

ISSN: 0974-0643 (P)

Volume 45, Issue 1, January 2025

DESIDOC

Journal of Library & Information Technology

<https://publications.drdo.gov.in/ojs/index.php/djlit>



Defence Research & Development Organisation

DESIDOC JOURNAL OF LIBRARY & INFORMATION TECHNOLOGY

A Publication of DRDO

DESIDOC Journal of Library & Information Technology (DJLIT), formerly *DESIDOC Bulletin of Information Technology (DBIT)*, is a bimonthly, peer reviewed, open access (<https://publications.drdo.gov.in/ojs/index.php/djlit>) journal of the Defence Research & Development Organisation (DRDO), Ministry of Defence, Govt. of India. It publishes research and review papers with a slant towards IT as applied to library sources, services, and products covering the issues, trends and developments in the LIS field. It will benefit the librarians, documentation and information professionals, students, and all others interested in the field.

Editorial Board

Dr. G. Rathinasabapathy

Tamil Nadu Veterinary and Animal Sciences University, Chennai, India

Dr. G. Mahesh

Council of Scientific and Industrial Research (CSIR), New Delhi, India

Prof. Jagtar Singh

Punjabi University, Patiala, India

Dr. K. Veeranjanyulu

National Institute of Technology (NIT), Warangal, India

Prof. K.P. Singh

University of Delhi, Delhi, India

Dr. M.R. Murali Prasad

Centre for Economic and Social Studies, Hyderabad, India

Dr. Mahendra N. Jadhav

Indian Institute of Technology Madras, Chennai, India

Prof. Manoj Kumar Verma

Mizoram University, Mizoram, India

Prof. Margam Madhusudhan

University of Delhi, Delhi, India

Dr. Nabi Hasan

Indian Institute of Technology Delhi, New Delhi, India

Prof. Naresh Agarwal

Simmons University, Boston, MA 02115, Boston

Dr. Nirmal Singh

Guru Angad Dev Veterinary & Animal Sciences University, Ludhiana, India

Dr. Pradeepa Wijetunge

National Institute of Library & Information Sciences, Sri Lanka

Dr. Satish Kanamadi

Tata Institute of Social Science, Mumbai, India

Dr. Yuh-Shan Ho

Asia University, Taichung, Taiwan Asia University, Taiwan

Editorial Team

Editor-in-Chief

Ms. Kiran Chauhan, DESIDOC, Delhi

Associate Editor-in-Chief

Dr. Mohd. Yousuf Ansari, DESIDOC, Delhi

Editor

Mr. Yogesh Modi, DESIDOC, Delhi

Assistant Editor

Mr. Rajiv Chopra, DESIDOC, Delhi

Mr. Ankur Pant, DESIDOC, Delhi

Design & Pre-Press

Ms. Bhawana Pal, DESIDOC, Delhi

Editorial Desk

Ph: 011-2390 2469/63

E-mail: djlit.desidoc@gov.in

Indexing/Full-text

The Journal is covered in Scopus, Web of Science (Emerging Source Citation Index), ProQuest, LISA, LISTA, EBSCO, Library Literature and Information Science Index/Full-text, Indian Citation Index, WorldCat, Google Scholar, and OCLC.

Printing

Mr. Rajesh Kumar Singh, DESIDOC, Delhi

Subscription and Enquiry

Mrs. Dipti Arora

DESIDOC, Metcalfe House

Delhi-110 054

Ph: 011- 2390 2612

Fax: 011-2381 9151

E-mail: marketing.desidoc@gov.in

Annual Subscription

₹ 1500.00

(Discount: 15 % to Publishers/Vendors and Individuals)

Subscription to be paid in advance by bank draft in the favour of **Director, DESIDOC**. Local subscribers may pay by cheque, payable at Delhi.

The editors or publisher do not assume responsibility for the statements /opinions expressed by the authors of the papers.

© 2025, Defence Scientific Information & Documentation Centre (DESIDOC), Delhi, India

DESIDOC Journal of Library & Information Technology

Volume 45

Number 1

January 2025

CONTENTS

Research Papers

- 3-15 Analysis of Students' Digital Literacy Skills and Attitude Towards Drug-Related Information Resources: A Study of Selected Pharmacy Institutes in India
Dayanandappa Kori and Umesh Kumar Patil
DOI : 10.14429/djlit.19894
- 16-21 A Comparative Analysis of Single Sign-On and Proxy Solutions for Facilitating Remote Access to Electronic Resources in Academic Libraries
Mohan Teja Mattigiri, Mahabaleshwara Rao and Shivananda Bhat K.
DOI : 10.14429/djlit.19823
- 22-27 Empowering Accessibility: Converting Books for Print-Disabled Students in Government Law College Tiruchirappalli within the Framework of the Indian Copyright Act
N. Suresh, T.C. Thirunavukkarasu and R.Rajyavardhanan
DOI : 10.14429/djlit.19848
- 28-34 Ranking of The Colleges in India: A Study of The Elite Club
Sanjoy De, Soumen Teli, Surajit Mandal, and Sujit Raychaudhury
DOI : 10.14429/djlit.20248
- 35-42 Assess the University Virtual Library Spaces for Digital Information Services in Nigeria
Saturday U. Omeluzor and Nelson Edewor
DOI : 10.14429/djlit.20348
- 43- 50 Cloud Computing Applications: Digital Agenda for Automation and Networking of Libraries in Karnataka
Mahesh G.T, Jayamma K.V and Mrutyunjaya Kotur
DOI : 10.14429/djlit.20332
- 51- 56 Artificial Intelligence in Libraries, A Multifaceted Analysis of Integration, Impact, and Collaboration Dynamic
Manash Esh
DOI : 10.14429/djlit.20309

Review Papers

- 57- 64 Preservation and Revitalization of Indian Languages through Digital Archiving: A Systematic Review of Bharatvani
Shilpi Saxena and Gurvinder Kaur
DOI : 10.14429/djlit.20138
- 65- 73 The Impact of Knowledge Creation, Acquisition, and Capture on Knowledge Sharing: An Investigation Among Nursing Professionals
Chennupati Deepti, Somipam R. Shimray, Abdoulaye Kaba and Chennupati Kodanda Ramaiah
DOI : 10.14429/djlit.20187

74- 81

Augmented Reality Trends and Popularity in Libraries: A Systematic Review

*Kiran Ranavagol S, Laxmi Yallappa Kamble,
Somanagouda Shankargouda Patil and Nijaguna
DOI : 10.14429/djlit.19878*

Back Cover: Information for Contributors

Analysis of Students' Digital Literacy Skills and Attitude Towards Drug-Related Information Resources: A Study of Selected Pharmacy Institutes in India

Dayanandappa Koridh^{#*} and Umesh Kumar Patil[§]

[#]University Library, Dr Harisingh Gour Vishwavidyalaya Sagar, Madhya Pradesh - 470 003, India

[§]Department of Pharmaceutical Sciences, Dr Harisingh Gour Vishwavidyalaya, Sagar Madhya Pradesh - 470 003, India

*E-mail: koridh@gmail.com

ABSTRACT

The research examined pharmacy students' digital literacy skills and attitudes toward drug-related information resources. A self-administered online questionnaire created with Google Forms was used to assess these aspects. The researchers used IBM SPSS to analyse the data. The study's findings indicated that students primarily relied on lectures and books but valued online resources despite concerns about reliability. While traditional resources were preferred, digital literacy skills proved crucial for accessing trustworthy online information. This underscored the importance of integrating responsible practices for online drug information resources in pharmacy education. The statistical analysis not only delves into how demographics influence student preferences but also offers valuable insights into how students accessed and perceived drug-related information sources. These findings had significant implications for the design of pharmacy education programs. The researchers suggested the need to promote digital literacy through targeted interventions and effective time management practices to better equip students for success in a digitalised healthcare landscape.

Keywords: Drug-Related information resources; Pharmacy students; Digital literacy; Online information resources

1. INTRODUCTION

In today's rapidly changing healthcare field, having reliable and easily accessible drug information is crucial for pharmacy students. With the increasing prevalence of online digital resources, students need a positive and thoughtful approach to these resources to enhance their learning and future professional practice. Access to updated and trustworthy drug information is essential for pharmacy students. As online drug information resources continue to gain popularity, cultivating a considerate attitude towards these resources becomes vital for the learning and future practice of pharmacy students. This study aims to examine pharmacy students' digital literacy skills and attitudes toward drug-related information resources, highlighting the need for a positive and thoughtful approach to these resources and providing valuable insights for the design of pharmacy education programs.

2. LITERATURE REVIEW

Alowais¹, *et al.* advocate for integrating technology skills into pharmacy education, echoing MacLure Stewart's² calls for user-centered design to bridge the digital divide. Similarly, Hallyburton³ addresses the under-researched area of healthcare professionals' health literacy and highlights its direct influence

on the quality of patient care. Beyond individual skills, concerns about digital literacy extend to broader issues of equity and access. Studies such as Campanozzi⁴, *et al.* emphasise the critical role of bridging the digital divide in facilitating equal access to telemedicine. Safdari⁵, *et al.* highlight the crucial role of effective communication and collaboration between medical librarians and researchers to optimise the librarian's role in supporting the research process. Galeshi⁶, *et al.* shed light on the specific information-seeking behaviours of young millennials regarding health topics and emphasise the need for more accessible and inclusive health information resources to bridge the digital divide and ensure equitable access to health resources. Tahamtan⁷, *et al.* bridge the gap between library services and researchers' needs through modernising capabilities. This aligns with the focus on identifying training programs as a potential solution for healthcare professionals who have difficulty accessing and managing medication information. Palumbo & Adinolfi⁸ research emphasises the importance of digital health literacy, which equips patients to find, understand, and use online health information.

3. OBJECTIVES OF THE STUDY

- To identify pharmacy students' preferences for drug information resources, comparing traditional and digital mediums.

- To evaluate the perceived reliability of various drug information resources among pharmacy students.
- To assess the digital literacy skills of pharmacy students and how these skills influence their information-seeking behaviors.
- To offer insights into optimising drug information resource usage among pharmacy students, facilitating better educational strategies and resource allocation.

4. HYPOTHESES FOR THE STUDY

- **H0:** Male and female pharmacy students have no significant difference in attitudes toward online drug information sources.
- **H0:** There is no significant difference in attitudes towards online drug information sources among pharmacy students from different nativity backgrounds.
- **H0:** There is no significant relationship between semester level and attitudes toward online drug information sources among pharmacy students.
- **H1:** There is an interaction effect between gender and nativity on attitudes towards online drug information sources among pharmacy students.

5. SCOPE AND LIMITATIONS OF THE STUDY

This study used a targeted Google Form survey to investigate the student's attitudes toward drug-related information resources among undergraduate pharmacy students at 25 pharmacy institutes from several Indian states, including Madhya Pradesh, Maharashtra, Karnataka, Uttarakhand, Andhra Pradesh, and Uttar Pradesh, providing a diverse representation of geography.

Using a quantitative questionnaire may miss nuanced insights into pharmacy students' digital literacy skills and attitudes toward drug-related information resources, which qualitative methods could uncover.

6. RESEARCH METHODOLOGY

A well-designed structured questionnaire using Google Forms collected 1460 responses. The research team reviewed all responses to ensure data quality and included 1430 in the final analysis. The online questionnaire was available to students from 12-30-2023 to 02-09-2024, allowing for a geographically diverse sample. Google Forms was used for easy access, secure data collection, and efficient management, while the questions were carefully designed to ensure data relevance to the study.

6.1 Sampling Method Used

The sampling method employed for this study was random sampling. This method is particularly advantageous in achieving a robust and statistically significant sample that accurately reflects the broader population.

6.2 Measure

The study employed a well-structured Google Forms online questionnaire to gather primary data on the chosen constructs. An "agree-disagree" Likert scale measured

pharmacy students' digital literacy skills and attitudes toward drug-related information resources to deepen understanding.

6.3 Validity And Reliability

This is one of the data collection methods; it produces systematic, error-free, and valid information. Several attempts were made to ensure the validity of the scale constructed for this study, such as analysing several books and articles on self-directed learning to empower students and deepen understanding., informal discussions with teachers and experts, and informal meetings with library and information science professionals.

6.4 Expert Review

The expert review ensures questionnaire items accurately measure study constructs. Experts assess relevance, clarity, and comprehensiveness to validate the questionnaire's alignment with research objectives.

6.5 Questionnaire Design

The questionnaire was self-designed by the authors, incorporating relevant constructs and dimensions identified through a review of existing literature and expert input. This ensures that the questions in the survey accurately reflect the study's goals and effectively address the research questions. By combining theoretical knowledge and subject matter expertise, the questionnaire was carefully designed to capture the necessary data for the study.

6.6 Statistical Tools Used

The investigators used several statistical tools to analyse the collected data. These tools include the Kaiser-Meyer-Olkin (KMO) measure and Bartlett's test to assess the adequacy and suitability of the data for factor analysis. Structural Equation Modeling (SEM) is utilised to explore the relationships between different factors and attitudes toward drug information sources. In addition, multivariate analysis is used to examine the effects of gender, semester, and nativity on pharmacy students' digital literacy skills and attitudes toward drug-related information resources. Hypothesis testing is also conducted to explore differences in perceptions based on gender, nativity, and semester levels. These statistical methods collectively provide a comprehensive understanding of the analysis of students' digital literacy skills and attitudes toward drug-related information resources.

7. DATA ANALYSIS AND INTERPRETATION

7.1 Pharmacy Institutes Selected for the Study

Table 1 displays selected institutes and student responses across 25 pharmacy institutes, revealing exciting insights. Madhya Pradesh dominates with 15 institutes and a commanding 59.4 %. Uttarakhand follows with a notable 5.6 %, while Andhra Pradesh

Table 1. Pharmacy institutes selected for the study

S.No.	Name of the pharmacy institute	Number of students	Percent
1	B. R. Nahata College of Pharmacy, Mandsaur, Madhya Pradesh	67	4.7
2	Babulal Tarabai Institute of Pharma Science, Sironja, Madhya Pradesh	35	2.4
3	Department of Pharmaceutical Sciences Doctor Harisingh Gour Central University Sagar, Madhya Pradesh	135	9.4
4	Dr. L. H. Hiranandani College of Pharmacy, Ulhasnagar, Maharashtra	15	1.0
5	Dr. Satyendra Kumar Memorial College of Pharmacy, Bhopal, Madhya Pradesh	26	1.8
6	Institute of Pharmacy Amity University, Gwalior, Madhya Pradesh	62	4.3
7	Institute of Pharmacy Gyanveer University Sagar, Madhya Pradesh	4	.3
8	Institute of Pharmacy H.N.B. Garhwal University, Srinagar Dist. Garhwal, Uttarakhand	80	5.6
9	Institute of Pharmacy ITM University Gwalior, Madhya Pradesh	1	.1
10	Institute of Pharmacy Jiwaji University, Madhya Pradesh	77	5.4
11	Institute of Pharmacy People's University, Madhya Pradesh	157	11.0
12	Institute of Pharmacy RKDF University Bhopal, Madhya Pradesh	2	.1
13	Institute of Pharmacy Teerthanker Mahaveer University, Bagadpur, Uttar Pradesh	3	.2
14	Institute of Pharmacy Vikram University, Ujjain, Madhya Pradesh	48	3.4
15	KLE College of Pharmacy, Belagavi, a constituent unit of KLE Academy of Higher Education and Research, Belagavi, Karnataka	133	9.3
16	Mandsaur Institute of Pharmacy, Mandsaur University, Mandsaur, Madhya Pradesh	10	.7
17	Medical College of Pharmacy, Bhopal, Madhya Pradesh	50	3.5
18	Ravishankar College of Pharmacy in Bhopal, Madhya Pradesh	288	20.1
19	Smriti College of Pharmaceutical Education (SCOPE), Indore, Madhya Pradesh	47	3.3
20	Sri Satya Sai Institute of Pharmaceutical Sciences, Bhopal, Madhya Pradesh	1	.1
21	Truba Institute of Pharmacy, Bhopal, Madhya Pradesh	65	4.5
22	Vedic Institute of Pharmaceutical Education and Research, Sironja, Madhya Pradesh	6	.4
23	VJ's College of Pharmacy, Rajamahendravaram, Andhra Pradesh	65	4.5
24	VNS Institute of Pharmacy, Bhopal, Madhya Pradesh	13	.9
25	Yadavrao Tasgaonkar Institute of Pharmacy, Karjat, Dist – Raigad Maharashtra	40	2.8
Total		1430	100.0

and Maharashtra each contribute 4.5 %. Karnataka adds 9.3 % to the tally. The remaining states -Uttar Pradesh, Rajasthan, and Andhra Pradesh have minimal representation, collectively accounting for less than 1 % of the student population. The sampling method employed for this study was random sampling.

7.2 KMO and Bartlett's Test

Table 2 provides information on the Kaiser-Meyer-Olkin (KMO) measure. The KMO measure, with a value of 0.935, indicates adequate sampling, meaning the variables can explain sufficient variance in the data. Bartlett's test, with a p-value less than 0.05, suggests significant correlations between the variables, supporting their suitability for factor analysis.

Table 2. KMO and Bartlett's test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.935
Bartlett's Test of Sphericity	Approx. Chi Square	7536.767
	df	45
	Sig.	.000

7.3 Distribution of Study Population According to Gender, Nativity, and Semester

Table 3 provides the study population according to gender, nativity, and semester. The study population consisted of 999 males (69.9 %) and 431 females (30.1 %). There was a notable gender imbalance across both nativity and semester. Males were more prevalent in all nativity groups, particularly in rural areas (77.3 %), and across all semesters. The test statistics provided indicate significant associations between gender distribution and both nativity and semester categories.

Table 3. Distribution of study population according to gender, nativity, and semester

S.No.	Nativity/ semester	Male	Female	Total	Male (%)	Female (%)	Test statistics
1.	Urban	390	220	610	63.9%	36.1%	chi-square statistic = 26.009, p<0.001 (significant association)
2.	Semi-urban	169	82	251	67.3%	32.7%	
3.	Rural	440	129	569	77.3%	22.7%	
4.	I Semester	292	136	428	68.2%	31.8%	chi-square statistic = 13.309, p<0.001 (significant association)
5.	III Semester	294	138	432	68.1%	31.9%	
6.	V Semester	250	71	321	77.9%	22.1%	
7.	VII Semester	163	86	249	65.5%%	34.5%	
Total		999	431	1430	69.9%	30.1%	

7.4 Sources Typically Used to Obtain Drug-Related Information

Table 4 highlights sources typically used to obtain drug-related information. Key Findings: Top Sources: Lectures (4.3 out of 5), Books and other publications (4.0), Drug information-related mobile apps (3.9), Social media platforms (3.9), Government websites (3.8), Lesser Used Sources: Online forums and discussion groups (3.6), Drug databases and directories (3.6), Scientific journals (3.6), Peer-reviewed articles (3.4), Hospital pharmacies (3.6), Decision Rule: The weighted average of 3.8 suggests an overall "High Perception" of using various sources for drug-related information but with variations in frequency.

7.5 Attitude Towards Online Drug Information Sources

Table 5 highlights the perception of online drug information sources. The weighted average of 4.1 suggests a positive inclination towards online drug information sources with a clear understanding of their limitations and the need for responsible use. Top perceived benefits: Valuable tool for learning about medications (4.3), Provides information about potential side effects and how to manage them (4.1), Provides general information about how to take medications (4.1), Helps make informed decisions about medication choices (4.1), Provides information about potential side effects and how to manage them, promoting safety and health while taking medications (4.0), Nuances in agreement: Statements emphasising privacy and regular updates received slightly lower deal (4.0). Verifying information and consulting healthcare providers was highlighted (4.0). Variability in reliability and the need for using reputable sources were acknowledged (4.1).

Table 6 shows the scores of preferences for drug information sources; the preference for traditional sources is significantly higher (mean=3.78) than for digital sources (mean=3.75), as the significance level of the t-test is less than 0.05.7.7

Table 4. Sources typically used to obtain drug-related information

S.No.	Sources	Mean	Std. Deviation	Rank	Decision
1.	Lectures	4.3	.95537	1	High Perception
2.	Books and other publications	4.0	1.05081	2	High Perception
3.	Drug information-related Mobile applications.	3.9	1.07234	3	High Perception
4.	Social media platforms (Facebook, YouTube, WhatsApp, Instagram, etc.)	3.9	1.10990	4	High Perception
5.	Government websites	3.8	1.12505	5	High Perception
6.	Drug Databases and Directories	3.6	1.16960	6	Low Perception
7.	Hospital Pharmacies	3.6	1.19843	7	Low Perception
8.	Online forums and discussion groups	3.6	1.17549	8	Low Perception
9.	Scientific journals	3.6	1.17224	9	Low Perception
10.	Peer-reviewed articles	3.4	1.18521	10	Low Perception

(Note: N=1430 5=Always 4=Often 3=Sometimes 2=Rarely 1=Never Decision - weighted average 37.7/10 =3.8)

Table 5. Attitude towards online drug information sources

S.No.	Attitude	Mean	Std. deviation	Rank	Decision
1.	Online drug information sources are valuable tools for learning about medications.	4.3	.80975	1	High Perception
2.	It provides general information about how to take medications.	4.1	.86946	2	High Perception
3.	It provides information about potential side effects and how to manage them.	4.1	.83398	3	High Perception
4.	It is varied in reliability, so it is important to use reputable sources from government websites, medical journals, and academic institutions.	4.1	.91664	4	High Perception
5.	It provides information about different medications and their potential side effects, which can help make informed decisions about medication choices.	4.1	.90707	5	High Perception
6.	It is a valuable tool for supplementing the information received from healthcare providers, but it should not replace the need to talk to a healthcare provider.	4.0	.92186	6	Low Perception
7.	It provides accurate information about medications. However, verifying the information with other sources and talking to your healthcare provider if you have any questions is essential.	4.0	.92136	7	Low Perception
8.	It provides information about potential side effects and how to manage them, which can help patients stay safe and healthy while taking medications.	4.0	.91381	8	Low Perception
9.	It is often updated regularly, ensuring access to the most current medication information.	4.0	.91943	9	Low Perception
10.	It is a private and secure way to learn about medications, provided you take steps to protect your privacy online.	4.0	.92631	10	Low Perception

(Note: N=1430 5=Strongly agree 4=Agree 3=Not sure 2=Disagree 1=Strongly Disagree Decision - weighted average 40.7/10 =4.1)

7.6 Score of Preferences For Drug Information Sources

Table 6 shows the scores of preferences for drug information sources; the preference for traditional sources is significantly higher (mean=3.78) than for digital sources (mean=3.75), as the significance level of the t-test is less than 0.05.

7.7 Attitude Score Towards Online Drug Information Sources by Nativity and Gender

Table 7 summarises how students view Drug-

related information resources, considering gender (male/female) and where they live (urban/semi-urban/rural). While everyone finds these resources somewhat valuable (average ratings around four on a likely unspecified scale), some variations exist. Students agree that online resources provide information on side effects more than privacy or reliability. Those in rural areas tend to rate the resources slightly lower than people in more urban areas.

Table 6. Source of preferences for drug information sources

Medium	Source	Mean	S.D.	Mean	S.D.	Paired t-test	
						t	Sig.
Traditional mediums	Lectures	4.30	0.96	3.78	0.86	2.072	0.038
	Books and other publications	3.99	1.05				
	Scientific journals	3.55	1.17				
	Peer-reviewed articles	3.45	1.19				
	Hospital Pharmacies	3.60	1.20				
Digital mediums	Drug information-related Mobile applications.	3.92	1.07	3.75	0.88		
	Social media platforms	3.88	1.11				
	Online forums and discussion groups	3.56	1.18				
	Government websites	3.76	1.13				
	Drug Databases and Directories	3.62	1.17				

Table 7. Attitude score towards online drug information sources by nativity and gender of pharmacy students

Component	Gender	Nativity						Total	
		Urban		Semi-urban		Rural		Mean	S.D.
		Mean	S.D.	Mean	S.D.	Mean	S.D.		
1	Male	4.32	0.88	4.17	0.96	4.29	0.77	4.28	0.85
	Female	4.29	0.76	4.29	0.68	4.19	0.66	4.26	0.72
	Total	4.30	0.84	4.21	0.88	4.27	0.74	4.27	0.81
2	Male	4.10	0.88	4.11	0.88	4.09	0.85	4.10	0.87
	Female	4.14	0.81	4.16	0.76	4.01	0.64	4.10	0.76
	Total	4.11	0.86	4.12	0.84	4.07	0.81	4.10	0.83
3	Male	4.17	0.87	4.08	0.90	4.05	0.88	4.10	0.88
	Female	4.20	0.87	4.22	0.82	4.02	0.79	4.15	0.84
	Total	4.18	0.87	4.13	0.87	4.04	0.86	4.12	0.87
4	Male	4.06	0.93	4.12	0.87	4.08	0.92	4.08	0.91
	Female	4.02	0.92	4.00	0.87	3.95	0.84	4.00	0.89
	Total	4.05	0.92	4.08	0.87	4.05	0.91	4.05	0.91
5	Male	4.03	0.95	3.99	0.96	4.03	0.94	4.03	0.95
	Female	4.00	0.90	4.07	0.87	3.99	0.69	4.01	0.83
	Total	4.02	0.93	4.02	0.93	4.02	0.89	4.02	0.91
6	Male	3.98	0.98	3.95	0.94	3.99	0.93	3.98	0.95
	Female	4.01	0.94	3.91	0.85	3.95	0.78	3.97	0.88
	Total	3.99	0.96	3.94	0.91	3.98	0.90	3.98	0.93
7	Male	4.00	0.94	3.98	0.95	3.99	0.94	3.99	0.94
	Female	4.01	0.93	4.07	0.89	4.00	0.73	4.02	0.87
	Total	4.00	0.94	4.01	0.93	3.99	0.90	4.00	0.92
8	Male	4.03	0.94	3.98	0.94	4.01	0.96	4.01	0.95
	Female	4.08	0.94	4.06	0.88	4.02	0.67	4.06	0.86
	Total	4.04	0.94	4.00	0.92	4.01	0.90	4.03	0.92
9	Male	4.02	0.95	3.98	0.92	4.04	0.97	4.02	0.95
	Female	4.10	0.90	4.06	0.87	3.99	0.72	4.06	0.85
	Total	4.05	0.94	4.00	0.90	4.03	0.92	4.03	0.92
10	Male	4.14	0.93	3.97	1.04	4.03	0.94	4.06	0.96
	Female	4.09	0.87	4.01	0.87	4.09	0.68	4.07	0.82
	Total	4.12	0.91	3.98	0.98	4.05	0.89	4.07	0.92

7.8 Multivariate Test Results of Variation of Attitude Towards Online Drug Information Sources by Nativity and Gender of Pharmacy Students

Table 8 shows how gender, location (urban/rural, etc.), and their interaction influence attitudes toward online medication resources. This table reveals minimal independent effects of gender or location. Location or gender might weakly influence perceptions of privacy, keeping information updated, and reliability, but these factors seem to have little overall impact.

7.9 Student Attitude Over Semester

Table 9 shows the students' attitudes over the semester. Students seem to view online medication resources favorably (average scores around 4), with a possible slight increase in finding them valuable over time. However, the changes across statements and semesters are small. While the specific scale and student population are unknown, this table suggests a generally positive and stable student perception.

Table 8. Multivariate test results

Component	ANOVA			MANOVA		
	Gender	Native	Gender * Native	Gender	Native	Gender * Native
	F (Sig.)	F (Sig.)	F (Sig.)	F (Sig.)	F (Sig.)	F (Sig.)
1	0.002 (0.962)	0.863 (0.422)	1.321 (0.267)			
2	0.000 (0.985)	1.000 (0.368)	0.762 (0.467)			
3	0.618 (0.432)	3.674 (0.026)	0.710 (0.492)			
4	3.043 (0.081)	0.256 (0.774)	0.344 (0.709)			
5	0.001 (0.982)	0.038 (0.963)	0.363 (0.696)	1.288 (0.232)	1.236 (0.213)	0.787 (0.733)
6	0.061 (0.806)	0.368 (0.692)	0.220 (0.803)			
7	0.406 (0.524)	0.067 (0.936)	0.215 (0.806)			
8	0.636 (0.425)	0.219 (0.803)	0.161 (0.851)			
9	0.391 (0.532)	0.305 (0.737)	0.605 (0.546)			
10	0.088 (0.766)	1.385 (0.251)	0.466 (0.628)			

Table 9. Student attitude over semester

Component	1 semester		3 Semester		5 Semester		7 Semester	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
1	4.21	0.83	4.30	0.78	4.20	0.91	4.44	0.65
2	4.03	0.91	4.13	0.76	4.05	0.90	4.23	0.70
3	4.07	0.89	4.15	0.82	4.03	0.95	4.25	0.79
4	4.01	0.95	4.08	0.82	3.98	0.98	4.17	0.88
5	3.99	0.97	4.08	0.80	3.88	1.04	4.17	0.80
6	3.96	0.96	3.99	0.85	3.87	1.02	4.11	0.83
7	3.96	0.92	4.06	0.86	3.89	1.03	4.12	0.86
8	3.96	0.93	4.05	0.86	3.93	1.04	4.22	0.82
9	3.98	0.93	4.04	0.86	4.00	1.00	4.16	0.90
10	4.04	0.93	4.06	0.85	3.98	1.03	4.22	0.83

7.10 ANOVA/MANOVA Results

Table 10 shows the ANOVA/MANOVA Results. Pharmacy students' attitudes towards online drug information sources differed significantly based on their semester level. Two findings showed this. First, scores for each question about online drug information sources varied across semesters (ANOVA p-value < 0.05). For instance, 7th-semester students had the highest average score on the first statement, while 5th-semester students had the lowest. Second, when all questions were analysed together (MANOVA), a significant difference (p-value < 0.05) was again observed between semesters. This confirms a relationship between students' semesters in the program and their views on online drug information resources.

Table 10. ANOVA/MANOVA results

Component	ANOVA		MANOVA	
	F	Sig.	F	Sig.
1	10062.3	0.000		
2	8688.5	0.000		
3	8063.4	0.000		
4	7169.0	0.000		
5	6996.4	0.000		
6	6618.9	0.000	214.312	0.000
7	6814.7	0.000		
8	6894.3	0.000		
9	6860.9	0.000		
10	7073.6	0.000		

7.11 Hypothesis Table

Table 11 shows the hypothesis table. This study delved into how pharmacy students across various institutes perceive online drug information sources. Surprisingly, neither gender nor native background significantly influenced their attitudes.

Table 11. Hypothesis table

S.No.	Hypothesis description	Test used	Result
1.	Difference in attitudes towards online drug information sources between genders	ANOVA MANOVA	No significant difference
2.	The difference in attitudes towards online drug information sources among different nativity	ANOVA MANOVA	No significant difference
3.	Relationship between semester level and attitudes toward online drug information sources	ANOVA MANOVA	The significant difference
4.	Interaction Effect between gender and nativity on attitudes towards online drug information sources	ANOVA MANOVA	There is no significant interaction; individual effects are inconclusive

7.12 Total Variance Explained by Source

Table 12 shows the variance explained by each extracted component. The table suggests that the first component has the potential to explain approximately 55 % of the total variance explained by all the variables related to "Sources typically used to obtain drug-related information." Understanding this primary factor would provide crucial insights into the overall structure of preferences for drug information sources.

Table 12. Total variance explained by source

Component	Initial eigenvalues			Extraction sums of squared loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.477	54.772	54.772	5.477	54.772	54.772
2	.965	9.652	64.423			
3	.811	8.114	72.537			
4	.511	5.111	77.649			
5	.501	5.007	82.656			
6	.427	4.270	86.925			
7	.388	3.879	90.805			
8	.376	3.760	94.564			
9	.281	2.811	97.375			
10	.263	2.625	100.000			

Extraction method: Principal component analysis.

7.13 Total Variance Explained by Factor

Table 13 provides details of the proportion of variance explained by each component. The first component, attitude toward inline drug information sources, can explain approximately 65 % of the variance explained by mentality. This suggests a robust and central dimension shaping these preferences and attitudes.

Table 14 shows the correlation between the first extracted components of sources used to obtain drug-related information and sources that assess attitudes toward online drug information. The strength of the correlation is moderate, suggesting a relationship but not a perfect

overlap. Students who rely on specific sources for drug information tend to have similar attitudes toward online drug information sources.

7.15 Logistic Regression Analysis

Table 15 Provides the logistic regression analysis report. The result suggests that concerning the female, the male group has 1.16 times higher utility for obtaining drug-related information, which is found significant with a p-value of less than 5 %. Whereas attitude towards the online drug-related details, both the groups had approximately equal odds ratio for the male group was 0.933 compared with the female group.

Table 13. Total variance explained by factor

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6.516	65.164	65.164	6.516	65.164	65.164
2	.646	6.462	71.626			
3	.513	5.130	76.755			
4	.405	4.048	80.803			
5	.393	3.928	84.731			
6	.359	3.587	88.318			
7	.336	3.359	91.678			
8	.325	3.245	94.923			
9	.274	2.739	97.662			
10	.234	2.338	100.000			

Extraction method: Principal component analysis

Table 14. Correlation between the extracted components

Statement	Correlations	Source typically used to obtain drug-related information.
Attitude towards online drug information sources	Pearson Correlation	.425**
	Sig. (2-tailed)	.000
	N	1430

** . Correlation is significant at the 0.01 level (2-tailed)

Table 15. Logistic regression analysis

S.No.	Statement	Gender	Odds ratio	p-value	95% C.I. for odds ratio	
					Lower	Upper
1.	Source use to obtain drug-related information	Male	1.161	.018	1.026	1.314
2.	Attitude toward drug information	Male	.933	.280	.822	1.058

Table 16. Multinomial Regression

S.No.	Nativity	Sources	Odds ratio	p-value	95% Confidence interval for OR	
					Lower bound	Upper bound
1.	Semi-urban	Lectures	.967	.705	.814	1.149
2.		Drug information-related Mobile applications.	.948	.560	.792	1.134
3.		Social media	1.041	.617	.889	1.220
4.		Online forums and discussion groups	.971	.759	.808	1.169
5.		Government websites	.958	.667	.788	1.165
6.		Drug Databases and Directories	1.007	.947	.816	1.244
7.		Scientific journals	.994	.953	.805	1.227
8.		Peer-reviewed articles	.983	.866	.801	1.206
9.		Hospital Pharmacies	1.041	.667	.868	1.248
10.		Books and other publications	.936	.481	.777	1.126
1.	Rural	Lectures	1.135	.075	.987	1.306
2.		Drug information-related Mobile applications.	.939	.383	.814	1.082
3.		Social media platforms	1.059	.370	.934	1.200
4.		Online forums and discussion groups	.982	.803	.848	1.136
5.		Government websites	.926	.335	.793	1.082
6.		Drug Databases and Directories	1.120	.180	.949	1.323
7.		Scientific journals	.985	.859	.834	1.163
8.		Peer-reviewed articles	.927	.357	.790	1.089
9.		Hospital Pharmacies	1.155	.050	1.000	1.333
10.		Books and other publications	.828	.011	.715	.958

The reference category is Urban; p-value<0.05 will be considered significant

7.16 Multinomial Regression

Table 16 shows the results of multinomial regression. The analysis suggests that, concerning the urban group, the rural group has an odds ratio of 1.155 times higher for hospital pharmacies and a lower odds ratio of 0.828. Overall, rural students favor traditional and readily available sources, highlighting potential disparities in accessing newer information channels between urban and rural areas.

7.17 Results of Multinomial Regression

Table 17 shows the results of multinomial regression. The analysis suggests that concerning the first-semester group, the third-semester group has an odds ratio of 0.801 times less for scientific journals, 1.221 times higher for peer-reviewed articles, and 1.058 times higher for hospital pharmacies. For the 5th-semester group, mobile applications, online forums, discussion groups, and peer-reviewed articles had higher odds of 1.283, 1.237, and 1.255, respectively, and lower odds of 0.831 for books and publications. Meanwhile, for the 7th semester, drug databases and directories have a lower odds ratio of 0.787 and a higher odds ratio of 1.266 for peer-reviewed articles.

Figure 1 shows the structural equation model; it demonstrates intricate relationships among attitudes, preferences, and semesters. The semester significantly influences attitude (0.014) and preferences (0.032). Attitudes significantly predict preferences (0.726).

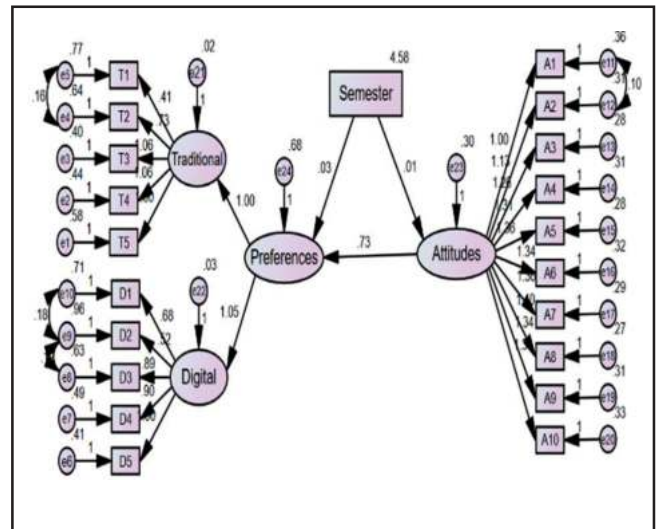


Figure 1. Structural equation model.

Table 17. Results of multinomial regression

S.No.	Semester	Sources	Odds ratio	p-value	95% Confidence interval for OR	
					Lower bound	Upper bound
1	3 Semester	Lectures	1.032	.703	.879	1.211
2		Drug information-related Mobile applications.	1.053	.534	.895	1.239
3		Social media platforms	1.014	.847	.878	1.172
4		Online forums and discussion groups	1.057	.522	.893	1.251
5		Government websites	1.007	.941	.843	1.202
6		Drug Databases and Directories	.957	.652	.792	1.157
7		Scientific journals	.801	.024	.661	.971
8		Peer-reviewed articles	1.221	.035	1.014	1.470
9		Hospital Pharmacies	1.058	.500	.897	1.249
10		Books and other publications	.915	.295	.774	1.081
1	5 Semester	Lectures	.894	.203	.752	1.062
2		Drug information-related Mobile applications.	1.283	.007	1.069	1.540
3		Social media platforms	.882	.124	.752	1.035
4		Online forums and discussion groups	1.237	.025	1.027	1.489
5		Government websites	1.090	.397	.893	1.329
6		Drug Databases and Directories	.843	.116	.681	1.043
7		Scientific journals	.978	.841	.791	1.211
8		Peer-reviewed articles	1.255	.031	1.021	1.543
9		Hospital Pharmacies	.902	.270	.752	1.083
10		Books and other publications	.831	.051	.690	1.001
1	7 Semester	Lectures	.973	.782	.799	1.184
2		Drug information-related Mobile applications.	1.179	.104	.967	1.437
3		Social media platforms	.931	.416	.783	1.106
4		Online forums and discussion groups	1.116	.285	.912	1.366
5		Government websites	1.142	.232	.919	1.419
6		Drug Databases and Directories	.787	.044	.624	.994
7		Scientific journals	.996	.972	.791	1.254
8		Peer-reviewed articles	1.266	.038	1.013	1.582
9		Hospital Pharmacies	1.039	.703	.853	1.267
10		Books and other publications	.965	.736	.786	1.185

The reference category is 1 semester; a p-value<0.05 will be considered significant.

7.18 Model Fit

Table 18 shows the analysis employed a linear regression model that fits the data (RMSEA=0.048, NFI=0.957, IFI=0.966, CFI=0.966). This suggests positive attitudes, higher semesters, and specific factors related to preferred learning methods (traditional/digital) all influence overall preference for learning methods. Interestingly, there's a slight preference for digital sources, and the influence of attitudes on preference appears to strengthen as students progress through their studies.

Table 18. Model fit

RMSEA	NFI	IF	CFI
0.048	0.957	0.966	0.966

7.19 Regression Weights

Table 19 shows the regression analysis, which explored how attitudes, semesters, and learning method preferences (traditional/digital and additional factors) influence overall learning method preference. Positive

attitudes and higher semesters were associated with stronger preferences. Interestingly, there was a slight but significant preference for digital methods. The analysis also revealed that specific factors related to traditional or digital methods play a role, and the influence of attitudes on preference appears to strengthen as students progress through their semesters.

8. DISCUSSION OF FINDINGS

The research examined pharmacy students' digital literacy skills and attitudes toward drug-related information resources. The Kaiser-Meyer-Olkin measure and Bartlett's test confirmed the adequacy and suitability of the data for factor analysis. Gender and semester-wise distribution indicated significant associations with attitudes toward

Table 19. Regression weights

			Estimate	S.E.	C.R.	P
Attitudes	<---	Semester	0.014	0.007	2.068	0.039
Preferences	<---	Attitudes	0.726	0.052	13.860	***
Preferences	<---	Semester	0.032	0.011	2.917	0.004
Traditional	<---	Preferences	1.000			
Digital	<---	Preferences	1.049	0.048	22.018	***
T5	<---	Traditional	1.000			
T4	<---	Traditional	1.061	0.032	33.528	***
T3	<---	Traditional	1.063	0.031	34.054	***
T2	<---	Traditional	0.733	0.029	25.017	***
T1	<---	Traditional	0.411	0.028	14.759	***
D5	<---	Digital	1.000			
D4	<---	Digital	0.899	0.026	34.421	***
D3	<---	Digital	0.887	0.028	31.715	***
D2	<---	Digital	0.516	0.030	17.458	***
D1	<---	Digital	0.679	0.027	25.145	***
A1	<---	Attitudes	1.000			
A2	<---	Attitudes	1.130	0.037	30.692	***
A3	<---	Attitudes	1.262	0.046	27.201	***
A4	<---	Attitudes	1.307	0.048	27.024	***
A5	<---	Attitudes	1.359	0.049	27.781	***
A6	<---	Attitudes	1.344	0.049	27.190	***
A7	<---	Attitudes	1.362	0.049	27.696	***
A8	<---	Attitudes	1.399	0.049	28.293	***
A9	<---	Attitudes	1.344	0.049	27.311	***
A10	<---	Attitudes	1.303	0.049	26.706	***

drug information sources. Overall, attitudes toward online resources were favorable, although preferences varied between traditional and digital sources, with traditional mediums being rated slightly higher. Multivariate analysis revealed minimal independent effects of gender or location on attitudes, while differences at the semester level significantly impacted perceptions. Hypothesis testing indicated no significant differences based on gender or nativity, but it did reveal a notable relationship between semester levels and attitudes. The study emphasised the high value placed on online resources, although variations in perceptions and preferences suggested opportunities for targeted improvements.

