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Aims and Scope

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Contents

Understand Work Alienation, Digital Technology Overload and Job Satisfaction Among Library Professionals in India

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A B S T R A C T

The present study uses a quantitative method and attempts to explain the rationale for work alienation among library professionals working in India during the COVID-19 period. A total of 151 usable survey questionnaires were collected from library professionals working in Central Universities, the Indian Institute of Management (IIM), and other important institutions in India. Data were analysed using SPSS 19 software. Results revealed that digital technology complexity ($\beta= 0.354$) and digital technology overload (0.276) were two important independent variables that were positively related to work alienation and significantly explained the phenomenon among library professionals in India. It was also interesting to note that perceived organisational support (-0.122) and job satisfaction (-0.165) among library professionals were negatively related to work alienation among library professionals. This study proved digital overload and digital complexity as two major antecedents of work alienation while, also confirming that job satisfaction is a major antecedent that reduces work alienation. It urges the top management of the library institutions to provide organisational support to the library professionals to ensure lesser or no work alienation happen among them.

Keywords: COVID-19; Digital overload; Digital complexity; Work alienation; Job satisfaction; Perceived organisational support

Introduction

Libraries are institutions that act as knowledge reservoirs. They have contributed to the growth and development of the nation by storing and disseminating knowledge sources such as books, journals, manuscripts, reports, and many other such documents.[1-2] Students, academicians, and other professionals use these knowledge reservoirs and prepare themselves to better contribute to the development of their respective fields. The objectives and the goals of the libraries are achieved with the help of dedicated library professionals and personnel.[3] They facilitate the transaction of knowledge and act as a bridge between knowledge users and libraries. Thus, library professionals are one of the major stakeholders of knowledge storage provision and dissemination. As library professionals are very integral to the entire knowledge dissemination and management process hence research studies must be conducted to better understand their job-related attitudes and behaviour.[4]

The COVID-19 pandemic impacted every domain of human life and educational institutions such as schools colleges, and libraries were not an exception.[5] Although digitalisation and computerisation were taking pace in India well before the pandemic, the momentum picked up during the COVID-19 pandemic.[6] Libraries wanted to contribute their role in the educational sector and online or digital process adoption was the way forward.

It led to an unanticipated accelerated growth of digitalisation in libraries. This fast-paced digitalisation posed both challenges as well as opportunities for libraries as an institution. As an opportunity digitalisation enabled access to online content and knowledge transfer in form of online books, journals, and other related databases to its users. However, the challenges were multiple.7 Out of many challenges,one important challenge before the libraries was how will library professionals respond to the increased technology and digital load.8 While some studies on job satisfaction had been carried out among library professionals internationally9-10 and locally focussing on a particular state,11 no study has been reported so far at the national level from India. This study attempts to answer the above question. The researcher tries to capture the response of library professionals via a survey questionnaire and analyae it to understand the behavioral response and attitudes of employees against the increased digital load and complexity. Overall, the study attempts to answer the following research questions:

RQ 1. What is the impact of digital technology overload and complexity on work-related behavior among library professionals?
RQ 2. What is the role of perceived organisational support in the entire process?

Researcher conceptually proposes that digital technology complexity and overload will develop a feeling of work alienation i.e., a psychological separation or estrangement from the workplace among library professionals. Furthermore, perceived organisational support will help library professionals in reducing the detrimental impact of digital technology complexity and overload. In the following sections, the researcher presents the literature review, hypothesis development, methodology, analysis, results, and discussion segment.

2. LITERATURE REVIEW AND HYPOTHESES
2.1 Digital Technology Overload and Complexity
Digital overload is a high influx of information coming via multiple channels that slows and/or inhibits the information processing of the users in the digital context.12 Due to COVID-19 library professionals were prone to digital overload as they had to address a large number of queries of the users through smart phones, computers, the internet, intranet, portal, library apps, etc. Due to the increased digital overload library professionals were compelled to the following conditions: (a) process more information than usual, (b) work faster on the information, (c) work on a very timely and tight schedule as it was digital access, and (d) adopt some new digital technology.[13]

Apart from digital overload library professionals also faced digital complexity issues. As some of the digital technologies were relatively new and the professionals had very little idea or no idea about them.14 Furthermore, library professionals required time to understand these newly adopted digital technologies, and training was also required to understand and assimilate these new technologies into day-to-day functioning.

