97 (94.2%) reported very high or high awareness of the metaverse concept. While 91 (88.3%) reported being able to operate metaverse access devices, 29 (28.2%) reported being able to upload library content. Reliable internet connectivity was reported by 87 (84.5%), and augmented reality devices by 27 (26.2%). Inadequate training was the most highly rated challenge, reported by 98 (95.1%). Awareness was correlated with digital skills ($r = 0.49$, $p < 0.001$), and infrastructure with organizational support ($r = 0.38$, $p < 0.001$).

Conclusion

Librarians appeared to be aware of metaverse technology, but their skills and resources seemed better suited to accessing virtual environments than to delivering library services within them.

1. Introduction

The metaverse refers to a persistent, shared multiuser virtual

environment that merges physical reality with digital virtuality,

in which users interact with one another and with digital content through avatars, supported by virtual, augmented, and mixed reality technologies [1]. The term originated in the 1992 science fiction novel *Snow Crash*, and the concept has since attracted substantial attention from technology companies and researchers [1,2]. In academic libraries, metaverse technologies have been applied or proposed for virtual tours, exhibitions, information literacy instruction, access to digital collections, and interaction between librarians and users [3,4].

Librarians' awareness of and readiness for metaverse technology have been examined in Thailand, the Gulf region, the United States, and Nigeria [5–8]. Factors reported to influence adoption include librarians' awareness and digital competence; the availability of devices, software, bandwidth, and electricity; and organizational support in the form of funding, training, technical assistance, and policy [9,10]. Privacy, data protection, and cybersecurity have also been identified as implementation concerns [11].

In Nigeria, studies of university libraries have reported variation in digital competencies and technological resources, and interest in metaverse applications alongside limitations in expertise, infrastructure, funding, training, and policy [8,12]. Federal Universities of Technology hold a mandate for technological education and research; however, librarians' awareness, digital skills, and perceptions of infrastructure, organizational support, and challenges relating to metaverse technology in these institutions remain insufficiently documented.

This study aimed to assess librarians' awareness, digital skills, perceived infrastructure, organizational support, and challenges regarding metaverse technology in Federal Universities of Technology in Nigeria, and to examine the relationships between awareness and digital skills and between infrastructure and organizational support.

2. Literature Review

2.1 Awareness of Metaverse Technology among Librarians

Proposed library applications of metaverse technology include immersive user engagement and changes to collections and reading spaces [3,13]; virtual, augmented, and mixed reality services [14]; virtual tours, simulations, tutorials, and collaborative spaces [4]; and immersive information literacy instruction [15]. From the user perspective, studies have examined willingness to patronise a metaverse academic library [16], intentions to use metaverse digital library services [17], knowledge exchange through a virtual living library [18], and information needs involving interaction, participation, and user-generated content in metaverse communities [19]. Among librarians, moderate awareness has been reported in Thailand [5] and in Nigeria, where it was accompanied by enthusiasm for adoption [12]. However, the

relationship between librarians' awareness and their digital skills has not been examined in Nigerian Federal Universities of Technology.

2.2 Digital Skills Possessed by Librarians for the Adoption of Metaverse Technology

New professional capabilities have been described as necessary for librarians in intelligent library environments [20]. Librarians in the Gulf region have reported substantial familiarity with and interest in metaverse technology, together with barriers related to expertise and technical resources [6]. Positive views of metaverse integration have also been reported alongside gaps in technical expertise [21]. In Nigeria, digital skills have been associated with preparedness for metaverse-enabled services [12], and readiness and digital capacity have been reported to vary across universities [8]. Training has been recommended to address these gaps [4,10,22]. However, existing studies have not distinguished librarians' ability to navigate virtual environments from their ability to create content, retrieve resources, and communicate with users within them.

2.3 Adequacy of Technological Infrastructure for the Adoption of Metaverse Technology

Infrastructure has been identified as a factor in the adoption of metaverse technologies in academic libraries [9] and has been associated with readiness among library professionals in Pakistan [23]. Immersive library applications and scalable metaverse service models require high-capacity connectivity, and internet and infrastructure constraints have been identified as barriers to implementation [4,14]. Reviews of metaverse technologies in libraries have also highlighted implementation constraints [10,22]. In Nigeria, studies have reported uneven technological resources and limited institutional readiness [8,12]. In a related context, facilitating conditions have been associated with librarians' adoption of artificial intelligence [24].