9. DISCUSSION AND CONCLUSION

The paper highlights the need to revamp pharmacy curriculums to include digital literacy and information verification skills. Although factors like semester level and gender did not impact students' attitudes toward drug-related resources, it underscores the need for training. Despite concerns about online reliability, it finds a positive attitude towards various resources, including lectures, books, mobile apps, and even social media. Statistical analysis explores how demographics influence student preferences, providing valuable insights into how students access and view drug information. Pharmacy education is changing as digital drug information resources become indispensable. Teaching students how to verify information and develop digital literacy skills is crucial. Including these skills in the curriculum prepares future pharmacists for modern healthcare. The study suggests incorporating digital skills into the curriculum, partnering with reliable online resources, and monitoring student usage patterns.

REFERENCES

1. Alowais, M.; Rudd, G.; Besa, V.; Nazar, H.; Shah, T. & Tolley, C. Digital literacy in undergraduate pharmacy education: a scoping review. *Journal of the American Medical Informatics Association.*, 2023, **31**(3), 732-745. doi: 10.1093/jamia/ocad223
2. MacLure, K. & Stewart, D.A qualitative case study of pharmacy staff's eHealth and digital literacy experiences. *Research in social & administrative pharmacy: RSAP.*, 2018, **14**(6), 555–563. doi: 10.1016/j.sapharm.2017.07.001
3. Hallyburton, A. A conceptual approach to practitioners' health information literacy, *Reference Services Review.*, 2016, **44**(2), 178-190. doi: 10.1108/RSR-02-2016-0006
4. Campanozzi, L.L.; Gibelli, F; Bailo, P.; Nittari, G.; Sirignano, A. & Ricci, G. The role of digital literacy in achieving health equity in the third-millennium society: A literature review. *Frontiers in public health.*, 2023, **11**, 1109323. doi: 10.3389/fpubh.2023.1109323
5. Safdari, R.; Ehtesham, H.; Ziaee, N. & Robiaty, M. The new roles of medical librarians in medical research: A comparison of the viewpoint of researchers and librarians in Iran, *Information and Learning Sciences.*, 2018, **119**(11), 682-696. doi: 10.1108/ILS-06-2018-0046
6. Galeshi, R.; Sharman, J. & Cai, J. Influence of ethnicity, gender, and immigration status on millennials' behavior related to seeking health information: Results from a national survey, *Equality, Diversity and Inclusion.*, 2018, **37**(6), 621-631. doi: 10.1108/EDI-05-2017-0102
7. Tahamtan, I; Tavassoli Farahi, M; Afshar, A.S. & Baradaran, H.R. Drug information seeking behaviors of health care professionals in Iran, *New Library World.*, 2015, **116**(3/4), 173-186. doi: 10.1108/NLW-06-2014-0070
8. Palumbo, R.; Nicola, C & Adinolfi, P. Addressing health literacy in the digital domain: Insights from a literature review, *Kybernetes.*, 2022, **51**(13), 82-97. doi: 10.1108/K-07-2021-0547

ACKNOWLEDGEMENT

The authors sincerely appreciate all the students for their valuable responses and extend heartfelt gratitude to th staff, teachers and principals for their steadfast support.

CONTRIBUTORS

Dr. Daynandappa Kori holds a PhD, Master in Library and Information Science, and PG Diplomas in Digital Library and Information Management, Computer Applications, and Yoga Studies. He works as an Information Scientist at the University Library, Dr Harisingh Gour Vishwavidyalaya (Central University), Sagar (MP), India.

His contributions to the current work include writing the manuscript.

Prof. Umesh Patil completed his B.Pharm, M.Pharm, and PhD from Dr Harisingh Gour University, Sagar (India), and Postdoctoral studies from the Institute of Biology, Leiden University, The Netherlands. He works as a Professor and Head at the Department of Pharmaceutical Sciences, Dr Harisingh Gour Vishwavidyalaya (A Central University), Sagar.

His contributions to the current work include collecting primary data.

A Comparative Analysis of Single Sign-On and Proxy Solutions for Facilitating Remote Access to Electronic Resources in Academic Libraries

Mohan Teja Mattigiri, Mahabaleshwara Rao* and Shivananda Bhat K.

Department of Library and Information Science Manipal Academy of Higher Education, Manipal - 576 104, India

*E-mail: m.rao@manipal.edu

ABSTRACT

In the era of internet-driven information, in libraries, the comparative analysis of Single Sign-On (SSO) and Proxy Technologies plays a vital role in understanding the features and importance of these technologies in providing information to patrons. The study investigated the SSO authentication systems that effectively provide users convenience in managing multiple login credentials and proxy technologies that enable remote access to library materials and extend services beyond physical library premises. Proxy authentication, which is decentralised and based on IP addresses. The study analyses the differences between the authentication methods. The challenges explored in the article are budget, lack of knowledge of the library professional, and user's disinterest in adapting to new technological advances. The study provided expert insights and recommendations, offering libraries a way to make decisions in choosing the right authentication system to provide remote access to e-resources. The study also suggested future trends aligning with the goals, scalability needs, and resource accessibility. The study offered insights into the changing landscape of authentication systems, helping libraries navigate the challenges of choosing the approach to enhance client satisfaction in today's digital era.

Keywords: Single sign-on; IP-authentication; Remote access service; Digital resources; Academic libraries

1. INTRODUCTION

The libraries emphasise the importance of technology. The analysis of Single Sign-On (SSO) and Proxy technologies in libraries highlights how they differ in streamlining user access and aiding in safeguarding assets¹. Librarians who are information disseminators are well-versed with authorisation methods, and user experiences within platforms play a crucial role. Robust authentication mechanisms become essential as libraries transform into information-providing hubs².

The study on SSO and Proxy Authentication sheds light on their abilities, functions, applications, and implications within the field of libraries. The exploration helps understand various authentication systems' role in shaping libraries, focusing on characteristic features like ensured user convenience, security, and optimised accessibility to resources. The research aimed to provide information professionals and technology stakeholders insights for library decision-making. Technologies are revolutionising information centres, and libraries must comprehend the differences between SSO and proxy authentication to balance user access and stringent security measures.

2. LITERATURE REVIEW

Karfa Bizi³ opined that libraries nurture simple security systems to protect and maintain informational

resources. E-resources are provided to patrons remotely to ensure users' need for timely information. The librarian must ensure continuous library resource access beyond library walls. Nagra⁴ observed that several concerns had been raised over the years regarding the security and access to library-subscribed e-resources beyond the organisation's premises. Corrado⁵ stated that one explored solution is a Proxy IP-based solution that relies on IP address validation. Goff and Scofield⁶ pointed out that proxy authentication needs a proxy server that acts as an intermediary between the user and the webserver to help prompt and provide access to remote users. Zhu⁷ stated that proxy authentications have effectively expanded the accessibility to library resources beyond physical boundaries. Implementation of Proxy authentication is comparatively easy in a library with minimum technical resources.

Kondo⁸, *et al.* conducted a case study that depicted reliance on the proxy solution alone as possibly leading to dependency issues and impacting the remote access performance at the libraries. They concluded that a proxy authentication solution offers flexible pricing models and can be implemented gradually in libraries. Iles and Erturk⁹ found in a case study evaluating proxy-based authentication that cloud-hosted software services help libraries in the long run, and the conversion to SSO depends on the security requirements of the respective institution.

Purwinarko¹⁰, *et al.* explained that single sign-on is a centralised authentication system with a user-centric design. Kodam¹¹ elaborated that authentication reduces the hassle of multiple login credentials. The centralised authentication model simplifies access to library-subscribed resources. The SSO is popularly known for granular usage statistics and custom personalisation features. Shastri and Chudasma¹² found that analysing SSO and Proxy Technologies in libraries shows advantages and challenges. Jayakanth¹³, *et al.* explained that SSO dramatically enhances user experiences for Proxy Authentication to meet the needs and demands for off-site access. Pham¹⁴, *et al.* suggested that SSO implementation often requires an initial investment. Shi¹⁵, *et al.* believed that the preferred authentication system for a library is contingent upon its specific library system. Implementation challenges usually arise due to financial constraints, as libraries face limitations in allocating funds for robust authentication measures. Furthermore, a shortage of skilled professionals and a lack of awareness about authentication systems impede successful implementation. Felts and Carpenter¹⁶ concluded that with careful consideration of user requirements and parent organisational needs, the libraries could decide on a solution for picking proxy or SSO authentication systems to provide remote access services in academic libraries. Tej and Rao¹⁷ conducted a case study on implementing OpenAthens, a single sign-on authentication system; the study provided guidelines and pointers for the smooth operation of single sign-on authentication in response to the challenges encountered.

3. PROBLEM STATEMENT

The present study is entitled “a comparative analysis of single sign-on and proxy solutions for facilitating remote access to electronic resources in academic libraries.”

4. OBJECTIVES

1. To explore and contrast Single Sign-On (SSO) and Proxy Authentication models for accessing library e-resources.
2. To address the challenges experienced when implementing Proxy Authentication and Single sign-on in libraries.
3. To examine the instrumental factors in deciding on authentication and the future trends in providing e-resources with libraries.

5. METHODOLOGY

The literature from recent years was reviewed, which mentioned the theoretical frameworks to contrast how SSO and Proxy technologies were chosen and used in libraries. Aspects such as functionalities and practical uses of Single Sign On (SSO) and Proxy Authentication were covered by many research articles, conference proceedings, and reports and, hence, were considered in this study. The study is classified into 2 phases. In the initial phase of the study, literature review is conducted to establish a solid theoretical foundation. This review focused on published journal articles from scholarly

databases to gain insights into the progress, technological foundations, and conceptual differences between SSO and Proxy Authentication within library contexts.

After the literature review, in phase 2 of the study, frameworks obtained in the literature review are combined to create an organised comparison between SSO and proxy technologies. The synthesis of the combination mainly revolved around organising and categorising literature focused on user experience, security concerns, and practical implications for libraries. The perspectives are evaluated to bridge the gaps and discrepancies between SSO (Single Sign On) and Proxy Technologies. The insights of various libraries that have implemented the authentication systems are evaluated and analysed to provide solutions to challenges faced to enable remote access to electronic resources.

6. SINGLE SIGN-ON AND PROXY AUTHENTICATION IN ACADEMIC LIBRARIES

Libraries are actively changing from time to time. As libraries grow, authentication systems become mandated to provide security and accessibility to library users. There are several authentication systems, but the widely used authentication systems that provide protection and accessibility are SSO and IP-based authentications.

Implementing Single Sign On technology has changed user authentication methods and access control. SSO simplifies the login process by offering an approach that allows users to explore resources¹⁸. The SSO is a centralised authentication solution that does not streamline the network of library resources. The increased adoption of SSO authentication among library professionals is founded on practical merits. It helps reduce the hassle of remembering and managing multiple login credentials, significantly saving the users' time¹⁹. The SSO aids the librarians as it helps provide granular usage statistics, which are instrumental in developing the inventory on demand.

One of the top authentication systems, Proxy authentication, has gained massive popularity within the library profession due to its ability to grant access to various digital materials. Due to its decentralised authentication approach, Proxy authentication extends its services beyond library premises due to its reliance on IP addresses for user authentication. The Proxy server connects the remote user by verifying their IP address and grants authorised access by safeguarding the integrity of resources²⁰. Proxy authentication is significant because it balances between user convenience and content protection. The proxy is considered an advanced method, ensuring that libraries have access to information while still adhering to security protocols and licensing agreements.

7. ANALYSIS

To compare SSO and Proxy authentication, examining the aspects of both methods is essential before discussing their features; it's important to understand the installation process to determine what works best for the library. SSO-

based authentications can be costly. One may need the knowledge to implement it in a library configuration, even though proxy authentications are readily accessible on forums.

7.1 Single Sign-On Configuration and Software Components for Installation

Single Sign-On software packages are readily available for download on the websites. After the download, run the software installer and follow the instructions on screen²¹. The following are the steps to configure SSO installation:

- Choose installation options such as installation directory and server settings.
- Configure the identity provider (IdP) settings, including organisation details and certificates.
- Set up user authentication methods such as username/password or federated identity providers.
- Define attribute mappings to map user attributes between the IdP and Service Providers (SPs).
- Configure access policies to control user resource access based on roles or attributes.
- Test the SSO setup by logging in with different user accounts and accessing protected resources.

7.2 Proxy Configuration and Software Components

Proxy authentication software can be downloaded from the vendor’s website, most of which are Open-Source software. Run the proxy authentication installer as directed on the screen installation wizard to install the software²².

The following are the steps to configure proxy installation:

- Specify the installation directory and server settings during installation.
- Configure network settings such as IP addresses and port numbers for incoming connections.
- Set up Access Control Lists (ACLs) to define which users

- or IP addresses can access resources through the proxy.
- Configure authentication methods such as IP-based authentication or LDAP integration.
- Enable logging and monitoring features to track user activities and resource access.
- Test the proxy server setup by accessing resources through the proxy from different devices and locations²³.

Fig.1 below shows a flowchart illustrating the Single Sign-On (SSO) and Proxy authentication steps involved in installation.



Figure 1. Installation steps: sso vs. proxy.

Table. 1 Below depicts the differences in features between single sign-on and proxy authentication. The differences help the professional choose the authentication preferred by the libraries based on the number of digital resources, size of the library, and scalability²⁴⁻²⁵.

The centralised SSO authentication and decentralised proxy authentication approaches provide ease in setting integrated functions and remote access to subscribed digital resources. The single sign-on has federated search capabilities, unlike proxy authentication. SSO provides a resource link generator to those digital resources that are not integrated into the authentication system. Although both authentication systems have dashboard facilities, the SSO maintains global standards that give user group statistics, individual user statistics, and resource usage statistics²⁶.

Table 1. Differences between sso and proxy based authentication

S. No.	Features	SSO	Proxy
1.	Model of Authentication	Centralised	Decentralised
2.	User Experience	Uniform and seamless user experience	Focuses on remote users
3.	Considerations of Security	Robust security procedures to minimise vulnerabilities and secure user credentials.	A layer of protection by authenticating users based on IP addresses
4.	Scalability	Ability to handle a rising user base	Needs an upgrade for an expanding user base
5.	Access to e-resources	Smooth between services without re-logging	Users in regions with non-standard IP addresses may have difficulties.
6.	Integration Difficulty	Complicated during the initial setup	Integrating Proxy Authentication systems is simple
7.	Compatibility Across Platforms	Interoperability with various operating systems and devices is smooth	It is critical to ensure that users may safely connect from diverse platforms
8.	Iterative Improvement and User Feedback	Continuous review and changes based on user feedback contribute to the authentication system’s	Libraries should set up systems for gathering feedback.
9.	Data Privacy and Compliance	Compliance with data protection standards is critical	Compliance with applicable data protection legislation must be maintained.

8. CHALLENGES AND CONSIDERATIONS

Implementing Single Sign-On (SSO) or proxy authentication in libraries to access electronic resources may be challenging and require expertise and careful attention. Even though SSO and proxy-based authentications benefit the stakeholders, the task can be intricate and requires detailed analysis²⁷. A significant obstacle is possible resistance from users who have grown accustomed to authentication techniques and may need time to adjust to new techniques²⁸. Implementation of SSO is possible with the latest computer specifications, but integrating the existing library applications can be a tedious job and might require technical assistance from an expert. SSO implementation can be possible for more extensive libraries with more significant patron numbers²⁹.

Although proxy authentication doesn't require higher system configuration, it needs a stable internet connection and minimum computer specifications to provide the service smoothly³⁰. Managing the IP of the users is a difficult task, and providing remote access to e-resources becomes an uphill task. SSO and proxy authentication require security measures to address data privacy and policy adherence³¹. In choosing the library, it is essential to analyse the authentication abilities and other features like scalability, cost, requirement, size, and customisation capability.

9. SUGGESTIONS

Several factors come into play when deciding which approach is best for a library, including scalability, cost-benefit analysis, and more. The user experience evaluation is the most crucial step in identifying the right impact solution for electronic resources. Accessibility of the resources facilitated by the SSO and Proxy solutions should consider ease of access from remote locations and compatibility with various browsers and devices regardless of their technical capabilities. They are ensuring

the evaluation of SSO and Proxy in scaling to support user-increasing needs without compromising performance and security. Using usage metrics can help understand the effectiveness of SSO and proxy solutions. Evaluating statistics, such as login frequency and user satisfaction score, helps optimise and improve. Vulnerability scanning can be conducted regularly for security assessment. Additionally, compliance requirements, such as meeting the industry standards for data protection, must be considered. Continuous user education, educating library staff about best practices and risks in providing remote access provision, and feedback inclusion will enhance these authentication systems over time, ultimately improving the user experience while ensuring secure access to library resources. Fig. 2 presents a flow chart illustrating the considerations involved in making decisions.

10. FUTURE TRENDS

The libraries' potential and future trends depend on the field's shifting user preferences and new technological developments. Many libraries have transformed from traditional authentication systems to advanced ones, such as SSO. In addition to operational efficiency, future authentication systems improve the user experience by including artificial intelligence and machine learning techniques. It is believed that library collection security and authentication processes would be enhanced using such technologies. Utilising XR technology is expected to bring about fully immersive experiences and might aid in effectively promoting library usage. Patron confidentiality will influence library practices, and technologies such as biometrics with real-time reliable verification may take over to provide security to the patrons who are accessing the resources remotely. An emphasis on security, data ethics, and sustainability will lead to expanding remote access alternatives, and the shift depends on the strategies the skilled librarians use.

Factors	Suggestion
User Experience Prioritization	Evaluate how each authentication method, whether Single Sign-On (SSO) or Proxy Authentication, aligns with the preferences and expectations of library patrons.
Security Measures	Consider the robustness of security protocols, potential vulnerabilities, and the ability of the chosen solution to safeguard user data.
Scalability And Future Growth	Choose an authentication method that scales effectively, accommodating an increasing number of users and evolving library services.
Cost-benefit Analysis	Consider not only the initial implementation costs but also ongoing maintenance, licensing fees, and potential costs associated with user training and support.
Integration Complexity	Evaluate the ease of integration with existing library systems and applications. Consider the technical complexities associated with implementing each authentication method.
Adaptability To Remote Access Needs	Given the increasing importance of remote access, especially in the wake of evolving work and study patterns, assess how each authentication model caters to off-site users.

Figure 2. Factors involved in decision-making.

11. CONCLUSION

The study investigated the distinctions between Single Sign On (SSO) systems and Proxy Technologies, which are IP-based in the context of library systems. The study depicted that both authentication systems are helpful and user-centered. The right choice for the library depends on its size; a small library with a limited budget can use IP-based authentication to reach out to users remotely from all locations. An enormous library with numerous databases without budgetary issues can opt for SSO to reduce the burden of remembering multiple login credentials and provide remote and secure access to e-resources. The implementation problems that libraries constantly face are budget problems, authentication mechanisms, lack of knowledge, user experiences, security, scalability, and resource accessibility. Some advantages of authentication systems are user experience for more straightforward navigation, remote access provision, and granular usage statistics to provide insights to stakeholders on acquisition. Within the realm of library technology, the study highlighted the significance of user authentication procedures, providing libraries with insights that can assist them in making educated decisions on implementing customised authentication systems.

REFERENCES

- Joshi & Madgu. Mobile App: Futuristic approach for academic libraries. Shreepublishers, 2023. doi: 10.5281/zenodo.7890668
- Kabo, F.; Paulson, A.; Bradley, D.; Varnum, K.J. & Teasley, S. Longitudinal associations between online usage of library-licensed content and undergraduate student performance. *College & Research Libraries.*, 2023. doi: 10.7302/6979
- Karfa Bizi, M. Exploring e-library challenges in the north east of nigeria tertiary institutions library. *International Journal of Scientific Engineering and Applied Science (IJSEAS).*, 2021, 7. www.ijseas.com (accessed on 06 May 2024)
- Nagra, K.A. Managing access to library e-resources when institutional IP ranges change: A strategic and practical approach. *Serials Librarian.*, 2019, 77(3-4), 75-83. doi: 10.1080/0361526X.2019.1652950
- Corrado, E.M. Issues in e-resources authentication and authorisation. *Technical Services Quarterly.*, 2020, 37(3), 302-314. doi: 10.1080/07317131.2020.1768704
- Goff, E. & Scofield, I. Improving e-resource stewardship with EZproxy: By Elaine Goff and Ian Scofield, Oregon State University. *Journal of Electronic Resources Librarianship.*, 2023, 35(2), 159-162. Routledge. doi: 10.1080/1941126X.2023.2197798
- Zhu, J. Implementing and assessing seamless access: A publisher's experience. *Information Services and Use.*, 2023, 43(3-4), 311-322. doi: 10.3233/ISU-230203
- Kondo, M.; Saroinsong, T. & Polii, A. Single Sign On (SSO) system with application of central authentication service (CAS) at manado state polytechnic. *5th International Conference on Applied Science and Technology on Engineering Science.*, 2023, 698-702. doi: 10.5220/0011863100003575
- Erturk, E. & Iles, H.R. Case study on cloud based library software as a service: Evaluating EZproxy, *ArXiv*, 2015. <https://arxiv.org/abs/1511.07578> (accessed on 06 May 2024)
- Purwinarko, A.; Hardyanto, W. & Adhi, M.A. Implementation of google single sign-on (SSO) in the library management system. *Journal of Physics: Conference Series.*, 2021, 1918(4). doi: 10.1088/1742-6596/1918/4/042129
- Kodam, T.A roadmap for ensuring SAML authentication using identity server for on-premises and cloud A roadmap for ensuring SAML authentication using identity server for on-premises and cloud Triveni Kodam (trikod-5), 2019. <https://www.diva-portal.org/smash/get/diva2:1316547/FULLTEXT01.pdf> (accessed on 20 May, 2024)
- Shastri, D.K. & Chudasma, P. The perception of ICT skills and challenges of usage of technologies among the library professionals of the gujarat state during the COVID-19: A comprehensive study. *Quality and Quantity.*, 2022, 56(3), 1093-1120. doi: 10.1007/s11135-021-01167-x
- Jayakanth, F.; Byrappa, A.T. & Viswanathan, R. Off-campus access to licensed online resources through Shibboleth. *Information Technology and Libraries*, 2021, 40(2). doi: 10.6017/ITAL.V40I2.12589
- Pham, T.H.; Vo, Q.H.; Dao, H. & Fukuda, K. SSO Login: A framework for automated web privacy measurement with SSO logins., 2023, 69-77. doi: 10.1145/3630590.3630599
- Shi, R.; Yang, Y.; Xie, H.; Feng, H.; Shi, G. & Zhang, J. PriSign, A privacy-preserving single sign-on system for cloud environments. *Applied Sciences (Switzerland).*, 2023, 13(2). doi:10.3390/app13020727
- Felts, J. & Carpenter, T. Leveraging federated authentication to simplify access: Understanding changes in access mechanisms to online content. *NASIG Proceedings*, 2023, 37(0). doi: 10.3998/nasig.4020
- Tej, M.; Rao, M. & K. S.B. Enabling openathens-single sign-on (SSO) remote access authentication to e-resources: A case study. *DESIDOC Journal of Library & Information Technology*, 2023, 43(5), 347-353. doi: 10.14429/djlit.43.05.18872
- Konstantinov. Protection of the front end and backend using azure active directory authentication, 2023, https://www.theseus.fi/bitstream/handle/10024/803102/Konstantinov_Roman.pdf?sequence=2 (accessed on 04 May 2024)
- Vijaya Chandra, J.; Challa, N. & Pasupuletti, S.K.

- Authentication and authorisation mechanism for cloud security. *International Journal of Engineering and Advanced Technology*, 2019, **8**(6), 2072–2078. doi: 10.35940/ijeat.F8473.088619
20. Dowling, T. We have outgrown IP authentication. *Journal of Electronic Resources Librarianship*, 2020, **32**(1), 39–46. (accessed on 15 May 2024). doi: 10.1080/1941126X.2019.1709738
 21. Okike, B.O.I. & Adetoro, Niran. Securing the information systems of libraries and the influence of tech-skills of librarians and users. *Education and Information Technologies*, 2019, **24**(2), 1583–1602. doi: 10.1007/s10639-018-9842-z
 22. Chen, J.A.; Tu, Y.F.; Hwang, G.J.; & Wu, J.F. University librarians' perspectives on an importance-performance analysis of authentication system attributes and their attitudes towards authentication log visualisation. *Journal of Academic Librarianship*, 2022, **48**(4). doi: 10.1016/j.acalib.2022.102528
 23. Leffler, D.J. Onboarding openathens: Considerations for switching to open athens authentication, 2023. https://www.researchgate.net/publication/370346614_Onboarding_OpenAthens_Considerations_for_Switching_to_OpenAthens_Authentication (accessed on 04 May 2024)
 24. Sanjeeva. Remote library platforms for accessing e-resources, 2023. <https://ssrn.com/abstract=4706148> (accessed on 20 April 2024)
 25. Ruenz, M.M. Remote authentication: One library's journey on offering EZProxy and open athens. *Internet Reference Services Quarterly*, 2022, **26**(3), 153–167. doi: 10.1080/10875301.2022.2067283
 26. Colquitt, M.E. The sun shining in the middle of the night: How moving beyond IP authentication does not spoil the fun, ease, or privacy of accessing library resources. *Proceedings of the Charleston Library Conference*, 2020, 391–394. (accessed on 20 May 2024) doi: 10.5703/1288284317204
 27. Cisney, L.B.; Hoover, B. & Thormodson, K. The technology, budget, and other challenges of growing health systems on academic health sciences libraries: A deeper dive. *Journal of Electronic Resources in Medical Libraries*, 2022, **19**(3), 59–84. doi: 10.1080/15424065.2022.2113349
 28. Subbarao, D.; Raju, B.; Anjum, F.; Rao, C. Venkateswara & Reddy, B.M. Microsoft azure active directory for next-level authentication to provide a seamless single sign-on experience. *Applied Nanoscience (Switzerland)*, 2023, **13**(2), 1655–1664. doi: 10.1007/s13204-021-02021-0
 29. Li, H.; Holly, C. & Goodrich, T. Openathens implementation: A two-phased move at our library. *Serials Review*, 2022, **48**(3–4), 201–205. doi: 10.1080/00987913.2022.2106817
 30. Chithanuru, V. & Ramaiah, M. An anomaly detection on blockchain infrastructure using artificial intelligence techniques: Challenges and future directions- a review. *Concurrency and Computation: Practice and Experience*, 2023, **35**(22). doi: 10.1002/cpe.7724 (accessed on 20 May 2024)
 31. Romano, J. & Huynh, N. Openathens odyssey: Challenges of implementing federated authentication for a multi-institutional user population. *Journal of the Medical Library Association*, 2021, **109**(4), 648–655. doi: 10.5195/jmla.2021.1170

CONTRIBUTORS

Mr. Mohan Teja Mattigiri is a T.M.A. Pai Research Scholar in the Department of Library and Information Science, Manipal Academy of Higher Education, Manipal. His areas of interest include Emerging technologies, Enhanced services, Electronic resources, and National education policy-2020 for academic libraries. He has collected, organised, processed, and presented the data and created the first draft of the study.

Dr. Mahabaleshwara Rao works as Associate Professor and Deputy Chief Librarian at the Department of Library and Information Science and Health Sciences Library, Manipal Academy of Higher Education (MAHE), Manipal, Karnataka. He has 31 years of professional experience. He has 33 papers to his credit published in National and International Journals and 41 papers presented in Conferences. He has edited four books. His areas of interest include: Health sciences librarianship, Web resources, ICT applications, and Information literacy. In the current study, he has conceived the idea, conceptualisation the manuscript, and constant supervision followed by proofreading the final draft of the study.

Dr. Shivananda Bhat K. obtained his MLISc from Mangalore University and PhD from the University of Mysore. Presently, he is working as Chief Librarian in the Health Sciences Library of Manipal Academy of Higher Education (MAHE), Manipal, and as Co-Ordinator & Professor in the Department of Library and Information Science, MAHE, Manipal. He has published several papers in peer-reviewed journals and conference proceedings. His current areas of interest include : Information literacy, Innovative methods in search strategies, and Scientometrics. In the current study, he has done the editing and proofreading of the final version of the manuscript.

Empowering Accessibility: Converting Books for Print-Disabled Students in Government Law College Tiruchirappalli within the Framework of the Indian Copyright Act

N. Suresh^{#,*}, T.C. Thirunavukkarasu[§] and R.Rajyavardhanan[#]

[#]Government Law College, Tiruchirappalli - 620 023, India

[§]Anna Centenary Library, Chennai - 600 085, India

^{*}E-mail: iamnsuresh@gmail.com

ABSTRACT

The National Education Policy (NEP) 2020, the University Grants Commission (UGC), and the National Assessment and Accreditation Council (NAAC) have recognised the importance of providing barrier-free access to education for individuals with disabilities. Knowing the vitality of empowering accessibility, the Government Law College library in Tiruchirappalli addresses the issue of print disability students accessing information. The library has undertaken a pilot effort to convert Ten postgraduate printed law books into audio books by utilising the provisions of the Indian Copyright Act of 2012. The audiobooks were stored in the DSpace repository and shared with students. The objective of this study was to ensure that print-disabled students had access to the same resources as their others. The findings suggest that audiobooks have the potential to enrich print-disabled students' confidence in their ability to learn and read, leading them to become motivated and involved in their studies.

Keywords: Law libraries; Accessible format; Print disability; Audio books; Copyright act 2012; NEP 2020

1. INTRODUCTION

Knowledge is currently regarded as the most valuable asset for each individual worldwide. The proverb "Knowledge is Power" is one that everyone has come across practically¹. Every individual in the world has the right access to knowledge, so they may improve their lives, but for someone with a disability of any type, it can be more difficult to do so. According to the Indian Census of 2011, there are about 5.4 million visually impaired people in the country². The Indian Constitution has provisions for education particularly Article 21-A, the Right to Education Act 2005 mentions Person with disabilities as part of the general population³. The National Education Policy (NEP) 2020 encourages initiatives to increase access to education for marginalised groups, such as children with disabilities⁴. For a variety of reasons, whether for informational, entertainment, or educational purposes, it is crucial for visually impaired people to read just like everyone else. Printing materials were only used by this group of individuals after being transformed into an accessible format.

Printing materials were only used by this group after being transformed into an accessible format. From 2010 to 2019, approximately 14 % of published books were available in alternate formats usable by people with print disabilities⁵. This shows that only a small proportion

of printed titles are available in eBook format, limiting access for those with print disabilities. This study has attempted to convert printed law books to audio books using limited resources and with the help of student volunteers for print disability students to access print textbooks and improve their academic performance at Government Law College, Tiruchirappalli.

2. BARRIER-FREE ACCESS TO EDUCATION FOR CHILDREN WITH DISABILITIES

The National Education Policy 2020 (NEP) introduced a pivotal provision dedicated to ensuring barrier-free access to education for all disabled children. This provision assured children with disabilities that they have equal opportunities to receive education. It achieves this by providing them with assistive devices, suitable technology-based tools, and teaching-learning materials that are linguistically appropriate⁶.

In line with NEP's emphasis on inclusivity, the University Grants Commission (UGC) have also implemented comprehensive Accessibility Guidelines and Standards for Higher Education Institutions and Universities. Provision 8.3.2 of these guidelines specifically addresses the services rendered by the library to persons with visual disabilities. According to this provision, libraries are required to provide scanners to convert documents via OCR readers and digital libraries⁷.

The National Assessment and Accreditation Council (NAAC) created a guide for checking and confirming data from colleges that are part of higher education institutions. This guide, specifically section 7.1.7, emphasises the need for technology and facilities to help people with disabilities in schools⁸.

3. INDIAN COPY RIGHT LAW 2012

The copyright act of 2012 has introduced measures to support individuals with disabilities. Specifically, the amendment to the Indian copyright law (52(1)(zb)) established a new copyright exemption targeted at improving access for those with print disabilities such as blindness and dyslexia. This exemption allows for the modification of work to meet the unique needs of individuals with print disabilities, as well as organisations for them. For instance, a traditional printed book can be converted into various formats such as Braille, large print, or audio versions, without the need for copyright holder permission⁹.

Furthermore, the copyright act of 2012 has provisions that benefit students with print disabilities. According to the law, this is not a violation of copyright for any individual or organisation working for the benefit of a person with disabilities on a nonprofit basis to create accessible format copies or distribute them to those who cannot fully enjoy the work in its original form. However, under Section 31 B, after securing a license, any individual or organisation working for the benefit of a person with disabilities for profit or business purposes can proceed with the conversion and distribution of work after obtaining a license from the copyright board, following the specified procedures outlined in this section¹⁰.

The provisions granted by the copyright act of 2012 for the benefit of print disabilities imply that obtaining permission from publishers to convert their books into accessible formats is not mandatory. This flexibility allows for the creation and distribution of works in various accessible formats, such as Braille, large print, or audio, to individuals with disabilities who may not be able to access the original printed version.

4. LITERATURE REVIEW

Obtaining information for print disability depends on people helping each other, showing how important social connections are for accessing information¹¹. The Marrakesh Treaty is a global agreement aimed at making it easier for people with disabilities to access books and printed materials. India agreed to this treaty and made changes to its copyright laws to help visually impaired people access information more easily. However, there are still problems regarding how well this treaty is being followed in India. Therefore, it is important to improve how the treaty is applied to India to fully support its goals¹².

The copyright amendment act of 2012 in India made changes to help authors, including special provisions for people with disabilities, and made it easier for people to work, aiming to update Indian copyright laws to match international agreements, such as the Internet Treaties, WIPO Copyright Treaty, and WIPO Performances and Marrakesh Treaty¹³.

The challenges experienced by visually impaired people in accessing library and information services are significant. Several studies have highlighted the gaps in the provision of services and the specific needs of visually impaired individuals. For example, The Istanbul university central library has established an information centre for print-disabled students, which objects to creating an inclusive for all the students. This initiative ensured that print-disabled students had access to the same resources as their others¹⁴.

The efforts made by libraries to meet the reading needs of visually impaired individuals through assistive technology devices and the role of Information Technology (IT) in promoting their inclusion and autonomy. The visually impaired library in India relies heavily on Braille books and Talking book services as the primary sources of information and provides tactile access to written content, enabling visually impaired individuals to read independently. Talking book services, however, audio books, allowing users to listen to the content. These tools have been helpful in bridging the information gap between the visually impaired communities¹⁵.

Digital libraries can help blind students more easily¹⁶, but it is important to keep university digital libraries safe from cyber threats. This ensured that the information and data in these libraries were protected¹⁷.

Blind or visually impaired people in Delhi, India, have trouble using library websites because they do not have enough online catalogs or assistive technologies. They also pointed out that more people recognised the skills of those with disabilities and wanted to include them in society¹⁸. However, no research has been conducted on the provision of special library services for students with print disabilities in Indian legal institutions.

5. STATEMENT OF THE PROBLEM

The government law college, Tiruchirappalli, offers various undergraduate and postgraduate law courses to 1440 students. Every year, colleges spend a significant amount on purchasing printed books, legal reports, and digital databases. However, students with print disabilities face challenges accessing printed information independently and rely on others for assistance. To address this issue, the library decided to convert the printed books into audio books. In the first phase, ten postgraduate law books were converted into audio books. This study aimed to explore existing research findings related to the use of audiobooks as an alternative format for print disability students and to identify the scope of future research directions.

6. SCOPE OF THE STUDY

There were 40 disabled students, 10 of whom were print disabled at the Government Law College Tiruchirappalli. Ten print disability students were interviewed to suggest alternative formats and solutions to meet their needs and preferences. They stated that audiobooks were the most common option to meet their information needs.

There were 80 subjects for both UG degree courses and 25 subjects for PG degree courses in law courses, with each subject having at least three textbooks in English and two books in Tamil. It must take 430 titles to convert into an audiobook to fulfil the information needs of print disabled students. As an initiative, it was decided ten English law books from postgraduate students were converted into audiobooks.

7. LIMITATION OF THE STUDY

In this study, ten books were initially converted, and not included Tamil law books. This study focused purely on audiobooks and did not examine alternative formats.

8. BACKGROUND OF THE STUDY

The government law college, Tiruchirappalli Library, is committed to providing updated legal materials in print and online formats to students and faculty. The library comprises 42,000 printed books on various legal aspects, 2200 back volumes of law reports, 16 law journals and law reports that are subscribed to, and two major online legal databases. The library recognises the conditions of the disabled and has begun to provide special library services for disabled students. Furthermore, it includes a specific space for students with different disabilities to work independently and move around. It has built specific facilities, such as ramps, rails, and washrooms, as well as made other required improvements to meet their needs.

The library provides print disability students with specialised digital information services, including audiobooks for competitive exams and NVDA.

9. OBJECTIVE OF THE STUDY

This study aimed to enable accessibility for students with print disabilities by converting library textbooks into audiobooks for accessing library resources to ensure that print-disabled students had to access the same resources as their others.

10. ADVANTAGES OF AUDIOBOOK

10.1 Accessibility

Audiobooks are important for students with print disabilities because they provide the same content in printed books in an audio format, thereby supporting diversity in education¹⁸. emphasise that audiobooks offer students with print disabilities the opportunity to conveniently access educational materials. Students with print disabilities can readily access printed textbooks at the library with the help of audiobooks.

10.2 Independence

Audiobooks enable students with print disabilities to learn independently and can be a valuable tool for individuals with intellectual and reading disabilities. Students with disabilities were found to express a high degree of satisfaction with the availability of audiobooks and other information services at the university's central library at Imam Muhammad bin Saud Islamic University in Saudi Arabia¹⁹. The print disability students frequently depend on others to access to educational materials. They can access educational content without needing continual support, though, by using audiobooks.

10.3 Flexibility

Audiobooks are very flexible; people with print disabilities can listen to audiobook books on different devices such as phones, laptops, or computers, making it easy for them to listen to books anywhere, whether at home, school, or on the go. This ensures that these students can learn like everyone else²⁰.

10.4 Confidence and Motivation

Listening to audiobooks can help students with print disabilities feel more confident and motivated. Research has shown that when students listen to someone reading well while they follow along, it can make them better readers, more fluent and better understand the material. It also makes reading more fun, which makes them feel more confident about their abilities²¹.

11. DESIGN AND ARCHITECTURE

The architecture for an audiobook must have several crucial components²². These components include the selection of books, narration and voice, recording equipment, audio editing and noise reduction, metadata and arrangement, file format, storage, and distribution. These components form the foundation for creating an effective and accessible audio-book.

Table 1. List of books converted to audio-book

S. No.	Title	Author
1	Constitutional Law –New Challenges	Tripathi, G.P.
2	Judicial Process	Sheetal Kanwal
3	Law & Social Transformation	Malik & Raval
4	Law Relating to Government Servants & Management of disciplinary Proceeding	Narendar Kumar
5	Law Relating to trade unions	Srivatsava, KD
6	Lectures On Administrative Law	Takwani CK
7	Human Rights	Aggarwal, HO
8	Intellectual Property Law	Narayanan, P
9	Criminal Procedure	Kelkar, RV
10	Criminology and penology	Paranjape

11.1 Selection of Books

Book selection is an essential consideration in audiobook design architecture²². The ten textbooks were converted by an audio book suggested by a subject-taught teacher in the college, ensuring that the content was relevant and aligned with the curriculum. Table 1 shows that the list of printed books was converted to audio books as the first stag.

11.2 Narration and Voice

Numerous mobile applications are available to assist the conversion of text to audio, but the clarity and quality of the voice are critical. In this project, the voice-person must know the law, have relevant experience, and have a clear voice. Based on these criteria, a student volunteer with relevant subject knowledge and a clear voice was chosen to record the project's audiobook.

11.3 Recording Equipment

BESTOR[®] high-quality voice recording device was used in this study to record voices. A podcast mic with a boom arm and microphone with a stand was included in this set.

11.4 Audio Editing and Noise Reduction

Audio editing and noise reduction techniques have been employed to enhance audio quality and remove unwanted noise. In this project, audio editing-free software (<http://audiodenise.com/>) was utilised for this purpose.

11.5 Metadata and Arrangement

To efficiently organise the audiobook, metadata and audio file structure are essential. This audiobook project is well-structured and has excellent introductions. Further, the addition of metadata to the Dublin Core has been used to describe audiobooks, and a thumbnail improves usage for a better user experience.

11.6 File Format

The audiobooks in this project are saved in MP3 and MP4 formats with an appropriate bit rate to balance audio quality and file size. This allows students with print disabilities to access and download the audiobooks on various devices

11.7 Storage and Distribution

DSpace7 open-source institutional repository software was used to store audiobooks. This software helps students access audiobooks anywhere in college campuses. Therefore, this project is restricted to students with print disabilities, and regular students are not permitted to download or use audio books. Fig. 1: Digital Repository Homepage: This figure presents the main landing page of the digital repository, showcasing its layout and key features. Fig. 2: Content

Page: This figure displays a typical content page within the repository, illustrating how information is organised and presented. Fig. 3: Audio Player Page: This figure demonstrates the dedicated audio player page, highlighting its controls and functionalities. Fig. 4: Student Service Utilisation: This figure visualises how students engage with various services offered by the platform, providing insights into usage patterns and trends.

11.8 Feedback and Modification

After listening to the audiobook, feedback from students with print difficulties was gathered to improve their future audiobook efforts. Most students suggested improving their voice quality for the sake of studying.



Figure 1. Digital repository home page.