2.2 Work Alienation
Work alienation has been defined as psychological separation from one's workplace professionally or/ and socially.[15] There are various antecedents of work alienation listed in the literature. According to Muttar,[16] et al., complex organisational structures and transactional leadership styles may lead to work alienation among employees. Earlier DiPietro and Pizam[17] had also illustrated (a) strict control of organisational processes, (b) formalised structure, and (c) overburdening with work as critical antecedents of work alienation among employees.

Since in the present COVID-19 context library professionals have to work on digital technology overload and digital complexity in limited time and resources, it may so happen that the library professionals may develop a feeling of work alienation. The researcher used job demands and resources (JDR) theory to support the above postulations.[18] According to the job demands and resources (JDR) theory employees have limited resources at the workplace such as time, tools, and skill sets, and too many demands such as new technology adoption, work overload, and other jobs to complete. It is bound to happen that employees may feel stressed and alienated from the work if the job demands surpass the job resources available at hand.

Hence, the following hypothesisis proposed:

H1: Digital overload will be positively related to work   alienation among library professionals

H2: Digital complexity will be positively related to work alienation among library professionals

2.3 Perceived Organisational Support

Perceived organisational support (POS) has been defined as a feeling or belief among employees that their organisation and management care for their overall well-being.[19] It is well established in the literature that POS has helped employees achieve the following: (a) commitment to the organisation, (b) Task performance and productivity, and (c) intention to stay with the organisation[20] well, achieve goals, and stay committed to the organisation. Further, Bhatnagar and Aggarwal[21] validated that perceived organisational support may be negatively related to work alienation among employees. Thus, based on the aforementioned research the following hypothesis is proposed:

H3: Perceived Organisational Support will be negatively related to Work alienation among library professionals

2.4 Job Satisfaction

Job satisfaction has been defined as "the pleasurable emotional state resulting from the appraisal of one's job as achieving or facilitating the achievement of one's job values".[22] In simple words, job satisfaction is a positive and happy attitude toward one's job and workplace.[23] There are various antecedents and consequences of job satisfaction in the workplace. Some of the important antecedents of job satisfaction at the workplace are work autonomy and socialisation at the workplace. Job satisfaction is also found among employees who are less stressed.[24] Studies exploring the positive aspect of job satisfaction indicate that job satisfaction is positively related to the job and organisational loyalty and organisational citizenship behavior among employees.[25] As work alienation is estrangement from the workplace that appears opposite of job and organisational loyalty hence, we propose that library professionals who are satisfied with their job will be less work alienated. Thus, the following hypothesis:

H4: Job satisfaction will be negatively related to work alienation among library professionals.

3. RESEARCH METHODOLOGY

3.1 Research Design

The present study uses correlational research design and simple regression to understand the relationships between digital technology overload, digital complexity, work alienation, perceived organisational support, and job satisfaction among library professionals.

3.2 Sample Size

Samples were full-time and part-time working library professionals (Table 1) in libraries of central universities, the Indian Institute of Management (IIMs), state universities, and other important institutions of India. The convenience sampling method was used for the data collection process.

A total of 151 usable questionnaires were collected for research analysis.