2.4 Organizational Support Available for the Adoption of Metaverse Technology

Institutional encouragement has been linked with favorable perceptions of metaverse technology among librarians [6], and leadership support has been identified as a component of readiness in Pakistan [23]. In urban libraries in the United States, overall operating expenditure and population served did not explain the application of metaverse-related technologies [7]. In Nigeria, financial and policy constraints have been reported [12]. Recommended measures include professional development [20]; phased implementation, training, and user feedback [4]; and collaboration, policy, and investment [10,22].

2.5 Challenges Affecting the Adoption of Metaverse Technology among Librarians.

Reported barriers include technical, financial, and ethical concerns in Thailand [5]; connectivity, training, and service delivery [4]; resource and inclusion issues [10,22]; and costs, skills, funding, and readiness in Nigeria [12]. Professional challenges include changes to librarians' roles [20] and changes associated with the convergence of metaverse technology and artificial intelligence [25]. Ethical and security concerns

have also been identified [5,22], including cybersecurity and data protection [11]. At the service level, challenges relate to community participation and ownership of information [19] and to the transfer of knowledge exchange into virtual settings [18]. The characteristics and main findings of the reviewed studies are summarized (Table 1).

Table 1. Characteristics and main findings of the reviewed studies.

Ref.	First author (year)	Setting	Focus	Main findings
[3]	Margam (2024)	Conceptual	Metaverse and user engagement	Immersive engagement in libraries
[4]	Tella (2025)	Distance learning libraries	Metaverse service delivery	Tours, simulations, tutorials; connectivity and training barriers; phased implementation
[5]	Alam (2024)	Thailand	Librarians' awareness	Moderate awareness; technical, financial, and ethical concerns
[6]	Subaveerapandiyan (2025)	Gulf region	Metaverse literacy	High familiarity and interest; expertise and resource barriers; institutional encouragement
[7]	Guo (2024)	United States	Metaverse technologies in urban libraries	Expenditure and population served did not explain application
[8]	Subaveerapandiyan (2025)	Nigeria	Metaverse readiness	Variation in digital capacity and resources; limited readiness
[9]	Shahzad (2026)	Systematic review	Adoption factors in academic libraries	Infrastructure identified as an adoption factor
[10]	Adeyinka (2026)	Systematic review	Metaverse in public libraries	Resource, inclusion, and implementation barriers
[11]	Oladokun (2025)	Conceptual	Cybersecurity in metaverse libraries	Cybersecurity and data protection concerns
[12]	Oladokun (2026)	Nigeria	Preparedness of academic librarians	Moderate awareness; skills linked to preparedness; funding, cost, and policy constraints
[13]	Daradkeh (2023)	Conceptual	Metaverse in intelligent libraries	Changes to collections and reading spaces
[14]	Jayasuryan (2025)	Conceptual	Metaverse in information spaces	VR, AR, and MR applications requiring high connectivity
[15]	Okuonghae (2025)	Rapid review	Immersive information literacy	Immersive information literacy instruction
[16]	Adetayo (2023)	Academic library users	Patronage of a metaverse library	Users' willingness to patronise
[17]	Sediyarningsih (2023)	Digital library users	Usage intentions	Factors influencing intention to use
[18]	Liu (2024)	Conceptual	Living library in the metaverse	Knowledge exchange in virtual settings
[19]	Guo (2025)	Metaverse communities	User information needs	Interaction, participation, user-generated content, ownership
[20]	Daradkeh (2023)	Conceptual	Metaverse librarian roles	New professional capabilities needed; changing roles
[21]	Oladokun (2025)	Higher education	Librarians' perspectives on integration	Positive views; gaps in technical expertise
[22]	Khosravi (2025)	Conceptual	Metaverse and library traditions	Training, policy, investment; ethical and security concerns

Table 1. Continued....