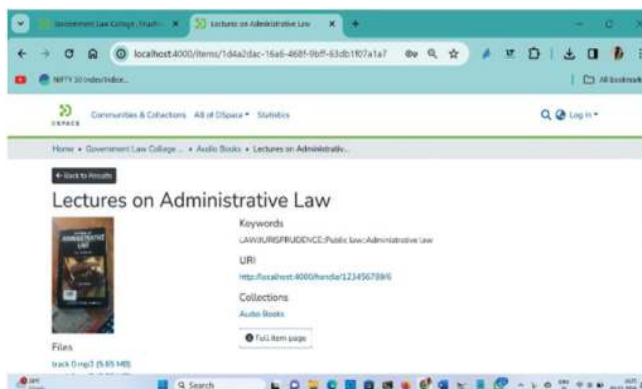


Figure 2. Content page.

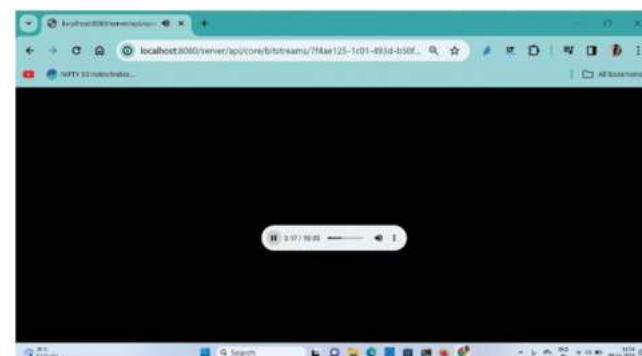


Figure 3. Audio player page.



Figure 4. Service utilisation by students.

12. SUGGESTION & CONCLUSION

The project to convert printed law books into audio books at the Government Law College Tiruchirappalli Library has been successful in helping students with print disabilities. However, students pointed out that audio quality needs to be improved. Future studies could focus on improving audio quality and finding other accessible formats such as Braille and large fonts to meet the different needs of disabled students. This study indicates that all law books should be converted into audio books.

Also, getting financial help and technical support is crucial to turn all printed law books into audio books, making sure that all students with print disabilities in Tamil Nadu and India can benefit from this. The project aims to make legal materials more accessible for people with print disabilities. By addressing the issues raised by students and looking into new research areas, libraries can continue to be important in providing access to information and education in an inclusive and fair way.

REFERENCES

1. Wang, X. & Fujieda, M. Static knowledge vs. dynamic argumentation: A dual theory based on kripke semantics. *arXiv*, 2022. doi: 10.48550/arXiv.2209.13082
2. Anumol, R.B. & Anuja, S.B. Indian paper currency recognition framework for blind and visually impaired people using deep learning model. In the international conference on scientific innovations in science, technology, and management (NGCESI-2023), 2023, pp. 1-15. https://ijatem.com/wp-content/uploads/2023/08/IJATEM_NGCESI-2023_001.pdf (accessed on 20 Dec. 2023)
3. Laxman, P. Indian constitutional provisions on school education. *International Journal of Multidisciplinary Research* 2023, **5**(4), 1-3. <https://doi.org/10.36948/ijfmr.2023.v05i04.5356>
4. Singh, D. & Mishr, R.S. Equity and inclusion in indian education: Constitutional principles and NEP 2020 approaches. *BSSS J. Educ.*, 2023, **XII**(1), 106-117.
5. Grigas, V. & Gudiniavičius, A. Book publishing and print disabilities. *Logos*, 2023, **34**(1), 61-70. doi: 10.1163/18784712-03104059

6. Ministry of Education, National Education Policy, Government of India, 2020. <https://www.education.gov.in/nep/about-nep> (accessed on 18 Dec. 2023)
7. University Grants Commission (UGC). Accessibility guidelines and standards for higher education institutions and universities, Government of India, 2022. <https://www.ugc.gov.in/Guideline> (accessed on 18 Dec. 2023)
8. National Assessment and Accreditation Council (NAAC). Standard operating procedure (SOP) for data validation and verification of affiliated colleges manual, Government of India, 2022. http://naac.gov.in/images/docs/Manuals/revised_2022/Updated-SOP-for-HEIs-Revised-Affiliated-compressed_manual_28-4-22n.pdf (accessed on 18 Dec. 2023)
9. Copyright office. Exceptions to infringement under copyright act, India, 1957. <https://copyright.gov.in/Exceptions.aspx>(accessed on 20 Dec. 2023)
10. Hadjidakou, K. Improving disabled students' learning: Experiences and outcomes. *Int. J. Disabil., Dev. & Educ.*, 2012, **59**, 125-126. doi: 10.1080/1034912X.2012.654981
11. Konya, U.; Cihan, F. & Bayrak, E. Disabled services in turkish university libraries: Istanbul university central library: The project of 'Information Centre for (Dis) Abilities'. *Qual. Quant. Methods Libr.*, 2014, 69-74.
12. Girish, A. & Vaidyanathan, S. Visually impaired persons and access to copyrighted works: The indian roadmap. *Indones. J. Int. Law*, 2021, **18**(4), 501-522. doi: 10.17304/ijil.vol18.4.821
13. Scaria, A.G. Does india need digital rights management provisions or better digital business management strategies?. *Journal of intellectual property rights*, 2012, **17**(5), 463-477. <http://nopr.niscpr.res.in/handle/123456789/14771> (accessed on 18 Dec. 2023)
14. Ahmed, M.R. & Naveed, M.A. Information accessibility for visually impaired students. *Pak. J. Inf. Mgmt. & Libr.*, 2020, **22**, 16-36. doi: 10.47657/1793
15. Anis, R. Use of electronic information services in the visually impaired libraries. *Indian Journal of Information Sources & Serv.*, 2015, **5**(1), 14-19. doi: 10.51983/ijiss.2015.5.1.421
16. Shukla, R.K. Library services to blind users in digital environment: Their fundamental right in the information age. In Seminar Papers 51st All India Conference: ILA, 2005, pp. 183. <https://drtc.isibang.ac.in/ldl/bitstream/handle/1849/305/RAJESH-BHARDWAJ-4.pdf?sequence=1&isAllowed=y> (accessed on 18 Dec. 2023).
17. Liu, Y. Risk and preventive strategy of network security in university digital library. In 9th International conference on management, education and information (MEICI 2019). 2019, pp.133-137. (accessed on 18 Dec. 2023) doi: 10.25236/meici.2019.026
18. Kumar, S. & Sanaman, G. Web challenges faced by blind and vision impaired users in libraries of

- delhi: An Indian scenario. The Electronic Library, 2015. **33**(2), pp. 242-257.
doi: 10.1108/EL-03-2013-0043
19. Smadi, O.Y. The satisfaction level of students with disabilities with library and information services. *International Journal of Education in Mathematics, Science, and Technology (IJEMST)*, 2022, **10**(2), 436-457.
doi: 10.46328/ijemst.2352
 20. Davies, D.K.; Stock, S.E.; King, L.R. & Wehmeyer, M.L. "Moby-Dick is my favorite: "Evaluating a cognitively accessible portable reading system for audiobooks for individuals with intellectual disability. *Intellect. & Dev. Disabil.*, 2008, **46**(4), 290-298.
doi: 10.1352/1934-9556(2008)46[290:MIMFEA]2.0.CO;2.
 21. Esteves, K.J. Audiobooks for struggling readers: Using audio-assisted reading in a balanced literacy program. *Scholarship & Prof. Work – Educ.*, 2009. <https://digitalcommons.butler.edu/coepapers/73> (accessed on 20 Dec. 2023)
 22. Boberg, C.; Nerbonne, J. & Watt, D. Handbook of dialectology. John Wiley & Sons, *Inc.*, 2017, 1-600.
doi: 10.1002/9781118827628

ACKNOWLEDGEMENT

We would like to express my deep gratitude to the Director of Legal Studies Prof.(Dr) J. Vijayalakshmi and the Dr. M. Rajeswaran Principal Government Law College, Tiruchirappalli, for their unwavering support and encouragement throughout the process of writing this research article. Their guidance and dedication have been invaluable, and their commitment to advancing legal education has inspired this work.

CONTRIBUTORS

Dr. N. Suresh has 20 Years of experience in various kinds of libraries and is credited with the introduction of several innovative technology-based services and facilities at the Government Law College, Tiruchirappalli Library. In addition to the Government Law College Tiruchirappalli, he assisted in the implementation of library automation using Koha open-source software, and developed an institutional repository with DSpace for variance institutions.

His contributions to this study were conceptualisation and draft of the paper.

Mr. T.C. Thirunavukkarasu is an experienced Librarian and Information Assistant with 12 years of expertise. He holds an MSc in Information Science, MA in Public Administration, and a PGDLAN. He has worked at Anna Centenary Library and TSN College of Arts and Science, among others. Thirunavukkarasu is a UGC NET qualifier, a visiting faculty at Ordnance factories institute of learning, and the joint secretary of madras library association.

His contribution to this study was to review the related literature and develop the final draft paper.

Prof. R. Rajyavardhanan has taught for over 14 years, His expertise includes intellectual property law, business law and environmental law. Participated and presented papers at over two dozen national and international seminars. Has been teaching Intellectual property and business law to students in undergraduate and postgraduate schools for more than 14 years. His contributions to this study were legal opinion about copy right act 2012.

Ranking of The Colleges in India: A Study of The Elite Club

Sanjoy De[#], Soumen Teli^{§,*}, Surajit Mandal[!], and Sujit Raychaudhury[^]

[#]Department of Economics, Shyampur Siddheswari Mahavidyalaya, Howrah - 711 312, India

[§]Central Library, Shyampur Siddheswari Mahavidyalaya, Howrah - 711 312, India

[!]Department of Physics, Shyampur Siddheswari Mahavidyalaya, Howrah - 711 312, India

[^]Library, IIT Kalyani, Kalyani - 741 235, India

*E-mail: soumenn165@gmail.com

ABSTRACT

The National Institutional Ranking Framework (NIRF) comes out with rankings of top degree colleges of countries on the basis of certain broad parameters. A lot of uproar surrounds this ranking. Here we attempt to look into this ranking through a critical lens. From the aggregative analysis we see that all the broad parameters - 'Teaching, Learning & Resources', 'Research and Professional Practice', 'Graduation Outcomes', 'Outreach and Inclusivity' and 'Perception' have some positive influence on overall rank at 5 % level of significance. The present study also digs deep into these parameters and segregates the sub-parameters as per the production technology perspective. In fact, the distinct segmentation of the sub-parameters into inputs and outputs allows us to conduct data envelopment analysis for preparing the ranks for the colleges. The ranks that we find through this approach show some divergence from the NIRF ranks. Some move up the ladder while some falter down. From the resource generation standpoint, the results also show scope for improvements. The study shows that about 40 % of the top 100 colleges in the country are operating less than efficiently. However, this study only includes the elite 100 colleges in India and examines the resource conversion gap.

Keywords: Ranking; NIRF ranking; Rank consistency; Efficiency analysis; Kendall's tau; Data efficiency

1. INTRODUCTION

Ranking the Higher Educational Institutions (HEIs) has become a standard custom throughout the world. Rankings provide straight forward information about the quality and affairs of an institution. It also simplifies and clarifies matters for the interested parties¹. This type of evaluation is also very challenging as different higher educational institutes have their own peculiarities, distinct strengths or weaknesses, varied sizes, programs, disciplines and resources. The socio-economic condition of the locality where the institution is situated also bears huge importance in the estimation of ranks².

The National Institutional Ranking Framework (NIRF) under the aegis the Ministry of Human Resource Development (MHRD) has released the ranking of Higher Educational Institutes (HEIs) in the country for the latest available year, i.e., year 2023. In this paper we are bothered about only the ranks given to the top 100 colleges in India by the NIRF³. We attempt at analysing the ranks at the aggregative level and also check the concordance of the overall ranks with the ranks attributed to different parameters. The distinct separation of the parameters alongside the different sub-parameters into inputs and

outputs provides us the chance to conduct non-parametric Data Efficiency Analysis (DEA). This efficiency study allows us to come out with our own ranking of the colleges. Notably, application of DEA technique in education sector is a well-known practice since the early phase of DEA development. Studies on various types of academic institutions including primary and secondary educational institutions, colleges, universities, departments, training institutes used DEA techniques. In India, there is some modicum of literature on the efficiency studies on education sector. The present study utilises the NIRF data and conducts non-parametric DEA technique. It also checks the concordance of college ranks in different sub-parameters with that of the grand rank and among the ranks in different sub-parameters.

Efficiency studies, particularly of the academic institutions, are of huge significance as the higher educational institutes in India are plagued with huge resource crunch. Proper allocation of funds and effective utilisation of the paltry academic resources warrant a thorough efficiency examination which deals with resource use pattern. Majority of the studies on HEIs put emphasis on the quality of education and gave very less emphasis on the role of efficiency. The present study analyses the technical efficiency of top 100 colleges in India using the data provided by the NIRF.

The paper is divided in six sections. Brief literature and the data used to conduct this exercise, are explained in section 2 and section 3 respectively. In Section 4, we embark upon using a sophisticated efficiency analysis tool. The parameters which contain both some inputs and outputs pertinent to the education sector, allow us to carry out non-parametric data efficiency analysis here. The underlying methodology is provided here. We also look into the consistency of the overall rank in this section. The findings of the efficiency results are kept in section 5. Finally, we conclude in section 6.

2. LITERATURE REVIEW

Several studies have assessed the indicators of the ranking system in the field of higher education. Nassa⁴, *et al.* studied the performance of HEIs during the period 2016 to 2020 on various performance yardsticks. The study came to the conclusion that over the five years, parameters such as the number of publications including the highly-cited publications and citations by the institutions have grown in importance. Mukherjee⁵ investigated the feasibility of the factor ‘research and professional practice’ in the NIRF ranking by examining the research credentials of scientists from five top-notch Central Universities in India for a period of three years. The study recommended that an altogether different type of ranking framework should be there for universities that focus chiefly on research and development and for those which concentrate primarily on teaching.

Verma⁶, *et al.* studied the Ranking of eight National Institutes of Technology (NITs) in the northeast region of India. They found that NIT Silchar, Assam emerged as the best performer in various categories such as web pages, internal and external links, Web Impact Factor, and obviously grabbed the top rank among all NITs. In a study, Mondal Singh⁷, *et al.* assessed the contributions put forward by the best 25 universities in different sub-parameters, as prescribed by NIRF. The study showed that the Bangalore-based Indian Institute of Science secured top score in the parameter ‘Teaching, Learning, and Resources’ and ranked first in the university category. On the other hand, Jawaharlal Nehru University attained the top score in ‘Graduation Outcomes’ and ‘Outreach and Inclusivity’ categories, but it was ranked second.

Ray⁸ employed DEA and regression modelling technique to estimate efficiency in Connecticut’s public schools. The study reveals that productivity varies significantly across district due to socio-economic divergences, while managerial efficiency variation is less than the DEA results suggest. Sengupta⁹, *et al.* analyses school data from an Indian district, revealing significant discrepancies in deprivation, social, and policy indicators, which adversely affect the efficiency of the primary school education system. Arshad¹⁰ uses TIMSS 2011 data from 40 countries and DEA method to calculate the level of technical efficiency. The study found that almost all the members of the Organisation of Islamic Cooperation are technically inefficient in using their educational resources.

Mohapatra¹¹ evaluates India’s efficiency in class 10 levels using two outputs and five inputs. Out of 23 states, only 10 were efficient, with Goa turning out to be the most super-efficient state. The study suggests that all super-efficient states can lower their input use while remaining efficient, potentially improving the country’s educational standard. Ghose¹² evaluates the efficiency of primary and upper primary education in India. In her study, she considered both output and input-oriented measures of technical efficiency. The study identifies factors affecting efficiency, such as central grants, infrastructure at the school level, social indicators, and policy variables.

Prathap¹³ analysed the 2019 scores from NIRF for the elite 100 colleges from the construct validity perspective. The study found disproportionately high regional biasness among the top 100 colleges. They found that in 2019, 82 % of the top 100 colleges in India were from Tamil Nadu, Delhi, and Kerala only. They also identified that the parameter ‘perception’ used as a parameter is flawed with potential biasness. They suggested that the application of the input-output model-based X-score, might offer a precise result.

In fact, there is no ubiquitously accepted ranking procedure. Different researchers are of diverse opinions regarding the selection of ranking procedure and the importance of parameters. But, nowadays, the DEA technique, Stochastic Frontier Analysis and free disposal hull are frequently used in analysing the efficiency of the HEIs across the globe¹⁴⁻¹⁶. Here we employ DEA technique. Additionally, we check rank consistency so as to acquire some idea about the concordance of overall score with the scores obtained under different parameters. This concordance checking actually provides some solid theoretical justification for taking recourse to the efficiency analysis.

3. DATA USED: NIRF RANKING FRAMEWORK

The NIRF has published the ranking of educational institutions including the colleges in the country latest for the year 2023. Five parameters-Teaching, Learning & Resources (TLR), Research & Professional Practice (RP), Graduation Outcomes (GO), Outreach & Inclusivity (OI) and Perception (PR) – have been used for the determination of ranks. Each of these parameters includes several other sub-parameters. A particular weighting system, as given in GOI¹⁷ is used to arrive at the aggregate score for an institution. On the basis of aggregate score, the incumbent institutions are ranked. The paper is built upon using data from various sub-parameters of the aforementioned broad parameters to arrive at our own ranks of colleges.

Since there is lack of comprehensive third-party database for carrying out such a gigantic exercise across the breadth and width of the country, relevant information are sought by the NIRF from the higher educational institutions. Different HEIs report information in the specific format in the NIRF portal. To ensure that a reporting institution does not resort to unethical practices, the NIRF has also been empowered to conduct

physical verification. Additionally, NIRF can access some internationally recognised databases such as Indian Citation Index, Web of Science, Scopus or other suitable sources if it deems fit to do so in the interest of rationalisation necessitated by the exigencies or the nature of the data encountered.

The parameters used for the estimation of the grand score can be distinctly categorised into inputs and outputs. This allows us to conduct non-parametric data envelopment analysis. In the *model 1*, we take some sub-parameters from the broad parameters ‘Teaching, Learning & Resources (TLR)’ and ‘Outreach & Inclusivity (OI)’ as inputs. These include sub-parameters ‘Student Strength (SS)’, Faculty-student ratio (FSR)’, ‘Faculty with Quality and Experience (FQE)’, ‘Financial Resources and their Utilisation (FRU)’ hailing from the broad parameter ‘Teaching, Learning & Resources (TLR)’. The inputs emanating from the broad parameter include ‘Outreach and Inclusivity (OI)’ include ‘Region Diversity (RD)’, ‘Women Diversity (WD)’, ‘Economically & Socially

Challenged Students (ESCS)’, ‘Facilities for Students who are Physically Challenged (PCS)’. So, there are eight inputs. For selection of outputs, we relied upon the broad parameters-*Research & Professional Practice (RP)*, *Graduation Outcomes (GO)* and *Perception (PR)*. From Research & Professional Practice (RP), we have chosen ‘Combined metric for Publications (PU)’, ‘Combined metric reflecting Quality of Publications (QP)’ and from Graduation Outcomes (GO), we have picked ‘Combined metric for Placement, Higher Studies, and Entrepreneurship (GPH)’, ‘Metric for University Examinations(GUE)’, ‘Median Salary(MS)’ as outputs. Score obtained in *Perception (PR)*, has also been taken as an output. So, there are six outputs. In *model 2*, we have dropped the output variable Perception (PR), because of its subjective nature. All other inputs and outputs have remained the same in model 2. Classification of inputs and outputs are given in Table 1 for easy reference. This classification is upon the methodological framework provided by the Source: NIRF, Ministry of Human Resource Development⁹.

Table 1. Classification of inputs and outputs

	Broad parameter	Inputs	Outputs
Model 1	Teaching, Learning & Resources (TLR)	‘Student Strength (SS)’, Faculty-student ratio (FSR)’, ‘Faculty with Quality and Experience (FQE)’, ‘Financial Resources & their Utilisation (FRU)’	-
	Outreach and Inclusivity (OI)	‘Region Diversity (RD)’, ‘Women Diversity (WD)’, ‘Economically & Socially Challenged Students (ESCS)’, ‘Facilities for Students who are Physically Challenged (PCS)’	-
	Research and Professional Practice (RP)	-	‘Combined metric for Publications (PU)’, ‘Combined metric reflecting Quality of Publications (QP)’
	Graduation Outcomes (GO)	-	‘Combined metric for Placement, Higher Studies, and Entrepreneurship (GPH)’, ‘Metric for University Examinations(GUE)’, ‘Median Salary(MS)’
	Perception (PR)	-	Perception (PR)
Model 2	Teaching, Learning & Resources (TLR)	Student Strength (SS)’, Faculty-student ratio (FSR)’, ‘Faculty with Quality and Experience (FQE)’, ‘Financial Resources & Utilisation (FRU)’	--
	Outreach and Inclusivity (OI)'	‘Region Diversity (RD)’, ‘Women Diversity (WD)’, ‘Economically & Socially Challenged Students (ESCS)’, ‘Facilities for Students who are Physically Challenged (PCS)’	‘Outreach and Inclusivity (OI)’
	Research and Professional Practice (RP)	--	‘Combined metric for Publications (PU)’, ‘Combined metric reflecting Quality of Publications (QP)’
	Graduation Outcomes (GO)	-	‘Combined metric for Placement, Higher Studies, and Entrepreneurship (GPH)’, ‘Metric for University Examinations(GUE)’, ‘Median Salary(MS)’

Source: Prepared by the authors with NIRF data

4. METHODOLOGY

The study focuses on developing ranking of the 100 colleges based on the data provided in the NIRF set up. We resort to the output-oriented DEA technique to derive our ranks for the elite 100 colleges. The paper also attempts at to look into the consistency of NIRF ranks by employing simple statistical technique.

4.1 Use of Non-Parametric DEA Analysis

In order make an efficiency analysis, it is necessary to treat education as a production exercise where inputs are turned into outputs. Given the education technology, one can gauge the ability of an institution to transform inputs more efficiently than others. Since the production technology in higher education is not exactly specified, the use of non-parametric DEA is perhaps the only feasible way out here.

Some attempts have been initiated across the globe to evaluate the efficiency level of public universities and the HEIs. Studies have been conducted that applied DEA method so as to have some information about the operations of UK universities¹⁸⁻¹⁹. Later, Abbott and Doucouliagos²⁰ and Avkiran²¹ used DEA to ascertain the efficiency levels in universities in Australia. Cadavid²², *et al.*, conducted an efficiency analysis of 32 public universities in Columbia for the year 2012. The universities were then ranked using Pareto efficient cross efficiency model.

In India, usage of DEA methodology for examining the efficacy of HEIs is comparatively less. Tyagi, Yadav and Singh²³ resorted to the DEA technique to assess the performance of nineteen academic departments of the Indian Institute of Technology, Roorkee. Various combinations of inputs and outputs such as academic and non-academic staff, number of enrolled students, operating expenses, development and research aspects were used to judge the performance of various departments.

More recently, Srinivasan²⁴, *et al.*, used the NIRF data to construct efficiency using DEA method. This method emphasises on the perception aspect of the NIRF scheme. It uses the fuzzy method to transform multiple inputs and outputs into a single virtual input and single virtual output for each HEI. The efficiency of each HEI “is obtained as the ratio of this single virtual output to single virtual input and it is a function of the corresponding multipliers.”

Once we are able to zero in on the inputs and outputs, we can embark upon the non-parametric DEA. Notably, this linear programming method aids in the construction of a piece-wise linear set. This actually serves as the envelope of a set of observed input and output variables..

Following Ray²⁵, suppose ‘N’ represents the number of Decision Making Units (DMUs). Also consider that by using ‘h’ number of inputs, each DMU produces ‘g’ number of outputs. The input basket applicable to typical DMU t is given by - $x_t = (x_{1t}, x_{2t}, \dots, x_{ht})$ and the output bundle produced is represented by $y_t = (y_{1t}, y_{2t}, \dots, y_{gt})$. Now, it is assumed that the production function under consideration exhibits constant returns to scale (CRS)..

In such situation, if (x, y) is feasible then for any λ_j is also feasible. Here, the production possibility frontier under the assumption of CRS can be symbolised as–

$$T^{CRS} = \{(x, y) : x \geq \sum_{j=1}^N \lambda_j x^j; y \leq \sum_{j=1}^N \lambda_j y^j; \lambda_j \geq 0; (j=1, \dots, N)\} \dots\dots(a)$$

Here λ_j is feasible and is for all . For any DMU, the mathematical solution of the below mentioned liner programming problem proves the estimate of the output oriented technical efficiency

$$\begin{aligned} & \text{Max } \phi \\ & \text{Subject to } \sum_{j=1}^N \lambda_j y_{rj} \geq \phi y_{rt}; (r=1, 2, \dots, g) \\ & \sum_{j=1}^N \lambda_j x_{ij} \leq x_{it}; (i=1, 2, \dots, h) \\ & \sum_{j=1}^N \lambda_j = 1, \lambda_j \geq 0; (j=1, 2, \dots, N) \dots\dots(b) \end{aligned}$$

Knowing ϕ , the maximum value of ϕ , by solving equation (b), output oriented TE of firm can be determined by using equation (c).

$$TE_0^{cr} = TE_0^{cr}(x^t, y^t) = 1/\phi^* \dots\dots(c)$$

Where ϕ^* is the solution to equation (b), which shows the maximum value of ϕ . Also, y^* can be considered as the maximum output bundle that can be produced from the input bundle x^t and is defined as $y^* = \phi^* y^t$.

Under ϕ CRS, ϕ^* and y^* can be estimated by solving equation (b) along with the constraint $\sum_{j=1}^N \lambda_j = 1$ taking into consideration the CRS frontier (equation a). With knowledge of ϕ^* , determination of technical efficiency of the firm can be ascertained.

4.2 Use of Kendall’s tau (τ) Test for Checking Rank Consistency

We also check the concordance of college ranks attained under different types of metric with that of the grand ranking and among the metrics. For doing that we use non-parametric Kendall’s tau (τ) test²⁶. Kendall’s tau is a coefficient that represents the degree of concordance between two sets of ranked data on the same set of individuals. Tau-a is used for non-tied ranks, which we are taking into consideration here. Kendall’s tau (τ) can be mathematically depicted as the following:

$$\tau = \frac{C - D}{C + D}$$

where C and D are the numerical number of

concordant pairs and the discordant pairs respectively. For a concordant pair, (x_2-x_1) and (y_2-y_1) have the same sign. For a discordant pair (x_2-x_1) and (y_2-y_1) have the opposite signs Kendall's measure is regarded as suitable measure for studying the degree of association among three or more sets of rankings.

5. FINDINGS

From the results obtained from non-parametric efficiency analysis, it is observed that in both model 1 and model 2, about 40 % of the top colleges are operating less than efficiently (Table 2). In model 1, 27 % of the colleges and in model 2, 29 % of the elite colleges are 'moderately efficient' (efficiency score more than equal to 0.90 but less than unity). In both the models, 9 % of the colleges are 'less efficient' (efficiency score more than equal to 0.80 but less than 0.90). In model 1, 3 % colleges are 'least efficient' (efficiency score less than 0.80), whereas this figure is 4 % in case of model 2. This actually reveals the fact that there is huge scope for improvement given the existing resources of these elite colleges in India. This does not provide a very bright picture of our higher education system. There is huge scope for improvement given the existing resources.

Table 2. Distribution of efficiency scores

Efficiency scores	Efficiency model 1 -Frequency	Efficiency model 2- Frequency	Level of efficiency
Score<0.80	3	4	Least efficient
0.80≤Score<0.85	3	5	Less efficient
0.85≤Score<0.90	6	4	
0.90≤Score<0.95	13	18	Moderately efficient
0.95≤Score<1	14	11	
Score=1	61	58	Efficient
Total	100	100	

Source: Author's calculation

Table 4. Consistency of NIRF ranks: overall rank VS ranks on broad parameters

	Overall	Teaching, learning & resources	Research and professional practice	Graduation outcomes	Outreach and inclusivity	Perception
Overall	1					
Teaching, Learning & Resources	0.2899* 0.0000	1				
Research and Professional Practice	0.3345* 0.0000	-0.0483 0.4784	1			
Graduation Outcomes	0.3077* 0.0000	0.0558 0.4128	-0.1655* 0.0148	1		
Outreach and Inclusivity	0.1994* 0.0033	0.1099 0.1058	-0.1461* 0.0315	0.2368* 0.0005	1	
Perception	0.3982* 0.000	0.0489 0.4728	0.1667* 0.0141	0.1244 0.0669	0.0416 0.5414	1

Source: Author's calculation

Table 3. Some basic statistics of efficiency scores

Statistic	Model 1	Model 2
Mean	0.965	0.960
STDEV	0.062	.0671
CV	6.455	6.996
MIN	0.664	0.645
Max	1	1
Skewness	-2.426	-2.256
Kurtosis	9.671	8.694

Source: Author's calculation

From table 3 we find that there is not much difference between the values of some basic statistics of efficiency score derived in the two models.

Also, we see discernible changes in the NIRF ranks of the colleges from that of our ranks. Tamil Nadu-based PSGR Krishnammal College for Women, , which grabbed fourth rank in NIRF yardstick, falters down to the sixty sixth rank as per DEA ranking (Model 1). Similarly, Atma Ram Sanatan Dharm College, New Delhi, which gets a NIRF rank of sixth, falls down to sixty seventh rank as per DEA ranking (Model 1). On the contrary, Scottish Church College, West Bengal (NIRF rank 100) moves up the ladder to seventy third position (Model 1).

From model 2, we see that Presidency College, Tamil Nadu, the third top ranked colleges, moves down to ninety seventh rank in our ranking. Again, Queen Mary's College, Tamil Nadu (NIRF rank 60), gets thirty second rank as per DEA ranking (Model 2).

Now, if we look at the relationships between overall NIRF ranks and the ranks on broad parameters, we see that all these broad parameters have positive correlation with the overall ranks at 5% level of significance. This provides justification of utilising these broad parameters in influencing the overall rank of an HEI (Table 4).

Now, if we look at the pair wise concordance, we find positive statistical relationship between ‘Research and Professional Practice’ and ‘Perception. Quite naturally, excellence in research and quality publication activities has positive bearing on the subjective parameter ‘Perception’. Also, there is statistically positive concordance between ‘Outreach and Inclusivity’ and ‘Graduation Outcomes’. This signifies that increased diversity in the college level is translated to better placement, enhanced salary and transition to top universities. However, there is negative statistical relationship between ‘Research and Professional Practice’ and ‘Graduation Outcomes’, which is not quite natural. Same kind of unusual negative relation is seen between ‘Research and Professional Practice’ and ‘Outreach and Inclusivity’ too.

Here it is also to be noted that though non- parametric DEA approach is indeed very useful in examining the efficiency level of academic institutions, but it is also very sensitive to the presence of outliers. Presence of extreme value in data can significantly impact results. The study, though involves the top 100 colleges in the country, shows perceptible variations in the data set.

Moreover, here, we are actually analysing the performance of top 100 colleges in India as per the NIRF report card. As per the All India Survey of Higher Education Final Report 2021-22, 42,825 colleges responded in the survey and of which 25,719 colleges (60.1 %) are General in nature (GOI 2022). So, the top 100 colleges with enhanced infrastructure, finance and other facilities do not provide much information about the real picture of the college education in India. It is ordinarily believed that there is not much novelty in the better performance of this elite club. Technically speaking, these institutes should have higher efficiency score. In fact, in both the models that we have derived, the efficiency score of majority of the colleges lie above 80 %. This actually instigated us to set a higher standard of efficiency level. We have selected the colleges in the efficiency range ($0.90 \leq \text{Score} < 1$) as moderately efficient, colleges in the efficiency range ($0.80 \leq \text{Score} < 0.90$) as Less efficient and colleges in the efficiency range ($\text{Score} < 0.80$) as least efficient.

6. CONCLUSION

Even among the top 100 colleges in the country, with more financial and physical facilities, around 40 % colleges are operating less than efficiently. This actually reveals that there is huge scope for improvement given the existing resources of these elite colleges in India.

We see some topsy-turvy in the DEA ranks designed by us with that of the NIRF ranks. But, obviously the grand ranking that we framed has fair degree of converging trend also. Whatsoever, ranking is essential and it may also seem reasonable but with some caution. There is an urgent need to demarcate between First Boys and the last boys²⁷, and particularly the last girls. They must have to be judged, but on a different footing. In this case, efficient use of resources could be a good parameter.

It is unethical and impossible to judge a Lilliputian and a Brobdingnagian²⁸. In fact, this discourse of elite HEIs (only top 100 colleges in the country) does not provide a great idea about the measure of college education in the country as a whole. A study encompassing a sizable majority of the colleges can only provide better insights.

REFERENCES

1. Sandstrom, Anna-Malin. 10 reasons why rankings matter in higher education. 26 April 2016. <https://www.eaie.org/blog/10-reasons-rankings-matter-higher-education.html>. (accessed on 8 June, 2024).
2. Porzionato, M. & De Marco, F. Excellence and diversification of higher education institutions’ missions. In the european higher education area: Between critical reflections and future policies, edited by Curaj, A.; Matei, L.; Pricopie, R.; Salmi, J.; Scott, P. Springer, Cham, 2015. doi: 10.1007/978-3-319-20877-0
3. Ministry of education (India). All india survey on higher education 2021-22. Department of higher education, ministry of education, New Delhi, 2022.
4. Nassa, A.; Arora, J.; Singh, P.; Joorel, J.P.; Trivedi, K.; Solanki, H. & Kumar, A. Five years of India rankings NIRF and its impact on performance parameters of engineering institutions in India. *DESIDOC J. of Lib. & Inf. Tech.*, 2021, **41**(2), 116-129. doi: 10.14429/djlit.41.02.16674
5. Mukherjee, B. Ranking of indian universities through research and professional practices of NIRF: A case study of selected central universities in India. *Journal of Indian Library Association*, 2019, **52**(4).
6. Verma, M.K. & Brahma, K. Ranking of NITs of northeast vicinity of India on the idea of net effect aspect. *COLLET Journal of Scientometrics and Information Management*, 2017, **11**(2), 235-248. doi: 10.1080/09737766.2017.1292667
7. Mondal, D.; Singh, A. & Kar, D.C. Ranking of universities: A study for last four years of top 25 indian universities. *Indian Journal of Information Sources and Services*, 2021, **11**(2), 31-44. doi: 10.51983/ijiss-2021.11.2.2959
8. Ray, S.C. Resource-use efficiency in public schools: A study of connecticut data. *Management science*, 1991, **37**(12), 1620-1628. doi: 10.1287/mnsc.37.12.1620
9. Sengupta, A. & Pal, N.P. Assessing the primary schools-a multi-dimensional approach: A school level analysis based on indian data. *International Journal of Educational Development*, 2012, **32**(2), 264-272. doi: 10.1016/j.ijedudev.2011.04.006
10. Arshad, M.N.M. Efficiency of secondary education of a selected OIC countries. *Global Education Review*, 2014, **1**(4).
11. Mohapatra, R. Ranking of efficient states of India on the basis of performances in secondary education: An application of super efficiency models. *Asian Journal*

- of Research in Social Sciences and Humanities*, 2015, **5**(12), 1-15.
doi: 10.5958/2249-7315.2015.00254.3
12. Ghose, A. Efficiency of elementary education in India: Empirical evidence using a nonparametric data envelopment approach. Springer, 2016
 13. Prathap, G. Construct validity maps and the NIRF 2019 ranking of colleges. *Current Science*, 2019, **117**(6), 1079-1083.
<https://www.jstor.org/stable/27138389>
 14. Puertas, R.; Guaita-Martinez, J.M. & Marti, L. Analysis of the impact of university policies on society's environmental perception. *Soc. Econ. Plan. Sci.*, 2023, 101672.
doi: 10.1016/j.seps.2023.101672
 15. Kuah, C.T. & Wong, K.Y. Efficiency assessment of universities through data envelopment analysis. *Proc. Comput. Sci.*, 2011, **3**, 499-506.
doi: 10.1016/j.procs.2010.12.084
 16. Giraleas, D. Can we assess teaching quality on the basis of student outcomes? A stochastic frontier application. *Stud. High. Educ.*, 2021, **46**(7), 1325-1339.
doi: 10.1080/03075079.2019.1679762
 17. Ministry of HRD (India). National institutional ranking: Methodology for ranking of academic institutions in India. Ministry of human resource development, New Delhi, 2017.
 18. Athanassopoulos, A. & Shale, E. Assessing the comparative efficiency of higher education institutions in the UK by means of data envelopment analysis. *Educ. Econ.*, 1997, **5**, 117-134.
doi: 10.1080/09645299700000011
 19. Flegg, A.T.; Allen, D.O.; Field, K. & Thurlow, T.W. Measuring the efficiency and productivity of british universities: An application of DEA and the malmquist approach. *Educ. Econ.*, 2004, **12**, 231-249.
 20. Abbott, M. & Doucouliagos, C. The efficiency of australian universities: A data envelopment analysis. *Economics of Education Review*, 2003, **22**, 89-97.
doi: 10.1016/S0272-7757(01)00068-1
 21. Avkiran, N.K. Investigating technical and scale efficiency of australian universities through data envelopment analysis. *Soc. Econ. Plan. Sci.*, 2008, **35**, 57-80.
doi: 10.1016/S0038-0121(00)00010-0
 22. Cadavid, D.M.; Gomez, M.M. & Guijarro, F. Assessing the efficiency of public universities through DEA: A case study. *Sustainability*, 2017, **9**(8), 1-19.
doi: 10.3390/su9081416
 23. Tyagi, P.; Yadav, S.P. & Singh, S.P. Relative performance of academic departments using DEA with sensitivity analysis. *Eval Program Plan*, 2009, **32**, 168-177.
doi: 10.1016/j.evalprogplan.2008.10.002
 24. Srinivasan, R.; Vidyottama, J. & Dharmaraja, S. Perception based performance analysis of higher education. *Soft Computing*, 2019, **24**, 513-521.
doi: 10.1007/s00500-019-03931-6
 25. Ray, S. Data envelopment analysis: Theory and techniques for economics and operations research. cambridge university press, Cambridge, 2004.
 26. Kendall, M.G. Rank correlation methods. Hafner Publishing Co., New York, 1955.
 27. Sen, Amartya. The country of first boys. and other essays. Oxford University Press, Oxford, 2016.
 28. Swift, Jonathan. Gulliver's travels. Penguin Random House, UK, 2016.

CONTRIBUTORS

Dr. Sanjoy De has more than 5 years' teaching experience. He has published many books and articles in various national/international journals, conference proceedings. His contributions towards the current work include: Statistical analysis and interpretation of data.

Dr. Soumen Teli has more than 7 years' experience of Librarian. He has published more than 20 articles in various national/international journals, conference proceedings, books, etc. His contributions towards the current work include: Writing and editing of the manuscript

Mr. Surajit Mandal has more than 10 years' teaching experience. He has published many book chapters and articles in various national/international journals. His contributions towards the current work include: Conceptualisation of ideas, review of literature and writing of the manuscript.

Mr. Sujit Raychaudhury is currently working as a Library Assistant at IIIT Kalyani. His contributions towards the current work include: Data collection and editing of the manuscript.

Assessing the University Virtual Library Spaces for Digital Information Services in Nigeria

Saturday U. Omeluzor* and Nelson Edewor

Federal University of Petroleum Resources, Effurun, Delta State - 330 003, Nigeria

**E-mail: omeluzor.saturday@fupre.edu.ng*

ABSTRACT

The university Virtual Library Space (VLS) is increasingly becoming a strategic source for information access. The digital libraries are opening up avenue to information for the virtual library users whose number is increasing exponentially. This current study assessed the use of VLS at the university library in Nigeria. A descriptive survey design was used with a population of 233 academic librarians at the federal, state and private universities in South-South zone of Nigeria. With a sample size of 213 (91.4 %) of the population who responded to the online questionnaire that were analysed, the findings shows that university libraries are at the threshold of increasing access to digital information with advancement in VLS. The finding showed that most university libraries in Nigeria have developed one form of virtual/digital space such as ILS, ERM, social media sites, library website, web catalog, institutional repository and library Blog. The findings revealed that more than 50 % of the respondents attested that they have used VLS frequently on daily, weekly, monthly and bi-monthly to disseminate digital information such as e-books, e-journals, dataset, lecture notes, students projects, e-thesis and dissertations, inaugural lectures, laboratory results and conference proceedings. The findings further showed that the major challenges facing the use of VLS at the university library were inadequate funding, lack of training, poor technical support, irregular power supply, poor internet connectivity, lower bandwidth and inadequate ICT infrastructure. The study concluded with specific recommendations to enhance the use of VLS at the university library for the benefit of library patrons.

Keywords: Virtual library space, Digital libraries, University library, South-south, Nigeria

1. INTRODUCTION

The advancement in technology is increasing the use of data, internet and other Information Technology (IT) tools to access digital information. The convergence of ICT is creating a community of library users who accesses critical digital information outside the physical library. The diversity of thoughts and users' behaviour leading to continuous access to information on the internet with the use of technology is raising a concern on how to engage the dynamic community of information users who are gradually shifting from the physical library towards the Internet for digital information sources. The library is any building or space containing collections of print and electronic information resources for use by community members¹ Some libraries are today facing existential challenges with the rapid technological growth in ICT coupled with the introduction of some advanced technology such as Artificial Intelligence (AI) and other innovative tools that are enhancing access, retrieval and information dissemination. Information is critical to library patrons for the preparation of academic works such as research, lecture notes, publications, assignments and examinations among others. Every researcher relies on relevant, current, authoritative and reliable information.

Hence, the over-dependence of library users on available digital information on the Internet is increasing the need to know whether there are Virtual Library Spaces (VLS) at the university libraries in Nigeria.