3.3 Procedure

The research design used for the present study was quantitative. The sample for the current study was library professionals working in libraries of universities and other higher institutions in India. Questionnaires containing items related to digital overload, digital complexity, work alienation, job satisfaction, and perceived organisational support were circulated to the library professional staff via the official institute email id or social networking sites. Data were collected during January and February 2022. The survey was voluntary and participants were assured that their responses will be kept confidential. Item responses were recorded on a 7- point Likert scale. From Figure 1, it can be observed that more male (55 %) library professionals participated in this survey compared to Females (45 %). Similarly, figure 2 reveals that 47.7 % of respondents are in the age group 20 to 35 years; 33.1 % of respondents are in the 36 to 50 age group and 19.2 % of respondents are above 50 years. As far as the type of institution is concerned, 29.6 % of respondents come from other institutions, followed
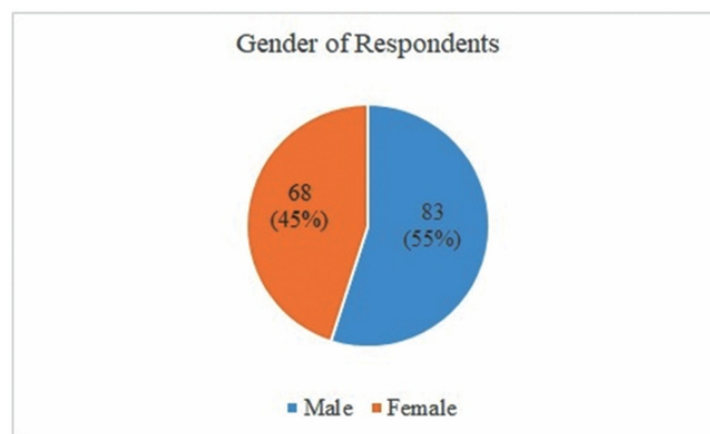
Figure 1. Gender-wise distribution of respondents.

by 25.2 % of respondents from central universities, 23.2 % respondents from the state university, and 22 % from IIMs. Analysis of their designation shows that 28.3 % of respondents are Librarians, 26.3 % are Professional Assistants, 25.7 % are Library Assistants, and 20.4 % are other Library Staff members. Concerning years of experience, 39.1 % of respondents hold experience below five years, 22.5 % hold experience from 10 to 15 years, 21.2 % have experience from 6 to 10 years, and 17.2 % have work experience above 15 years.

Table 1. Employment details of the respondents

Type	Division	Frequency	Percentage
Type of institutions	Central universities	38	25.2
	State universities	35	23.2
	IIM	33	22

	Other institutions	45	29.6
Designation	Other library staff	30	20.4
	Professional assistant	40	26.3
	Library assistant	39	25.7
	Librarian	42	28.3
Experience	Below 5 years	59	39.1
	6-10 years	32	21.2
	10-15 years	34	22.5
	Above 15 years	26	17.2

4. RESULT AND ANALYSIS

Table 2 shows the descriptive statistics for 151 respondents of library staff in various universities, institutes, and colleges. Measures of Digital Overload (M= 4.2, SD=1.6), Digital complexity (M=4.2, SD = 1.5), Work Alienation (M=3.7, SD=1.3), Job satisfaction (M = 5.3, SD = 1.1) and Perceived Organisational Support (M = 4.3, SD = 1.1) was found.

The data were also analysed statistically by Carl Pearson's correlation product-moment method to determine the relationship between digital overload and work alienation (Hypothesis 1); digital complexity and work alienation (Hypothesis 2); Work alienation and Perceived organisational support (Hypothesis 3) and Work alienation and job satisfaction (Hypothesis 4).

The results of the inter-correlations between variables are shown in Table 3. It was found that digital overload and digital complexity are positively and significantly correlated ($r = 0.84$, $p < 0.01$), and digital overload and
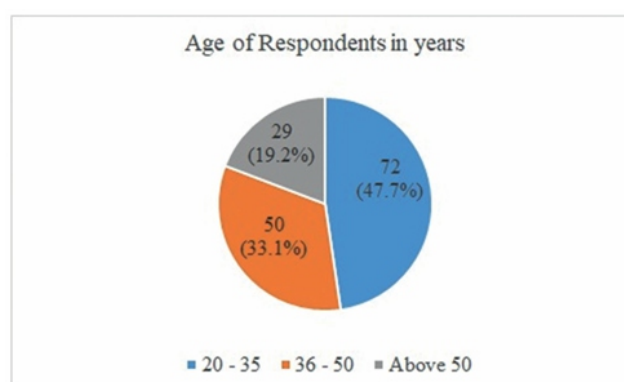
Figure 2. Age-wise distribution of respondents.