[23]	Subaveerapandiyan (2024)	Pakistan	Metaverse readiness	Infrastructure and leadership support linked to readiness
[24]	Subuhpoto (2026)	University librarians	Artificial intelligence adoption	Facilitating conditions influence adoption
[25]	Oladokun (2024)	Higher education	Metaverse and AI convergence	Disruption and changes in library roles

AI, artificial intelligence; AR, augmented reality; MR, mixed reality; VR, virtual reality.

2.6 Theoretical Framing

The Unified Theory of Acceptance and Use of Technology (UTAUT) identifies performance expectancy, effort expectancy, social influence, and facilitating conditions as determinants of technology acceptance and use [26]. Facilitating conditions refer to the technical and organizational resources available to support technology use. UTAUT has been applied in studies of digital services in library settings [27–29]. In this study, facilitating conditions were examined through librarians' perceptions of technological infrastructure and organizational support, alongside awareness, digital skills, and perceived challenges.

3. Methods

3.1 Study Design and Setting

This was a cross-sectional survey. It was carried out in the libraries of six Nigerian federal universities with a mandate for technological education and research: Federal University of Technology, Akure (FUTA); Federal University of Technology, Minna (FUT Minna); Federal University of Technology, Owerri (FUTO); Modibbo Adama University, Yola (MAU); Federal University of Technology, Ikot Abasi (FUTIA); and Abubakar Tafawa Balewa University, Bauchi (ATBU). Data were collected between April 2026 and 30 July 2026. This study was reported in line with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guideline.

3.2 Participants and Sampling

The target population was academic librarians working in these universities. The six universities were selected purposively because of their federal status and technological mandate. Within each university, librarians were recruited through convenience sampling. Because the total number of eligible librarians who received

the survey link was not known, no sample size calculation was performed, and a response rate was not calculated.

3.3 Inclusion Criteria

Librarians were included if they were academic librarians employed in one of the six selected universities during the data collection period and agreed to take part in the study.

3.4 Exclusion Criteria

Questionnaires were excluded if they were incomplete [or duplicated]. Librarians who took part in the pilot study were not eligible, as the pilot was conducted in other institutions.

3.5 Data Items (Questionnaire)

Data were collected with a structured questionnaire developed from the study objectives and published studies on metaverse technology in libraries. The questionnaire had six sections:

Section A: demographic data (gender, age, academic qualification, years of work experience, and technology-related training). Section B: awareness of metaverse technology (10 items). Section C: self-reported digital skills (10 items). Section D: perceived technological infrastructure (10 items). Section E: perceived organizational support (10 items). Section F: perceived challenges to adoption (10 items).

Sections B to F each matched one research objective and used a four-point scale. Awareness items were scored as Very High Awareness (4), High Awareness (3), Low Awareness (2), and Very Low Awareness (1). All other items were scored as Strongly Agree (4), Agree (3), Disagree (2), and Strongly Disagree (1). For challenge items, higher scores meant a greater perceived challenge. A four-point scale was used so that respondents had no neutral option.

3.6 Validity and Reliability

Three experts in Library and Information Science and Information Systems reviewed the draft questionnaire. They checked it for clarity, relevance, coverage, fit with the study objectives, and ambiguous or double-barreled items, and their suggestions were included in the final version. The questionnaire was then pilot-

tested with 20 academic librarians from institutions outside the study. Internal consistency was measured with Cronbach's alpha (Table 2). Alpha values were 0.872 for awareness, 0.901 for digital skills, 0.884 for technological infrastructure, 0.891 for organizational support, and 0.913 for challenges, showing high internal consistency [30].

Table 2. Reliability statistics for the five constructs.

S/N	Construct	No. of items	N	Cronbach's alpha (α)
1	Awareness of metaverse technology	10	20	0.872
2	Self-reported digital skills	10	20	0.901
3	Perceived technological infrastructure	10	20	0.884
4	Perceived organisational support	10	20	0.891
5	Perceived challenges affecting adoption	10	20	0.913

3.7 Data Collection Procedure

The questionnaire was built in Google Forms, and the link was sent electronically to academic librarians in the six universities (by email / WhatsApp groups / library staff lists). The first page of the form explained the purpose of the study, and respondents gave consent before answering. (Responses were limited to one per respondent / Duplicate entries were checked and removed). All responses were checked for eligibility and completeness, and 103 valid questionnaires were kept for analysis.