Envisaging the foreclosing challenges on the physical library, library collections and library profession, especially with the recent wave of COVID-19 that affected information services, this study focuses on how the university library is developing VLS for its users. VLS is a critical component that complements the physical library. There are a variety of terms that are used in the Library and Information Science to describe VLS, including digital library, electronic library, e-library, and virtual library² This study considers VLS as described in² that provides its users with quick and simplified access to all electronic resources from a single point. In this study, the term 'Virtual Library Space (VLS)' is used to describe a collection of information sources in an electronic format that is accessible on the Internet such as Institutional Repository (IR), database, Blog, website and Online Public Access Catalog (OPAC) among others. The collections of a VLS may include digital collections of pictures, articles, maps, videos, websites, or library records. This paper therefore investigates the development of VLS for users' engagement among university libraries in Nigeria and is guided by the following research questions:

1. Does the library have VLS on the Internet?
2. What kind of VLS does the library have on the Internet?
3. What are the available information resources on VLS?
4. What kind of request do librarians receive on VLS?
5. What is the frequency and kind of information that the library disseminates on VLS?
6. What are the challenges facing the development of VLS at the library?

2. LITERATURE REVIEW

The current library space is adjudged to serve mostly the traditional users who prefer to visit the library to access information sources such as books, journals and magazines. According to³ the declining number of visits to the physical libraries suggests that library patrons are accessing information electronically without visiting a library. Many large libraries and universities are currently digitising information with a view of making it accessible to members and the general public³. Modern users are accessing the library via technology. The information sector is developing with several non-practitioners engaging in information service provision. Academic libraries and publishing houses are rising to their responsibility of providing additional free resources and curating personalised sources so that patrons can have uninterrupted access to content for learning⁴.

The public library is changing rapidly due to developments in technology and the communication revolution⁵. With traditional the library in place and the introduction of VLS, the university library is playing a dual role of simultaneously providing access through the physical library and VLS. The learning demands, preferences and differences in information needs endear the library patrons to both virtual library and physical library². However⁶ stated that modern library users prefer virtual spaces, not somewhere they go physically for services but a place they reach from a remote location. Hence, reshaping the library space in this modern time requires the use of technology as its primary tool for learning and combinations of library collections and information technology in support of advanced research⁶. To achieve holistic information services, Wolff-Eisenberg⁷ suggested that the goals and challenges of students should be the central point for organising the right kind of spaces to meet the needs of patrons. As a result of the high demands, libraries are deeply increasing their educational roles; redefining their associations with users; and rethinking the use of virtual spaces for people and collections⁸.

The physical libraries are becoming less attractive to the information users in the digital age. There are diverse and convincing opinions about their future, services, goals and space in the 21st century⁵. Certainly, such debate is leading to the development of digital spaces that promote library services to its virtual community users⁹. The digital library curates all digital content and

makes it accessible on the library website for users to access. Most libraries in South Africa consider digital libraries as essential pathway to high-quality information resources and educational content, including Open Educational Resources OER⁴. During the COVID-19 pandemic, digital libraries enabled university libraries in South Africa to stand out in providing online services, therefore ensuring that learning, research and teaching were not truncated⁴.

The services of VLS span beyond the four walls of the library building. As long as the needs of the library users go beyond print to digital sources, the services of VLS are fast evolving. VLS development and designing can offer a rich learning environment². A study that examined VLS in Nigerian universities showed that 50.8 % and 57.7 % of respondents who were lecturers used VLS for email and academic research. A lower percentage of the respondents, 36.2 %, 19.2% and 18.5 % used VLS to network with colleagues on their ongoing papers, access teaching materials and publish works⁹. VLS not only provides content but presents documentary services that are bound by time-related restrictions and are useful resources in the educational field for students, teachers and researchers¹⁰. VLS also provides resources, access and help in promoting visual literacy where users have the capacity to analyse and assess information within a visual environment⁸.

The development of VLS is becoming prominent in this age of advancement in ICT. Before and during the COVID-19 pandemic, several university libraries were experimenting with new technologies to develop VLS to foster access and a sense of community among their users. For instance, Wolff-Eisenberg⁷ noted that "Johns Hopkins Sheridan Libraries hosted a YouTube live stream featuring study tips, ambient music, and backdrops of the library. Also, Scottsdale Community College Library built out demos to show students how they can collaboratively study with others in Google Hangouts, WebEx, and Zoom." Similarly, the University of Maryland, Baltimore County Library also hosted Zoom study rooms with the plan of using Discord in the future⁷.

The National Library of Nigeria (NLN) hosted some electronic information services including virtual library service, index to Nigeria newspapers, Online Public Access Catalog (OPAC) and National repository of Nigeria on its website¹¹. The resources allow access to digital contents for the virtual information users. Research has shown that some university libraries in Nigeria, including University of Jos and University of Nigeria Nsukka among others are maintaining VLS on their websites while most universities in Nigeria are digitising their information resources such as students' projects, theses and dissertations, inaugural lectures and lecture notes, making them available on their VLS to boost the quality of education and information services in Nigeria¹². Similarly, Otubelu¹³ reported that the National Open University Digital Library has online

services with the presence of electronic databases such as AGORA, Bibliomania, Bioline International, British Library for Development Studies and Chemistry Central for their virtual library users.

Despite the growing needs of users for VLS and digital information in Nigeria, there are challenges facing its advancement. One of the major constraints of VLS in university libraries in Nigeria is funding. Financial constraint poses a major problem for the growth of digital libraries¹⁴. Shrinking budgetary allocation for the library reduces the prospects and projected achievements of VLS in Nigeria which limits access to a wide range of electronic publications and databases¹⁴. Besides, Nigerian libraries are known to suffer budget cuts following the economic crisis affecting the country. Currently, inflation and the high cost of ICT tools are making digital library development prohibitively expensive¹². Technological challenge is another problem facing the development of university's VLS in Nigeria. According to Gbaje¹⁵, the lack of a national fiber network backbone infrastructure was a major issue for the successful execution of VLS. Bandwidth and internet connectivity for higher education institutions and their Internet service are not stable and reliable¹⁶. Other challenges affecting the use of VLS include poor and inadequate telecommunication facilities, lower computer literacy, poor computer facilities, inefficient ICT infrastructure and lack of awareness⁹. Furthermore, technical skills in maintaining web servers that host locally digitised materials and other digital resources were challenges^{9,14}. Similarly, a lack of technical infrastructure, epileptic power supply, network and Internet problems and librarians' lack of technical skills were found to be challenges for the development of VLS in Nigeria. In addition, inadequate training of academic librarians on ICT related skills is affecting their ability to manage VLS; coupled with poor technical support from developers and lack of efficient virtual resources were among the challenges facing the development of VLS in South-Eastern Nigeria libraries¹⁷.

3. METHODS

3.1 Research Approach

The descriptive survey design was adopted for this study. The descriptive survey design is a reliable means that provides the opportunity to use data that is collected for a single research and helps to show how such data is used in a study. The use of descriptive survey design has shown some significant level of consistency in social science research¹⁸

3.2 Population

The population of the study consist librarians at the federal, state and private universities in the South-South geo-political zone of Nigeria. Reports on headcount from various libraries in the South-South zone of Nigeria show that there were a total of 233 academic librarians in the federal, state and private universities. This number was

corroborated from the study of¹⁹. 'Among the respondents, 95 of them were from the federal universities, 93 of the respondents were from the state universities while 45 of the respondents were from the private universities given a total of 233.

3.3 Research Instrument

The instrument for data collection was a structured online questionnaire designed by the researchers using Google Form. The online questionnaire was used because it was easier to reach out quickly to all the respondents without the risks of travelling either by road or air and spending money on transportation. The instrument had seven sections (Section A to G). The seven sections focus on the demographics and the six research questions that were set to provide answers on this study.

3.4 Testing and Retesting of the Questionnaire

In order to ascertain the validity of the instrument, the researchers used pre-reliability tests such as face, content and construct checks. The researchers used the services of information professionals to ascertain the construct validity. The professional went through the instrument and made some minor corrections before she certified that the instrument was suitable for collecting data for the study. To verify the content validity, the researchers sent the instrument to 15 librarians at the Imo State University, located in the South-East geopolitical zone of Nigeria, who were not part of the population for the study. The 15 questionnaires were all returned and analysed using the Cronbach's Alpha correlation coefficient at the 0.5 level of acceptance, which gave a result of $r = 0.81$. This result indicates that the instrument was reliable and good for data collection for the study, since the test result was above the acceptance point of 0.5.

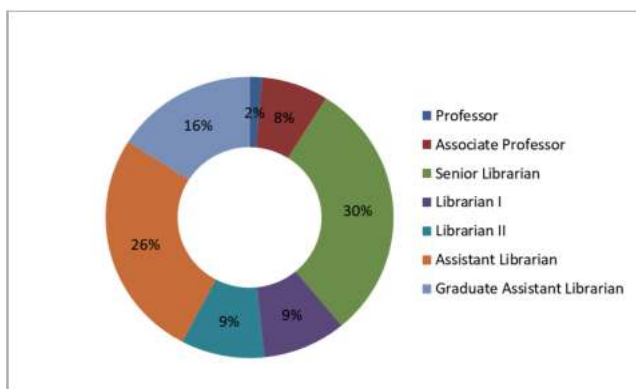
3.5 Distribution and Data Collection

The questionnaire was distributed to the respondents via the verified WhatsApp group of Nigeria Library Association (NLA) and individual verified WhatsApp and email addresses. The email addresses of the respondents were retrieved from an earlier attendance sheet of the Nigerian Library Association's annual conference and general meeting. The use of this method to send out the questionnaire directly to the respondents eradicated responses from unintended respondents. Out of the total population of 233 librarians who received the questionnaire, there were 213 responses, giving a 91.4 % response rate, and these were used for the analysis of this study. The data collected was analysed using SPSS (Statistical Package for the Social Sciences), version 16.0 for descriptive analysis. The result of the analysis is presented in charts, frequency tables, mean score and standard deviation for clarity and understanding. In Table 4, the mean scores are rated as follows: a mean of 0.1 to 1.9 is very low, 2.0 to 2.4 is low, 2.5 to 2.9 is high, and 3.0 and above is very high.

4. RESULT

Result showing the designation of the respondents

The result in Fig. 1 reveals that among the respondents, 3 (2 %) of them were professor, 16 (8 %) were Associate Professor, 64 (30 %) were Senior Librarian, 20 (9 %) were Librarian I and II respectively. It also shows that 56 (26 %) of the respondents were Assistant Librarian while 34 (16 %) were Graduate Assistant Librarian. The result indicates that the study has good representation of all categories of librarians in the South-South of Nigeria. On the qualification of the respondents, result shows that 34 (16 %) had Bachelors Degree, a higher number of the respondents 96 (45 %) had Masters Degree while 83 (39 %) of the respondents had Doctoral Degree.



N = 213

Figure 1. Designation of respondents.

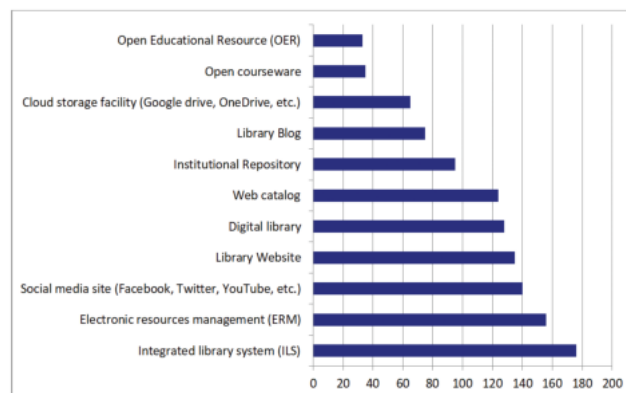
Providing information to the VLS is all an encompassing cutting across all the library departments; hence, the research sought to know the various departments of the respondents. The result reveals that 5 % of the respondents work at the Medical Library, 15 % of the respondents work at Special Collection and the Research and Development (R&D) units respectively. Another 14 % works at Acquisition Unit while 16 % of the respondents work at the Readers Services and Serials Units respectively. Result also shows that 8% of the respondents work at Open Access and E-Library respectively while 3% of the respondents were attached to the University Librarians' office. On the gender of the respondents, the result shows that 130 (61 %) of them were female while 83 (39 %) were male. The result reveals that there were more female librarians than their male counterpart which indicates a gender imbalance among the respondents.

5. FINDINGS

5.1 Research Question: Does the library have VLS on the Internet?

The first research question requires the respondents to indicate if their library had VLS. The result shows that majority or 199 (93 %) responded in the affirmative while a lower number or 14 (7 %) responded in the negative. The overwhelming positive response signifies that a larger number of university libraries in South-South zone of Nigeria have VLS for their library users.

5.2 Research Question: What kind of VLS does the library have on the Internet?



N = 213

Figure 2. Showing the kind of virtual library spaces.

The result in figure 2 shows the kind of virtual library space that the university library maintains on the Internet. The result reveals that 176 (82.6 %) of the respondents agree that their library has ILS, 156 (73.2 %) of the respondents agree that their library had ERM. Another 140 (65.7 %) of the respondents indicated that their library had social media sites (Facebook, Twitter, etc.), 135 (63 %) of the respondents agree that their library had website while 128 (60 %) of the respondents agree that their library had digital library. The result also reveals that 124 (58.2 %) of the respondents agree that their library had Web catalog, another 95 (44.6 %) of the respondents agree that they had institutional repository while 75 (35 %), 65 (30.5 %), 35 (16.4 %) and 33 (15.4 %) of the respondents agree that their library had Library Blog, cloud storage facility, open courseware and OER respectively. This result implies that the university library maintains several VLS on the internet.

5.3 Research Question: What are the available information resources on VLS?

The result in Table 1 reveals available information resources on university VLS. The result indicates that majority or 89.2 % and 83.6 % of the respondents affirm that e-books and e-journals were always and often available on their VLS. The result also shows that 89.2 % and 49.3 % of the respondents confirm that dataset and courseware were available. The result indicates that 73.7 % and 70.9 % of the respondents indicate that lecture notes and students' projects were always available. Another majority or 83.1 % and 73.7 % of the respondents indicate that e-theses/dissertations and inaugural lectures were always and often available on their VLS. The result shows that fewer respondents 36.6 %, 16.9 % and 30.5 % of the respondents strongly agree and affirms that laboratory results, video recording and image collection were always and often available while majority 63 %, 83.1 and 69.4 % indicate that the resources were rarely and never available. The result in Table 1 further shows that 78% and 79.4 % of the respondents state that newsletter and conference proceedings were always and often available on their VLS for their digital library users. This result implies that there were available electronic information resources on the university library VLS for its users.

Table 1. Showing available information resources on university library’s VLS

Available information resources	Always available	Often available	Rarely available	Never available
e-book	157 (73.7)	33 (15.5)	13 (6.1)	10 (4.7)
e-journal	121 (56.8)	57 (26.8)	13 (6.1)	22 (10.3)
Dataset	154 (72.3)	36 (16.9)	-	23 (10.3)
Courseware	49 (23)	56 (26.3)	-	108 (50.7)
Lecture notes	75 (35.2)	82 (38.5)	10 (4.7)	46 (21.6)
Students projects	65 (30.5)	86 (40.4)	13 (6.1)	49 (23)
e-theses and dissertation	88 (41.3)	89 (41.8)	-	36 (16.9)
Inaugural lecture	75 (35.2)	82 (38.5)	10 (4.7)	46 (21.6)
Laboratory results	65 (30.5)	13 (6.1)	86 (40.4)	49 (23)
Videos recording	36 (16.9)	-	88 (41.3)	89 (41.8)
Image collections	59 (27.7)	6 (2.8)	48 (22.5)	100 (46.9)
Newsletter	96 (45.1)	70 (32.9)	12 (5.6)	35 (16.4)
Conference proceedings	109 (51.2)	60 (28.2)	6 (2.8)	38 (17.8)

N = 213

5.4 Research Question: What kind of request do librarians receive on VLS?

In Table 2, the result shows that 69.8 % of the respondents strongly agree and agree that they receive request for downloading of e-books and e-journals. Another 59.1 % of the respondents strongly agree and agree that they receive feedback about library services on their virtual library space. The result also reveals that 69.6 % of the respondents attest that they receive request for training on the use of library resources.

Furthermore, the result in Table 2 shows that 83.1 % of the respondents strongly agree and agree that they receive requests to access electronic databases while 78.3 % of the respondents strongly agree and agree that they receive requests for support services and 74.4 % of the respondents strongly agree and agree that they receive requests for research materials on the library virtual space. This result signifies that VLS is a proven medium for receiving, responding and providing information services to the library users.

Table 2. Kind of request received on VLS

Request received on VLS	Strongly agree	Agree	Strongly disagree	Disagree
I receive request for downloading of e-books and journal articles	43 (18.7)	117 (50.9)	9 (3.9)	44 (19.1)
I receive feedback about the library services	41 (17.8)	95 (41.3)	22 (9.6)	55 (23.8)
I receive request on training in the use of library resources	54 (23.5)	106 (46.1)	31 (13.5)	22 (9.6)
I receive request to access electronic databases	63 (27.4)	128 (55.7)	17 (7.4)	22 (9.6)
I received request for support services	63 (27.4)	117 (50.9)	11 (4.8)	22 (9.6)
I receive request for research materials	85 (37)	86 (37.4)	11 (4.8)	31 (13.5)

N = 213

5.5 Research Question: What is the frequency and kind of information that the library disseminate on VLS?

The result in Table 3 shows the frequency of posting of information and services at the VLS. The result reveals that the respondents shared information and services daily, weekly, bi-monthly, monthly and quarterly on their VLS for their library patrons. This is evident as majority or 55 % and 22 % of the respondents share current awareness and SDI weekly and daily respectively to the users. Similarly, 23.1 % and 31.8 % also disseminate new arrivals on weekly and daily basis, 8.5 % and 13.8 % disseminate new arrivals

quarterly and monthly while 18.5 % never disseminate new arrivals. The result in Table 3 also reveals that majority or 50.3 % of the respondents shared developing stories on technological advancement bi-monthly on their VLS. Another 45.3 % and 13.8 % of the respondents disseminate targeted information daily, weekly and monthly to users based on their information needs. The result further shows that majority or 41.1 % of the respondents create awareness for current issues/ events weekly while 18.5 % and 13.8 % did the same quarterly, bi-monthly and daily respectively. The result also indicates that majority or 45.3 % share e-books, articles, and other materials to users.

Table 3.

Information and frequency	Quarterly	Monthly	Bi-monthly	Weekly	Daily	Not at all
Current awareness/SDI to users	-	22 (8.5)	36 (13.8)	143 (55)	59 (22.6)	-
New arrivals	22 (8.5)	36 (13.8)	11 (4.2)	60 (23.1)	83 (31.8)	48 (18.5)
Developing issues on technological advancements	24 (9.2)	48 (18.5)	131 (50.3)	22 (8.5)	24 (9.2)	11 (4.2)
Information to users based on their needs	11 (4.2)	11 (4.2)	36 (13.8)	36 (13.8)	118 (45.3)	48 (18.5)
Create awareness on current international, national and local issues and events	48 (18.5)	11 (4.2)	36 (13.8)	107 (41.1)	36 (13.8)	22 (8.5)
E-books, articles, and other materials to users	22 (8.5)	-	48 (18.5)	118 (45.3)	48 (18.5)	24 (9.2)
Link to online resources such as (OER)	11 (4.2)	24 (9.2)	95 (36.5)	11 (4.2)	71 (27.3)	48 (18.5)
Link to the library portals, website and digital resources	11 (4.2)	11 (4.2)	36 (13.8)	36 (13.8)	166 (63.8)	-
Link to online public access catalog (OPAC)	24 (9.2)	11 (4.2)	36 (13.8)	11 (4.2)	178 (67.5)	-

N = 213

5.6 Research question: What are the challenges facing the development of VLS at the library?

The result in Table 4 shows that there are several challenges facing the development of VLS at the university library under study. The result reveals that inadequate funding ($X = 3.5$) was a challenge. Irregular power supply with $X = 3.2$ was also a challenge for the development of VLS while poor internet connection and bandwidth ($X = 3.5$) was a challenge. The result indicates that lack of technical knowledge and skill by librarians were

less of challenge for the development of VLS ($X = 2.2$). However, inadequate ICT infrastructure with $X = 2.8$, lack of training with $X = 2.7$ and poor technical support with $X = 3.0$ were challenges for the development of VLS. With an overall $X = 2.9$ the result in Table 4 implies that the challenges are enormous and weighty and can hinder the development of VLS at the university library.

Table 4. Challenges of developing VLS at the university library

Challenges	N	Min	Max	Mean (X)	Std. Dev
Inadequate funding	213	1.00	4.00	3.5	0.80
Irregular power supply	213	1.00	4.00	3.2	0.99
Poor internet connectivity and bandwidth	213	1.00	4.00	3.5	0.94
Lack of technical knowledge and skill of librarians	213	1.00	4.00	2.2	1.28
Inadequate ICT infrastructure	213	1.00	4.00	2.8	1.11
Lack of training	213	1.00	4.00	2.7	1.11
Poor technical support	213	1.00	4.00	3.0	1.04
Grand Mean				2.9	

6. DISCUSSION OF FINDINGS

The adoption of digital platforms for the provision of information services at the library is increasing dramatically. There is evidence in Fig. 1 that university library has a host of VLS that are used to provide information services to virtual library users. The findings in Fig. 1 also reveal that there were above 100 of the respondents out of the 233 in this study who indicated that their library hosted Web-catalog, digital library, library website, social media sites, ERM and ILS. This finding is synonymous with the findings of¹¹ and¹² which indicate that libraries were utilising VLS to provide information to users. The findings reveal that university libraries are recognising the importance of VLS as a medium of communication and information sharing with library patrons. There is a high demand for VLS by library users who are internet savvy because of their learning demands and differences in information needs². VLS is known for increasing access to multiple digital resources; hence, exploiting would help to boost the image of the library. Digital libraries are extremely important because it provide access to e-books, journals, and educational content such as OER with a high patronage by library patrons⁴.

The findings in Table 1 reveal the information and sources that were available on VLS across the university libraries in this study. It shows that there were a number

of information resources on the VLS that can enhance the research activities of library users. The finding shows that e-books, e-journals, dataset, courseware, lecture notes, theses and dissertations among others were part of the information resources on the VLS. These findings substantiate the findings of⁹ that has shown that research papers, statistical data and teaching syllabuses were available on VLS and were used by lecturers in Nigerian universities.

On the kind of request that the librarians receive on VLS, the findings in Table 2 show that VLS serve as a medium for librarians to receive requests that border on downloading of e-books, journal articles, research papers and training from the library patrons. The finding also reveals that librarians receive feedback from majority of VLS users about the library services. The findings indicate that majority or above 50 % of the respondents confirmed that they receive request from the library patrons on various needs. This means that VLS is a veritable means of engagement with library patrons. This finding confirms the assertion that VLS is useful in the educational field for students, teachers and researchers to communicate with librarians¹⁰. The use of VLS has been experimented with positive results in several libraries including Johns Hopkins Sheridan Libraries which hosted a YouTube live stream featuring study tips⁷.

In Table 3, the findings show the frequency of VLS usage by the respondents. The findings indicate that the respondents dispatch information on daily, weekly, bi-monthly, monthly and quarterly basis to the users. The level of communication between the librarians and users may not be unconnected to the fact that modern library users prefer VLS⁶. The findings reveal that there were some variations in the amount of information that was communicated to the users. This may have been a result of the number of requests from the users. However, the finding shows that there was more engagement among the patrons on bi-monthly, weekly and daily compared to quarterly and monthly.

The finding in Table 4 shows that there were challenges affecting the use of VLS at the university library. These challenges can be classified into two: managerial challenges and technological challenges. Among the managerial challenges were inadequate funding and a lack of training and technical support. This finding substantiates the findings of¹³ and¹⁶ who found out that shrinking library budgets affected the development of VLS in university libraries in Nigeria. On the other hand, the technological challenges were a lack of ICT infrastructure, poor power supply and lack of internet connectivity. This finding corroborates with that of⁹ and¹⁴ who reported that lack of technical infrastructure, epileptic power supply, network and internet problems and librarians' lack of technical skills were the major challenges facing the realisation of VLS at most of the university libraries. These challenges facing the realisation of VLS are affecting the potential impacts of VLS on library patrons. With the overall mean of 2.9 which is higher than 2.5 acceptable mean, it shows that the challenges facing the development of VLS are myriad and overarching.

7. CONCLUSION

This study assesses VLS for digital information development at the university library in Nigeria. The adoption, maintenance and use of VLS at the university library in Nigeria is encouraging. The results buttress the fact that university libraries are utilising VLS to bring together several information resources and making information and services more accessible to online users. Indeed, virtual library is a database for electronic resources, enabling access to them. This study reveals that the use of VLS as a medium of communication helps to boost real-time information services to the information users through online engagements that contribute to revive trust in the library as a recourse for information access. The survival of innovative information services such as VLS in the library depends on managerial and technological factors. Those factors as shown in Table 4 are impediments in actualising VLS at the university library and may ridicule the good intention of the library towards providing information and services to its users.

8. RECOMMENDATION

From the foregoing, the researchers make the following recommendations:

1. The library management should encourage the librarians to increase the use of all available VLS for improved information services to online information users.
2. The university library should sensitize users on the importance of courseware, video recording and image collections to increase the use of VLS.
3. The university librarians should endeavour to increase the frequency of posting information as they unfold for the users on VLS.
4. The library management should put together training programmes for librarians to be acquainted with advanced technologies and VLS to enhance the delivery of virtual services to users.
5. University management should endeavor to improve funding for the acquisition of ICT facilities to enhance the provision of virtual services to library users.
6. The university management should ensure to provide a constant power supply to the library department using alternative sources of energy to enhance the use of VLS for effective information services to the virtual library users.

REFERENCES

1. Appleton, L. & Hall, H. The public library as public spheres: A longitudinal analysis. *Journal of Documentation*, 2023, **79** (1), 112-126. doi: 10.1108/JD-02-2022-0031
2. Kaur, A. Role of virtual libraries in learning process, In handbook of research on role of virtual libraries in learning process. *IGI Global*, 2015, 42-52. doi: 10.4018/978-1-4666-8178-1.ch003
3. Mintbook, 10 digital library advantages you must know, 2020. Accessible at: <https://mintbook.com/blog/digital-library-advantages/>

4. Chisita, C.T. & Chizoma, U.S. Rethinking academic library space amidst the COVID-19 pandemic in south africa: preparing for the future. *Information Discovery and Delivery*, 2021, 49 (2), 105-113. doi: 10.1108/IDD-07-2020-0087
5. Majidi, S.A. & Ghobad, M. Rethinking the architecture of public library spaces in order to redefine a new paradigm. *Research on Information Science and Public Libraries*, 2023, 29 (1), 34-60. doi: 10.61186/publij.29.1.34
6. Thomas, M.A. Redefining library space: Managing the co-existence of books, computers, and readers. *The Journal of Academic Librarianship*, 2000, 26 (6), 408-415. doi: 10.61186/publij.29.1.34
7. Wolff-Eisenberg, C. Creating virtual library spaces: Emerging technologies. ITHAKA S+R, 2020. Accessible at: <https://sr.ithaka.org/blog/creating-virtual-library-spaces/>
8. Demas, S. From the ashes of alexandria: What's happening in the college library? In library as place: Rethinking roles, rethinking space. council on library and information resources, Washington, D.C. 2005, 25-40.
9. Nwezeh, C.M.T. Virtual library in Nigerian universities: A necessity for academic excellence. *University of Dar es Salaam Library Journal*, 2005, 7(2), 43-60. doi: 10.4314/udslj.v7i2.26637
10. Telefonica. Virtual libraries: A new way of storing and accessing knowledge, 2022. Accessible at: <https://www.telefonica.com/en/communication-room/blog/virtual-libraries-a-new-way-of-storing-and-accessing-knowledge/>
11. National library of nigeria. Our services, 2024. Accessible at: <https://nlngov.gov.ng/>
12. Abdussalam, T.A.B.; Adewara, J.O.; Abdurraheem, J.W.; Oyedokun, T.T. & Balogun, T.R. Funding issues and development of digital libraries in nigeria. *Library Hi Tech News*, 2021, 9, 23-25. doi: 10.1108/LHTN-10-2021-0067
13. Otubelu, N.J. E-Learning through digital libraries: The case of national open university of nigeria" (2011). *Library Philosophy and Practice (e-journal)*, 615, 2011. Accessible at: <https://digitalcommons.unl.edu/libphilprac/615>
14. Okello-Obura, C. Assessment of the problems LIS postgraduate students face in accessing e-resources in makerere university, Uganda. *Collection Building*, 2010, 29 (3), 98-105. doi: 10.1108/01604951011060385
15. Gbaje, E.S. Implementing a national virtual library for higher institutions in Nigeria. *LIBRES Library and Information Science Research Electronic Journal*, 2007, 17 (2), 1-15. Accessible at: https://cpb-us-e1.wpmucdn.com/blogs.ntu.edu.sg/dist/8/644/files/2014/06/Vol17_I2_Gbaje.pdf
16. Akinlolu, A.O.; Azeez, R.A. & Ayo, S.A. Challenges and prospects of internet connectivity in developing universities in Nigeria. A case study of fountain university, Osogbo. *Fountain Journal of Natural and Applied Sciences*, 2018, 7(2), 8-14. doi: 10.53704/fujnas.v7i2.192
17. Nwosu, J.C. & Obiano, D.C. Challenges of virtual library services in academic libraries of federal universities in South-Eastern Nigeria. *Research Journal of Library and Information Science*, 2021, 5(1), 13-21. doi: <https://doi.org/10.22259/2637-5915.0501003>
18. Omeluzor, S.U. Evaluation of integrated library system (ILS) Use in university libraries in Nigeria: An empirical study of adoption, performance, achievements, and shortcomings. *Evidence Based Library and Information Practice*, 2020, doi: 10.18438/eblip29604
19. Oyovwe-Tinuoye, G.O.; Omeluzor, S.U. & Ijiekhuamhen, O.P. Influence of ICT skills on job performance of librarians in university libraries of South-South, Nigeria. *Information Development*, 2021, 1-14. doi: 10.1177/0266666920983393

CONTRIBUTORS

Mr. Saturday U. Omeluzor, PhD is a researcher and currently head of Public Services Division at the University Library of Federal University of Petroleum Resources Effurun, Nigeria. He is a certified librarian and member of several Library Associations including: Nigeria Library Association (NLA), Association for Information Science & Technology (ASIS & T) and Association of Adventist Librarians (ASDAL) among others. His research interest includes Artificial Intelligence (AI) in library science, SDGs and librarianship, indigenous information and technology, ICT in library science, electronic information resources and database management.

Mr. Nelson Edewor, PhD is a Librarian, and Researcher at the Dennis Osadebay University, Nigeria. He is particularly interested in e-journals, ICT application, online learning, library automation, information needs, open science in the research an innovation ecosystem. He is currently the University Librarian at Dennis Osadebay University, Asaba, Nigeria and has extensive experience providing research support for faculty and students for various research projects. He holds a PhD in Library and Information Science from University of Nigeria, with a focus on open access, e-learning and ICT application.

Cloud Computing Applications: Digital Agenda for Automation and Networking of Libraries in Karnataka

Mahesh G.T^{#,*}, Jayamma K.V[§] and Mrutyunjaya Kotur[!]

[#]Government First Grade College, Saligrama - 571 604 Mysore, Karnataka, India

[§]Nrupathunga University, Bangalore - 560 001, India

[!]Government First Grade College for Women Dharwad - 580 008 Karnataka, India

*E-mail: maheshgt@gmail.com

ABSTRACT

This paper envisioned to convey a study of government first grade college libraries that have automated their day-to-day services and activities. The main purpose of the study is to offer a significant view of the proficient practices of the government first grade college librarians in automating their house keeping processes. The study is been carried out using the survey method by collecting the data among 432 Government colleges across Karnataka state using online structured questionnaire and received 345 (79.86 %) responses. Some of the key findings of the study are, among these colleges out of which 68.2 % (295) college libraries were completely automated using e-Granthalaya, KOHA, NewGenlib, Libsoft, SLIM⁺, Easylib software. Many of these libraries were using cloud applications as an integrated library management system and for some reasons which various from library to library such as lack of computer facility, economic problems, lack of qualified and skilled professionals and insufficient collections in the libraries and sufficient infrastructure libraries were not automated. The study was limited to the automated libraries in Karnataka which gives a standing view of the cloud applications used by diverse libraries and the view of the library professionals about the performance of the software they use. And this paper is an attempt to expose the details involved in cloud computing applications and its advantages in effective applications in higher education institutions which is emphasised in this paper. This paper is also been attempt to explore how cloud computing applications can extend library and information services for improved sustainability. It is observed from the study that majority of the surveyed colleges i.e., 203 (58.84 %) were using e-Granthalaya 4.0 cloud version ILMS out of 345 libraries. Implication of cloud computing can benefit libraries in streamlining information services like acquisitions, cataloguing, service flow, discovery and retrieval of information. It also helps in augmenting the economy of libraries and evades repetition of library acquisitions.

Keywords: Cloud computing; Automation; Networking; College library; Karnataka

1. INTRODUCTION

Cloud computing is an online application where collective data, information, resources, and applications are provided to the group of computers and other devices on request using web-based technologies. Cloud computing mainly works on the internet; generally, the internet is envisaged as a cloud to store and operate remotely. This uniqueness of linking all stuffs on to the web permits executing a web based online library supply chain, collaborate it with diverse types of the technological advancements such as Wi-Fi and Internet based technologies, database management, acquisition of data and cloud computing systems. Through the incorporation of these stated systems, many online services can be offered and delivered.

Cloud computing applications are a technological expertise that allows us to share the pool of services and resources on the network instead of owning these

resources and facilities on local servers, nodes or private devices. This Cloud computing framework allows us to have data access as long as associates in harbouring devices that has permission to the online and these types of systems licenses library professionals to symbolise remotely.

1.1 Government First Grade Colleges in Karnataka

Karnataka state has a strong network system of government funded undergraduate colleges, offering an excellent system of education to learners across the state. These higher education institutes play a significant role in offering available and inexpensive higher education facility, exclusively for the students who are from disadvantaged and deprived experiences.

Here's a transitory outline of their significant landscapes, Inexpensive: Government institutions are acknowledged for their reasonable fee structure when related to privately funded colleges, offering higher education accessible

to a all students. Offering Different Courses: These institutions offers various selection of undergraduate courses, including humanities, science, commerce, and management programs. Qualified and competent faculty: They appoint experienced and competent teaching faculties who are dedicated in delivering excellence teaching. Organisation Structure: While few colleges have basic substructure, many are established with well equipped with libraries, laboratories, and other infrastructural amenities to enhance student learning environment. Government Funding: As government-run institutions, they receive funds from the state government, guaranteeing their monetary constancy and sustained process. Monetary accessibility: Affordability makes higher education achievable for students from various socio-economic backgrounds. Excellence Education: Government funded colleges uphold high values of education and deliver a solid basis for forthcoming professions. (DCE, Karnataka)

While government colleges in Karnataka come across few challenges in terms of infrastructure and financial resources, they continue to showcase a vital role in providing value based and sustainable education, empowering students and contributing in building a well-developed nation.

Libraries of Government funded colleges in Karnataka plays a significant role in pillarising the instructive voyage of variety of learners. While knowledge resources may differ dependent on the college and its setting, these library and information centres usually offer core purposes., Extensive Collection: Housing a diverse collection of books, journals, and other learning materials covering various subjects, catering to the academic needs of students across disciplines. Digital Resources: Offering access to online resources, e-journals, and e-books, escalating the teaching and learning horizons of students beyond conventional print materials. Reference Services: Assisting students with research, bibliographical information, and other referral queries, addressing them towards appropriate knowledge resources. Learner Space: Providing a favourable learning environment for attentive study and self-regulating learning, creating the easy way of learning.

The college libraries are the most significant adjunct of all colleges, needs and requirements of the students and faculties in complementing the education and research programmes of the institutions and assistance to conserve and dissemination of knowledge. It aims at understanding of organisational objectives. Library and information centers represent communities and they empower by adapting latest ICT's that has perceived a significant renovation in building a very good collection development policies and practices of the availability of ICT's

2. LITERATURE REVIEW

“Now days most of the university and college libraries are going for virtual servers, in collaboration with other academic institutions by saving financial burden and professionals time.”

Wada, I¹ (2018) in this study proposes a compelling

argument for the adoption of cloud computing in libraries, highlighting its potential to transform them into “smart institutions” within the burgeoning Internet of Things (IOT) landscape. The Autor outlines a compelling case for cloud adoption, emphasising its cost-effectiveness, energy, efficiency and ability to enhance library services and global reach and it also identifies key benefits of cloud computing for libraries.

Panda, Subhajit and Chakravarty. Rupak² (2021) explores the growing interest in cloud computing as a solution for modernising library management systems. It highlights several advantages of cloud-based solutions, including reduced data redundancy, improved resource accessibility, scalability, and simplified maintenance. The focus is on the implementation of cloud-based library management systems in India, particularly government initiatives like the NIC National Cloud, Meghraj, and e-Granthalaya. This study suggests a growing trend towards cloud adoption in libraries, while acknowledging the need for further research into addressing the challenges and ensuring successful integration and implementation.

Lazarus C. Njoku & Eucharia Ken-Agbiriogu³ (2021) The study looked at how libraries in a few university libraries in Imo State, Nigeria, were using and understanding cloud computing. The rise of cloud computing and its acceptance in academic libraries is one of the other ways that libraries can adapt and win back the hearts of their patrons. The use of cloud computing in libraries is a progressive response by librarians to an evolving information landscape and the need to stay relevant in the fast-paced, information-driven world of today.

Swaminathan⁴ (2020). A basic overview of cloud computing and its use in academic libraries is given in this study. We have nearly unlimited on-demand computing resources due to cloud computing. This paper offers some fundamental guidance on selecting and assessing cloud services for academic libraries. Cloud computing enables libraries to provide their resources, services, and knowledge to users when they need them, in a way that accommodates their needs and is easy for them to understand. A wide range of practical web-based library services can be obtained using cloud computing, which can also significantly reduce library expenses. The fundamental characteristics and unique opportunities make it inevitable.

Sivankalai⁵ (2021). The article contains suggestions on how to get the best use of cloud computing resources for university libraries and professional librarians worldwide. The creation of cloud-based services for university libraries might benefit from this article. According to the article, increased Internet bandwidth, quick information transfer, and high-quality cloud providers should all help to enhance academic library services in the future. Both academic libraries and the current information innovation depend upon the use of cloud computing.

Ekhaguosa, Otote, Irughe, Egharevba, & Akporhonor⁶, (2022). A case study of university librarians in the Niger Delta region using cloud computing to access

digital resources. Overview The current research looked into the way librarians in academic libraries in the Niger Delta Region of Nigeria used cloud computing applications to access electronic resources. Data for this study were gathered using a self-structured questionnaire consisting of forty-three items, using the descriptive research method. The researcher employed the stratified random sample technique in the process of choosing the university libraries. Establishing a digital library, storing files, developing community, and increasing library automation are all made possible by cloud computing. The implementation of cloud computing technology in university libraries yields several advantages, including enhanced computational efficiency, expanded storage capacity, global library material accessibility, and potential cost savings on information technology investments.

3. OBJECTIVES OF THE STUDY

In terms of ascertaining the cloud computing applications with reference to the present status of library network initiated by the government first grade colleges in Karnataka. Some of the main objectives of the current study are as follows:

- To identify the implementation of cloud computing applications in terms of Integrated Library Management Software (ILMS) packages in their libraries.
- To categorise the influencing factor for the selection of ILMS.
- To find out what software's are being used in Automated Libraries in Bengaluru city
- To identify the explanations for not implementing cloud applications in computerising library.
- To know the computing applications of different modules & functionalities for which they are being implemented and practised.
- To investigate the insights of the library personnel and users about the cloud computing applications in library in general and e-Granthalaya in particular

4. METHODOLOGY

The study was carried out by using survey method which is supported by personal and telephonic interviews using online questionnaire and also by visiting personally. The views of Library professionals regarding ILMS were collected by means of a designed questionnaire. Personal interview was also conducted on the base of the survey questionnaire. Views on ILMS selection, modules automated and various issues related to the in-house keeping processes of the library amongst the librarian respondents were obtained. The survey questionnaires were distributed thorough online link using personal e-mail id's and were also mailed through the professional what's app group to 432 Government First Grade College (GFGC) librarians across the state, out of which 79.86 % (345) responses were received appropriately completed with the entire suitable evidences demanded in the questionnaire. Study seeks the responses from the respondents regarding the status of automation, ILMS used, application modules and

the challenges they are facing during the implementation. The Current study is restricted to the government first grade college libraries of Karnataka state only.

5. DATA ANALYSIS AND DISCUSSION

The present study acknowledged 345 completed responses from library professionals of GFGC's in Karnataka, which institutes the prime facts for the examination and explanation.

Below Table 1 shows the distribution of survey responses. Data collected through the questionnaires was analysed with the help of tables, and interpretation of data is been worked out by keeping the main objectives of the study. Numerous queries were entreated in connection with the cloud computing applications in automating and networking of the library and information centers and in contrast to this the responses acknowledged from the professional librarians are charted and presented in the below tables with appropriate findings of the study.

Above Table 1 shows that responses of 345 (79.86 %)

Table 1. Particulars of questionnaires distributed to library professionals

S.No.	Source college	No. of questionnaires distributed	No. of questionnaires received	% of responses
1	Government First Grade Colleges, Karnataka	432	345	79.86%

out of 432 government colleges were received among the librarians. The study was confined to Government colleges only.

5.1 Library Automation Status Among Government First Grade College Libraries in Karnataka State

Library Automation shall try to deliver the information resources to their user community by offering innovative enhanced knowledge services. Computerised library in-housekeeping operations includes the process of acquisition, cataloguing, classification, subject headings, circulation, periodical control, payment gateway, bills processing, report generation budget allocation, reminders, group reminders, reference services, membership management OPAC. The present status of implementation of ILMS among GFGC's of Karnataka is shown in Table2.