Table 2. **Mean and standard deviation scores of digital overload, digital complexity, work alienation, job satisfaction, and perceived organisational support (POS) (N= 151)**

S. No.	Variable	Mean	Std. deviation
1	Digital overload	4.2	1.6
2	Digital complexity	4.2	1.5
3	Work alienation	3.7	1.3
4	Job satisfaction	5.3	1.1
5	Perceived Organisational Support (POS)	4.3	1.1

work alienation are positively and significantly correlated (r = 0.74, p < 0.01), thus confirming hypothesis 1. Digital overload and perceived organisational support are negatively and significantly related (r = -0.26, p < 0.01).Correlation between digital overload and job satisfaction are negatively and significantly related (r = -0.22, p< 0.01). Further digital complexity and

Table 3. **Correlation between Digital Overload (DO), Digital Complexity (DC), Work Alienation (WA), POS, and Job Satisfaction (JS) among library professionals**

Correlation	DO	DC	WA	POS	JS
DO	1				
DC	0.84**	1			
WA	0.74**	0.78**	1		
POS	-0.26**	-0.36**	-0.41**	1	
JS	-0.22**	-0.32**	-.43**	0.64**	1

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

work alienation are positively and significantly correlated (r = 0.78, p< 0.01), thus confirming hypothesis 2. Digital complexity and perceived organisational support are negatively and significantly related (r = -0.36, p< 0.01). Correlation between digital complexity and job satisfaction are negatively and significantly related (r = -0.32, p < 0.01). Moreover, correlation between work alienation and POS are negatively and significantly related (r = -0.41, p< 0.01). Thus, confirming hypothesis 3. Finally, the correlation between work alienation and job satisfaction is negatively and significantly related (r = -0.43, p < 0.01). Thus, confirming hypothesis 4. The multiple regression equation explained above is of the following form:

$$y = b_1 x_1 + b_2 x_2 + \ldots + b_n x_n + c.$$

Here, b_i 's (I =1,2…n) are the regression coefficients. It represents the value at which the dependent variable (Y) changes when the independent variable (X) changes.

The results of the multiple regression as shown in Table 4 suggest that the adjusted R square value is 0.67 which indicates a good regression model. Moreover, the F test was significant at a 0.00 level. As far as

Table 4. Multiple regression table having work alienation as the dependent variable and digital overload, digital complexity, POS, and job satisfaction as the independent variable

R square	0.677644353				
Adjusted R square	0.668812692				
Standard error	0.74368339				
Observations	151				
ANOVA					
	df	SS	MS	F	P-value
Regression	4	169.74444	42.43611	76.72898	0.00
Residual	146	80.74749	0.55306		
Total	150	250.49193			
	Coefficients	Standard error	t Stat	P-value	
Intercept	2.428401553	0.431839	5.623402	0.000000	
POS	-0.122036794	0.075042	-1.626245	0.106054	
DO	0.276247962	0.071253	3.876977	0.000159	
DC	0.354514579	0.076453	4.637048	0.000008	
JS	-0.164846326	0.072817	-2.263848	0.025057	

the independent and dependent variables are concerned work alienation was the (dependent variable) and digital overload, digital complexity, Perceived Organisational Support (POS), and job satisfaction were the independent variables. Based on the readings of the coefficients of independent variables it can be predicted that 66.7 % variation in work alienation can be explained by the above multiple regression model. It is also interesting to note that digital complexity has the highest significant positive coefficient (0.35). It indicates that digital complexity is the biggest factor that is causing work alienation among library professionals. Similarly, digital overload has the second highest significant positive coefficient (0.35). Job satisfaction has the highest significant negative coefficient (-0.16) indicating that job satisfaction is reducing work alienation among library professionals.

5. DISCUSSION AND CONCLUSION

Researcher conceptually formulated the present study and attempted to answer two research questions and prove three hypotheses that suggested work alienation among library professionals as a response of digital overload and digital complexity. Based on the correlation and regression analysis it was found that library professionals do develop work alienation in response to digital overload and digital complexity. These two independent variables were significantly and positively explaining work alienation among library professionals. It was interesting to note that the job satisfaction of library professionals was negatively and significantly related to work alienation. Perceived Organisational Support (POS) was negatively related to work alienation but was not significant.