3.8 Data Analysis

Data were analyzed with the Statistical Package for the Social Sciences (SPSS), version 26. Frequencies and percentages were used to describe the respondents' demographic characteristics.

Means and standard deviations were calculated for each research objective. A criterion mean of 2.50, the midpoint of the 1–4 scale, was used to interpret the results [31,32]. A mean of 2.50 or above showed a high level, an adequate condition, or a notable challenge, depending on the construct, and a mean below 2.50 showed a low level or an inadequate condition. Before the correlation analysis, normality was checked using skewness, kurtosis, and the Kolmogorov–Smirnov and Shapiro–Wilk tests (Table 3). All five constructs had non-significant Shapiro–Wilk results ($p = .214, .389, .476, .352, \text{ and } .083$). Perceived challenges had a significant Kolmogorov–Smirnov result ($p = .034$), but its Shapiro–Wilk result was non-significant, and its skewness (-0.68) and kurtosis (0.21) were within acceptable limits. The data were therefore considered suitable for parametric analysis, and Pearson product-moment correlation was used to test the two hypotheses at a 0.05 level of significance.

Table 3. Test of normality of the study variables.

Variable	N	Skewness	Kurtosis	K–S statistic	Sig.	S–W statistic	Sig.
Awareness of metaverse technology	103	−0.42	−0.31	0.082	0.087	0.983	0.214
Self-reported digital skills	103	0.18	−0.47	0.071	0.200	0.987	0.389
Perceived technological infrastructure	103	−0.15	−0.38	0.069	0.200	0.989	0.476
Perceived organisational support	103	0.09	−0.42	0.074	0.200	0.986	0.352
Perceived challenges affecting adoption	103	−0.68	0.21	0.091	0.034	0.978	0.083

K–S, Kolmogorov–Smirnov; S–W, Shapiro–Wilk.

4. Results

Of the 103 respondents, 65 (63.1%) were female and 38 (36.9%) were male. The largest age group was 36–45 years, with 47 (45.6%) respondents. A total of 58 (56.3%) respondents held a

4.1 Demographic Characteristics

master's degree and 38 (36.9%) held a PhD. The largest experience group was 6–10 years, with 48 (46.6%) respondents (Table 4).

Table 4. Demographic characteristics of respondents.

Variable	Category	n (%)
Sex	Male	38 (36.9)
	Female	65 (63.1)
Age (years)	≤ 25	8 (7.8)
	26–35	26 (25.2)
	36–45	47 (45.6)
	≥ 46	22 (21.4)
Highest qualification	Bachelor's degree	7 (6.8)
	Master's degree	58 (56.3)
	PhD	38 (36.9)
Years of experience	< 2	9 (8.7)
	2–5	24 (23.3)
	6–10	48 (46.6)
	> 10	22 (21.4)

4.2 Awareness of Metaverse Technology

All 10 awareness items had a mean of 2.50 or above. The highest mean was for awareness of the concept of metaverse technology (3.53 ± 0.64), with 97 (94.2%) respondents reporting very high or high awareness. The lowest mean was for awareness of virtual

library tours (3.00 ± 0.89), with 77 (74.8%) respondents reporting very high or high awareness. The overall mean awareness score was 3.26 ± 0.47 (Table 5).

Table 5. Awareness of metaverse technology among librarians in Federal Universities of Technology in Nigeria.