It is known from the above table 2 that, the automation

Table 2. Stauts of library automation

S.No.	Automation status	Frequency N	Percentage (%)
1	Completely Automated	203	58.85%
2	Partially Automated	122	35.36%
3	Automated Initiated	20	5.79%

status among the 345 GFGC libraries that were surveyed under the research, 203 (58.85 %) were completely automated and 122 (35.36 %) were partially automated and remaining 20 (5.79 %) were in the initial stage of automating their libraries. The study found that majority of the libraries was fully automated by means of both paid exclusively and open-source software's depending on their financial and individual needs and necessities.

5.2 Types of Cloud Computing ILMS Used

It is very much essential for any library automation to use cloud version of ILMS that accomplishes the desirable functions in mechanising the library and information services effectively. The kind of ILMS depends based on the necessities and it may be as modest as to achieve the doings of acquisition, organisation, cataloguing, and circulation and in integrating the library management software that can achieve the facilities of collection, cataloguing, circulation, serials control, micro documents maintenance and other activities. The libraries that are using different types of software either open source, free or proprietary are congregated and signified in the below table 3.

It is known from the study that 50 (14.49 %) of the

Table 3. Type of cloud computing ILMS

Type of the software	Frequency N	Percentage
Open-Source software	50	14.49%
Paid Software	295	85.50%

libraries were using Open-source software, and most of libraries were using paid software 295 (85.50 %). This is mostly because of the hands-on training support both online and offline and additionally technically supporting including maintenance offered by the vendors.

5.3 Integrated Library Management Software (ILMS) Implemented

An Integrated Library Management System (ILMS) is a software package that benefits and assists all library and information centers and manages all the acquisitions and processes more proficiently. The implementation of ILMS makes the effective use of library and information resources effectively by the user community, and also it avoids the repetition of workflow for the librarians.

Implementation of ILMS by the library professionals

Table 4. Intergrated library management software(ILMS) implemented

S. No.	ILMS implemented	No. of colleges	Percentage
1	e-Granthalaya	203	58.84%
2	EasyLib	41	11.88%
3	KOHA	32	9.27%
4	NewGenlib	18	5.21%
5	Others	51	14.78%

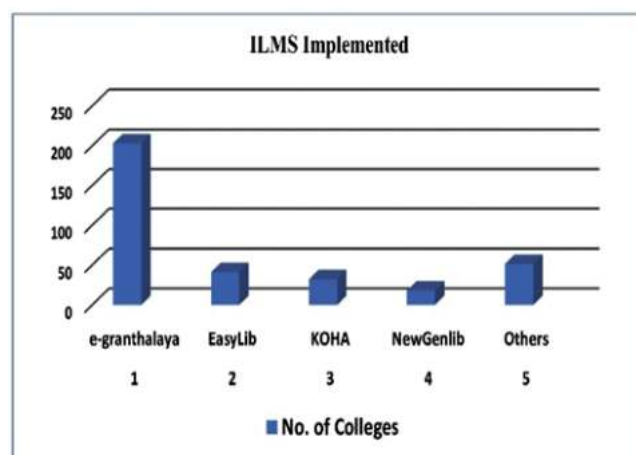


Figure 1. ILMS implemented.

is been portrayed in the above Table 4. It is observed that 203 (58.84 %) of libraries have implemented e-Granthalaya, followed by 41 (11.88 %) of libraries have installed Easylib, 32 (9.27 %) have installed KOHA open-source software and 18 (5.21%) libraries have installed NewGenlib in their libraries. Remaining 51 (14.78%) libraries were not using cloud version software as they were using Library Manager, Libsoft, SLIM and few inbuilt software's.

5.4 Integrated Library Management System (ILMS)

Integrated Library Management Systems (ILMS) are very much active and multipurpose solutions that empowers library and information centers to acclimatize to the ever-changing digital phase. They automate, modernise, and augments many library processes, permitting libraries to deliver effective information services to their clientele and retain the momentum with the dynamic landscapes of library management. As information centers endure to advance, the characteristic feature of ILMS in determining the future of these knowledge hubs remains dominant. Some of the well-known popular ILMS packages available are LIBSYS, EasyLib, e-Granthalaya, SLIM, KOHA, NewGenlib, Library Manager, Libsoft, Libero.

5.5 Why Cloud Version e-Granthalaya?

It is a most reliable and all-time access for various searches and accomplishes databases on a modest processor configuration. The facilities are of nominal and quality-oriented substitute. The only thing we need to have systems with high-speed Internet connection with the browsers permitted. National Informatics Centre (NIC), New Delhi will provide the database with the nominal fee of Rs 21000 for government institutions. Anyone can make use of this E-Granthalaya software, the best-in-class bibliographic search & retrieval package that delivers the access to catalogues through web search services, that grants classy online searching like auto-indexes, multiple document presentation, programmed searching of several forms and formats.

Various modules were automated using ILMS in

Table 5. Modules implemented in library operations through ILMS

S.No.	Modules in the software	No. of libraries (Frequency N)	Percentage (%)
1	Administration	296	85.79%
2	Acquisition	214	62.02%
3	Cataloguing	318	92.17%
4	Circulation	325	94.20%
5	Serials Control	177	51.30%
6	Digital Library/ Micro Documents	68	19.71%
7	Reports Generation	326	94.49%
8	Article Indexing	68	19.71%
9	Multilingual	168	48.69%
10	Web OPAC	318	92.17%

the First Grade College libraries have been summarised in the above Table-5 and the data depicts that 296 (85.79 %) libraries have been using administration module, 214 (62.02 %) libraries been used acquisition module, 318 (92.17 %), librarians were using cataloguing module, 325 (94.20 %) library professionals have been using circulation module as this is one of the most wanted and much needed module for any library as this module gives the data about the usage of library collections by its users. In this module all the ILMS had the easy gateway of issue, return and renewal of documents both book and non-book materials. Incorporation of Barcode, RFID and Dropbox compatibility were found in all these packages. And this module offers us the facilities of reserving and renewing features and also has the in-built SMS, e-mail and payment gateways. It offers many customised reports and also gives us the detailed customised data reports.

The results of the study shows that 177 (51.30 %) libraries have been automated their serials control, 68 (19.71 %) have the digital library and micro documents maintenance facilities, 326 (94.49 %) have the reports generation utility, 68 (19.71 %) have indeed their documents using automated module, 168 (48.69 %) have the facility of entering the data in multilingual mode, and lastly majority of the packages have the web OPAC facility, Ability to access Easylib Cloud from anywhere there is Internet. All the packages mentioned above hosts the database on cloud and maintain it and assures approximately 24x7 hours of accessibility with ease and convenience. All these ILMS gets us the complete features of the package deprived of having to finance on a big server and its preservation and much more inexpensive also.

It is known from the study that most of the libraries have been implemented cloud computing applications by utilising most of the modules available in the ILMS in one or the other way. Cloud computing applications as a digital platform for automating the library housekeeping operations as well as membership services and networking for the purpose of sharing the knowledge resources. This

cloud computing platform offers us a comprehensive technological solution with an integrated management of library services and support. It's a valuable component in transforming conventional libraries to a virtual with digital library component providing number of online membership facilities by a unique platform access system. All these packages have the "Cloud Ready" applications providing the web enabled services in an enterprise mode with the centralised database systems.

Cataloguing module (92.4 %) implemented by the

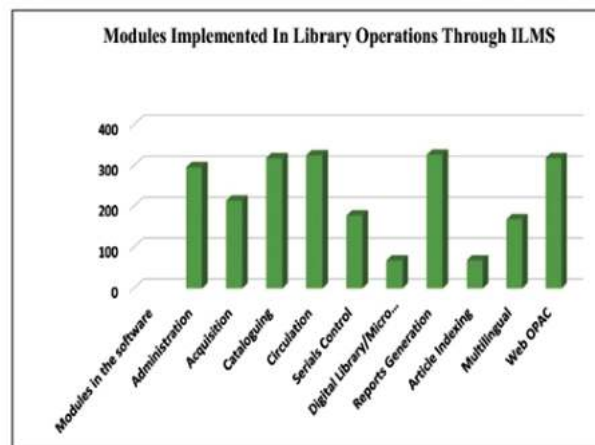


Fig. 2 Modules implemented in library operations thorough ILMS.

libraries using ILMS enabled competent library professionals in creating and managing bibliographic archives for print books, periodicals and other resources. This module supported them to automate several aspects of the cataloguing process, making it quicker and more precise.

Circulation module (99.5 %) of an ILMS holds visitors' check-ins and check-outs, issues/returns, and renewals of library materials. With an ILMS, librarians can track who has borrowed that material, its due date, reminders and whether it has been returned on time.

Acquisitions module (92.81 %) of an ILMS accomplishes the purchasing and receiving new resources. With an ILMS, librarians can generate acquisition orders, track the position of orders, and manage demands and payments. This is helping all librarians stay on topmost of their finance and make sure they have the funds to aid their user community.

Reporting and Analysis (88.6 %) of an ILMS often offers modules in reporting and analysing, that allows librarians to keep track of usage patterns of various user's community, identifies common materials, and make data-driven decisions about collection development and other library services. This data is helping very much to all librarians understanding which resources are in high demand, which materials may need to be rearranged, and which items need to be extended or purchased.

User Management (95.5 %) of an ILMS among the surveyed colleges offers a user management module that empowers librarians to achieve various user accounts, including communication information, details of individual and group borrowings, and fines. This segment can also generate reports on user activities, serving librarians

understand how their users use their library and information resources.

5.6 Impact and Application of Cloud Computing Applications in Libraries

Huge amount of data and information can be operated with very much comfort and accurateness Easy in operation, with minimum manpower, saving the lot of time allowing both user and professionals in avoiding or eliminating repetition of labour by enhancing the customer gratification. Functions at an excessive rapidity and timeliness. All the above factors. It also cut down the financial crunch by cooperative collection of documents on a single platform in terms of a cloud and also the libraries under the cloud can be connected through network meeting the dedicated user community demands.

6. FINDINGS AND DISCUSSION

Some of the major findings of the study are:

1. Majority of the libraries is been automated using cloud application
2. Most of the Libraries have been using all the available modules in their day-to-day activities
3. The study results show that only 50 (14.49 %) are using open-source cloud computing application software for automating the library in-house keeping operations.
4. E-Granthalaya 203 (58.84 %) is the highly used paid cloud computing software.
5. Cataloguing, Circulation and OPAC are the highly used modules when Compared to other modules.
6. Cloud computing applications inspires higher education institutions augmenting calibration of assessment norms and processes so that the many fragments of the cloud computing models that can execute appropriately and competently.
7. A cloud computing application offers tools and techniques to examine our information excellence and aptitude to precise the bulk information.
8. These application offers capability to apprehend wide-ranging particulars of our library membership data that includes customising the data fields, importing the membership data, mass updating and generation of report and statistics.
9. Library members can also create their own profiles and allowing the integration with institution Enterprise Resource Planning (ERP) software, either externally or one provided with the ILMS.
10. E-books lending service, union and shared catalogue, document downloading services, digital preservation and scanning services, current awareness service by document sharing including bulletin board services and social interactions with the user community with social interactions among the users are some of the major findings found among the colleges during the study.

7. CHALLENGES AND LIMITATIONS

1. Preparation and executing the high-quality library and information services in the ever shifting dynamic societal and scientific settings.
2. Establishing library and information networks to assist the user community efficiently.
3. Design and development of knowledge systems that meets the user requirements of library and information centers.
4. Successful integration of ICT, artistically and efficiently into library and information services.
5. And some other major challenges might be deficiency in financial aspects for upgrading the status and hands on training, software and hardware compatibility, librarian competitiveness.
6. It's very much big concern that there are issues related to privacy and security of data. Network connectivity and bandwidth with respect to speed is also a concern.

Teaching and learning in Indian higher education institutions and the education system is the world's largest schooling system with a greater number of institutions across the country. The challenges modelled by the increasing demands for academic necessities are enormous. Cloud computing applications streamlines organisation of cooperative information and knowledge resources usage, distant access for multiple users Excellency, offering the essential tools at some instances of the exercising technique. Knowledge resource collections are also retrieved through "Software as Services (SaaS)". The academic library resources for e-Learning schemes are frequently made available any time to several teaching learning institutions through cloud. LaaS is undoubtedly going to take a paradigm shift in e-Learning. Academic institutes can customise the cloud based open source ILMS which will lead to heaps of financial savings.

When the libraries working with their own arrangement's association among the libraries by networking is very much tough and expensive too. A library and information center collect and maintains the data which is scattered in various scattered structures, subsequent in library's feeble network existence. Knowledge explorers working in shared network settings and in scattered arrangements find it very much difficult to access the information resources due to their inattentive on the web. By moving in to cloud in-house or by taking the services of Cloud Service Provider, the above cited issues can be fixed. Once moving on to cloud the library presence could be much visualised through the network across the globe. Integration of information resources and sharing of knowledge resources becomes very much simple when it is on the cloud. It will be benefit and cost effective to smaller and medium sized institutions.

Information resources can be shared and distributed between the networked cloud users and it can be done very much faster in the scattered networked environment. Having shared infrastructure, it makes sure to work professionally and competently with several users and various applications. As the infrastructure is provided by the third party, users can operate it from any part of the world simply through the internet. As the servers on

cloud are available 24*7, it is very much reliable and there is a least chance of cloud burst or infrastructure failure. As it is very much cost efficient, scalability is very much high and with greater security and accessibility, portability with adjustable storage capacity with unlimited storage. With backup and recovery automatic updates facility is also available.

However, Libraries can overcome economic limitations and also be able to address the competent professionals' issues by, Getting financial assistance and support by the State governments and college development authorities can provide monetary funding to libraries. And also, by seeking the support of Alumni's, Philanthropists of the institution.

Training staffs of library and information centers can offer skill-based training programmes to library professionals on innovativeness planning of resources and ILMS. Libraries can provide online instructions to personnels, so that they can acquire and augment their technical skills although they are working.

Utilising institutional workshops for libraries that are part of a bigger institutions and universities can take benefits of in-house programmes for technical assistance, software's, client service, and other issues.

7.1 Advantages of Cloud-Based ILMS

Cloud-based LMS have numerous advantages, such as:

- Minimum expenses: Cloud-based LMSs can avoid setup expenses and advance financial distribution.
- Easier to install and use with not much time consuming
- Enhanced accessibility: Cloud-based LMSs cost effective, ease of access, can be retrieved anywhere/ anytime remotely having access with many connections and networks and devices.
- Improved security: Cloud-based LMSs can enhance the assurance of the security of data.
- Easy maintenance: These Cloud-based LMSs are very much easier in maintaining and operation.
- Storage Capacity: All of our data, with lots of imageries and contented data, will be uploaded directly to the cloud LMS, freeing up memory space on our hard disks and drives with lesser or least management of space.
- Customisation: Cloud-based LMSs convenient and customisable for both the user community and library professionals.

7.2 Looking Beyond Four Walls of Libraries with Automation and Artificial Intelligence: Scope for Further Research

Automation of Libraries with cloud computing ILMS, libraries can now restructure many of the manual and laborious processes such as cataloguing, record management, article indexing, and reference services. Artificial intelligence lets libraries to proficiently accomplish collection management, circulations, answering user queries and cataloguing of books while providing AI-powered references and interpretation of suggestions to the users. When shared with AI, automation tools can pointedly boosts efficiency,

enables informal access to the information systems and augment working competence. Based on this study, library and information science we try to derive how future libraries will function in the era of automation and artificial intelligence.

8. CONCLUSION

The study results found that the ILMS augmented the excellence of employability, competence of library personnel with the enhanced professional gratification, user relations, self-esteem, work pace and the regulation of higher education institutions. Results of the study shows that 58.85 % colleges were completely automated out of which E-Granthalaya 203 (58.84 %) was one of main ILMS used among the libraries, it was also found that 85.50 % were using paid ILMS. Cataloguing module (92.4 %), circulation module (99.5 %), acquisitions module (92.81 %), reporting and analysis (88.6 %), user management (95.5 %) are some of the major outcomes of the study, where cloud computing ILMS has played a major role in augmenting effective delivery of library and information services. In addition to these issues like professional connection among the librarians in the implementing these cloud applications, involvement in hands on training, and attitudes and competitiveness of library personnel towards the shift established a positive response. Cloud computing applications are very much simple in acquiring and implementing, libraries financial environment is augmenting across the state. As the cloud computing technology is already out there and our library and information centers need to start think rationally about how they may have to regulate their services in order to efficiently acclimatize to how user community are associating with it. Cloud computing applications in terms of library automation has transformed and redefined the description of the library professionals. However, many radical changes have been happening in the field of library and information centres in the rouse of swift developments in ICT and of knowledge explosion, GFGC's are moving a step ahead to accomplish the innovative prospects through the execution of the cloud computation and networking of library and information centres across Karnataka. As the higher education institutions have been facing lots of complications due to economic crisis the application of cloud is one of the feasible opportunities as moving to cloud the academic institutions can now move on to focus on their essential activities of teaching, learning and research.

REFERENCES

1. Wada, I. Cloud computing implementation in libraries: A synergy for library services optimisation. *International Journal of Library and Information Science.*, 2018, **10**(2), 17-27.
doi: 10.5897/IJLIS2016.0748
2. Panda, S. & Chakravarty, R. Implementation cloud enabled SaaS services in library automation: A study of government initiatives in India. In *Emerging*

- trends in academic libraries in *ICT Era.*, 2021, pp. 28-51. Chandigarh, India: Saptrishi Publication.
doi: 10.31235/osf.io/ywavc
3. Njoku, L.C. & Ken-Agbiriogu, E. Awareness and use of cloud computing: Its implications in selected academic libraries in Imo State, *Nigeria. Journal of Information and Knowledge Management.*, 2021, **12**(1), 62-75.
doi: 10.4314/ijikm.v12i1.5
 4. Swaminathan, K.S.M. Cloud computing in academic libraries: An overview. *Indian Journal of Library and Information Science.*, 2020, **14**(2), 97-100.
doi: 10.21088/ijlis.0973.9548.14220.9
 5. Sivankalai, S. The impact of cloud computing on academic libraries. *Library Philosophy and Practice (e-journal).*, 2021, 6207. <https://digitalcommons.unl.edu/libphilprac/6207>
 6. Ekhaguosa, V.; Otote, G.O.; Irughe, M.; Egharevba, E. & Akporhonor, B.A. Cloud computing application for accessing e-resources by university librarians: Case study of university librarians in niger delta region. *Library Philosophy and Practice.*, 2022, 7232. <https://digitalcommons.unl.edu/libphilprac/7232>
 7. <https://dce.karnataka.gov.in/> Accessed and Retrieved on 21-08-2024

CONTRIBUTORS

Dr. Mahesh G.T working as Librarian-Selection Grade in Associate Scale at Government First Grade College, Saligrama, affiliated to University of Mysore, He has 22 years of professional and

research experience and has published more than 35 research papers by presenting/contributing more than 15 research papers in National and International conferences. Areas of interests include, User behaviour, Cloud computing applications in libraries, Library automation, Soft-skills for librarians, Networking of libraries, Knowledge management and application of ICT in libraries, Artificial intelligence.

His contribution to the current study is conceptualisation of ideas by developing the framework, preparing the draft of the paper, completing the initial draft including data interpretation and analysis and revising the manuscript.

Dr. Jayamma K.V working as Librarian-Selection Grade in Associate Scale, has Obtained MLISc, MPhil and PhD in Library and Information Science. Her area of interest includes: Library automation, Information seeking behaviour, Knowledge management & Academic libraries.

Her contribution to the work includes drafting questionnaire and collection of data for the study & writing research framework and review.

Dr. Mrutyunjaya Kotur working as Librarian-Selection Grade in Associate Scale and holds Master's Degree from Karnatak University, Dharwad, and MPhil from Alagappa University, Karaikudi, in 2006. He completed his PhD from Shri JTT University, Jhunjhunu, Rajasthan, in 2015. He has attended more than 30 national, and international-level seminars, conferences, and workshops, presented and published more than 30 papers as well.

His contributions to the current study include, data collection, analysis, tabulation of data and writing the framework for the current study.

Artificial Intelligence in Libraries, A Multifaceted Analysis of Integration, Impact, and Collaboration Dynamic

Manash Esh

University of North Bengal, University Library, Siliguri – 734 013, India
E-mail: manash@nbu.ac.in

ABSTRACT

This study investigates the centrality and density of the 'Artificial Intelligence' cluster within interdisciplinary research networks, contrasting it with thematic clusters like 'prediction' and 'library.' The research aims to assess AI's impact on education and services compared to other thematic clusters. To achieve this, we employed Python analysis tools on a dataset of 587 articles from the Web of Science Core Collection, examining centrality measures and collaboration dynamics. The methodology includes systematic data collection, centrality analysis, and advanced visualisation techniques. The findings indicate AI's high centrality and moderate density, underscoring its pivotal role in driving interdisciplinary research. Comparative analysis reveals AI's broader application potential and influence compared to other clusters. Additionally, insights into country collaborations and centrality measures within clusters illuminate network dynamics and key nodes. Visualisations, such as scatter and box plots, offer comprehensive insights into centrality distribution and relationships within the collaboration network. These results contribute significantly to understanding AI's role in interdisciplinary research, informing strategic planning and resource allocation for future advancements. The broader implications of findings suggest potential practical applications and directions for future research in leveraging AI's influence across various domains.

Keywords: Artificial intelligence; Collaborative networks; Centrality measures; Library science; Centrality and density

1. INTRODUCTION

The integration of AI in libraries offers significant potential for improving information management, retrieval, and analysis. Over time, AI has evolved from basic automation tools to sophisticated systems that personalize user experiences and enhance search algorithms. Early applications of AI in libraries focused on automating cataloging processes, but modern AI systems now drive more complex tasks. Adewojo, A.A., & Dunmade, A.O¹. like personalised recommendations and advanced data analytics. Key milestones in AI development include the advent of machine learning, the rise of big data, and the recent advancements in natural language processing. Duan, Y., Edwards². These innovations have progressively transformed how libraries operate, enabling more efficient information access and greater user engagement. This study examines the 'artificial intelligence' cluster's role in research, particularly its centrality and density compared to other thematic clusters such as 'prediction' and 'library.' The study aims to explore how AI's high centrality and moderate density influence its integration across diverse domains. Also, it assesses AI's impact on 'education' and 'services' relative to clusters like 'prediction,' 'challenges,'. By understanding

these dynamics, the research provides insights into AI's critical role in driving interdisciplinary research, fostering technological advancements, and supporting global collaborations in the digital age.

2. LITERATURE REVIEW

The existing literature on AI applications across various fields shows significant promise but also reveals critical gaps in empirical validation and practical implementation. For instance, Ng³, *et al.* reviewed AI in nursing care, emphasising documentation and predictive analytics, but highlighted the lack of randomised controlled trials, revealing a gap in robust empirical evidence. Lantada⁴, *et al.* explored AI in designing microtextured surfaces for biomedical applications but did not consider its broader implications in material science, leaving a gap in understanding its full impact. In library science, Lund⁵, *et al.* examined librarians' perceptions of AI adoption, which revealed varied attitudes but did not explore how these perceptions affect AI implementation, indicating a gap in practical application. Ridley and Pawlick-Potts⁶ focused on algorithmic literacy in libraries but lacked empirical data on the effectiveness of programs, pointing to a gap in educating library staff and patrons on AI. Al-Aamri and Osman⁷ discussed AI in library knowledge management, identifying challenges but

lacking a critical analysis of implementation issues, suggesting the need for more detailed studies. Yordy⁸ explored AI-generated prior art in patent law, focusing on innovation but not its effects on patent system efficiency, highlighting a gap in understanding AI's broader legal implications. Taha⁹, *et al.* reviewed AI in liver diseases and surgery, noting the benefits but overlooking limitations and ethical concerns, while Van Dieren¹⁰, *et al.* demonstrated AI's potential in melanoma diagnosis but did not address challenges in clinical adoption, revealing gaps in translating AI research into practice. In manufacturing, Garois¹¹, *et al.* proposed an AI model for predicting hardness profiles but did not explore practical implications or scalability, highlighting a gap in real-world industrial applications. Potnis¹², *et al.* classified public library innovations but failed to analyse their long-term impact, while Ekstrand and Strandberg¹³ provided an overview of technological trends in Swedish medical libraries without addressing integration challenges, pointing to gaps in practical implementation. Bryant¹⁴, *et al.* emphasised digital literacy in England's NHS for AI-driven healthcare but lacked empirical evidence on the effectiveness of these initiatives.

Collectively, these studies underscore AI's transformative potential while highlighting significant gaps in empirical validation and implementation. This research builds upon these findings, aiming to fill these gaps by providing a critical analysis of AI applications in libraries and offering insights into their practical implementation.

3. METHODOLOGY

The methodology initiated with a search on the Web of Science Core Collection to identify articles on "Artificial Intelligence in Libraries." The criteria included articles published between January 1, 2014, and December 31, 2023, focusing on those relevant to AI in library science. The search yielded 587 articles in RIS format. Also, the methodology had some limitations, such as excluding non-English studies and limiting the scope to articles, potentially omitting valuable research from other formats or databases. For the analysis, data preprocessing was performed by importing the RIS data into a structured dataframe using the Biblioshiny package in RStudio. Python was also used for further analysis within the PyCharm Integrated Development Environment. The Pandas library was crucial for data manipulation, enabling the conversion of raw data into a more usable format. Visualisation of data was conducted using Matplotlib and Seaborn, which provided the necessary tools for creating scatter plots and box plots to represent centrality measures and collaboration dynamics effectively. NetworkX was employed for network analysis, allowing for an in-depth exploration of the relationships and interactions within the dataset. The dataset included 31,868 references, with 1,419 Keywords Plus and 2,384 Author's Keywords highlighting the main themes. The

involvement of 2,739 authors and the fact that 29.75 % of collaborations were international underscore the global scope of the research. The study builds on prior research by Ng *et al.* (2022) and Lantada *et al.* (2020), addressing gaps in the understanding of AI's specific applications in library science. This comprehensive analysis aims to guide future research, strategic planning, and resource allocation within the field.

4. RESEARCH QUESTIONS

Artificial intelligence (AI) is becoming increasingly central to various research fields, influencing technological advancements and interdisciplinary collaborations. To understand its impact comprehensively, we explore key aspects of AI's role within research networks.

Key Terms

- **Centrality:** A measure of the importance or influence of a node (in this case, the 'artificial intelligence' cluster) within a network.
- **Density:** A measure of how tightly connected the nodes within a cluster are.
- **Impact:** The overall influence of a cluster, often gauged by citation metrics and the reach of its contributions.
- **Betweenness centrality:** Measures the extent to which a node lies on the shortest paths between other nodes, reflecting its role as a connector or broker in a network.
- **Closeness centrality:** Measures how quickly a node can reach all other nodes in the network, indicating its overall accessibility and proximity to others.

RQ1: How do the high centrality and moderate density of the 'artificial intelligence' cluster influence the development and integration of AI technologies in various research fields, compared to other clusters such as 'prediction' with centrality and density or 'library' with centrality and high density?

RQ2: How does the high impact and centrality of the 'artificial-intelligence' cluster, particularly in the contexts of 'education' and 'services,' influence advancements in these fields compared to other clusters such as 'prediction' and 'challenges' or 'drug discovery' with varying levels of impact and centrality?

RQ3: What are the key determinants influencing the intensity and directionality of country collaborations, as evidenced by the frequency and geographic distribution of collaborative relationships among nations?

RQ4: How do the centrality measures (Betweenness, Closeness, and PageRank) of nodes within different clusters affect the structure and cohesiveness of the collaboration network?

5. DATA ANALYSIS AND DISCUSSION

5.1 High Centrality and Moderate Density of the ‘Artificial Intelligence’ Cluster: Implications for Development and Integration Across Research Fields.

The dataset analysis visualised the relationship between Callon Centrality and Callon Density across various clusters. The generated scatter plot in Fig. 1 provides insightful visualisation, allowing for easy identification of patterns and outliers among the clusters.

To validate RQ1, data analysis focuses on centrality and density across clusters. Visualisation emphasises their significance, with key clusters highlighted in red. The ‘artificial intelligence’ and ‘prediction’ clusters are pivotal, connecting network parts, while the ‘library’ clusters maintain internal cohesion. Variability in centrality and density indicates diverse cluster roles, from bridging to internal connectivity. This visualisation offers insights into network structure, identifying key clusters based on centrality and density.

- Callon Centrality measures the importance of a cluster within the research network by quantifying how well-connected it is to other clusters.
- Callon Density assesses the internal cohesion of a cluster by evaluating the strength of connections within the cluster itself.
- The ‘artificial intelligence’ (AI) cluster stands out with the highest Callon Centrality (8.59), indicating its crucial role as a hub for interdisciplinary collaboration within the research network. Its moderate density (49.50) suggests a balanced internal structure, supporting AI’s broad adoption and influence. In contrast, the ‘prediction’ cluster has lower centrality (6.23) and slightly higher density (54.41), reflecting strong but less influential integration. The ‘library’ clusters, with low centrality and high density, indicate strong internal collaboration but limited interdisciplinary impact, highlighting AI’s unique role in driving diverse research and technological advancements.

These findings justify the research question’s focus on understanding AI’s unique development and integration across various domains, informing strategic planning and resource allocation for future advancements. The ‘artificial intelligence’ (AI) cluster stands out with the highest Callon Centrality (8.59), indicating its crucial role as a hub for interdisciplinary collaboration within the research network. Its moderate density (49.50) suggests a balanced internal structure, supporting AI’s broad adoption and influence. In contrast, the ‘prediction’ cluster has lower centrality (6.23) and slightly higher density (54.41), reflecting strong but less influential integration. The ‘library’ clusters, with low centrality and high density, indicate strong internal collaboration but limited interdisciplinary impact, highlighting AI’s unique role in driving diverse research and technological advancements. These findings justify the research question’s focus on understanding AI’s unique development and integration across various domains, informing strategic planning and resource allocation for future advancements

5.2 Impact of ‘Artificial Intelligence’ Cluster in Education and Services: A Comparative Analysis with other Clusters

Figure 2 presents a scatter plot generated using Python code to illustrate the relationship between centrality and impact across various clusters. In this plot, the x-axis represents centrality, the y-axis represents impact, the size of the points indicates frequency, and different clusters are distinguished by colour. Each point is labelled accordingly. This visualisation addresses the research question by comparing the artificial intelligence cluster’s impact and centrality in the domains of education and services with other clusters, such as prediction, challenges, and drug discovery. The scatter plot reveals how AI’s significant impact and centrality in education and services contribute to transformative changes, improved efficiencies, and

Table 1. Cluster analysis metrics

Cluster	Callon centrality	Callon density	Rank centrality	Rank density	Cluster frequency
prediction	6.229884986	54.41347552	29	15	274
impact	2.524729151	56.73380463	27	16	62
library	1.727436444	72.54166667	26	24	83
cohort	0.5	75	22.5	26	6
model	4.083486853	48.69218474	28	2	158
artificial-intelligence	8.590311959	49.50115203	30	3	320
de-novo design	0.25	75	21	26	8
inhibitors	1.608333333	60.546875	25	18	26
assist	0	66.66666667	9.5	21.5	6

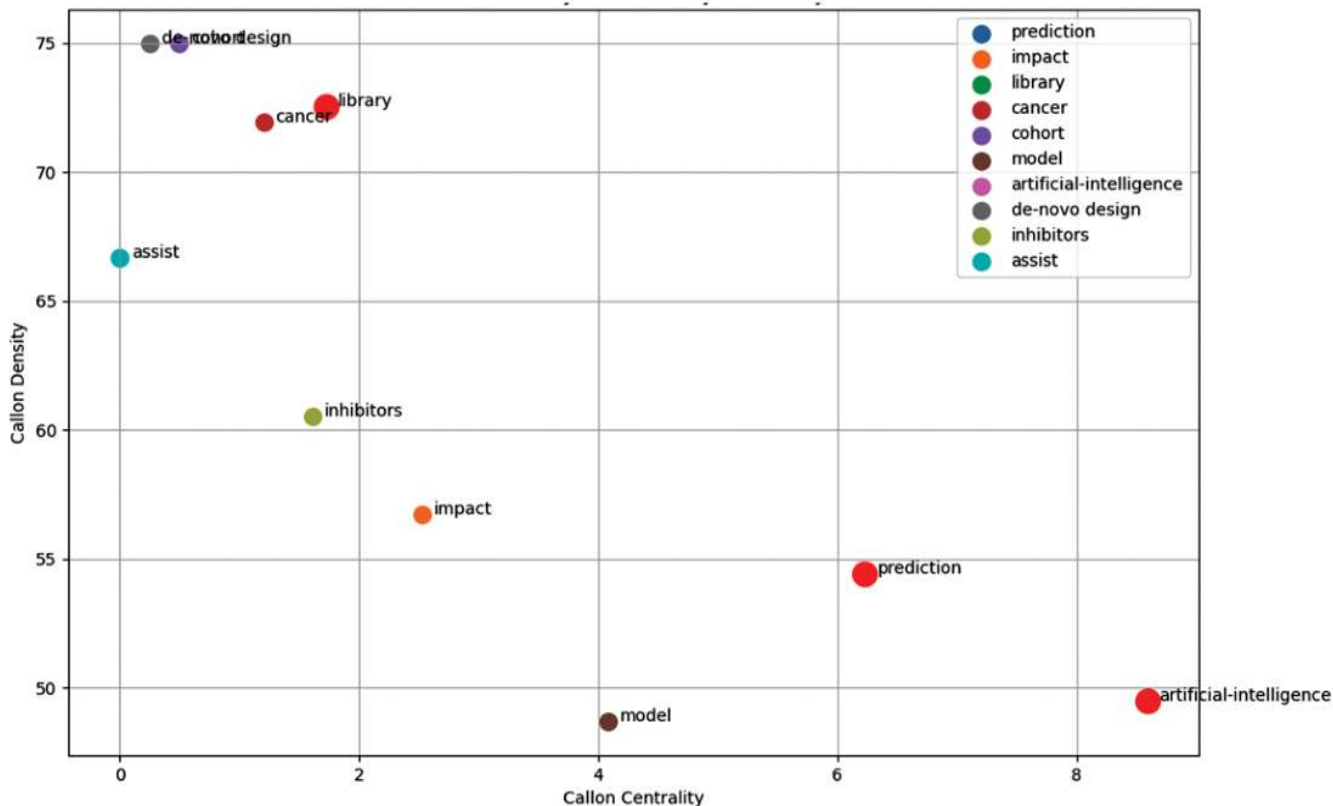


Figure 1. Cluster analysis: centrality vs. density.

innovative solutions. By comparing AI’s role with other clusters, the plot helps to understand AI’s influence on learning outcomes, service delivery, and emerging challenges. This analysis provides insights into AI’s unique strengths and limitations compared to other thematic clusters, enriching the understanding of AI’s role across various fields. Thus, Fig. 2 directly supports the research question by highlighting how AI’s centrality and impact in key areas differentiate it from other clusters.

5.3 Determinants of Country Collaborations: Frequency and Geographic Distribution Analysis

Figure 3 presents a comprehensive analysis of country collaborations, highlighting several key determinants. Notably, high collaboration frequencies are observed between major research powerhouses such as the USA and China. Most collaborations occur infrequently, with many countries engaging in only 1 or 2 collaborative efforts. Higher collaboration frequencies often indicate stronger and more sustained research relationships. For

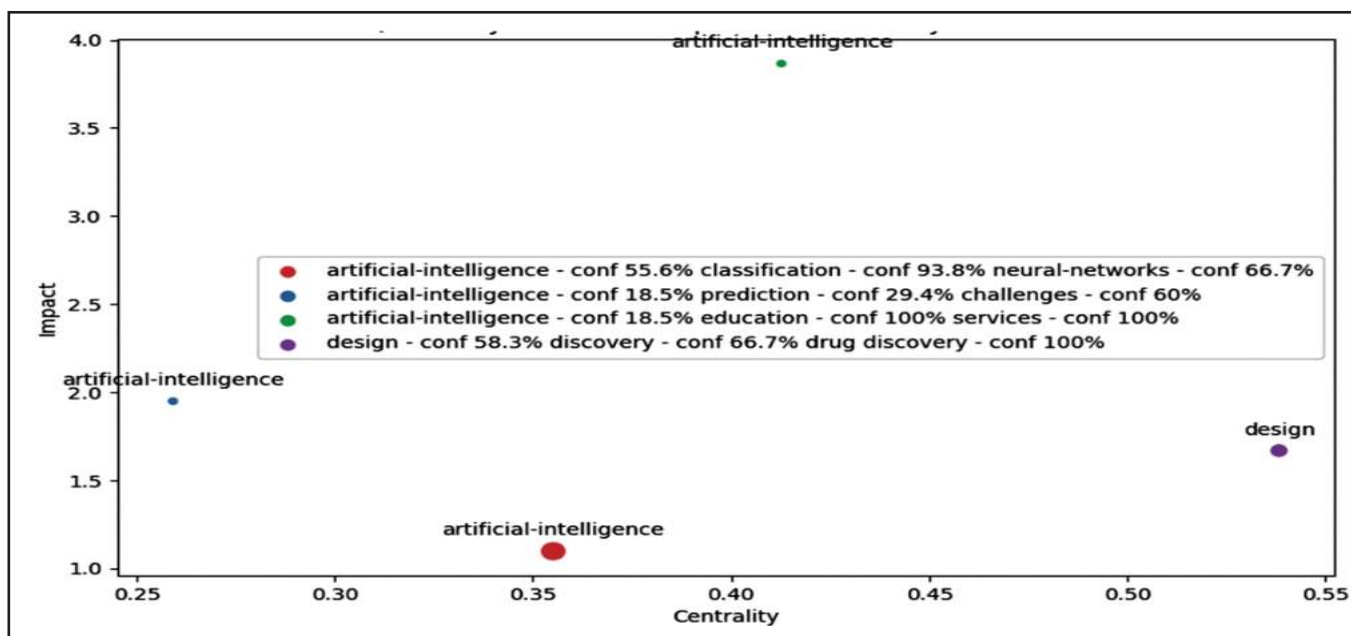


Figure 2. Impact and centrality in different clusters.

instance, collaborations between continents-such as those between North America and Asia (e.g., USA-China, USA-Germany)-highlight global research ties. Conversely, regional clusters, influenced by factors such as geographical proximity, historical ties, or economic connections, are also evident. Collaborations between neighboring countries can have significant geopolitical implications. Significant collaborations, especially those involving major economic players like the USA and China, stand out due to their frequency and strategic importance. The increasing number of collaborations involving China, in particular, signals a shift in global research dynamics. By recognising emerging trends and key partnerships, it can better anticipate future developments in global research collaborations and identify strategic areas for expansion and collaboration.

5.4 Impact of Centrality Measures on Collaboration Network Structure.

Tables 2 and 3 offer insights into centrality measures within Cluster 1. Nodes like ‘cox am’, ‘liu d’, ‘liu y’, and ‘wang f’ have zero betweenness centrality, indicating no bridging role, while ‘huang y’ has a high betweenness centrality of 113.204762, highlighting its critical network role. Clusters 8 and 9 show strong internal connectivity with a closeness centrality of 1.00. Clusters 3, 4, and 2 exhibit the highest betweenness centrality, emphasising their bridging functions. Variations in PageRank across clusters reflect differing node influence. These measures offer a detailed understanding of the network’s structure and dynamics.

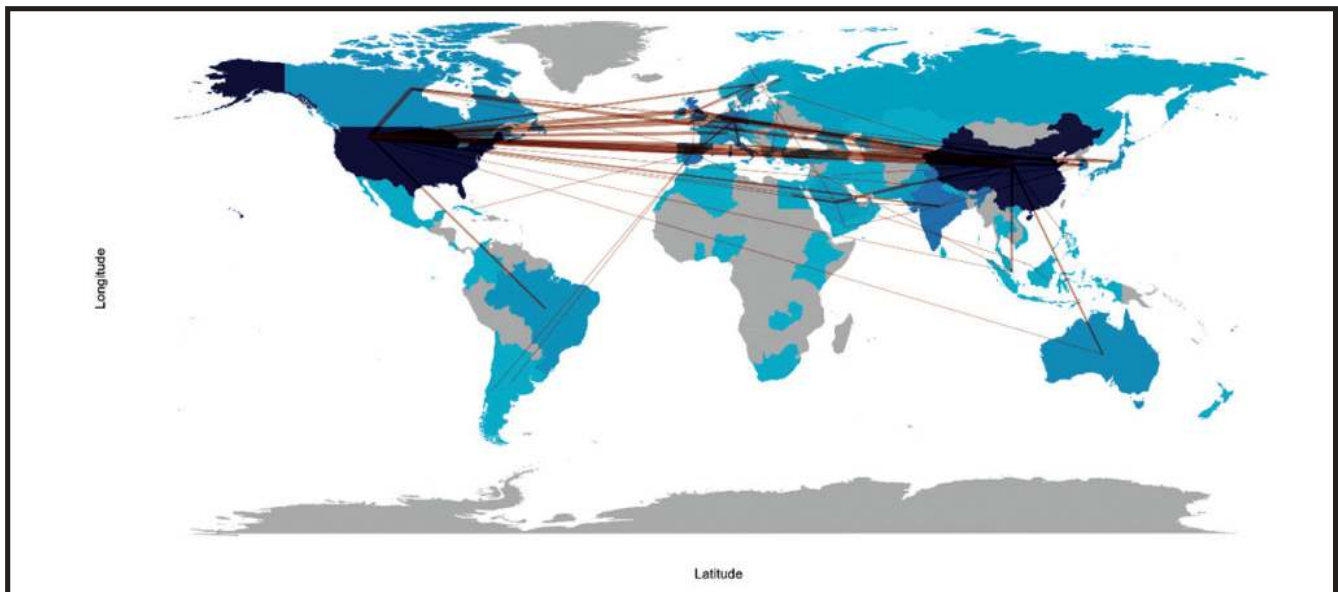


Figure 3. Country collaboration map.