The findings of the study have several implications for theory and practice. Firstly, this study is among the first few studies that have attempted to study the response and work-related behavior of library professionals during COVID-19. Secondly library science literature is largely filled with user-related studies very few studies have attempted to study the behavior and attitude of library professionals.

This study fills the gap and contributes to the literature. Moreover, this study contributes to the theory of work alienation and confers digital overload and digital complexity as two major antecedents of work alienation. This study also confirms job satisfaction as a major antecedent that reduces work alienation. Through the findings this study urges the top management of the library institutions to provide organisational support to the library professionals which could be in form of the availability of resources, providing training, coaching, and other mentoring activities. If these organisational supports are provided probably lesser work alienation will occur among library professionals. Apart from contributing to literature and practice, this study has a few limitations too. The limitations are as follows: (a) Issue of common method bias: As the study uses data collected from self-reported measures hence there may occur common method bias, (b) This study is cross-sectional hence the generalise ability scope is very limited, (c) Sample size is not very large and hence there is a scope to work on the larger sample set. Future studies may apply simple random sampling instead of convenience sampling. Studies may also compare the level of work alienation across different types of library institutions.

This research indicates that the library professionals worked throughout COVID-19 lockdown to provide resources to the needed clients via electronic channels and the top level administration need to support and encourage them. The organisational support means a lot to every personnel and will lead to better job satisfaction and no alienation from work.

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For this study she has done the data collection, analysis and interpretation.

Role of Public Libraries in Bridging the Digital Divide: Study of Kerala State Central Library

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A B S T R A C T

The present study investigated the role of public libraries in bridging the digital divide in the Kerala State Central library (KSCL), Thiruvananthapuram. The study employed a descriptive survey method using a structured questionnaire distributed among library users. It discussed the use of ICT and internet services in the library, the purpose of using the internet, digital services, e-governance services, e-resources provided by the library and factors that cause the digital divide. The findings revealed that the majority of the users are not aware of ICT (47.0 %) and internet services (39.4%) provided by the library. The users preferred photocopy (43.2 %) and OPAC (31.8 %) services. The library users access the internet for education, reading news, and employment purposes, and mostly use computers to access e-journals and e-books provided by the library (52.2 %). M-governance (12.8 %) and E-district (12.0 %), were the most frequently used e-governance information services provided by the library. The users opined the primary factors that causes digital divide are lack of ICT skills and illiteracy. Non-parametric test showed the significant differences between the purpose of internet usage and the place of living, as well as the factors driving the digital divide. Public library services are essential for common people to overcome the digital gap and the library can bring new technologies to reduce the digital gap of public users and can assist them in getting education, employment, and government services. The respondents suggested that the library should conduct user awareness program about emerging technologies and orientation for users to familiarise the services provided by the library.

Keywords: Public library; Digital divide; e-governance; ICT; State Central Library; Thiruvananthapuram; Kerala

Introduction

In today's increasingly digitalised world, access to information and technology has become a crucial factor in determining one's social, educational, and economic wellbeing. Unfortunately, not everyone has equal access to these resources, leading to a digital divide that exacerbates existing societal inequalities. In this context, public libraries have emerged as vital institutions for bridging the digital divide and ensuring that individuals from all walks of life have the opportunity to participate fully in the digital age. The digital divide denotes the inequality between demographic and geographic regions with and without access to modern Information and Communication Technology (ICT), including telephone, television, personal computers, and internet connection.[1] The rural libraries are essential for economically disadvantaged people to educate and become aware of society.[2] Modern libraries play a far more prominent role in their communities by providing users with counselling, training, and access to ICT, and most crucially, library usage is free.[3]