S/N	Awareness item	VHA, n (%)	HA, n (%)	LA, n (%)	VLA, n (%)	Mean	StD
1	I am aware of the concept of metaverse technology.	62 (60.2)	35 (34.0)	5 (4.9)	1 (1.0)	3.53	0.64
2	I am aware of virtual reality as a component of metaverse technology.	41 (39.8)	41 (39.8)	16 (15.5)	5 (4.9)	3.15	0.86
3	I am aware of augmented reality as a component of metaverse technology.	36 (35.0)	43 (41.7)	22 (21.4)	2 (1.9)	3.10	0.80
4	I am aware of mixed reality as a component of metaverse technology.	32 (31.1)	47 (45.6)	21 (20.4)	3 (2.9)	3.05	0.80
5	I am aware that metaverse technology can provide virtual library environments.	66 (64.1)	28 (27.2)	6 (5.8)	3 (2.9)	3.52	0.74
6	I am aware that metaverse technology can provide virtual library tours.	33 (32.0)	44 (42.7)	19 (18.4)	7 (6.8)	3.00	0.89
7	I am aware that metaverse technology can support immersive learning activities.	38 (36.9)	41 (39.8)	20 (19.4)	4 (3.9)	3.10	0.85
8	I am aware that metaverse technology can facilitate virtual interaction between librarians and library users.	62 (60.2)	34 (33.0)	6 (5.8)	1 (1.0)	3.52	0.65
9	I am aware that metaverse technology can provide access to digital library resources.	32 (31.1)	50 (48.5)	18 (17.5)	3 (2.9)	3.08	0.78
10	I am aware that metaverse technology can support collaborative research activities.	62 (60.2)	32 (31.1)	8 (7.8)	1 (1.0)	3.50	0.68

VHA, Very High Awareness (4); HA, High Awareness (3); LA, Low Awareness (2); VLA, Very Low Awareness (1); StD, standard deviation. Mean ≥ 2.50 = high awareness; mean < 2.50 = low awareness.

4.3 Self-reported Digital Skills

Four of the 10 digital skill items had a mean of 2.50 or above. The highest mean was for operating digital devices used to access metaverse environments (3.35 ± 0.71), with 91 (88.3%)

respondents agreeing or strongly agreeing. The lowest mean was for uploading digital library content to a metaverse environment (2.05 ± 0.87), with 29 (28.2%) respondents agreeing or strongly agreeing. The overall mean digital skills score was 2.57 ± 0.52 (Table 6).

Table 6. Self-reported digital skills of librarians for the adoption of metaverse technology in Federal Universities of Technology in Nigeria.

S/N	Digital skill item	SA, n (%)	A, n (%)	D, n (%)	SD, n (%)	Mean	StD
1	I can operate digital devices used to access metaverse environments.	49 (47.6)	42 (40.8)	11 (10.7)	1 (1.0)	3.35	0.71
2	I can navigate a metaverse environment using appropriate digital devices.	42 (40.8)	41 (39.8)	16 (15.5)	4 (3.9)	3.17	0.83
3	I can operate virtual reality equipment used in library services.	37 (35.9)	45 (43.7)	12 (11.7)	9 (8.7)	3.07	0.91
4	I can use augmented reality applications relevant to library services.	15 (14.6)	18 (17.5)	43 (41.7)	27 (26.2)	2.20	0.99
5	I can use mixed reality applications relevant to library services.	7 (6.8)	24 (23.3)	44 (42.7)	28 (27.2)	2.10	0.88
6	I can create digital content for use in a metaverse environment.	6 (5.8)	26 (25.2)	48 (46.6)	23 (22.3)	2.15	0.83
7	I can upload digital library content to a metaverse environment.	6 (5.8)	23 (22.3)	44 (42.7)	30 (29.1)	2.05	0.87
8	I can assist library users in navigating a metaverse environment.	49 (47.6)	39 (37.9)	12 (11.7)	3 (2.9)	3.30	0.79
9	I can retrieve information resources within a metaverse environment.	8 (7.8)	28 (27.2)	42 (40.8)	25 (24.3)	2.18	0.89
10	I can communicate with library users through a metaverse environment.	10 (9.7)	21 (20.4)	43 (41.7)	29 (28.2)	2.12	0.93

SA, Strongly Agree (4); A, Agree (3); D, Disagree (2); SD, Strongly Disagree (1); StD, standard deviation.
Mean ≥ 2.50 = high level of skill; mean < 2.50 = low level of skill.