Table 2. Centrality measures of nodes in cluster 1

Node	Cluster	Betweenness	Closeness	Page rank
cox am	1	0.000000	0.006623	0.008315
huang y	1	113.204762	0.008929	0.035166
liu d	1	0.000000	0.007634	0.017331
liu y	1	0.000000	0.006061	0.008430
wang f	1	0.000000	0.006623	0.008315

Table 3. Centrality measures by cluster

Cluster	Betweenness	Closeness	Page rank
1	29.864286	0.007301	0.017923
2	49.341403	0.008294	0.020801
3	64.299236	0.009221	0.026794
4	62.180728	0.009217	0.026294
5	16.333333	0.006321	0.015631
6	21.633477	0.008666	0.022960
7	27.087798	0.007976	0.020933
8	0.000000	1.000000	0.022222
9	0.000000	1.000000	0.022222

Figure 4 summarises centrality measures (Betweenness, Closeness, and PageRank) across clusters in the collaboration network. The plots display centrality score distributions, with the median marked by a central line and the interquartile range (IQR) capturing the middle 50 %. Wider distributions indicate greater variability in node importance, while higher median values suggest stronger connectivity. PageRank plots identify influential nodes, and correlation matrices reveal relationships between centrality measures, offering insights into the network’s structure and dynamics.

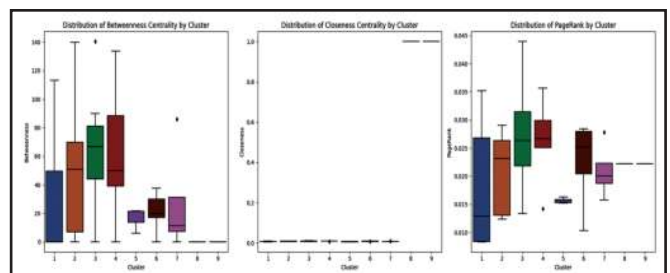


Figure 4. Distribution of betweenness, closeness and page rank by cluster.

6. CONCLUSION

The analysis reveals that the ‘artificial intelligence’ (AI) cluster plays a crucial role in research and technological advancements. With the highest centrality among clusters, AI significantly influences various research domains, fostering integration and innovation. Its moderate density reflects adaptability and ongoing field diversification. When compared with clusters like ‘prediction’ and ‘library,’ AI demonstrates broader application potential and greater influence. The study of AI’s impact on education and services highlights its transformative role in critical areas. Insights into country collaborations reveal diverse global dynamics and implications for authors. Centrality measures within clusters clarify network structure, identifying key nodes essential for optimisation. Visualisations, including scatter and box plots, provide detailed views of centrality distribution and network relationships, aiding strategic planning. However, the study’s reliance on the Web of Science Core Collection may omit relevant literature from other databases. Future research should broaden the dataset and include qualitative studies to further explore AI’s impact across various fields. The findings underscore AI’s importance in advancing interdisciplinary research and guiding future directions.

REFERENCES

1. Adewojo, A.A. & Dunmade, A.O. From big data to intelligent libraries: Leveraging analytics for enhanced user experiences. *Business Information Review*, 2024. (accessed on 17 May 2024)
doi: 10.1177/02663821241264707
2. Duan, Y.; Edwards, J.S. & Dwivedi, Y.K. Artificial intelligence for decision making in the era of big data – evolution, challenges and research agenda. *International Journal of Information Management*, 2019, **48**, 63-71.
doi: 10.1016/j.ijinfomgt.2019.01.021 (accessed on 17 May 2024)
3. Ng, Z.Q.P.; Ling, L.J.; Chew, H.S.J. & Lau, Y. The role of artificial intelligence in enhancing clinical nursing care: A scoping review. *Journal of Nursing Management*, 2022, **30**(8), 3654-3674.
doi: 10.1111/jonm.13425 (accessed on 24 May 2024)
4. Lantada, A.D.; Franco-Martínez, F.; Hengsbach, S.; Rupp, F.; Thelen, R. & Bade, K. Artificial intelligence aided design of microtextured surfaces: Application to controlling wettability. *Nanomaterials*, 2020, **10**(11). (accessed on 24 May 2024)
doi: 10.3390/nano10112287
5. Lund, B.D.; Omame, I.; Tijani, S. & Agbaji, D. Perceptions toward artificial intelligence among academic library employees and alignment with the diffusion of innovations’ adopter categories. *College & Research Libraries*, 2020, **81**(5), 865-882. (accessed on 7 June 2024)
doi: 10.5860/crl.81.5.865
6. Ridley, M. & Pawlick-Potts, D. Algorithmic Literacy and the role for libraries. *Information Technology and Libraries*, 2021, **40**(2). (accessed on 7 June 2024)
doi: 10.6017/ital.v40i2.12963
7. Al-Aamri, J.H. & Osman, N.E.E. The role of artificial intelligence abilities in library services. *International Arab Journal of Information Technology*, 2022, **19**(3A), 566-573. (accessed on 7 June 2024)
doi: 10.34028/iajit/19/3A/16
8. Yordy, L.R. The library of babel for prior art: Using artificial intelligence to mass produce prior art in patent law. *Vanderbilt Law Review*, 2021, **74**(2), 521-562 (accessed on on 7 June 2024)
9. Taha, A.; Ochs, V.; Kayhan, L.N.; Enodien, B.; Frey, D.M.; Krähenbühl, L. & Taha-Mehlitz, S. Advancements of artificial intelligence in liver-associated diseases and surgery. *Medicina-Lithuania*, 2022, **58**(4) (accessed on 7 June 2024)
doi: 10.3390/medicina58040459
10. Van Dieren, L.; Amar, J.Z.; Geurs, N.; Quisenarts, T.; Gillet, C.; Delforge, B. & Lellouch, A.G. Unveiling the power of convolutional neural networks in melanoma diagnosis. *European Journal of Dermatology*, 2023, **33**(5), 495-505 (accessed on 7 June 2024)
doi: 10.1684/ejd.2023.4559
11. Garois, S.; Daoud, M.; Traidi, K. & Chinesta, F. Artificial intelligence modeling of induction contour hardening of 300M steel bar and C45 steel spur-gear. *International Journal of Material Forming*, 2023, **16**(3) (accessed on 7 June 2024)
doi: 10.1007/s12289-023-01748-1
12. Potnis, D.D.; Winberry, J.; Finn, B. & Hunt, C. What is innovative to public libraries in the United States? A perspective of library administrators for classifying innovations. *Journal of Librarianship and Information Science*, 2020, **52**(3), 792-805 (accessed on 7 June 2024)
doi: 10.1177/0961000619871991
13. Ekstrand, M. & Strandberg, L. Technological trends in Swedish medical libraries. *Health Information and Libraries Journal*, 2023, **40**(3), 326-331 (accessed on 7 June 2024)
doi: 10.1111/hir.12500
14. Bryant, S.L.; Bridgen, R.; Hopkins, E.; McLaren, C. & Stewart, D. NHS knowledge and library services in England in the digital age. *Health Information and Libraries Journal*, 2022, **39**(4), 385-391 (accessed on 7 June 2024)
doi: 10.1111/hir.12457

CONTRIBUTOR

Mr Manash Esh is presently working as a Senior Information Scientist at the University of North Bengal. He obtained his B.Tech in Computer Science and MLIS, and plays a crucial role in managing library automation services and a strong background in data analysis and system management, he has contributed numerous research articles to reputable journals.

Preservation and Revitalisation of Indian Languages through Digital Archiving: A Systematic Review of Bharatvani

Shilpi Saxena* and Gurvinder Kaur

School of Humanities and Social Sciences, Thapar Institute of Engineering and Technology, Patiala-147 004, Punjab, India.

**E-mail:shilpi.saxena@thapar.edu*

ABSTRACT

Languages play a crucial role in shaping cultural identity, transmitting knowledge, and fostering social cohesion, however many languages around the world face extinction due to various factors such as globalisation and urbanisation. India is not an exception when it comes to language obsolescence. The present paper brings attention to the status of Indian languages and critically analyses India's largest language platform Bharatvani, as an important tool for preserving and reviving Indian languages and mother tongues. This systemic review examines Bharatvani's technological infrastructure, user interface, educational resources, and user testimonials. It utilises a qualitative research methodology and analyses secondary data from academic sources and user testimonials to provide insights into Bharatvani's efficacy and limitations. The study's findings, based on a feedback from 261 reviewers, reveal key insights into the app's functionality and user experience. Additionally, the findings also highlight obstacles in digital archiving, addressing both social and technological challenges such as accessibility issues, browsing difficulties for indigenous communities, and limited community awareness and engagement. The study thus concludes that Bharatvani is an effective tool for linguistic preservation with potential scalability. Recommendations for policy and practice include enhancing community engagement and ensuring technological accessibility and digital equity to optimize the platform's effectiveness.

Keywords: Digital archiving; Documentation; Bharatvani; Multimedia tools; Language preservation

1. INTRODUCTION

When it comes to language and culture, few nations of the world are as diverse as India. India's linguistic landscape is incredibly rich and diverse, shaped by centuries of interactions between different linguistic communities. This rich tapestry of languages has led to both collaboration and conflict, with challenges like linguistic identity disputes and the need for protective policies. The preservation of linguistic diversity is crucial amid rising concerns about language obsolescence. The study conducted by United Nations Educational Scientific and Cultural Organisation (UNESCO) in 2009 underscores the critical status of the Indian languages that are endangered or at risk of disappearing. In UNESCO's constantly evolving Atlas of the World's Languages in Danger (online), India leads the world with 197 entries¹. The concerning aspect is that these endangered languages include scheduled, non-scheduled, and even official languages of some states. Although there has been commendable progress in documenting and safeguarding Indian languages, there remains a pressing need to delve deeper into the root causes of linguistic endangerment and to design effective solutions. As Suzanne Romaine aptly suggests, "We should think about languages in the same way as we do other

natural resources that need careful planning: they are vital parts of complex ecologies that must be supported if global biodiversity is to be sustained"². Suzanne's statement underscores the need for comprehensive strategies to preserve and promote linguistic diversity. This issue must be dealt with at national as well as social level, where both the government and the communities must participate in the preservation of linguistic diversity. The central concern of this study is thus to contribute to the language preservation debate by examining factors and outcomes of declining linguistic diversity. Additionally, it critically reviews the Bharatvani project, which is dedicated to preserving Indian languages and mother tongues, analysing its technological infrastructure, user interface, educational resources, and user feedback.

2. THE STATUS OF INDIAN LANGUAGES

India's linguistic landscape mirrors its cultural diversity, with each region -from Jammu & Kashmir to Kanyakumari-showcasing distinct traditions, languages, and mother tongues, reflecting the nation's vibrant heritage. India's linguistic diversity is immense, with over 1950 languages or dialects spoken as mother tongues. According to the 2011 census data, there are 22 scheduled languages, and 99 non-scheduled languages³. However, figures from various sources may differ, largely due to

varying definitions of ‘language’ and ‘dialect’. In recent decades, a growing body of literature, scholarly articles, and media reports has forewarned of the alarming decline in the number of languages⁴⁻⁶. Some linguists think that as many as 40 to 50 % of India’s languages may face a potential risk of extinction within the next 100 years⁷⁻⁸. David Crystal suggests that, on average, one language in the world may disappear every two weeks over the next century⁹. In view of widespread language endangerment crisis, Krauss surveyed the global situation and estimated that approximately 10 % of languages have a likelihood of persisting into the distant future, while up to 50 % are already on a path toward becoming obsolete¹⁰. The remainders face the threat of becoming moribund by the century’s end. If these speculations prove accurate, only a scant few among the remaining languages will secure a stable future.

In Atlas of the World’s Languages in Danger (UNESCO), India leads the list of countries with 197 endangered languages classified as ‘extinct’, ‘unsafe’, ‘definitely endangered’, ‘severely endangered’ and ‘critically endangered’ (Table 1). Surprisingly, two languages included in the Eighth Schedule that receive Government protection Manipuri and Bodo are endangered in terms of being ‘unsafe’. Even though the endangered languages are found throughout the Indian subcontinent, a significant concentration exists in the North-East region and the tribal belts of Orissa, Jharkhand, West Bengal, Himachal Pradesh, Uttarakhand, and Jammu and Kashmir. The Table 1 below provides a detailed overview of the distribution of endangered languages in India based on the number of speakers. Blackburn and Opgenort emphasise in their study on languages in India and the Himalayan region that due to sparse data on vitality and speaker populations of smaller languages, classifying endangered languages should be regarded as tentative¹¹. Furthermore, a few languages classified as vulnerable might be described as “stable but potentially endangered”¹². Blackburn’s and Opgenort’s predictions give cause for concern as even the stable and healthy languages with a comparatively large

number of speakers like Bodo, Khasi, Tamang and Ho are at the risk of becoming endangered. Noted linguistic and cultural activist, Ganesh N. Devy also expresses his concern over language attrition and affirms that Indian languages are losing linguistic prowess: “India may have lost 220 languages since 1961. There were 1,100 languages since 1961, based on the Census number of 1,652 mother tongues. Another 150 languages could vanish in the next 50 years”¹³. Devy initiated a groundbreaking study of tribal communities and headed the research of Indian languages through the People’s Linguistic Survey of India in 2010. This report highlighted India’s remarkable linguistic diversity, with approximately 780 languages spoken and written using 86 different scripts. However, this linguistic richness is at risk, as the report notes that India has lost approximately 250 languages over the past six decades. This scenario emphasises the urgency to conserve and revitalise India’s linguistic heritage.

However, it is important to note that language loss is by no means inevitable or natural. A number of factors contribute to language loss and obsolescence¹⁴. Factors such as the legacy of colonisation, urbanisation, displacement, pressure from dominant languages, lack of institutional as well as community support, and disenfranchising policies related to indigenous languages and mother tongues are at the heart of language decline.

When languages fade away, the rich tapestry of diverse cultures, traditions, unique knowledge, perspectives, and expressions are also lost¹⁵⁻¹⁶. Language serves as a crucial vessel for preserving a community’s history, culture, and identity, as it embodies cultural wisdom and political significance¹⁷. When a language dies, it’s not just vocabulary or speech forms that disappear, it also signifies the disappearance of a unique worldview. Study findings by Fishman; Nettle & Romaine and Dalby¹⁸⁻²⁰ affirm that when a language fades away, a distinctive way of looking at the world also disappears. Indeed, beyond being a crucial aspect of cultural and individual identity, language is an invaluable source of information about human cognition for the global community.

Table 1. Endangered languages of india according to the number of speakers

Degree of vitality	Data not available	Zero to 5,000 speakers	5,000 to 10,000 speakers	10,000 to 20,000 speakers	20,000 To 50,000 speakers	50,000 to 100,000 speakers	Above 100,000 speakers	Total
Extinct	5	-	-	-	-	-	-	5
Critically Endangered	9	25	1	3	2	1	-	41
Severely Endangered	-	6	-	-	-	-	-	6
Definitely Endangered	4	18	8	6	6	4	15	61
Unsafe/ Vulnerable	3	4	5	3	22	12	35	84
Total	20	55	14	12	30	17	51	197

(Source: Constructed from data in Atlas of the world’s languages in danger (2010), UNESCO)

3. RECENT TRENDS AND FRAMEWORKS IN LANGUAGE PRESERVATION

Given the rapid disappearance of languages worldwide, it's imperative to recognise that each vanishing language signifies a profound loss of invaluable knowledge about human cognition and culture. Indeed, language preservation is a critical aspect of cultural heritage conservation, ensuring that diverse linguistic traditions are maintained and passed down to future generations. Peter K. Austin affirms that more than ever before, presently, there is a surge in concerted and cooperative initiatives aimed at reversing the trend of language loss²¹. These initiatives encompass a range of approaches including documentation, translation, digital technologies, community-centered immersion programs, and language nests.

In today's advanced tech era, data is crucial. AI and IT transform data usage, enabling communities to document and share languages, fostering learning and revitalisation efforts profoundly²²⁻²³. Indeed, technology can help endangered languages continued existence, offering many applications to extend the traditional methods of language preservation²⁴. Digital archiving, for instance, has emerged as a potent tool in promoting endangered languages. It offers a robust platform for languages, potentially motivating individuals to use minor languages more frequently.

3.1 Digital Archiving

Digital archiving employs digital tools to store, manage, and disseminate information, preserving digital content for future use. Initiatives like digital libraries, oral history repositories, and language documentation projects, ensure the preservation and continuity of languages for future generations. A.L. Berez²⁵ and Meighan²⁶ have underscored the impact of digital transformation on archival theory and practice, emphasising the shift from traditional paper-based archives to digital repositories. Babinski²⁷ et al. identifies these cutting-edge archives as tools that support the digitisation and meticulous documentation of historical texts, fostering intentional learning and promoting cultural understanding. These Digital Archival Collections (DACS) are licensed, digital corpora, typically consisting of text, image and audio-visual content²⁸.

These digital archives include collecting and documenting audio-visual materials, transcriptions, translations, linguistic annotation, thereby preserving linguistic and cultural heritage for future generations²⁹⁻³⁰. Candace K. Galla highlights the acknowledged benefits of digital archives, particularly their pivotal role in facilitating access to and preserving indigenous knowledge and languages³¹. The platforms like The Endangered Languages Archive (2002), Living Tongues (2005), CoEDL (2014), SIDHELA (2016), and Bharatvani (2016) amongst others have a proven track record in the documentation of linguistic heritage. These platforms provide a centralised and accessible repository for some of the indigenous and endangered languages, making it easier for linguists, researchers, and communities to access and share resources. By providing a space for

dialogue and collaboration among stakeholders, digital platforms become catalysts for teaching and revitalising endangered and indigenous languages³².

4. LITTERATURE REVIEW OF BHARATVANI

Recognising the critical importance of preserving linguistic diversity and addressing the decline in regional languages in India, the government has launched various initiatives to protect these languages. Among them, Bharatvani stands as an interactive, user-friendly multimedia tool offering easy access to numerous Indian languages. This multilingual web content is designed for easy access to applications and materials; ensuring information is preserved for future access, rediscovery, and presentation at any time³³. This digital archive is an initiative of the Ministry of Education, (India) to create a comprehensive online portal for multilingual education. It was launched by the Indian Government in 2016 on International Mother Language Day, 21st February by Government. It aims to provide various language resources, including audio-video recordings, dictionaries, glossaries, grammar books and language learning materials in multiple Indian languages. Irina Bokova, the former Director-General of UNESCO, commended this initiative, "I commend #India for the launch of the #Bharatvani portal to support the richness of linguistic diversity"³⁴.

This multilingual app, executed by The Central Institute of Indian Languages (CIIL), Mysuru, Karnataka, offers open knowledge under fair usage clauses of The Copyright Amendment Act, 2012 for educational purposes. It serves as a valuable resource, providing people worldwide with access to numerous monolingual and multilingual dictionaries, as well as other language resources in 118 Indian languages. The portal is designed to be comprehensive, engaging, and continuously updated with moderation ensuring quality and relevance. The Project is guided by a National Advisory Committee and a Technology Advisory Committee, besides Language Editorial Committees in each of the languages. Customised to meet the needs of a diverse range of language speakers, this interactive platform provides engaging lessons, vocabulary exercises, grammar resources, and pronunciation guides. This digital repository fosters intergenerational and intercultural communication, and promotes its use and relevance across different domains, including education, administration, research, cultural preservation, and language revitalisation.

5. RESEARCH METHODOLOGY

The study employs a systematic literature review approach to analyse qualitative data from Bharatvani user testimonials to provide a detailed overview of the app's perception and usage. It synthesises these findings, identifying gaps, and highlighting areas for further exploration. The review aims to offer valuable insights and guide future qualitative research, ultimately enhancing understanding and informing the app's development based on identified needs and opportunities.

5.1 Significance of Bharatavani

Bharatvani, recognised as the world's largest language corpus, has been instrumental in promoting the preservation and revitalisation of Indian languages. By prominently featuring scheduled, non-scheduled, and tribal languages and mother tongues, in the digital sphere, Bharatvani encourages the younger generation to actively use their languages in blogging, social media, education, and learning activities. This Multilingual Knowledge Portal (www.bharatavani.in and Bharatvani Android App) has accomplished the task of hosting more than 5500 resources in around 118 Indian languages including 22 officially recognised languages and 96 other Indian languages and mother tongues³⁵. The exact number of languages included in Bharatvani may vary over time as it is constantly incorporating materials, but it is intended to cover a wide range of books and materials in approximately 121 Indian languages. This app is currently supported by approximately 200+ multilingual dictionaries; however plans are underway to expand this number to 250 in the upcoming years³⁶. Bharatvani aims to lead a 'Digital Revolution' ('Digital Kranti') in alignment with the Government's ongoing Digital India mission. Through this portal and its mobile app, people from across the world can access knowledge on over 100 languages from a single platform. The portal's provision of multilingual content has a long lasting impact, which can be measured by increased language use in education, improved community engagement, and growth in digital content creation.

6. ANALYSIS AND SUMMARY OF TESTIMONIALS OF BHARATVANI USERS

The study has analysed the testimonials from Bharatavani users using a dataset collected on July 10, 2024, at 4:45 PM (IST)³⁷. The analysis of testimonials reveals key insights into the app's functionality and user experience. The review, which includes feedback from 722 users, provides valuable perspectives on the app's functionality and user experience. Of the 722 reviewers who provided feedback, only 261 customers rated the Bharatavani app on a one-to-five star scale for its content and accessibility (See Fig. 1). A key aspect of the review is the average user rating of 3.8 out of 5, derived from over 50,000 downloads. This suggests a positive reception, with strengths in content relevance and areas for improvement in browsing speed and offline accessibility. However, the absence of metrics on user accessibility and resource access neither on the app nor the website poses a notable limitation in fully assessing its usability. The analysis of Bharatavani highlights positive keywords such as 'richness of linguistic resources,' 'good content,' and 'easy navigation.' These terms underscore user satisfaction with the app's content relevance. The significant percentage of 5-star ratings (29.89 %) reflects widespread acclaim for these features, affirming Bharatavani's effectiveness in meeting user expectations and enhancing linguistic contents. Despite positive feedback, challenges emerge with Bharatavani. About 17.62 % of users rate it 4 stars due to 'slow browsing' and restrictions on 'content downloads',

impacting offline access in low-connectivity areas. Another 16.86 % rate it 3 stars, pointing to 'cumbersome features' and 'slow performance'. Enhancing performance, resolving download restrictions, and improving browsing speed are essential for boosting user satisfaction and app usability. Additionally, 15.71 % of customers give the app a 2-star rating, citing usability concerns like 'slow functioning' and difficulties with the 'dictionary search function'. A significant 19.92 % of users rate the app 1 star, expressing frustration with exclusive 'online access', an 'inefficient user interface', and excessive multimedia content that hampers usability on slower devices. Enhancing usability, introducing offline capabilities, and refining how content, especially photographs and tables, are presented are crucial steps toward improving user satisfaction and overall app performance.

The bar graph in Fig. 1 highlights reviewers' positive feedback on Bharatavani's rich content (29.89 %). However, concerns over download restrictions (17.62 %) and dissatisfaction with online-only access and cumbersome features (19.92 %) are notable. Suggestions for improvement include enhancing performance (16.86 %) and usability (15.71 %), indicating areas where the app could be refined to meet user expectations more effectively.

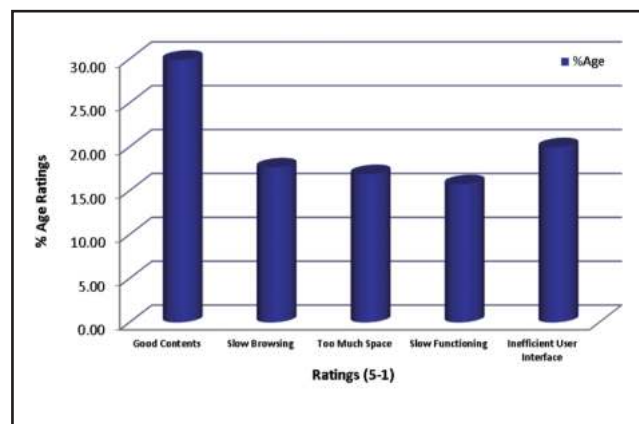


Figure 1. Illustration of reviewers' testimonials.

To effectively address these challenges, Bharatavani should prioritise enhancing offline functionality, optimising browsing speeds, and refining user interfaces for efficient access to its linguistic resources. Improving user feedback mechanisms and transparency in performance metrics would support ongoing enhancements that meet user expectations. Overall, while Bharatavani receives positive feedback for its comprehensive content and interface; there is considerable opportunity to enhance accessibility, performance, and user-centric design. These improvements are crucial for better catering to its diverse user base across different connectivity and device scenarios.

7. COMPARATIVE ANALYSIS OF GLOBAL AND REGIONAL DIGITAL ARCHIVING INITIATIVES FOR LANGUAGE PRESERVATION

Bharatvani, India's initiative for language diversity and digital archiving, contrasts and aligns with several regional and global digital archiving initiatives such as ELAR, Living tongues, DAILP, Missing scripts, CoEDL, SiDHELA, and the Endangered languages

Project in distinct ways, each offering unique features and best practices. While initiatives like, Endangered Languages Archive, Endangered Languages Project, and CoEDL focus on global endangered languages, offering extensive repositories of audiovisual and textual documentation, emphasising rigorous linguistic and anthropological research, Bharatvani uniquely prioritises India's vast linguistic diversity. In a similar vein, Living Tongues provides a free, mobile-friendly platform supporting over 400 under-represented languages worldwide, including many endangered languages of India. With 209,000+ dictionary entries and 963 citizen-linguists globally, it uses digital tools and community engagement for revitalising endangered languages for future generations.

Similarly, The Missing Scripts program endeavors to safeguard the diversity of global languages by preserving indigenous scripts and ensuring their digital presence, employing interdisciplinary approaches such as computational linguistics and historical linguistics. It aims to unlock cultural and historical insights through script decipherment, fostering global collaboration among researchers and scholars. DAILP, which stands for Digital Archive of Indigenous Language Persistence, is a global initiative created to support indigenous communities worldwide in preserving their languages and cultural heritage.

On a regional scale, SiDHELA, Sikkim-Darjeeling Himalayas Endangered Language Archive (SiDHELA) serves as a repository for primary linguistic data of five languages from Sikkim and North Bengal. In contrast to global initiatives, Digital Himalayas centers specifically on the Himalayan region, documenting languages, cultures, and traditions across Nepal, Bhutan, and the Indian Himalayan states. It utilises multimedia approaches to capture oral histories, folklore, and linguistic data, supporting local communities in preserving their cultural heritage and linguistic identities.

Overall, while Bharatvani focuses on India's linguistic diversity and digital accessibility, initiatives like ELAR, CoEDL, Missing Scripts, and the Endangered Languages Project contribute valuable best practices in documentation, preservation, community engagement, and interdisciplinary research on a global scale. Bharatvani distinguishes itself through its focus on India's rich linguistic tapestry, aiming to document and preserve not just mainstream languages and dialects, but also lesser-known tribal and regional languages spoken throughout the country. Unlike many initiatives that specialise in indigenous languages of specific regions, Bharatvani fosters inclusive digital literacy and cultural preservation tailored to India's diverse linguistic and cultural heritage.

8. IMPEDIMENTS TO DIGITAL ARCHIVING

Despite its value in preserving and accessing information, digital archiving poses several challenges:

8.1 Digital Obsolescence

Formats and storage technologies can become obsolete, making it difficult to access older digital materials.

Constant upgrading of formats is required to ensure continued accessibility.

8.2 Data Integrity

Ensuring that archived digital materials remain unchanged and uncorrupted over time is crucial. This requires robust data verification and validation mechanisms.

8.3 Scale and Volume

The sheer volume of digital data being generated can overwhelm archiving systems. Managing and processing large volumes of data is a significant challenge in digital archiving.

8.4 Metadata and Indexing

Accurate categorisation, description, and indexing of digital materials are crucial for efficient retrieval and utilisation.

8.5 Access and Usability

Providing easy access to archived materials while ensuring security is a delicate balance. Cushing & Osti³⁸ affirms that addressing challenges in usability, accessibility, and ethics is crucial for maximising the potential of digital archives in language preservation.

8.6 Adaptability

Creating adaptable digital preservation strategies is vital for ensuring the enduring relevance of archived materials. Burke & Zavalina³⁹ highlight the challenges and complexities of organising and retrieving archived data, emphasising the need for effective organisational strategies.

8.7 Privacy and Ethical Considerations

Digital archives may contain sensitive cultural or personal information. Ethical guidelines must be established to ensure privacy, accuracy, and informed consent for archival use as well as to safeguard against misappropriation or misrepresentation of sacred or sensitive materials.

8.8 Low Community Engagement

Low community engagement poses obstacles to digital archiving and documentation process, hindering transmission of intergenerational knowledge.

8.9 Digital Divide

Limited access to technology and internet obstructs efforts to digitally document, archive, and transmit endangered languages, hindering accessibility for remote communities. Digital archiving is vital for preserving endangered languages, but the digital divide hinders these efforts.

Indeed, the success of digital archives hinges on community awareness, outreach to remote areas, community

engagement, and ethical treatment of languages, knowledge and cultural materials.

9. STRATEGIES TO OVERCOME SOCIAL AND TECHNOLOGICAL BARRIERS TO DIGITAL ARCHIVING

9.1 Community Engagement

Organise workshops on the cultural significance of archiving, collaborate with local leaders for support, and implement accessible technology. Build connections through regular, diverse communication channels like social media, newspapers, and meetings.

9.2 Capacity Building

Provide training and resources to community members and archivists on digital preservation techniques, including digitisation, metadata creation, and long-term storage strategies.

9.3 Accessibility and Inclusivity

Ensure that digital archives are accessible to diverse audiences, including those with varying levels of technological proficiency and disabilities. Offering training can enhance digital equity for individuals with limited knowledge of technology.

9.4 Collaboration and Partnerships

Forge collaborations with local organisations, libraries, museums, educational institutions, and technological companies to leverage expertise, resources, and funding for digital archiving projects.

9.5 Data Security and Preservation

Implement robust data security measures to protect archived materials from loss, corruption, or unauthorised access. Develop strategies for long-term digital preservation to ensure the integrity of archived content over time.

9.6 Public Awareness and Advocacy:

Promote awareness through diverse channels to enhance participation and support for archival initiatives. Raise public awareness about the value of digital archiving through outreach campaigns, exhibitions, and educational programs.

9.7 Continuous Evaluation and Improvement

Regularly evaluate the effectiveness of digital archiving practices and technologies, incorporating feedback from users and stakeholders to refine processes and enhance accessibility.

By employing these strategies, awareness about platforms like The Endangered Languages Archive, Living Tongues, Bharatvani, SiDHELA and many others like that can be effectively spread among communities, encouraging them not only to actively participate in language preservation efforts but also to make the most of the resources available.

10. CONCLUSION

The study highlights that preserving India's linguistic heritage is crucial for maintaining the country's cultural, social, and educational well-being. Analysis of user testimonials reveals the factors that motivate engagement with the Bharatvani app, as well as the social and technical barriers that hinder access. Although the app receives favorable feedback for its content and interface, significant improvements are needed in accessibility, performance, and user-centric design. Although technology provides immense potential for the protection of language and culture, it is important to emphasise that community engagement remains essential for the preservation and revitalisation of languages. Governments, NGOs, and communities can collaborate to address the challenges of language preservation. This effort requires active involvement from various stakeholders, including community elders, educators, policymakers, and cultural leaders to effectively support linguistic initiatives. Such efforts should not be limited to the academic realm of a few individuals; instead, it should involve collaborative efforts that enhance the importance of indigenous languages, motivating younger generations to embrace and safeguard it.

REFERENCES

1. Moseley, Christopher. Atlas of the world's languages in danger. 3rd edition, UNESCO Publishing: France, 2010.
2. Romaine, Suzanne. Preserving endangered languages. *Language and Linguistics Compass*, 2007, 1.1-2, 115. doi: 10.1111/j.1749-818X.2007.00004.x
3. censusindia.gov.in (domain)
4. Sengupta, Papia. Endangered languages: Some concerns. *Economic and Political Weekly*, 2009 August 8, vol. xlv, no. 32. doi: 10.2307/25663414.
5. Gupta, Namrata. Endangered languages: Some concerns. *International Journal of Research in Social Sciences*, 2017, Vol. 7 Issue 7. https://www.ijmra.us/project%20doc/2017/IJRSS_JULY2017/IJMRA-11908.pdf
6. Gaur, Ramesh C. Preserving indian languages and Ancient scripts through language documentation and digital Archiving. *DESIDOC Journal of Library & Information Technology*, November, 2020, 40(05), 265-267. doi: 10.14429/djlit.40.05.16441.
7. Gautam, A.K. Language Endangerment in India: An overview. *Language in India*, 2022, Vol. 22:1. Dr. arvind endangerment of languages india final.pdf (languageinindia.com).
8. Derhemi, E & Moseley, C. Endangered languages in the 21st century. London: Routledge, 2023.
9. Crystal, David. *Language death*, Cambridge, UK: Cambridge University Press, 2000.
10. Krauss, Michael. The world's languages in crisis. *Language*, 1992, 68, 4-10. doi: 10.1353/LAN.1992.0075.
11. Blackburn S. & Opgenor J.R. India and the Himalayan chain. In atlas of the world's languages in danger,

- edited by Christopher Moseley, 3rd edition, UNESCO publishing: France, 59-63, 2010.
12. Krauss, M. Classification and terminology for degrees of language endangerment, In encyclopedia of the world's endangered languages, edited by C. Moseley, 2007, London/New York, Routledge.
 13. Devy, Ganesh N. Seven decades after independence, many tribal languages in India face extinction threat by Abhijit Mohanty published: wednesday 26 august 2020. Seven decades after independence, many tribal languages in India face extinction threat (downtoearth.org.in) (accessed on 20 February, 2024).
 14. Sharma, D. Early detection of factors, including pandemics and disasters, leading to language endangerment: Thinking statistically. *Iars International Research Journal*, 2021, 11(1), 31-35.
doi: 10.51611/iars.irj.v11i1.2021.153
 15. Harrison, David. *When languages die*. oxford: Oxford University Press, 2007.
 16. Gorenflo, L.; Romaine, S.; Mittermeier, R. & Walker-Painemilla, K. Co-occurrence of linguistic and biological diversity in biodiversity hotspots and high biodiversity wilderness areas. In proceedings of the national academy of sciences, 2012.
doi: 10.1073/pnas.1117511109
 17. Roche, G. & Tsomu, Y. Tibet's invisible languages and China's language endangerment crisis: Lessons from the gochang language of Western Sichuan. *The China Quarterly*, 2018, 186-210.
doi: 10.1017/S0305741018000012
 18. Fishman, Joshua A. *Language and ethnicity in minority sociolinguistic perspective*. Clevedon: Multilingual matters, 1989.
 19. Nettle, D. & Romaine S. *Vanishing voices: The extinction of the world's languages*. New York: Oxford University Press, 2000.
 20. Dalby, Andrew. *Language in danger*. London: Penguin, 2002.
 21. Austin, Peter K. *Language documentation and language revitalisation*. In *revitalising endangered languages: A practical guide*, edited by Justyna Olko & Julia Sallabank. Cambridge University Press, 2021.
 22. Galla, Candace K. Indigenous language revitalisation and technology: From traditional to contemporary domains. In *indigenous language revitalisation: Encouragement, guidance & lessons learned*, edited by J. Reyhner & L. Lockard, Northern Arizona University, 2009.
 23. Bernard, H.R. *Preserving language diversity: Computers can be a tool for making the survival of language possible*. march 11, 2010 cultural survival (accessed on 20 march, 2024).
 24. Meighan, Paul J. Indigenous language revitalisation using TEK-nology: How can traditional ecological knowledge (TEK) and technology support intergenerational language transmission? *Journal of Multilingual and Multicultural Development*, 2022. 1-19.
doi: 10.1080/01434632. 2022.2084548
 25. Berez, A.L. The digital archiving of endangered language oral traditions: Kaipuleohone at the university of hawai'i and C'ek'aedi hwnax in Alaska. *Oral Tradition*, 2013, 28(2), 261-270.
doi: 10.1353/ort.2013.0010
 26. Meighan, Paul J. Decolonizing the digital landscape: The role of technology in indigenous language revitalisation. *AlterNative: An International Journal of Indigenous Peoples*, 2021, Volume 17, Issue 3.
doi: 10.1177/11771801211037672
 27. Babinski, S.; Jewell, J.; Kim, J.; Haakman, K.; Lake, A.; Yi, I. & Bowern, C. How usable are digital collections for endangered languages? A review, proceedings of the linguistic society of america (PLSA), 2022, 7(1).
doi: 10.3765/plsa.v7i1.5219
 28. Murphy, Hugh. Understanding the value of digital archival collections to faculty at maynooth university library. *New Review of Academic Librarianship*, 2021, 27(4), 423-439, doi: 10.1080/13614533.2021.1976233
 29. Burke, M. Collaborating with language community members to enrich ethnographic descriptions in a language archive. In proceedings of the international workshop on digital language archives, 2021.
doi: 10.12794/langarc1851172
 30. Dayanand, S. Arul.; Devi, M. Uma & Kumar, Ramesh. Digital archives and preservation techniques for revitalising endangered languages. *One day international conference on recent trends in digital humanities: A focus on language and literature*, 2023, Vol. 12, Issue. 1.
doi: 10.34293/rtdh.v12iS1-Dec.133
 31. Galla, Candace K. Indigenous language revitalisation, promotion, and education: Function of digital technology, *Computer Assisted Language Learning*, 2016, 29:7, 1137-1151.
doi: 10.1080/09588221.2016.1166137
 32. Hermes, M. & King, K. Ojibwe language revitalisation, multimedia technology, and family language learning, *Language Learning & Technology*, 2013, 17(1), 125-144. <http://hdl.handle.net/10125/24513>
 33. Ludäscher, B.; Marciano, R. & Moore R. Preservation of digital data with self-validating, self-instantiating knowledge-based archives. *ACM Sigmod Record*, 2001, 30(3), 54-63.
doi: 10.1145/603867.603876
 34. Bokova, Irina. HRD minister smriti Irani launches Bharatavani, a portal and app to help learn indian languages and literature, Scoo news-India's leading school and education news network. (accessed on 20 march, 2024).
 35. Choudhary, N. et al. Bharatavani project - reviving linguistic diversity and cultural heritage in India: A case study, *ACM/IEEE JCDL'23, LangArc-2023 workshop*, July 2023.
doi: 10.12794/langarc2114300
 36. <http://bharatavani.in/> (accessed on 8 February, 2024)
 37. Bharatavani apps on google play https://play.google.com/store/apps/details?id=in.bharatavani.bharatavani&hl=en_

IN accessed on 10 July)

38. Cushing, Amber L. & Osti, Giulia. "So how do we balance all of these needs?": How the concept of AI technology impacts digital archival expertise. *Journal of Documentation*, 2022, Vol. 79 No. 7, 12-29. doi: 10.1108/JD-08-2022-0170
39. Burke, M. & Zavalina, Oksana L. Identifying challenges for information organisation in language archives: Preliminary findings. Published in *conference 23 carch*, 2020. doi: 10.1007/978-3-030-43687-2_52

ACKNOWLEDGEMENT

The first author, Shilpi Saxena, acknowledges the financial assistance provided by the Indian Council of Social Science Research (ICSSR), Ministry of Education under the Post-Doctoral Fellowship (Grant No. 3-24/2023-24/PDF/GEN).

CONTRIBUTORS

Dr. Shilpi Saxena holds an MA, MEd, and PhD Currently, she is pursuing a Post-Doctoral Fellowship at the ICSSR, within the School of Humanities and Social Sciences at Thapar Institute of Engineering and Technology in Patiala, Punjab. Her areas of interests are: Language, Identity and Culture. Her contribution to the current study include developing the conceptual framework, preparing the initial draft, collecting and analysing data, and writing the final manuscript.

Dr. Gurvinder Kaur is an MBA(HR) and PhD in Human Resource Management. Currently, she is working as an Associate Professor in School of Humanities and Social Sciences at Thapar Institute of Engineering and Technology, Patiala, Punjab. Her areas of interest are: Linguistics, Higher education and Design thinking. She contributed to the current paper by finalising and revising the draft, enhancing its clarity, coherence, and overall quality, and improving the presentation of the final manuscript.

The Impact of Knowledge Creation, Acquisition, and Capture on Knowledge Sharing: An Investigation Among Nursing Professionals

Chennupati Deepti^{#*}, Somipam R. Shimray[§], Abdoulaye Kaba[!] and Chennupati Kodanda Ramaiah[%]

[#]*Ashoda Hospitals, Alexander Rd, Shivaji Nagar, Secunderabad, Telangana – 500 003, India*

[§]*Department of Library and Information Science, Babasaheb Bhimrao Ambedkar University, Lucknow - 226 025, India*

[!]*College of Education, Humanities and Social Sciences, Al Ain University, Al Ain, United Arab Emirates*

[%]*Department of Library and Information Science, Pondicherry University, Pondicherry 605 014, India*

**E-mail:deeptic2001@yahoo.co.in*

ABSTRACT

This study aims to inspect the effect of knowledge creation, acquisition, and capture, on knowledge sharing among nursing professionals. This empirical study is based on the survey method and data collected using a questionnaire tool. The study used a simple random sampling technique for collecting data. The study's findings showed that knowledge creation, knowledge acquisition, and knowledge capture, demonstrated a positive correlation with knowledge sharing. Although this study focuses on nursing professionals, the findings can be applied to other knowledge-concentrated organisations. The results of this study direct institutions to capitalise on the management process, and more precisely, on knowledge sharing among nursing professionals.