The community has greatly benefited from the accessibility of computers and internet services provided by the library, as it effectively bridges the information and digital divide among people.4 Over time, there has been a noticeable rise in the number of individuals visiting libraries for internet usage, indicating a growing reliance on library internet access that is tailored to their specific requirements.5 The utilisation of digital devices fosters the adoption of digital reading among users, leading to enhanced access to information.6 The contributions of libraries to the solution of reduce digital divide. The digital divide affects the socio-economic factors of society, and it is based to access to the internet and computer technology.7 Many of the most marginalised communities are far behind by the digital transformation of government and private services. Due to the lack of digital skills and access, people cannot exercise their fundamental rights.8 The library play a significant role in the national   drive with a special focus on lending internet access to users who do not have access to the internet at their homes.[9]

2. REVIEW OF LITERATURE

 Barath and Sudhier10 investigated how users perceive e-resources and information services in a public library. Their research emphasises the significance of improving the library's existing resources and services through the widespread implementation of Information and Communication Technology (ICT). Halder11 evaluated library users reading habits, and electronic documents significantly improve readers' attitudes. The users feel comfortable with the digital environment while reading. Khanchandani12 addressed the evolving landscape of public libraries in India and their role in supporting the nation's digital transformation. The article highlights the importance of public libraries as catalysts for social and economic progress, emphasising their ability to empower individuals and communities through access to digital resources and services.

Varghese and Thirunavukkarasu[13] concluded that public libraries have the potential and responsibility to stand for the sustainable development of society at large. Manzuch and Maceviciute14 demonstrated the importance of digital inclusion in public libraries. It reveals that libraries struggle to redefine their social worth and acquire the resources and infrastructure required for digital inclusion initiatives.

Arindam15 explored the relationship between community information services and libraries. Public library act as community information centres and also serve the information need of inexperienced citizens. Prabhakaran and Periyasamy16 highlighted the main objective of public libraries is to offer a wide range of resources and services in various formats to cater to the educational, informational, personal development, recreational, and leisure needs of individuals and groups.

Strover9 investigated the role of libraries in promoting internet access and digital literacy. It reveals that libraries had diversified their services for bridging digital gaps in an environment by providing internet and computer services. Lediga and Fombad17 examined information and communication technologies used in libraries for bridging the digital divide. It is essential to standardise the digital services in the library, and it's an effective way to reduce the digital divide. Joselin and Panneerselvam18 investigated the library's diverse community information services. It is regarded as a problem-solving force that enables individuals to make the best decisions possible at the appropriate times. Ajithakumari and Francis19 conducted a study that specifically investigated the impact of the Kerala State Central Library (KSCL) on societal development. However, their research primarily concentrated on assessing the status of document collections, human resources, and services provided by the KSCL. The significance of public libraries in closing the digital gap within library remains largely unexplored. Therefore, this study aims to investigate and shed light on the role of KSCL in bridging the digital divide.

3. OBJECTIVES

The following are the objectives of the study:
• To understand the purpose of using internet in the Kerala State Central Library (KSCL).
 • To identify usage of e-resources provided in the library.
 • To know the e-governance information provided in the library.
 • To find the digital devices used in the library. • To determine digital services provided in the library.
 • To identify the factors affecting the digital divide.

4. METHODOLOGY

 A descriptive survey method and a simple random sampling were adopted for the study. The data were collected from the library users by distributing a structured questionnaire. The investigator collected 132 questionnaires out of 180 respondents, and the response rate was   73.33 %. The questionnaire was carefully designed to

Table 1. Demographic details

Variables	Values	Response	%
Gender	Male	104	78.8
	Female	27	20.5
	Others	1	.8
Age	Below 20	7	5.3
	20-30	61	46.2
	30-40	25	18.9
	40-50	12	9.1
	Above 50	27	20.5
Residence	Rural	63	47.7
	Urban	69	52.3
Employment	Govt. employment	12	9.1
	Private employment	27	20.5
	Self-employment	23	17.4
	Retired	13	9.8
	Unemployment	14	10.6
	Student	43	32.6
Qualification	Primary education	3	2.3
	High school	6	4.5

Matriculation	10	7.6
Under graduate	63	47.7
Post graduate & above	44	33.3
Diploma	6	4.5

cover all necessary components without compromising objectivity. The gathered data was analysed using the current versions of MS Excel and SPSS software.