4.4 Perceived Technological Infrastructure

Six of the 10 infrastructure items had a mean of 2.50 or above. The highest mean was for reliable internet connectivity (3.30 ± 0.80),

with 87 (84.5%) respondents agreeing or strongly agreeing. The lowest mean was for augmented reality devices (2.05 ± 0.99), with 27 (26.2%) respondents agreeing or strongly agreeing. The overall mean infrastructure score was 2.75 ± 0.53 (Table 7).

Table 7. Perceived technological infrastructure for the adoption of metaverse technology in Federal Universities of Technology in Nigeria.

S/N	Infrastructure item	SA, n (%)	A, n (%)	D, n (%)	SD, n (%)	Mean	StD
1	The library has reliable internet connectivity for metaverse applications.	50 (48.5)	37 (35.9)	13 (12.6)	3 (2.9)	3.30	0.80
2	The library has sufficient internet bandwidth for metaverse applications.	15 (14.6)	15 (14.6)	43 (41.7)	30 (29.1)	2.15	1.00
3	The library has computers with adequate processing capacity for metaverse applications.	40 (38.8)	44 (42.7)	17 (16.5)	2 (1.9)	3.18	0.78
4	The library has virtual reality devices for metaverse services.	11 (10.7)	20 (19.4)	40 (38.8)	32 (31.1)	2.10	0.97
5	The library has augmented reality devices for metaverse services.	13 (12.6)	14 (13.6)	41 (39.8)	35 (34.0)	2.05	0.99

Table 7. Continued....

6	The library has suitable software for providing metaverse services.	14 (13.6)	17 (16.5)	46 (44.7)	26 (25.2)	2.18	0.97
7	The library has adequate electricity supply for operating metaverse equipment.	38 (36.9)	43 (41.7)	20 (19.4)	2 (1.9)	3.14	0.79
8	The library has reliable backup power for metaverse equipment.	41 (39.8)	42 (40.8)	17 (16.5)	3 (2.9)	3.17	0.81
9	The library has sufficient digital storage capacity for metaverse content.	33 (32.0)	52 (50.5)	17 (16.5)	1 (1.0)	3.14	0.71
10	The library has network security systems suitable for metaverse services.	36 (35.0)	46 (44.7)	19 (18.4)	2 (1.9)	3.13	0.78

SA, Strongly Agree (4); A, Agree (3); D, Disagree (2); SD, Strongly Disagree (1); StD, standard deviation.

Mean ≥ 2.50 = adequate; mean < 2.50 = inadequate.

4.5 Perceived Organizational Support

Four of the 10 organizational support items had a mean of 2.50 or above. The highest mean was for management encouragement to explore metaverse technology (3.30 ± 0.83), with 89 (86.4%)

respondents agreeing or strongly agreeing. The lowest mean was for support for pilot projects (2.05 ± 0.95), with 25 (24.3%) respondents agreeing or strongly agreeing. The overall mean organizational support score was 2.55 ± 0.55 (Table 8).

Table 8. Perceived organizational support for the adoption of metaverse technology in Federal Universities of Technology in Nigeria.

S/N	Organizational support item	SA, n (%)	A, n (%)	D, n (%)	SD, n (%)	Mean	StD
1	Library management encourages librarians to explore metaverse technology.	50 (48.5)	39 (37.9)	9 (8.7)	5 (4.9)	3.30	0.83
2	Library management provides training on metaverse technology.	39 (37.9)	46 (44.7)	17 (16.5)	1 (1.0)	3.19	0.74
3	The library provides financial resources for metaverse technology.	37 (35.9)	43 (41.7)	22 (21.4)	1 (1.0)	3.13	0.78
4	Library management provides access to metaverse equipment for staff training.	11 (10.7)	22 (21.4)	41 (39.8)	29 (28.2)	2.15	0.95
5	The university provides technical assistance for metaverse technology.	9 (8.7)	20 (19.4)	46 (44.7)	28 (27.2)	2.10	0.90
6	The library has policies guiding the use of metaverse technology.	13 (12.6)	21 (20.4)	41 (39.8)	28 (27.2)	2.18	0.98
7	Library management provides opportunities for librarians to attend metaverse-related training programmes.	38 (36.9)	45 (43.7)	17 (16.5)	3 (2.9)	3.15	0.80
8	The library supports collaboration with technology specialists on metaverse projects.	13 (12.6)	17 (16.5)	38 (36.9)	35 (34.0)	2.08	1.01
9	Library management provides time for librarians to learn metaverse technology.	18 (17.5)	15 (14.6)	40 (38.8)	30 (29.1)	2.20	1.05
10	The library supports pilot projects involving metaverse technology.	12 (11.7)	13 (12.6)	46 (44.7)	32 (31.1)	2.05	0.95