Keywords: Knowledge management; Nursing professionals; Knowledge creation; Knowledge acquisition; Knowledge capturing; Knowledge sharing

1. INTRODUCTION

Knowledge may be defined as an aptitude for practical application, an awareness of individuals and situations, or a comprehension of facts. This understanding of facts referred to as propositional knowledge, is typically described as a true belief that is differentiated from mere opinion or conjecture through the presence of justification. Knowledge Creation (KCR) in nursing professionals encompasses creating and modifying knowledge to effectively address clinical scenarios¹. Nursing knowledge creation involves tailoring it to local contexts and utilising an integrated knowledge translation approach, leveraging pragmatic philosophy for practical application². In the health sciences, Knowledge Acquisition (KAC) includes research, clinical practice, and patient data; however, theoretical knowledge is acquired by nursing professionals through classroom teaching and hands-on training³. Clinical trials and medical research provide instructors and students with empirical information in the nursing sector⁴. In the health sciences, Knowledge Capture (KCA) refers to the organised data collecting, assembling, classification, and archiving process with the purpose of advancing research, improving patient care, and making accurate decisions⁵. Electronic health

records, systematic reviews, and meta-analyses⁶, as well as the preservation of important findings from research, clinical experiences, and patient information, all greatly enhance health outcomes. Knowledge Sharing (KSH) in nursing comprises skill transfer across specialties, units, and departments⁷, enhancing care quality, collaboration, innovation, clinical decision-making⁸, knowledge growth, accountability⁹ and teamwork¹⁰. In the healthcare industry, the knowledge management process is essential for improving patient safety, quality of treatment, and satisfaction. As a result, the researchers want to find out how knowledge generation, acquisition, and capture affect information sharing in the Indian nursing professionals.

2. LITERATURE REVIEW

Knowledge is an invaluable asset that fosters the development of people and organisations¹¹. Knowledge Management (KM) is the strategic application of knowledge enhancement courses to increase an organisation's competitive advantage and value. By promoting sharing of information and accessibility among medical personnel, effective knowledge management in nursing may improve patient outcomes and the quality of care provided¹². Knowledge production, acquisition, distribution, and retention are all part of the process of improving the knowledge base¹³.

2.1 Knowledge Creation

Knowledge creation is an ongoing process that produces, validates, and shares new knowledge to improve patient outcomes, medical practices, disease understanding, treatment, and prevention. In order to create and update knowledge in addition to successfully respond to clinical situations, KCR in nursing requires creative efforts to produce novel concepts¹⁴. KCR in Health sciences demands collaboration between organisations, researchers, and practitioners; it involves people dealing with and solving new problems through training¹⁵.

A number of strategies may be used to support the generation of new information, such as translational research, which links scientific investigation to clinical practice, and the conversion of laboratory results into clinically assessed therapies, diagnostic tools, or health interventions¹⁶. KCR patterns show interconnectivity and organising; nonetheless, their expression necessitates distinct contexts and situations¹⁷⁻¹⁸. Because of this, organisations that value Knowledge Creation (KCR) need to devote a large amount of funding to the advancement of KCR programs.

2.2 Knowledge Acquisition

Assimilation of knowledge from internal and external organisational resources involves discovering, accessing, capturing, and gathering sources, as well as examining anthropological, sociological, and technological aspects¹⁹. Acquiring medical expertise and knowledge, increasing medical education, and improving clinical outcomes all depend on the availability of knowledge resources in the healthcare industry²⁰. By including students as collaborators and learners, the practical field of nursing education significantly enhances students' KAC²¹.

According to Hassanian⁴, *et al.* nursing professionals acquire knowledge through five generic categories such as "moving towards upstream purposes (causal condition)", "the relative dynamism (context)", "persuade to acquire knowledge and deficit of it (facilitator and inhibitor)", "relative acquisition of knowledge in nursing (processes)" and relative accumulation of knowledge (consequences).

2.3 Knowledge Capture

Knowledge capture involves the conversion of implicit knowledge into explicit knowledge, and vice versa. KCA in nursing encompasses collecting data from clients, family members, medical records, and references to understand their health condition, treatment reactions, and potential risks²², documentation within formal clinical and academic publications²³ and capturing knowledge from the surroundings or individuals engaged within that surroundings²⁴.

2.4 Knowledge Sharing

The field of healthcare science is one in which medical knowledge is always expanding in an astronomical rate²⁵. Sharing knowledge is therefore regarded as an essential strategy for collaborating to enhance clinical outcomes and patient well-being. The study conducted by Asurakkody and Kim²⁶ discovered a strong positive

link between KSH behavior and creative work behavior in nursing students. Yoo⁸, *et al.* found that there is a clear correlation between decision-making ability and the sharing of explicit knowledge. On the other hand, Shehab¹⁸, *et al.*'s study observed that knowledge self-efficacy acts as a moderating factor in the link between information-sharing behaviors and the three individual characteristics of reputation, reciprocity, and trust. According to the Assem & Pabbi²⁷ study, informal meetings and conferences-rather than formal knowledge management systems-are the main source of Ghana's healthcare sharing of knowledge.

The healthcare industry places a high value on knowledge management, as it fosters professional collaboration and improves patient outcomes. A study by Karamitri²⁸, *et al.* identified the main elements of knowledge management practices in the healthcare industry as leadership, synthesis, collaboration, synthesis, and dissemination of knowledge. The study emphasises the difficulties in applying Knowledge Management (KM) in the healthcare industry and recommends that administrators establish a knowledge-centric workplace, act as models, supply the required resources, and give knowledge brokers with incentives²⁸. Research on the effects of knowledge creation, acquisition, capturing, and sharing is lacking. This study is suggested in order to have a better understanding of KM practices in the Indian nursing profession. The following objectives guided our study:

- To examine the relationship between knowledge creation and knowledge sharing.
- To look at the relationship between knowledge acquisition and knowledge sharing.
- To study the relationship between knowledge capturing and knowledge sharing.

2.5 Construction of Hypotheses

Research studies on KM reveal that an organisation's capacity to produce, disseminate, and use knowledge efficiently has a major effect on its ability to survive and compete²⁹. By producing and disseminating new information, knowledge sharing helps people learn more by exchanging knowledge. The relationship between knowledge creation and sharing has been the subject of conflicting research; although some studies have identified a substantial association³⁰⁻³¹, others have suggested a positive correlation³². The disparity may result from the selection of different study models, analytical groups, or sample units. The process of gaining and expanding new knowledge whenever one acquires it is known as knowledge acquisition³³. Without strong factual support, knowledge sharing and acquisition are commonly seen as ambiguous and not easy³⁴. An earlier study discovered that faculty members' attitudes and subjective standards are significantly affected by their knowledge acquisition and sharing³⁵. Identifying and observing existing knowledge inside or outside of an organisation is an important procedure commonly referred to as "knowledge capture."

It is the methodical organisation and recording of undocumented inferred information for later retrieval or analysis. Research that has recently been published has shown that employee performance is significantly improved by knowledge sharing and capture³⁶. Thus, knowledge sharing is an integral part of an innovation process and knowledge sharing directly enhances creativity and innovation³⁷. This study attempts to explore the relationships between knowledge acquisition, sharing, and transfer and highlights their interconnectedness. Preceding studies have also reported how knowledge creation, acquisition, capturing, and sharing contribute to KM³⁸⁻³⁹. The review and findings of the previous studies helped us put forward the hypotheses below and a conceptual model (Fig. 1). The hypotheses are:

H₁: There is a positive relationship between knowledge creation and knowledge sharing.

H₂: There is a positive relationship between knowledge acquisition and knowledge sharing.

H₃: There is a positive relationship between knowledge capturing and knowledge sharing.

The relationship between knowledge sharing (the dependent variable) and the three independent variables including knowledge creation, acquisition, and capturing can be observed in the conceptual model that has been given below:

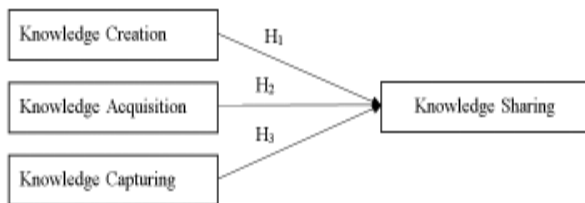


Figure 1. Conceptual model.

3. METHODOLOGY

3.1 Questionnaire Design

The questionnaire was created by the researchers using a variety of resources, including systematic literature reviews that were carried out specifically for the purpose of designing the questionnaire. The variables included in this investigation were chosen from the literature that has been published^{13,40,41,42}. This survey is divided into two sections: the first part covers about the demographics of the respondents, and the second half contains the 27 items that make up the research variable. Each item is rated on a five-point Likert scale, where 1 represents strong disagreement and 5 represents strong agreement. As an example, the first question asked, “I collect new information and make a connection between the new and the already available information.”

3.2 Study Sample and Data Collection

The study sample had been chosen in 2022–2023 from nursing schools affiliated with Pondicherry University. The Principals of Nursing Colleges affiliated with Pondicherry University helped in collecting data from students and research scholars for this study through

an online questionnaire. The respondents for this study were drawn using a simple random sampling technique. In order to promote wider involvement, a structured questionnaire was circulated through social media. To get the most out of the participants, three reminders were given. A total of 1015 completed questionnaires were received, resulting to 49.10 % response rate (Table 1). At the end, 968 completed and valid questionnaires were used to evaluate the suggested hypotheses and 47 (4.63 %) responses were omitted due to incomplete data.

Table 1. Details of data collection and study

College	Sample	Response	Response rate (%)
Mother Theresa Post Graduate and Research Institute of Health Sciences	295	165	55.93
Indirani College of Nursing	380	163	42.89
College of Nursing, Pondicherry Institute of Medical Sciences	360	213	59.17
Raak Nursing and Paramedical College	180	85	47.22
College of Nursing, East Coast Institute of Medical Sciences	192	94	48.96
Sri Manakula Vinayagar Nursing College	330	145	43.94
Sabari College of Nursing	150	66	44
A.G. Padmavathi College of Nursing	180	84	46.67

4. FINDINGS

4.1 Demographic Profiles

After the data-cleaning process, a total of 968 responses were considered for analysis. Table 2 presents the demographic profile of the study population. Of the total, the majority (73.35 %) of the respondents were females, less than half (48.86 %) of them belonged to the 26-30 years age group, the majority (88.95 %) had a B.Sc. degree in nursing and about one-fifth (21.9 %) of the respondents are from College of Nursing, Pondicherry Institute of Medical Sciences.

4.2 Assessing Measurement Model

For each dimension in this study, the reliability of the items was assessed through Cronbach’s alpha coefficient and Composite Reliability (CR). Table 2 provides the results of Cronbach’s alpha and CR values. The composite reliability values exceeded 0.85, greater than the satisfactory value of 0.7, and the constructs’ Cronbach’s alpha values exceeded the recommended reliability value of 0.7⁴³. Here comprehensive exercise was conducted to assess the validity.

First, to ensure content validity, we carefully selected scales from prevalent opinions based on the literature review.

Additionally, to improve participant understanding, we had subject matter specialists look into the questionnaire multiple times to get feedback on simplifying the language. In addition, the Comparative Fit Index (CFI) of 0.980 indicates a significant degree of fit to the data. Convergent Validity (CV) was assessed by the confirmatory factor. Similarly, the Tucker–Lewis Index (TLI) is 0.976, confirming a good fit. Additionally, the Incremental Fit Index (IFI) also stands at 0.980, supporting the model’s adequacy. Finally, the root mean square error of approximation (RMSEA) is 0.052, suggesting a close fit to the data (Fig. 3). All these indices were more significant than the minimum recommended values, and all factor loadings were greater than 0.70, and significant at the $p < 0.001$ level⁴³. Additionally, Average Variance Extracted (AVE) was examined to determine the amount of variance of the measurement items that the constructs can account for concerning measurement error. According to Table 1, all AVE values for each construct are greater than the suggested value of 0.5⁴³, which supports the convergent validity measures.

Table 2. Demographic profiles

Item	Category	Frequency	Percentage
Gender	Male	258	26.65
	Female	710	73.35
Age	21-25	283	29.24
	26-30	473	48.86
	31-35	128	13.22
	36-40	46	4.75
	41 & above	38	3.93
Education	UG	861	88.95
	PG	91	9.40
	Research Scholar	16	1.65
Colleges	Mother Theresa Post Graduate and Research Institute of Health Sciences	146	15.08
	Indirani College of Nursing	156	16.12
	College of Nursing, Pondicherry Institute of Medical Sciences	212	21.9
	Raak Nursing and Paramedical College	79	8.16
	College of Nursing, East Coast Institute of Medical Sciences	86	8.89
	Sri Manakula Vinayagar Nursing College	143	14.77
	Sabari College of Nursing	64	6.61
A.G. Padmavathi College of Nursing	82	8.47	

Table 3. Item loading, reliability, CR and AVE

Constructs	Item	Loading	Cronbach’s α	CR	AVE
Knowledge Creation	1	0.90	0.976	0.974	0.809
	2	0.91			
	3	0.92			
	4	0.90			
	5	0.91			
	6	0.90			
	7	0.89			
	8	0.89			
	9	0.86			
Knowledge Acquisition	1	0.92	0.973	0.973	0.818
	2	0.85			
	3	0.93			
	4	0.91			
	5	0.92			
	6	0.93			
	7	0.87			
	8	0.89			
Knowledge Capturing	1	0.90	0.947	0.947	0.782
	2	0.81			
	3	0.92			
	4	0.92			
	5	0.87			
Knowledge Sharing	1	0.91	0.875	0.858	0.671
	2	0.67			
	3	0.86			

Notes: CR:Composite Reliability, AVE: Average Variance Extracted

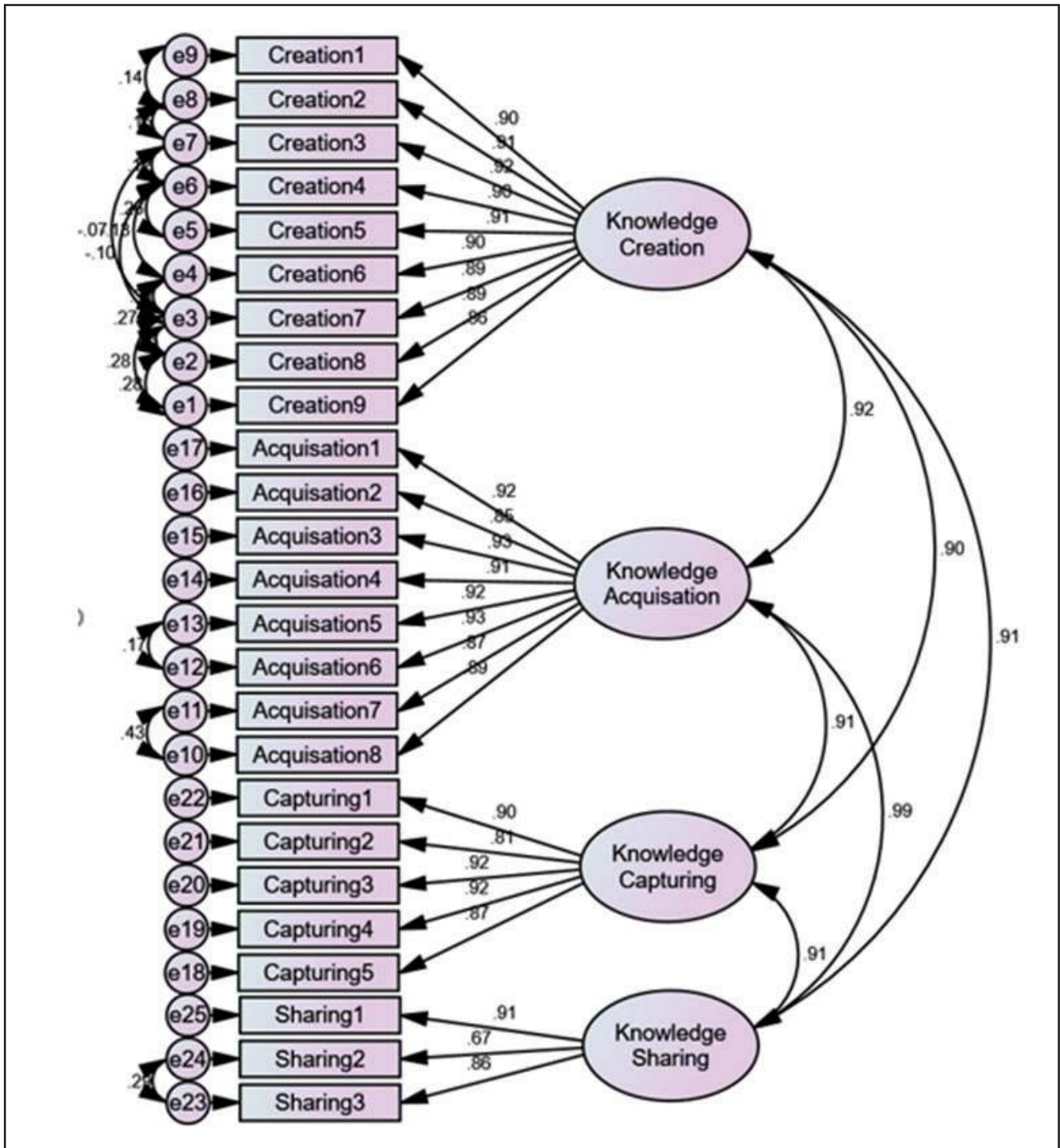


Figure 2. Factor model of knowledge management practice.

To calculate discriminant validity, we computed the square root of AVE for the respective construct and equaled it to correlations between the construct pairs⁴³. The square root of the respective construct's AVE value was more significant than its correlation with any other construct, as shown in Table 4 thus, this study's discriminant validity was proven. Based on the above findings, this study's reliability and validity estimations are quite satisfactory.

Table 4. Discriminant validity test

Variables	Mean	SD	KSH	KCR	KAC	KCA
KSH	3.392	1.190	0.819			
KCR	3.545	1.206	0.906	0.899		
KAC	3.606	1.243	0.987	0.923	0.904	
KCA	3.477	1.174	0.913	0.900	0.914	0.884

Notes: SD: Standard Division, KSH: Knowledge sharing, KCR: Knowledge creation, KAC: Knowledge acquisition, KCA: Knowledge capturing

4.3 Structural Model Valuation

The path coefficients and R² values were estimated as part of the structural model's valuation (Fig. 3). We discovered that knowledge creation ($\beta = 0.091, p < .05$), knowledge capturing ($\beta = 0.182, p < .05$) and knowledge acquisition ($\beta = 0.609, p < .05$) have a positive impact on knowledge sharing (Table 5). Linear regression is used to find the equation that generates the least amount of difference between the observed values and their fitted values. The R² value for knowledge-sharing was 0.67, indicating that it fits within an acceptable range and is therefore acceptable⁴³.

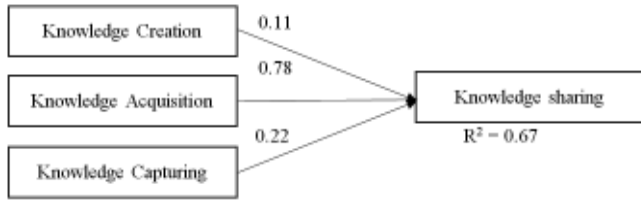


Figure 3. Final model with beta coefficients.

Table 5. Result summary

Hypothesis	Interaction	Coefficient	p-value	Conclusion
H ₁	KCR → KSH	0.091	0.015*	Supported
H ₂	KAC → KSH	0.609	0.014*	Supported
H ₃	KCA → KSH	0.182	0.015*	Supported

Notes: KCR: Knowledge Creation, KAC: Knowledge Acquisition, KCA: Knowledge Capturing, KSH: Knowledge Sharing.

5. DISCUSSION

Profili²⁵, *et al.* found that nursing is one in which new knowledge is constantly being created continuously. Akhavan³⁰ *et al.*, express that creating new knowledge presumes that people will identify important data, information and transform it into knowledge that will benefit the organisation. The primary focus of this study was to examine the relationship between creation of knowledge, acquisition, capturing and knowledge sharing among nursing professionals. Storey and Kelly⁴⁴ highlighted a positive atmosphere, organisational inventiveness, and a common goal are necessary for a knowledge creation learning culture. Knowledge sharing is characterised by common understanding, active communication, empowerment, and teamwork. As more knowledge is generated, it will eventually be shared more. Hence, institutions need to offer opportunities and resources for the creation of new knowledge that will improve the organisation's overall reputation. There is little evidence linking the creation and distribution of information. Akhavan³⁰, *et al.* found no evidence of any meaningful association³², despite several research showing a positive correlation. The discrepancy may arise from selecting different sample units, analytical levels, or research models. The findings of this study indicate a positive relationship between knowledge creation and knowledge sharing; therefore, these results support the opinions of Akhavan³⁰, *et al.* studies.

When there is not enough of substantial scientific

evidence, knowledge acquisition and sharing are usually viewed as unclear and problematic³⁴. According to previous research by Abdekhoda³⁵, *et al.* faculty members' attitudes and subjective standards are significantly influenced by the knowledge they learn and communicate. Agrifoglio⁴⁵, *et al.* explain that knowledge is acquired through various educational models and techniques, such as lectures, discussions, work-related examples, play-acting, behavioural demonstrating, on-the-job training, and learning by networking with others, which is additionally made more accessible by training programmes. Adam⁴⁶, *et al.* study shows that knowledge acquisition has a direct positive correlation with knowledge sharing and affects the quality of competitive advantage because it has a direct effect on knowledge sharing. However, the result contradicts the results of previous studies. This study's findings indicate a positive relationship between knowledge acquisition with knowledge sharing.

Zamir⁴⁷ analysis revealed a favorable correlation between knowledge capture and knowledge sharing; however, these findings differ from those of previous study results. Pacharapha and Ractham¹⁶ explain that it may be due to the receiver's prejudgments that influence individuals' knowledge acquisition. The influence depends on how knowledgeable a person is about the subject they have learned, whether he/she is an expert or a novice. According to a study by Suardy and Budiono³⁶, employee performance is significantly improved by knowledge capture and dissemination. This study result reveals a positive correlation between knowledge capturing and knowledge sharing. The study's findings offer new insights into the contributions nursing professionals made to the field of KM and its practices. These results provide valuable insights for nursing professionals in creating, acquiring, capturing, and sharing their knowledge. Overall, these results confirmed that knowledge creation, acquisition, and capture positive impact on knowledge sharing.

6. CONCLUSIONS

Knowledge is a vital strength for an organisation to gain a competitive advantage. Nursing professionals require different platforms to create, acquire, capture, and share knowledge. It is widely acknowledged that knowledge plays a vital role in society and that knowledgeable employees are the most valuable assets in any organisation. Thus, institutions must foster innovative ideas and enable individuals to create, acquire, capture, and share knowledge. This research contributes to a better comprehension of KM practices in healthcare organisations, by establishing the association between creation, acquisition, capture, and knowledge sharing among nursing professionals. As a result, this research expands the understanding of how knowledge is managed among nursing professionals. These results apply to all nursing organisations where healthcare delivery is a team effort that unites the widely dispersed and fragmented body of medical knowledge. While the primary emphasis of this study is nursing professionals, KM is essential in all organisations that

demand extensive knowledge. The results of this study would direct institutions to capitalise on the management process, and more precisely, on knowledge sharing among nursing professionals.

This study presents several limitations that pave the way for future research. Firstly, it focuses solely on examining the connection between KM practice, including knowledge creation, acquisition, capturing, and sharing. Additional investigations could explore the impact of other variables as moderators in the relationships between KM practices and endogenous constructs. Future research may build on the results of this study by incorporating specific KM enablers into the conceptual model and investigating the relationships between these variables. In addition, to further highlight this crucial facet of KM, studies into the nature of nursing professionals' knowledge-hiding behaviours inside healthcare organisations are to be investigated. In summary, this study lays the foundation for further exploration in the field, suggesting potential avenues for research that encompass broader perspectives on KM practices and incorporate additional factors influencing the outcomes in various organisations.

People need to gather important data and turn it into knowledge with consequences for research, practice, and policy. In our Teaching we must include techniques for role-playing, lectures, discussions, and group projects promote knowledge acquisition and information exchange. Consequently, businesses need a clear objective, an innovative learning environment, and an appropriate atmosphere for learning. Hence, organisations should support the creation and sharing of new knowledge since these endeavors improve nurses' expertise and ability to share information. Moreover, there is a need for further research on Knowledge Management (KM) strategies that adopt a more comprehensive approach and consider other factors that may affect the outcomes in different organisational contexts. Organisations should also focus more on how nurses share and apply their skills and knowledge.

REFERENCES

1. Ayanbode, O.F. & Nwagwu, W.E. Collaborative technologies and knowledge management in psychiatric hospitals in South West Nigeria. *Information Development*, 2021, **37**(1), 136-157.
doi: 10.1177/0266666919895563
2. Nowell, L. Pragmatism and integrated knowledge translation: Exploring the compatibilities and tensions. *Nursing Open*, 2015, **2**(3), 141-148.
doi: 10.1002/nop2.30
3. Makhene, A. Use of foundational knowledge as a Basis to facilitate critical thinking: Nurse educators' perceptions. *Nursing Research and Practice*, 2022, 1-7.
doi: 10.1155/2022/3736322
4. Hassanian, Z.M.; Ahanchian, M. & Karimi-Moonaghi, H. The process of knowledge acquiring in nursing education: Grounded theory. *Research and Development in Medical Education*, 2018, **7**(2), 68-76.
doi: 0.15171/rdme.2018.015
5. Shahmoradi, L.; Safadari, R. & Jimma, W. Knowledge management implementation and the tools utilised in healthcare for evidence-based decision making: A systematic review. *Ethiopian Journal of Health Sciences*, 2017, **27**(5), 541.
doi: 10.4314/ejhs.v27i5.13
6. Jiang, F.; Jiang, Y.; Zhi, H.; Dong, Y.; Li, H.; Ma, S.; Wang, Y.; Dong, Q.; Shen, H. & Wang, Y. Artificial intelligence in healthcare: Past, present and future. *Stroke and Vascular Neurology*, 2017, **2**(4), 230-243.
doi: 10.1136/svn-2017-000101
7. Zeng, Z.; Deng, Q. & Liu, W. Knowledge sharing of health technology among clinicians in integrated care system: The role of social networks. *Frontiers in Psychology*, 2022, **13**, 926736.
doi: 10.3389/fpsyg.2022.926736
8. Yoo, K.H.; Zhang, Y.A. & Yun, E.K. Registered Nurses (RNs)' knowledge sharing and decision-making: The mediating role of organisational trust. *International Nursing Review*, 2019, **66**(2), 234-241.
doi: 10.1111/inr.12488
9. Wu, S.-Y.; Wang, W.-T. & Hsiao, M.-H. Knowledge sharing among healthcare practitioners: Identifying the psychological and motivational facilitating factors. *Frontiers in Psychology*, 2021, **12**, 736277.
doi: 10.3389/fpsyg.2021.736277
10. Baek, H.; Han, K.; Cho, H. & Ju, J. Nursing teamwork is essential in promoting patient-centered care: A cross-sectional study. *BMC Nursing*, 2023, **22**(1), 433.
doi: 10.1186/s12912-023-01592-3
11. Karamat, J.; Shurong, T.; Ahmad, N.; Afridi, S.; Khan, S. & Mahmood, K. Promoting healthcare sustainability in developing countries: Analysis of knowledge management drivers in public and private hospitals of Pakistan. *International Journal of Environmental Research and Public Health*, 2019, **16**(3), 508.
doi: 10.3390/ijerph16030508
12. Jumoke, O. & Mutula, S. The relationship between knowledge management and nursing care performance. *South African Journal of Libraries and Information Science*. 2018, **84**(2), 39-51.
doi: 10.7553/84-2-1785
13. Farnese, M.L.; Barbieri, B.; Chirumbolo, A. & Patriotta, G. Managing knowledge in organisations: A nonaka's SECI model operationalisation. *Frontiers in Psychology*, 2019, **10**, 2730.
doi: 10.3389/fpsyg.2019.02730
14. Hassanian, Z.M.; Ahanchian, M.R.; Ahmadi, S.; Hossein Gholizadeh, R. & Karimi-Moonaghi, H. Knowledge creation in nursing education. *Global Journal of Health Science*, 2014, **7**(2), 44.
doi: 10.5539/gjhs.v7n2p44
15. Shongwe, M.M. Knowledge-creation in student software-development teams. *SA Journal of Information Management*, 2015, **17**(1).
doi: 10.4102/sajim.v17i1.613

16. Austin, C.P. Opportunities and challenges in translational science. *Clinical and Translational Science*, 2021, **14**(5), 1629-1647.
doi: 10.1111/cts.13055
17. Khan, D. & Ali, N. Knowledge sharing concept, attitude and influencing factors: A case with indian academic librarians. *Journal of Information & Knowledge Management*, 2019, **18**(03), 1950034.
doi: 10.1142/S0219649219500345
18. Shehab, S.; Al-Bsheish, M.; Meri, A.; Dauwed, M.; Aldhmadi, B.K.; Kareem, H.M.; Alsyof, A.; Al-Mugheed, K. & Jarrar, M. Knowledge sharing behaviour among head nurses in online health communities: The moderating role of knowledge self-efficacy. *PLOS ONE*, 2023, **18**(1), e0278721.
doi: 10.1371/journal.pone.0278721
19. Dalkir, K. Knowledge management in theory and practice. Cambridge, The MIT Press, 2011.
20. Khakpour, A. Effectiveness of knowledge acquisition in medical education: An argumentative literature review of the resources's requirements. *Future of Medical Education Journal*, 2020, **10**(3).
doi: 10.22038/fmej.2020.40998.1271
21. Krøger, E.; Sævareid, H.I. & Slettebø, Å. Facilitating nursing students' acquisition of knowledge about the public health perspective in nursing: Experiences from a pilot project. *Nordic Journal of Nursing Research*, 2018, **38**(2), 77-86.
doi: 10.1177/20571585177113378
22. Ahsan, A.; Dewi, E.S.; Suharsono, T.; Setyoadi, S.; Soplanit, V.G.; Ekowati, S.I.; Syahniar, N.P.; Sirfefat, R.S.; Kartika, A.W.; Ningrum, E.H.; Noviyanti, L.W. & Laili, N. Knowledge management-based nursing care educational training: A key strategy to improve healthcare associated infection prevention behavior. *SAGE Open Nursing*, 2021, **7**, 1-16.
doi: 10.1177/23779608211044601
23. Roshanzadeh, M.; Mohammadi, S.; Shomoossi, N.; & Tajabadi, A. Mutual relationship between knowledge management system with nursing process. *Iranian Journal of Nursing and Midwifery Research*, 2019, **24**(5), 401.
doi: 10.4103/ijnmr.IJNMR_37_19
24. Impey, S. Exploring factors that motivate or inhibit nurse-to-nurse knowledge sharing in outpatient settings. *International Journal of Integrated Care*, 2021, **21**(S1), 196.
doi: 10.5334/ijic.ICIC20439
25. Profili, S.; Sammarra, A.; Dandi, R. & Mascia, D. Clinicians-ability, motivation, and opportunity to acquire and transfer knowledge: An age-driven perspective. *Health Care Management Review*, 2019, **44**(3), 216-223.
doi: 10.1097/HMR.0000000000000187
26. Asurakkody, T.A. & Kim, S.H. Effects of knowledge sharing behavior on innovative work behavior among nursing students: Mediating role of self- leadership. *International Journal of Africa Nursing Sciences*, 2020, **12**, 100190.
doi: 10.1016/j.ijans.2020.100190
27. Assem, P.B. & Pabbi, K.A. Knowledge sharing among healthcare professionals in Ghana. *VINE Journal of Information and Knowledge Management Systems*, 2016, **46**(4), 479-491.
doi: 10.1108/VJIKMS-08-2015-0048
28. Karamitri, I.; Talias, M.A. & Bellali, T. Knowledge management practices in healthcare settings: A systematic review: Knowledge management in healthcare: A systematic review. *The International Journal of Health Planning and Management*, 2017, **32**(1), 4-18.
doi: 10.1002/hpm.2303
29. Ngah, R. & Wong, K.Y. Linking knowledge management to competitive strategies of knowledge-based SMEs. *The Bottom Line*, 2020, **33**(1), 42-59.
doi: 10.1108/BL-08-2019-0105
30. Akhavan, P.; Ghojavand, S. & Abdali, R. Knowledge sharing and its impact on knowledge creation. *Journal of Information and Knowledge Management*, 2012, **11**(2), 1250012.
doi: 10.1142/S0219649212500128
31. Swanson, E.; Kim, S.; Lee, S.-M.; Yang, J.-J.; Lee, Y.-K. & Byrd, H.F. The effect of leader competencies on knowledge sharing and job performance: Social capital theory. *Journal of Hospitality and Tourism Management*, 2020, **42**, 88-96.
doi: 10.1016/j.jhtm.2019.11.004
32. Andreeva, T. Tensions between knowledge creation and knowledge sharing: Individual preferences of employees in knowledge-intensive organisations. In D. Jemielniak & J. Kociatkiewicz (Eds.), *Handbook of Research on Knowledge-Intensive Organisations*, IGI Global, 2009, 459-477.
doi: 10.4018/978-1-60566-176-6.ch028
33. Al-Emran, M. & Teo, T. Do knowledge acquisition and knowledge sharing really affect e-learning adoption? An empirical study. *Education and Information Technologies*, 2020, **25**(3), 1983-1998.
doi: 10.1007/s10639-019-10062-w
34. Wei, P.-C.; Atalag, K. & Day, K. An open EHR approach to detailed clinical model development: Tobacco smoking summary Archetype as a case study. *Applied Clinical Informatics*, 2019, **10**(02), 219-228.
doi: 10.1055/s-0039-1681074
35. Abdekhoda, M.; Pourrasmi, A. & Ranjbaran, F. The effect of knowledge acquisition and knowledge sharing on the use of E-learning. *Journal of Information Science*, 2023, 016555152211424.
doi: 10.1177/01655515221142429
36. Suardy, M. & Budiono, N.A. The influence of community of practice, knowledge capturing, and knowledge sharing on the employees performance. *International Journal of Innovative Science and Research Technology*, 2022, **7**(2), 624-631.
37. Nham, T.P.; Nguyen, T.M.; Tran, N.H. & Nguyen, H.A. Knowledge sharing and innovation capability at both individual and organisational levels: An empirical study from Vietnam's telecommunication companies. *Management*

- & *Marketing*, 2020, **15**(2), 275-301.
doi: 10.2478/mmcks-2020-0017
38. Colnar, S.; Radević, I.; Martinović, N.; Lojpur, A. & Dimovski, V. The role of information communication technologies as a moderator of knowledge creation and knowledge sharing in improving the quality of healthcare services. *PLoS ONE*, 2022, **17**(8), 1-24. doi: 10.1371/journal.pone.0272346
 39. Opele, J.K. & Okunoye, O.O. A study of knowledge management (KM) practices of health information management practitioners in tertiary hospitals in Nigeria. *Sumerianz Journal of Social Science*, 2019, **2**(12), 256-263.
 40. Ghebrejorgis, F. An empirical study on determining factors affecting the performance of health service providers in Eritrea. *Sumerianz Journal of Business Management and Marketing*, 2019, **2**(3), 32-39.
 41. Hair, J.F.; Hult, G.T.M.; Ringle, C.M.; Sarstedt, M.; Danks, N.P. & Ray, S. *Partial Least Squares Structural Equation Modeling (PLS-SEM) Using R: A Workbook*. Springer international publishing, 2021. doi: 10.1007/978-3-030-80519-7
 42. Holdt Christensen, P. Knowledge sharing: Moving away from the obsession with best practices. *Journal of Knowledge Management*, 2007, **11**(1), 36-47. doi: 10.1108/13673270710728222
 43. Fornell, C. & Larcker, D.F. Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, 2016, **18**(1), 39-50. doi: 10.2307/3151312
 44. Storey, C. & Kelly, D. Innovation in services: The need for knowledge management. *Australasian Marketing Journal*, 2002, **10**(1), 59-70. doi: 10.1016/S1441-3582(02)70144-4
 45. Agrifoglio, R.; Briganti, P.; Varriale, L.; Metallo, C. & Ferrara, M. Understanding knowledge sharing through the working practices. *International Journal of Organisational Analysis*, 2021, **29**(4), 920-934. doi: 10.1108/IJOA-02-2020-2049
 46. Adam, Y.A.; Anwar, T.M.; Siddig, B.I. & Tarig, K.E. (2019). Knowledge acquisition and knowledge sharing as determines of organisational competitive advantage. *American Journal of Business, Economics and Management*, **7**(1), 32-39.
 47. Zamir, Z. (2019). The Impact of knowledge capture and knowledge sharing on learning, adaptability, job satisfaction and staying intention: A study of the banking industry in bangladesh. *International Journal of Entrepreneurial Knowledge*, **7**(1), 46-64. doi: 10.37335/ijek.v7i1.87

CONTRIBUTORS

Dr. Chennupati Deepti is working as a Duty Medical Officer working with Yashoda Hospitals, Secunderabad, India. She has done her MBBS from Shri B.M. Patil Medical College and Research Centre, Vijayapura, Karnataka, India and having over 6 years working experience. Her research interests are Healthcare communication and preventive medicine.

Dr. Somipam R. Shimray is an Assistant Professor in the Department of Library and Information Science at the Babasaheb Bhimrao Ambedkar University, Lucknow, India. He received his Ph.D. from the Department of Library and Information Science, Pondicherry University, Puducherry, India. His area of research interests include Research ethics, Knowledge sharing & Cultural informatics.

Dr. Abdoulaye Kaba is an Assistant Professor and a Library Director at Al Ain University, Al Ain, UAE. He has more than 18 years of experience in academic librarianship. Dr Kaba has authored/co-authored articles in peer-reviewed journals and presented papers at international conferences. His area of research interests include Library management and Knowledge management.

Dr. Chennupati K. Ramaiah is the former Dean of the School of Media and Communication (2014-2022), Director of Directorate of Distance Education, and also Professor and the Head of the Department of Library and Information Science, Pondicherry University, India. from 2010 to 2013. He worked as a Professor, Head of the Department of Library and Information Science and Librarian at Dravidian University, Kuppam, India. From 1999 to 2005. He has published about 160 papers and eight books. His areas of interests include Multimedia and Hypertext technologies, Human-computer interaction, User interfaces, Designing e-books, E-publishing, E-Learning, Archival informatics and bibliometrics.

Augmented Reality Trends and Popularity in Libraries: A Systematic Review

Kiran Ranavagol S^{#,*}, Laxmi Yallappa Kamble[#], Somanagouda Shankargouda Patil[#] and Nijaguna[§]

[#]Research Scholar Department of Library and Information Science, Rani Channamma University, Belagavi - 591 156, India

[§]Research Scholar Department of Library and Information Science, Gulbarga University, Kalaburgi - 585367, India

*E-mail: ranavagolkiran@gmail.com

ABSTRACT

Augmented Reality (AR) is emerging as a pivotal technology in education and library services, offering personalised and interactive learning experiences. This research investigates the advancements in AR applications for dynamic library services and the challenges associated with their implementation. Using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) method, the study analyses scholarly publications from databases including EBSCO, IEEE Explore, Emerald, Taylor & Francis, and Google Scholar. The review reveals that integrating AR into library systems enhances access to information resources, improves maritime capabilities, and bolsters user education. AR facilitates remote access to interactive resources and models, extending educational opportunities beyond the physical confines of libraries. However, significant challenges exist, such as the lack of integrated applications and inadequate technological infrastructure. Despite AR's growing popularity and potential in education, there is a scarcity of research on its adoption in libraries and strategic planning for AR-centred library services.

Keywords: Augmented reality (AR); Virtual reality (VR); Trends; ICT; Libraries; Systematic review

1. INTRODUCTION

Augmented Reality (AR) is a rapidly expanding technology that integrates digital information with the real world, significantly enhancing user experience and engagement¹⁻². Its broad applications span healthcare, education, retail, military, and industrial sectors³⁻⁴. In healthcare, AR has improved surgical precision by offering surgeons a three-dimensional view of anatomical structures⁵⁻⁶. In education, AR has revolutionised learning by promoting engagement, experiential learning, and personalised education⁷⁻⁸. AR delivers immersive experiences through non-immersive, semi-immersive, and immersive systems, utilising devices ranging from smartphones to Head-Mounted Displays (HMDs)⁹⁻¹⁰. For instance, AR applications in furniture shopping allow users to visualise how items fit in their spaces before purchase¹¹. Integration of Mixed Reality (MR) technology is essential for implementing digital twins, which blend real and virtual worlds¹². AR enhances user perception and interaction by overlaying virtual data, such as graphics, text, or audio, onto real-world objects¹³. As technology advances, AR's potential to bridge the digital and physical realms continues to grow¹⁴.

In libraries, AR is an innovative tool that enhances user experiences by integrating digital content with

the physical environment¹⁵⁻¹⁶. It can animate historical documents, provide virtual tours, and assist in locating books, making learning more interactive and engaging¹⁷. This research is crucial as it explores how AR can modernise library services, making them more engaging, and addressing gaps in current library technology.

2. METHODOLOGY

2.1 Study Design

This research was conducted using the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) approach¹⁸, a standardised method for conducting systematic reviews and meta-analyses. The study focused on identifying and evaluating scholarly articles related to the application of Augmented Reality (AR) in library services over the last twenty years.

2.2 Data Sources and Search Strategy

To gather relevant literature, the researchers utilised multiple academic databases, including EBSCO, IEEE Explorer, Emerald, Taylor & Francis, and Google Scholar. The search strategy involved the application of Boolean logic¹⁹, employing the operators AND, OR, and NOT to refine the search. The specific search query was (((Augmented Reality)) OR (AR)) AND (Libraries)). The search was conducted from December 2023 to

January 2024. Only articles published in English and directly related to the use of AR in library settings were included in the analysis.

The PRISMA checklist was used as a guideline to ensure the systematic review’s comprehensiveness and transparency.