5. DATA ANALYSIS
5.1 Demographic Details

Table 1 represents the demographic details of respondents. In gender-wise distribution, out of 132 respondents, 104 (78.8 %) are male, 27 (20.5 %) are female, and 1 (0.8 %) belong to the category of others, which shows that male users are high compared to female users. The age-wise distribution shows that 61 (46.2 %) respondents belong to the age group of 20-30 years, followed by 27 (20.5 %) above 50 years. This depicts that nearly half of respondents are in the age group of 20-30 years. While analysing the respondents' residence status, 69 (52.3 %) and 63 (47.7 %) respondents reside in urban and rural areas respectively, clearly stating that most live in urban areas. The analysis of the employment status of respondents revealed that 43 (32.6 %) are students, which is nearly half of the population, and 27 (20.5 %) respondents are private employees, followed by 23 (17.4 %) are self-employed. The qualification details of respondents depict that nearly half of the respondents are undergraduates.

Table 2. Usage of ICT in the library

Values	Response	%
Not applicable	62	47.0
1-2 year	38	28.8
3-4 year	14	10.6
4-6 year	10	7.6
Above 6 year	8	6.1

5.2 Usage of ICT

Table 2 shows the frequency of using ICT facilities by library users in the library. Out of 132 respondents, 62 (47.0 %), that is, nearly half of the population, marked the responses as not applicable, which means that they are not using any kind of ICT facilities in the library, followed by 38 (28.8 %) respondents using ICT facilities for 1-2 years. These findings shows the varying levels of ICT integration in libraries.
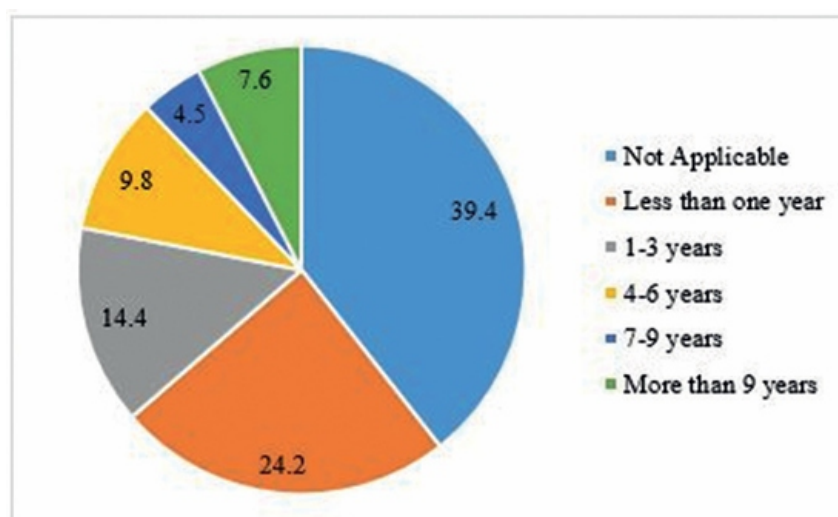
Figure 1. Use of internet in the library.

5.3 Internet Usage

Figure 1 shows the frequency of internet usage by respondents. While 52 (39.4 %) are not using the internet in the library, 32 (24.2 %) respondents were using the internet for less than one year, which shows that nearly half of the respondents are not using the internet in the library or who have limited experience with it.

5.4 Purposes of Using Internet

Table 3 depicts the purposes for using the internet by respondents in a library. The most common reason for using the internet in the library is education, with an mean score of 2.17. Reading online news (1.76) and employment (1.74) are the next popular purposes. On the other hand, online bill payments (0.83), online banking (0.86), and online ticket reservation (0.91) are the least common reasons for using the internet in the library. The mean value is less than 2.5, and it is clear that the library users are not using internet services as effectively. The non-parametric test was used to reveal the significance of the purpose of using the internet in the library and the user's residence. The p-value of the purpose of internet usage and the place of the users is 0.004, which is less than 0.05. Hence, there is a significant difference between the purpose of internet usage and respondents' residence.