SA, Strongly Agree (4); A, Agree (3); D, Disagree (2); SD, Strongly Disagree (1); StD, standard deviation.

Mean ≥ 2.50 = adequate; mean < 2.50 = inadequate.

4.6 Perceived Challenges

All 10 challenge items had a mean of 2.50 or above. The highest mean was for inadequate training opportunities (3.56 ± 0.62), with

98 (95.1%) respondents agreeing or strongly agreeing. The lowest mean was for resistance to technological change (3.38 ± 0.83), with 90 (87.4%) respondents agreeing or strongly agreeing (Table 9).

Table 9. Perceived challenges to the implementation of metaverse technology in Federal Universities of Technology in Nigeria.

S/N	Challenge item	SA, n (%)	A, n (%)	D, n (%)	SD, n (%)	Mean	StD
1	Inadequate funding limits the adoption of metaverse technology in the library.	59 (57.3)	38 (36.9)	5 (4.9)	1 (1.0)	3.50	0.64
2	High acquisition costs of metaverse equipment limit adoption.	63 (61.2)	33 (32.0)	6 (5.8)	1 (1.0)	3.53	0.65
3	Poor internet connectivity limits the use of metaverse technology.	59 (57.3)	35 (34.0)	8 (7.8)	1 (1.0)	3.48	0.68
4	Inadequate electricity supply limits the use of metaverse equipment.	62 (60.2)	32 (31.1)	8 (7.8)	1 (1.0)	3.50	0.68
5	Cybersecurity concerns discourage the use of metaverse technology in libraries.	58 (56.3)	31 (30.1)	13 (12.6)	1 (1.0)	3.42	0.75
6	Inadequate training opportunities hinder metaverse adoption.	64 (62.1)	34 (33.0)	4 (3.9)	1 (1.0)	3.56	0.62
7	Lack of institutional policies limits metaverse adoption.	57 (55.3)	37 (35.9)	7 (6.8)	2 (1.9)	3.45	0.71
8	Concerns about the protection of personal data hinder metaverse adoption.	62 (60.2)	31 (30.1)	9 (8.7)	1 (1.0)	3.50	0.70
9	Resistance to technological change hinders metaverse adoption.	57 (55.3)	33 (32.0)	8 (7.8)	5 (4.9)	3.38	0.83
10	Privacy concerns discourage the use of metaverse technology in libraries.	58 (56.3)	36 (35.0)	7 (6.8)	2 (1.9)	3.46	0.71

SA, Strongly Agree (4); A, Agree (3); D, Disagree (2); SD, Strongly Disagree (1); StD, standard deviation.

Mean ≥ 2.50 = notable challenge; mean < 2.50 = not a notable challenge.

4.7 Hypothesis Testing

Awareness of metaverse technology was positively correlated with self-reported digital skills, $r(101) = 0.49$, 95% CI [0.33, 0.62], $p <$

0.001. The first null hypothesis (H_{01}) was rejected. Perceived technological infrastructure was positively correlated with perceived organizational support, $r(101) = 0.38$, 95% CI [0.20, 0.53], $p < 0.001$. The second null hypothesis (H_{02}) was rejected.