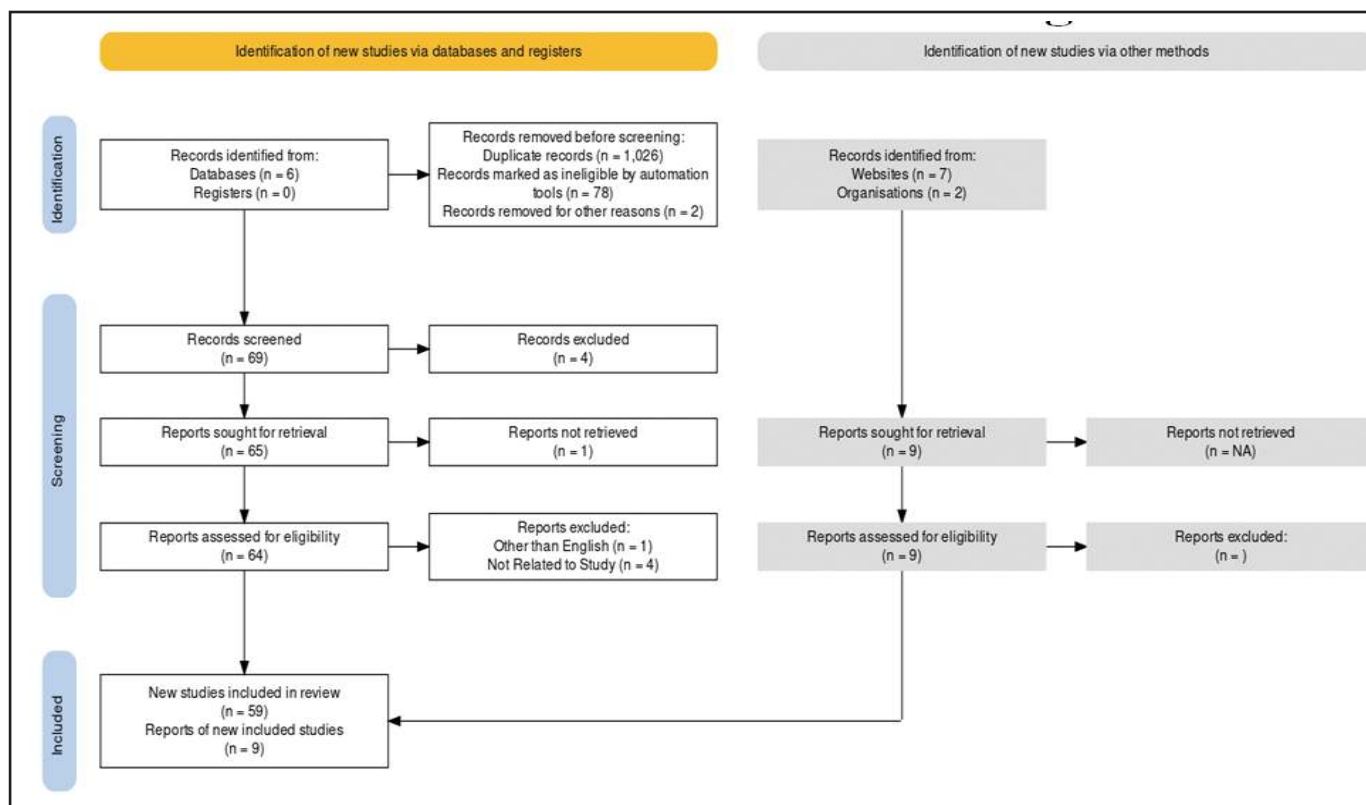


Figure 1. PRISMA-Flow chart¹⁸.

2.3 Inclusion and Exclusion Criteria

The inclusion criteria for the study were:

- Publications that explicitly discuss the application of AR in libraries.
- Articles published in English.
- Studies published within the last twenty years.

Publications were excluded if they:

- Did not have a clear focus on AR in libraries.
- Those were not available in English.
- Were opinion pieces or lacked empirical data.

2.4 Data Extraction and Analysis

The selected AR publications were critically evaluated for their relevance to library services. Data were extracted from these articles, focusing on the implementation of AR, its impact on library services, and the factors hindering its implementation. Additionally, institutional and organisational websites were consulted to define and clarify technical terms, providing a comprehensive understanding of the concepts discussed in the literature.

2.5 Quality Assessment

The quality of the selected studies was assessed based on their methodological rigour, the relevance of the findings to the objectives, and the clarity of the reported outcomes.

3. AUGMENTED REALITY IN LIBRARIES

The use of Augmented Reality (AR) technology is becoming increasingly prevalent in libraries to enrich user experiences and engagement²⁰⁻²¹. Its integration serves several purposes, such as providing access to information resources and facilitating user education and navigation. This technology has proven effective in enhancing library service systems and marketing initiatives, enhancing the reputation of institutions as innovative and interactive spaces²². The adoption of AR aligns with the broader trend of incorporating AR and

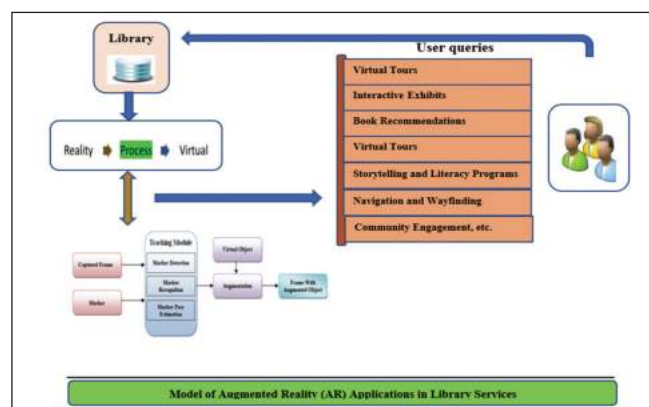


Figure 2.

VR technologies in service delivery, which has been observed since early 2018²³⁻²⁴. AR has been leveraged to create interactive storybooks in education, improving children's learning experiences by merging physical books with virtual models. Additionally, for Generation Z, AR provides interactive learning media that aids in accessing and utilising library collections²⁵⁻²⁶. Its applications include creating interactive OPAC brochures, showcasing collections, and assisting users in locating books on shelves²⁷. The advantages of AR in libraries include its cost-effective implementation, compatibility with existing technologies, and the promotion of interactive services²⁸. AR transforms libraries into media-rich environments catering to diverse information needs, from education to travel planning. This transformation is facilitated by AR's ability to blend the virtual and real worlds, creating a novel information space²⁹. While AR offers significant benefits in enhancing library services, careful planning is vital to ensure equitable access and successful integration³⁰⁻³¹.

3.1 AR in Academic Libraries

AR applications in libraries provide diverse services, such as augmenting physical book stacks, facilitating navigation, and offering digital information overlaid on the physical environment³². For specific groups, like Generation Z users, AR enhances learning experiences through interactive storybooks and provides access to library collections. Its cost-effective implementation and compatibility with existing technologies transform libraries into dynamic information spaces, promoting highly interactive services. Two prominent AR types in academic settings are markerless AR, which uses location data, and marked AR, which utilises two-dimensional barcodes to connect to information resources³³⁻²¹. While AR's potential to enhance academic achievement and student engagement is well-recognised, its adoption varies across institutions. Some academic libraries have introduced AR technologies like the Oculus Rift and HTC Vive for in-library use³⁴. The integration of AR in academic libraries not only enhances user experiences but also bolsters the institutions' reputations as innovative and tech-friendly environments³⁵⁻³⁶. AR's ability to create immersive and engaging environments can profoundly impact student learning and engagement, making it an invaluable tool for future educational strategies.

3.2 AR in Public Libraries

AR has the potential to enhance a range of public library services, including reader advisory, reference services, and indoor navigation, particularly benefiting younger patrons. It can support various functions such as information filtering, 3-D visualisation, and promoting user education through interactive learning materials³⁷. Additionally, AR can cater to diverse user groups, such as the elderly, by offering tailored information services that address their specific needs³⁸.

AR's ability to provide personalised and engaging experiences in public libraries is invaluable. Nonetheless, with thoughtful implementation and support, AR can transform public libraries into inclusive, modern information hubs³⁹⁻⁴⁰.

3.3 AR in National Libraries

National libraries, as repositories of a nation's cultural heritage and knowledge, have the potential to leverage AR for innovative services. AR can enhance the communication of exhibits, improve navigation, and support educational programs⁴¹. For instance, AR can create immersive experiences that allow users to engage with rare collections or historical documents in a virtual setting, thus preserving the actual artifacts while making them accessible⁴². Additionally, AR can assist in navigating expansive national library spaces, helping users locate materials and resources more efficiently. Adopting AR can help national libraries stay relevant in the digital age, attract new users, and fulfil their cultural and educational roles more effectively. AR offers national libraries a powerful tool for engaging users with their cultural heritage and improving access to resources.

4. APPLICATION OF AR TECHNOLOGY IN LIBRARY SERVICES

AR technology offers thrilling possibilities for pretty library services. Some of the way's libraries can leverage AR are:

4.1 Virtual Tours

AR allows patrons to explore library spaces and services dynamically. The virtual tours can be particularly beneficial for orienting new users to the library, showcasing facilities, and promoting information literacy⁴³.

4.2 Interactive Exhibits

Libraries can use AR to construct immersive exhibitions in which users can learn about many different subjects through interesting digital content made on real objects or exhibits. These exhibits can include navigation aids, access to extended textual and audio-visual information, and interactive learning experiences⁴⁴.

4.3 Book Recommendations

AR apps can provide personalised book recommendations based on a user's interests, consenting them to discover new books and authors interactively⁴⁵.

4.4 Storytelling and Literacy Programs

AR books can bring characters to life or provide interactive elements that encourage children to engage with stories. AR has been progressively combined into library services, particularly in storytelling and literacy programs, as it has the potential to transform the way literacy is taught and experienced, making it more interactive and aligned with the digital communication landscape⁴⁶.

4.5 Navigation and Wayfinding

The expansion of a customised AR navigation app for libraries will bolster cognitive abilities by integrating iBeacon technology with an app system to establish an indoor positioning system. AR is likely to alleviate cognitive strain and amplify wayfinding performance, empowering users to navigate complex library layouts more efficiently⁴⁷.

4.6 Community Engagement

AR has the latent to create interactive practices that encourage community engagement. Examples include scavenger hunts or interactive displays that prompt users to contribute content⁴⁸.

4.7 Digital Archives and Special Collections

AR is increasingly used in libraries to improve user engagement and access to valuable materials, allowing for interactive experiences without handling fragile items, particularly beneficial for rare books and manuscripts⁴⁹.

4.8 Collaborative Spaces

AR can enable collaborative workspaces in the library, allowing users to share digital content, annotate documents, or work together on projects in a virtual environment⁵⁰⁻⁵¹.

4.9 Historical Reconstructions

Libraries with historical collections can use AR to create virtual reconstructions of historical events or locations, providing users with a unique perspective on the past⁵². It enables users to interact with digital enhancements overlaid on the physical world, providing a unique way to experience historical content⁵³.

4.10 Interactive Library Displays

IFLA firmly believes that the integration of AR and ChatGPT technology grips huge latent for attractive user experiences. With the incorporation of chatbots into AR apps, users can expect more personalised and engaging interactions with virtual elements⁵⁴. Incorporating visual cues also promises to make interactions with digital avatars feel more natural and enjoyable. Moreover, the University of Illinois Urbana-Champaign is actively developing a mobile application using optical character recognition (OCR) to scan text documents and provide customised recommendations based on the scanned content⁵⁵⁻⁵⁶.

4.11 Current Awareness Services (CAS) and Selective Dissemination of Information (SDI) Services

The SDI service and the CAS are two academic library facilities accessible to researchers at the University of Bahrain and these services are AR-based. The AR system allows researchers to receive rapid help and comprehend their needs while also functioning as an effective personal learning tool⁵⁷. A prototype for

an AR system is developed to provide scholars with current information about available library items and how to use them. The University of Houston Library has an AR-based SDI and CAS services system called the 'ARLib'. This system uses the QR code linked to AR content to deliver information about the CAS and SDI services. This system creates accounts in the 'Aurasma' studio, creates brochures with QR codes, and distributes them so that patterns can access information via the HP reveal program⁵⁸.

5. ETHICAL AND PRIVACY CONCERNS

5.1 Data Privacy and Security in AR Applications

When developing AR applications, it is crucial to prioritize user data collection and storage and ensure its security. Transparency and consent are essential, and libraries must seek explicit consent from users before gathering personal information. Libraries need to balance providing tailored AR services with respecting user autonomy and privacy, addressing the digital divide for equitable access, and managing intellectual property and copyright concerns when using digital content.

5.2 User Diversity and Accessibility

When designing AR applications, it is crucial to consider users with disabilities. This means integrating features like audio descriptions, text-to-speech options, and screen reader compatibility for those with visual and hearing impairments. Additionally, alternative input methods should be provided to address the needs of users with physical disabilities.

6. FACTORS HINDERING THE IMPLEMENTATION OF AR IN LIBRARIES

While AR technology offers benefits such as improved user education and interactivity, its adoption in libraries faces several obstacles. These include infrastructural, budgetary, cultural, and technical issues. Ethical concerns related to privacy, data security, and digital citizenship also arise⁵⁹⁻⁶⁰. A significant barrier to AR implementation is the lack of integrated applications and limited technological support⁶¹. Budgetary constraints further complicate adoption, as the costs associated with AR technologies can be prohibitive, particularly in settings with tight budgets, like medical libraries⁶². Additionally, cultural resistance from users and staff may impede the adoption of AR, necessitating extensive training and professional development for librarians to effectively utilise the technology⁵⁶. Despite the growing interest in AR and its educational potential, research on its implementation in libraries is still limited. However, existing literature suggests that AR has the potential to significantly enhance the library experience, which can help attract and retain users⁶³⁻⁶⁴. While AR has promising benefits for libraries, its successful adoption requires overcoming privacy concerns, budget limitations, and cultural resistance, along with proper training and integration.

7. MAJOR FINDINGS AND SUGGESTIONS

7.1 Major Findings

Augmented Reality (AR) technology significantly enhances user experience in libraries by offering interactive access to information and improved navigation. In academic libraries, AR facilitates access to physical book collections, navigation, and digital resources. Public libraries use AR to enhance services like reader advisory, reference services, and indoor wayfinding. National libraries leverage AR for interactive exhibits, enhanced navigation, and educational programs. AR also supports virtual tours, book recommendations, storytelling, and scavenger hunts. It improves engagement with digital archives while safeguarding delicate items. Effective AR implementation requires staff training and continuous user feedback. Implementing Augmented Reality (AR) in libraries faces several challenges that hinder its effectiveness and adoption. Cost is a primary barrier as AR technology requires significant financial investment in both hardware and software, which many libraries cannot afford. Additionally, technical expertise is essential for the deployment and maintenance of AR systems, but libraries often lack staff with the necessary skills. Another challenge is integration with existing systems. Libraries already use various technologies and integrating AR smoothly with these systems can be complex and time-consuming. Content creation is also a significant hurdle as it requires specialised knowledge and resources to develop AR applications that are both engaging and educational. Patrons may need time to adapt to new technology, and without proper training and outreach, they might not fully utilize AR features. Furthermore, privacy concerns related to data collection and user tracking in AR environments could deter adoption. Finally, technical limitations such as the need for high-speed internet and advanced hardware can restrict access, especially in under-resourced libraries. Addressing these factors requires careful planning and investment to ensure successful AR implementation.

7.2 Suggestions

Promoting AR technology in libraries is crucial for raising awareness and generating interest among patrons. To achieve this, stakeholders must collaborate to develop affordable, user-friendly, and secure AR systems⁵⁹. Library professionals should receive adequate training and support to effectively utilise this technology. Effective AR implementation necessitates careful consideration of staff training, technological infrastructure, and the creation of suitable AR components⁶⁵. Librarians can enhance AR adoption by setting up interactive AR demonstrations and exhibits within the library to showcase its potential applications⁶⁶. Partnering with schools, universities, and local organisations can facilitate joint AR events and projects, thereby reaching a broader audience. Utilising social media platforms to promote AR initiatives through videos, photos, and testimonials can also generate interest and engagement⁶⁷. Additionally, featuring AR projects

and events on the library's website and in newsletters helps keep patrons informed and involved. Libraries should consider collaborating with AR developers and companies to create AR experiences tailored to their collections and services. Offering incentives or rewards, such as discounts on library services or exclusive access to AR content, can encourage participation. Gathering feedback from patrons is essential for assessing interest and refining future AR initiatives⁶⁸. These strategies collectively contribute to the successful integration of AR into library services.

8. CONCLUSION

Libraries are abandoning their image as dusty archives and embracing Augmented Reality (AR). The implementation of Augmented Reality (AR) in libraries holds significant promise for enhancing user engagement and expanding learning opportunities. AR can bring exhibits to life by overlaying digital information on physical displays, allowing for compelling exploration. AR navigation apps can help visually challenged customers navigate the library, while audio descriptions and text-to-speech functions can help them learn. AR promotes inclusivity, allowing everyone to engage in the library experience. Regardless of the challenges, AR's potential is apparent. Libraries that embrace modern technology can turn into vibrant learning centers, attracting new generations and reviving their goal to connect people with knowledge and instill a love of learning. AR provides a unique chance to connect the physical and digital worlds, resulting in a truly dynamic and engaging library experience for everyone.

REFERENCES

1. Babu, A.; Kumar, A.S.; Saju, S.; John, T. & Varghese, T. Augmented reality vs virtual reality, *Int. J. Eng. Technol Manag Sci.*, 2022.
2. Aukstakalnis, S. Practical augmented reality: A guide to the technologies, applications, and human factors for AR and VR, *Addison-Wesley Professional.*, 2016, 594.
3. Avola, D.; Cinque, L.; Foresti, G.L.; Mercuri, C & Pannone, D.A. Practical framework for the development of augmented reality applications by using ArUco Markers. *ICPRAM.*, 2016, 645-54.
4. Augmented Reality: An overview science direct topics Internet, cited 2024 Jan 27. Available from: <https://www.sciencedirect.com/topics/social-sciences/augmented-reality>
5. IEEE standards association. Augmented reality Internet. IEEE standards association. cited 2024 Jan 28. Available from: <https://standards.ieee.org/faqs/ar/>
6. Virca, I.; Bârsan, G.; Oancea, R. & Vesa, C. Applications of augmented reality technology in the military educational field. *Land Forces Acad Rev.*, 2021, 26(4), 337-47.
7. Hameed, B.M.; Somani, S.; Keller, E.X.; Balamaniandan, R.; Mahapatra, S. & Pietropaolo, A. Application of virtual reality, augmented reality, and mixed reality in endourology and urolithiasis: An update by YAU

- Endourology and urolithiasis working group. *Front Surg.*, 2022, **9**, 866-946.
8. Monfared, M.; Shukla, V.K.; Dutta, S. & Chaubey, A. Reshaping education through augmented reality and virtual reality. *Tavares JMRS.*, 2022, **291**, 619-29.
 9. Li, K.C.; Tsai, C.W.; Chen, C.T.; Cheng, S.Y. & Heh, J.S. The design of an immersive english learning environment using augmented reality. 2015 8th *International conference on Ubi-Media computing (UMEDIA)*., 2015, 174-9.
 10. Gaol, F.L.; Kamil, M.I.; Iswardhana, A.M.; Firnandes, S.G.; Fahrezi, F.; & Matsuo, T. Utilisation of augmented reality technology in the campus environment. Smys S., Kamel K.A., Palanisamy R., 2023, **563**, 657-67.
 11. Moares, R.; Jadhav, V.; Bagul R.; Jacobo, R. & Rajguru, S. Inter are interior decor apps using augmented reality technology. Proceedings of the 5th International conference on cyber security & privacy in communication networks (ICCS)., 2019.
 12. Tao, F.; Zhang, M. & Nee, A.Y.C. Digital twin and virtual reality and augmented reality/mixed reality. Digital twin driven smart manufacturing. *Academic Press.*, 2019, 219-41.
 13. Gupta, N. & Rohil, M.K. Exploring possible applications of augmented reality in education. 4th *International conference on signal processing and integrated networks (SPIN)*., 2017.
 14. Shaukat, S.M. Exploring the potential of Augmented reality (AR) and virtual reality (VR). *Int. J. Adv. Res. Sci. Commun Technol.*, 2023.
 15. Oyelude, A.A. Virtual reality (VR) and Augmented Reality (AR) in libraries and museums. *Libr. Hi. Tech. News.*, 2018, **35**(5), 1-4.
 16. Poddubnaya, N.; Kulikova, T.; Ardeev, A. & Alekseeva, P. Formation of digital literacy of students by means of virtual and augmented reality technologies. *International scientific conference on innovative approaches to the application of digital technologies in education.*, 2020.
 17. Varnum, K.J. Beyond reality: Augmented, virtual, and mixed reality in the library. *American Library Association.*, 2019, 145.
 18. Haddaway, N.R.; Page, M.J. & Pritchard, C.C.; McGuinness L.A. PRISMA2020: An R package and Shiny app for producing PRISMA 2020-compliant flow diagrams, with interactivity for optimised digital transparency and open synthesis. *Campbell Syst Rev.*, 2022, **18**(2), 1230.
 19. Dinet, J.; Favart, M. & Passerault, J.M. Searching for information in an online public access catalogue (OPAC): The impacts of information search expertise on the use of Boolean operators. *J. Comput Assist Learn.*, 2004, **20**(5), 338-46.
 20. Jhanavi, M. Augmented reality application for education.
 21. Wang, S.; Liu, H.; Shu, H.; Zhang, X. & Zhang, Y. Design and development of campus environment display system based on augmented reality technology. *IOP Conf Ser Mater Sci Eng.*, 2020, **790**(1), 012-031.
 22. Skubis, M. Users' Awareness of augmented reality technology in mobile applications. *Mark Sci. Res. Organ.*, 2021, **40**(2), 1-22.
 23. Yasin, A.M.; Isa, M.A.M. & Endut, N.A. Interactive prophet's storybook using augmented reality. envisioning the *Future of Online Learning.*, 2016, 391-9.
 24. Aulianto, D.R. Inovasi perpustakaan melalui pemanfaatan teknologi augmented reality dan virtual reality di era generasi. *Inf. Libr Stud N-JILS.*, 2020, **3**(1), 103-14.
 25. Chen, C.M. & Tsai, Y.N. Interactive augmented reality system for enhancing library instruction in elementary schools. *Comput Amp Educ.*, 2012, **59**(2), 638-52.
 26. Sambodo, R.A.; Prayitno, B.A. & Karyanto, P. The development of ECO AR learning media based on augmented reality technology on the topic of ecosystem. *AIP Conference Proceedings.*, 2019, 020-108. doi: 10.1063/1.5139840
 27. Gurevych, R.; Silveistr, A.; Mokliuk, M.; Shaposhnikova, I.; Gordiichuk, G. & Saiapina, S. Using augmented reality technology in higher education institutions. *Postmod Open.*, 2021, **12**(2), 109-32.
 28. Vasilyeva, N.V. Augmented reality in libraries. *Sci-Tech Libr.*, 2020.
 29. Khrusch, S. Use of augmented reality technologies in modern media libraries. *Digit Platf Inf Technol Sociocult Sphere.*, 2022, 5.
 30. Pence, H.E. Smartphones, smart objects, and augmented reality. *Ref. Libr.*, 2011, **52**(1/2), 136-45.
 31. Cervera-Urbe, A.A. The augmented library: An approach for improving users awareness in a campus library. *IEEE International Symposium on Mixed and Augmented Reality (ISMAR-Adjunct)*., 2017, 15-9.
 32. Santos, J.F. & Esposito-Betan, S.M. Advantages and challenges of using augmented reality for library orientations in an academic/research library setting. *Proceedings of the IATUL Conferences.*, 2018.
 33. Venkatesan, M.; Moha, H.; Ryan, J.R.; Schürch, C.M.; Nolan, G.P. & Frakes, D. Virtual and augmented reality for biomedical applications. 2021
 34. Baumgartner-Kiradi, B.; Haberler, M. & Zeiller, M. Potential of augmented reality in the library. *CEUR Workshop Proc.*, 2018, **22**(99), 30-7.
 35. Hussain, A. Augmented reality in academic and Research Libraries. *Libr Hi Tech News.*, 2022, **39**(9), 23-5.
 36. Tzima, S.; Styliaras, G. & Bassounas, A. Augmented reality applications in education: Teachers point of view. *Educ. Sci.*, 2019, **9**(2), 1-18.
 37. Hahn, J. Mobile augmented reality applications for library services. *New Libr World.*, 2012, **113**(9/10), 429-38.
 38. Hannah, M.; Huber, S. & Matei, S.A. Collecting virtual and augmented reality in the twenty-first century library. *Collect Manag.*, 2019, **44**(2-4), 277-95. doi: 10.1080/01462679.2019.1587673
 39. Parhizkar, B. & Badioze Zaman, H. Development of an augmented reality rare book and manuscript for special library collection (AR Rare-BM). Visual

- informatics: Bridging research and practice. 2009, 344-55.
40. Lu, J. Mobile augmented reality technology for design and implementation of library document push system. *J. Real-Time Image Process.*, 2021, **18**(2), 283–93. doi: 10.1007/s11554-020-01048-w
 41. Huang, T.C.; Shu, Y.; Yeh, T.C. & Zeng, P.Y. Get lost in the library?: An innovative application of augmented reality and indoor positioning technologies. *Electron Libr.*, 2016, **34**(1), 99-115. doi: 10.1108/EL-08-2014-0148/full/HTML
 42. Mahadik, A.; Katta, Y.; Naik, R.; Naikwade, N. & Shaikh, N.F. A review of augmented reality and its application in context-aware library system. *International Conference on ICT in Business Industry & Government (ICTBIG)*., 2016, 1-6.
 43. LeMire, S.; Graves, S.J.; Hawkins, M. & Kailani, S. Libr-AR-y tours: Increasing engagement and scalability of library tours using augmented reality. *Coll Undergrad Libr.*, 2018, **25**(3), 261-79. doi: 10.1080/10691316.2018.1480445
 44. Ramírez, M.; Ramos, E.; Cruz, O.; Hernández, J.; Pérez-Cordoba, E. & Garcia, M. Design of interactive museo graphic exhibits using augmented reality. 23rd *International Conference on Electronics, Communications and Computing.*, 2013, 1-6.
 45. Mohamad, A.; Bakri, N.; Shahibi, M.; Noordin, S.; Abdul Rahman, S. & Tengku Izhar, T.A. Conceptualising mobile augmented reality (MAR) and E-Learning to enhance library wayfinding. *Adv. Sci. Lett.*, 2017, **23**(5), 4136–40.
 46. Holloway-Attaway, L. & Vipsjö, L. Using augmented reality, Gaming technologies, and transmedial storytelling to develop and Co-design local cultural heritage experiences. *Visual Computing for Cultural Heritage.*, 2020, 177-204. doi: 10.1007/978-3-030-37191-3_10
 47. Aiswarya, R.; Sreeram, V.K.; Vp, S. & Menon, H.P. Augmented reality-based way finder system in libraries. 2nd *International Conference on Automation, Computing and Renewable Systems (ICACRS)*., 2023, 1740-4.
 48. Brinkman, B. & Brinkman, S. AR in the library: A pilot study of multi-target acquisition usability. *IEEE International Symposium on Mixed and Augmented Reality (ISMAR)*., 2013, 241-2.
 49. Armstrong, G.; Hodgson, J.; Manista, F. & Ramirez, M. The SCARLET project: augmented reality in special collections. *SCONUL Focus.*, 2012, **54**, 52-7.
 50. Lukosch, S.; Billinghamurst, M.; Alem, L. & Kiyokawa, K. Collaboration in augmented reality. *Comput. Support Coop Work CSCW.*, 2015, **24**(6), 515-25.
 51. Ifrim, A.C.; Moldoveanu, F.; Moldoveanu, A. & Grădinaru, A. LibrARy – Enriching the cultural physical spaces with collaborative AR content. *Cham: Springer International Publishing.*, 2021, 626-38.
 52. Challenor, J. & Ma, M.A. review of augmented reality applications for history education and heritage visualisation. *Multimodal Technol Interact.*, 2019, **3**(2), 39.
 53. Portalés, C.; Lerma, J.L. & Pérez, C. Photogrammetry and augmented reality for cultural heritage applications. *Photogramm Rec.*, 2009, **24**(128), 316–31. doi: 10.1111/j.1477-9730.2009. 00549.x
 54. Hahn, J. Mobile augmented reality applications for library services. *New Libr World.*, 2012, **113**(9/10), 429-38.
 55. University libraries internet. cited 2024 Feb 2. Available from: <https://www.lib.umd.edu/>
 56. IFLA. Augmented reality in libraries Internet. IFLA. 2023 cited 2024 Jan 21. Available from: <https://www.ifla.org/news/augmented-reality-in-libraries/>
 57. Enis, M. VR Meets The Real World. *Libr J.*, 2018, **143**(6), 22-5.
 58. Noh, Y. Imagining library 4.0: Creating a model for future libraries. *J. Acad Librarianship.*, 2015, **41**(6), 786-97.
 59. Esposito-Betan, S.M.S. & Santos, J.F. Advantages and challenges of using augmented reality for library orientations in an academic/research library setting. *IATUL Annu Conf Proc.*, 2017, 1-11.
 60. El Miedany, Y. Virtual reality and augmented reality. *Springer international publishing.*, 2019, 403-27.
 61. Taghian, A.; Abo-Zahhad, M.; Sayed, M.S. & Abd El-Malek, A.H. Virtual and augmented reality in biomedical engineering. *Biomed Eng. Online.*, 2023, **22**(1), 76.
 62. Green, M.; Hill Lea, J. & Mcnair, C.L. Reality check: Augmented reality for school libraries. *Teach Libr.*, 2014, **41**(5), 28-34.
 63. Liu, D.Y. Combined with augmented reality navigation applications in the library. *International Conference on Advanced Materials for Science and Engineering (ICAMSE)*., 2016, 441-3.
 64. Savitskaya, T.E. Augmented reality technology in library practice. *Bibl Russ J. Libr. Sci.*, 2019, **68**(3), 249-57.
 65. Kipnis, D.G. Book Review: Beyond Reality: Augmented, Virtual, and Mixed Reality in the Library. *Ref User Serv Q.*, 2019, **59**(2), 134.
 66. Yuen, S.C.Y.; Yaoyuneyong, G. & Johnson, E. Augmented reality: An overview and five directions for AR in education. *J. Educ. Technol. Dev Exch. JETDE.*, 2011. **4**(1), 119–40.
 67. De Los Ríos, S.; Cabrera-Umpiérrez, M.F.; Arredondo, M.T.; Páramo, M.; Baranski, B. & Meis, J. Using augmented reality and social media in mobile applications to engage people on cultural sites. *Springer International Publishing.*, 2014, 662-72.
 68. Scholz, J. & Smith, A.N. Augmented reality: Designing immersive experiences that maximize consumer engagement. *Bus Horiz.*, 2016, **59**(2), 149-61.

CONTRIBUTORS

Mr. Kiran Ranavagol S. is currently a full-time research scholar in the Department of Library and Information Science at Rani Channamma University in Belagavi. He obtained his postgraduate (MLISc) in 2017, and he qualified for the UGC-NET in December 2019.

His contributions to the current work include: Searching the literature and locating and selecting papers. Screening and reviewing as well as preparing framework for the manuscript.

Ms. Laxmi Yallappa Kamble is a Research Scholar, Department of the Library and Information Science, at Rani Channamma University Belagavi. She obtained a BA from KLE's Lingaraj College Belagavi and MLISc from Rani Channamma University Belagavi in 2020. She qualified for the UGC-NET in 2022. Her contributions to the current work include: Screening the selected papers, reviewing scientific research works and citation-reference management, and preparing manuscripts.

Mr. Somanagouda Shankargouda Patil is currently a full-time research scholar in the Department of Library and Information Science at Rani Channamma University in Belagavi. He obtained his postgraduate (MLISc) in 2019, and he qualified for the UGC-NET and JRF in December 2019. His contributions to the current work include: Screening the selected papers, reviewing scientific research works, and preparing manuscripts.

Mr. Nijaguna is currently a full-time research scholar in the Department of Library and Information Science at Gulbarga University Kalaburagi. He obtained his postgraduate (MLISc) in 2019, and he qualified for the UGC-NET in December 2019. His contributions to the current work include: Screening the selected papers, reviewing scientific research works, and preparing manuscripts.

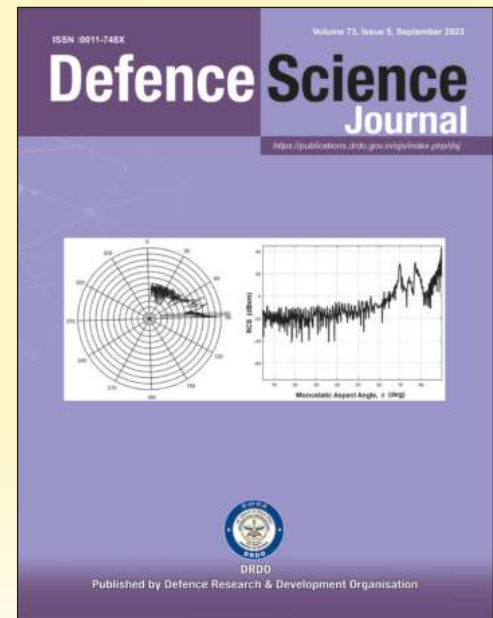
Defence Science Journal

pISSN: 0011-748X eISSN: 0976-464X

<https://publications.drdo.gov.in/ojs/index.php/dsj>

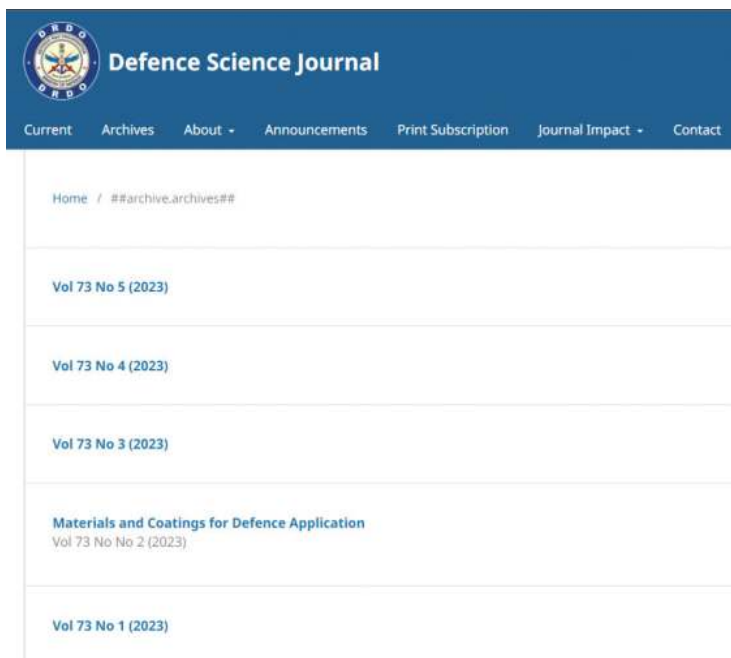
Impact Factor : 0.8 (JCR-2023) ; Cite Score : 1.8 (Scopus-2023)

- Started in 1949, Defence Science Journal (DSJ) is a peer-reviewed, bi-monthly, open access research journal in the area of defence science, engineering and technology
- Published in the months of January, March, May, July, September and November every year
- To maintain and improve the quality journal having 20 editorial board members (India – 13, Outside India - 7)
- Journal is indexed by major science indexing/ abstracting national and international databases - Science Citation Index Expanded, Journal Citation Report, Cambridge Scientific Abstracts, Chemical Abstracts, EiCompendex, Scopus, International Aerospace Abstracts, ProQuest, Google Scholar, Indian Science Citation Index, etc.
- Major subject fields include: Aeronautics, armaments, combat vehicles and engineering; computer sciences, electronics, material sciences, missiles, naval systems, etc.
- Journal upholds the highest standards of editorial integrity, including disclosure and independent peer review. Publishing process is reassuringly rigorous with reviewing
- More than 3,000 articles have been online published



Previous Special Issues of DSJ

- 2024 : Advances in Solid Mechanics and Composites
- 2023 : Materials and Coatings for Defence Application
- 2021 : Microwave Absorbing Materials and Vacuum Electronic Devices and Applications
- 2019 : Anti-submarine Warfare Oceanography; Microwave Absorbing Materials
- 2018 : Commemorative Issue on DRDO@60
- 2017 : Infrared Technologies; Combat Vehicles
- 2016 : Emerging Areas of Nano and Smart Materials; Chemical and Biological Warfare Agents; Cyber Security
- 2014 : Test and Evaluation of Armaments; Polymer Science and Technology



Defence Life Science Journal

pISSN: 2456-379X eISSN: 2456-0537
<https://publications.drdo.gov.in/ojs/index.php/dlsj>

Cite Score : 0.8 (Scopus-2023)

- First issue published in 2016, *Defence Life Science Journal* is a peer-reviewed, open access quarterly research journal
- Defence Life Science Journal has been conceptualized to cater the needs of scientists, researchers, academicians of life sciences and allied disciplines
- Published in the months of January, April, July, and October every year
- Editorial Board is represented by eminent academicians and scientists from India and Abroad
- Publishes research articles in the disciplines of biotechnology, bio-medicine, bio-engineering, bio-electronics, non-invasive life imaging, pharmacology and toxicology, physiology, NBC warfare, food technology, psychology, etc.
- Journal upholds the highest standards of editorial integrity, including disclosure and independent peer review. Publishing process is reassuringly rigorous with reviewing
- The journal is indexed by Scopus, Indian Citation Index.



Previous Special Issues of DLSJ

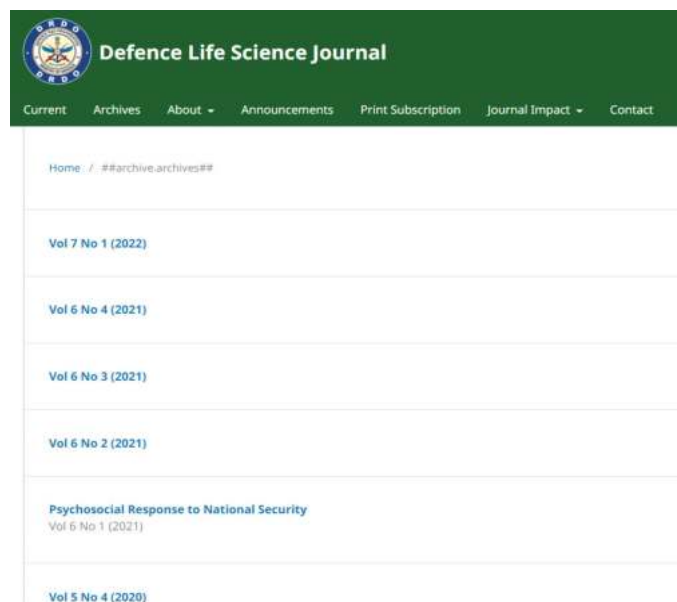
2024 : Integrated Physiology: Extreme Environment

2021 : Psychosocial Response to National Security

2020 : Microbiological Research and Applied Sciences

2019 : Food Safety and Biosecurity

2018 : Commemorative Issue on DRDO@60; Cold Arid Agro Animal Technologies; Extreme Environment: Occupational Challenges and Interventions; Personnel Selection, Organisational Behaviour and Psychological Strength



Recently Published Issues

November 2024

- Exploring the Impact of Social Networking Sites on Scholarly Communication: An Analysis Based on Selected LIS Journals through Almetric Explorer
Bwsrang Basumatary Nijwm Basumatary Mayank Yuvraj and Manoj Kumar Verma
- Measuring the Social Attention of the Leading Medicine Journals of India: An Altmetric Analysis
Pritam Dey and Mukut Sarmah
- Authorship Dynamics and Lotka's Law Applicability in the Realm of Archaeology
Harpreet Singh and Babita Jaiswal
- Growth of Science Research and Its Reflections on Academic Performance at the University of Kerala
Rajesh Kumar K. and P. Padma
- Scopus-indexed Journals of Humanities & Social Science in Tailand Through Bibliometric Analysis
Sattra Maporn and Jirarat Puseerit
- Indian Contribution to Artificial Intelligence in the Field of Social Sciences during 2014-2023
Seema Parmar Rajive K. Pateria Dinesh Kumari and Shallu
- Quantifying the Trends of DST-funded Environmental Science Research in India: A Scientometric Approach
Pritam Dey Rajdeep Choudhury and Mukut Sarmah
- Beneficiary Correlation on NLIST Services in Colleges of Assam: A Nationwide Assessment
Bhabananda Das and Manendra Kumar Singh
- *Exploring the Phenomenon of Library Anxiety in Higher Education Students: A Review*
Md. Firdaus and Dharamvir Singh
- *Status of Open Access Respositories in the Maritime Field: A Review of Open DOAR*
Chandrappa, Vasantha Raju N., N.S. Harinarayana

September 2024

- Implementing Free Persistent Identifiers in a Scientific Journal Management System Alternatively to DOI
Yasiel Pérez Vera and Alvaro Fernández Del Carpio
- Curating the Future of Research: Navigating FAIR Challenges in Academic Repositories
Juan-José Boté-Vericad, EminaAdilovich, Anna Caellas-Camprubi, and Ignasi Labastida
- Examining User Opinions, Satisfaction Levels, and Challenges Towards Institutional Repository: An Empirical Study
Unzila Hurum, K.L. Mahawarand and Somipam R. Shimray
- Article Processing Charge for Open Access Articles in Iran
Fatemeh Sohani, Maryam Shekofteh, Azam Shahbodaghi, and Sara Jambarsang
- A Meta-Analysis on the Correlation Between Traditional Metric Indicators and X Metrics of Library and Information Science Articles
Yysakh C.
- Content Analysis of Library Websites of the Centre with Potential for Excellence in Particular Area (CPEPA) Universities
Sanraj Roy and Nivedita Bhattacharyya Sahu
- Web Presence and Features of Library Websites/Webpages of NIRF-Ranked Pharmacy Institutes of South India: An Evaluative Study
Sanraj Roy and Nivedita Bhattacharyya Sahu
- Research Practices and Priorities of Chemistry Researchers in the Western Himalayan Region of India
Muruli N. and N.S. Harinarayana
- Marketing Strategy of Library Digital Services
Syifaun Nafisah, Nazilatul Laili Sa'adah, and Nazrul Effendy