5. Discussion

Studies of technology adoption in libraries have examined both individual factors, such as awareness and skills, and institutional factors, such as infrastructure and organizational support [26–29]. The present study examined both sets of factors among librarians in Nigerian Federal Universities of Technology. In the present study, 97 (94.2%) librarians reported very high or high awareness of the concept of metaverse technology, and the overall mean awareness score was 3.26. This was higher than the moderate awareness reported by Alam et al. among Thai librarians [5] and by Oladokun et al. among Nigerian academic librarians [12].

Findings on librarians' skills differed across studies. Subaveerapandiyan reported substantial familiarity with and interest in metaverse technology among Gulf librarians [6]. In contrast, Oladokun et al. reported gaps in technical expertise [21], and Subaveerapandiyan et al. reported variation in digital capacity across Nigerian universities [8]. The present findings were closer to the latter. While 91 (88.3%) respondents reported being able to operate devices used to access metaverse environments, only 29 (28.2%) reported being able to upload digital library content to a metaverse environment.

For infrastructure, 87 (84.5%) respondents reported reliable internet connectivity, whereas 30 (29.1%) reported sufficient bandwidth and 27 (26.2%) reported having augmented reality devices. These findings were consistent with the uneven technological resources reported in Nigerian university libraries [8,12] and with the connectivity constraints reported in distance learning libraries [4]. Infrastructure was also associated with readiness among library professionals in Pakistan [23].

For organizational support, 89 (86.4%) respondents reported management encouragement, whereas 25 (24.3%) reported support for pilot projects. Leadership support was also identified as a component of readiness in previous studies [4,23]. Findings on funding were conflicting. Guo et al. found that overall operating expenditure did not explain the application of metaverse-related technologies in United States urban libraries [7], whereas Oladokun et al. reported funding constraints in Nigeria [12]. In the present study, 80 (77.7%) respondents agreed that the library provided financial resources, while 97 (94.2%) agreed that inadequate funding limited adoption.

Inadequate training opportunities were the most highly rated challenge, with 98 (95.1%) respondents agreeing, although 85 (82.5%) respondents also agreed that library management provided training. Costs, funding, connectivity, and policy concerns were also reported in Thailand [5], Nigeria [12], and distance learning libraries [4], and cybersecurity and data protection concerns were reported in metaverse libraries [11].

Awareness was positively correlated with self-reported digital skills ($r = 0.49$). This was consistent with the association between skills and preparedness reported among Nigerian academic librarians [12]. Perceived technological infrastructure was also positively correlated with perceived organizational support ($r = 0.38$), consistent with previous studies that identified both infrastructure and leadership support as factors in metaverse adoption [9,23].

5.1 Limitations and Suggestions for Further Study

This study had some limitations. It was a cross-sectional survey of 103 librarians recruited through purposive and convenience sampling from six Federal Universities of Technology, so the findings cannot be generalized to all Nigerian academic libraries, and the response rate could not be calculated. All variables were measured with the same self-reported questionnaire, which may have introduced common method bias. Digital skills were not assessed through practical tasks, and facilities and organizational support were not independently verified. The correlations therefore showed associations between reported measures, not causal effects.

Further studies should combine questionnaires with practical skills assessments, equipment inventories, and records of training and budgets. Interviews could explain why respondents reported both the provision and the inadequacy of training, funding, electricity, and connectivity. Future research should also include other types of universities, library users, administrators, and technical staff, and should use longitudinal designs or evaluated pilot services to assess changes over time.

6. Conclusion

Librarians in the selected Federal Universities of Technology appeared to be aware of metaverse technology. However, their self-reported skills and the resources available to them seemed better suited to accessing virtual environments than to delivering library services within them. Specialized skills, equipment, and practical institutional support may need to be developed before metaverse-based library services can be implemented.

Declaration

Conflicts of interest: The authors have no conflicts of interest to disclose.

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Authors' contributions: B.D.O. was responsible for conceptualization, methodology, and validation. I.E.O. contributed to validation and writing – review & editing. E.N.B. provided supervision and contributed to methodology.

Use of AI: During the preparation of this work, the authors used Claude Opus 4.8 (Anthropic) to assist with text drafting and language editing, code development in R, and figure generation. After using this tool, the authors reviewed and edited the content as necessary and take full responsibility for the content of the publication.

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