5.5 E-Resources

Figure 2 shows the use of e-resources provided by the library. A total of 29 (22 %) used e-journals and e-books, which is less than a quarter of the total respondents. Few of the respondents, 18 (13.6 %), used e-magazines, followed by 17 (12.9 %) used e-newspapers. The utilisation of electronic theses and dissertations, e-reports, and audio books are relatively less, ranging from 3.8 % to 7.6 %.

5.6 E-Governance Services

Figure 3 depicts the analysis of the association between the information provided by the public libraries about e-governance in Kerala. The highest number of 16 (12.8 %) responded that public libraries provided information about M-governance, followed by 15 (12.0 %) about E-district and Aadhar and FRIENDS by 11 (8.8 %) each. According to the figure, most respondents obtain information on M-governance, followed by E-district, with a significantly lower number receiving information on E-MIST and TERMS.

5.7 Usage of Digital Devices

Figure 4 displays the analysis of the digital devices used by the users in the public library. Out of 132 respondents, 69 (52.2 %) used computers in the library. Few respondents, that is, 10 (7.6 %) and 9 (6.8 %), used scanners and printers, respectively. The majority of respondents use computers at the library rather than any other digital devices, as shown by the figure. It is clear

Table 3. Purposes of using internet in the library

| S. No.	Purposes	Always	Often	Sometimes	Rarely	Never	Mean
1	Educational (e.g., admissions, exam, results, assignments, projects, etc.)	39 (29.5%)	13 (9.8 %)	8 (6.1 %)	5 (3.8 %)	5 (3.8 %)	2.17
2	Employment (job, career, PSC exams)	26 (19.7 %)	11 (8.3 %)	10 (7.6 %)	8 (6.1 %)	10 (7.6 %)	1.74
3	e-governance services	14 (10.6 %)	9 (6.8 %)	7 (5.3 %)	9 (6.8 %)	15 (11.4 %)	1.21
4	Read online news	28 (21.2 %)	11 (8.3 %)	10 (7.6 %)	4 (3.0 %)	10 (7.6 %)	1.76
5	Health information	18 (13.6 %)	7 (5.3 %)	8 (6.1 %)	9 (6.8 %)	15 (11.4 %)	1.33
6	Political information	18 (13.6 %)	8 (6.1 %)	8 (6.1 %)	11 (8.3 %)	14 (10.6 %)	1.38
7	Recreation/ entertainment (music, games, etc.)	13 (9.8 %)	7 (5.3 %)	12 (9.1 %)	12 (9.1 %)	15 (11.4 %)	1.27
8	Online shopping	7 (5.3 %)	3 (2.3 %)	8 (6.1 %)	13 (9.8 %)	22 (16.7 %)	.90
9	Online ticket reservation	8 (6.1 %)	6 (4.5 %)	3 (2.3 %)	12 (9.1 %)	23 (17.4 %)	.91
10	Communication (E-mail/chat)	11 (8.3 %)	7 (5.3 %)	15 (11.4 %)	8 (6.1 %)	12 (9.1 %)	1.18
11	Online banking	6 (4.5 %)	7 (5.3 %)	5 (3.8 %)	8 (6.1 %)	24 (18.2 %)	.86
12	Online bill payments	6 (4.5 %)	8 (6.1 %)	4 (3.0 %)	6 (4.5 %)	24 (18.2 %)	.83
13	Use social networking sites Facebook, WhatsApp, Instagram, etc.	11 (8.3 %)	10 (7.6 %)	8 (6.1 %)	11 (8.3 %)	24 (18.2 %)	1.25
14	Access blogs	6 (4.5 %)	10 (7.6 %)	13 (9.8 %)	8 (6.1 %)	25 (18.9 %)	1.14
15	Access wikis	15 (11.4 %)	9 (6.8 %)	9 (6.8 %)	8 (6.1 %)	22 (16.7 %)	1.33
16	Downloading study materials	12 (9.1 %)	10 (7.6 %)	12 (9.1 %)	5 (3.8 %)	25 (18.9 %)	1.30
17	Sharing course materials/ lecture notes	13 (9.8 %)	10 (7.6 %)	12 (9.1 %)	4 (3.0 %)	22 (16.7 %)	1.30
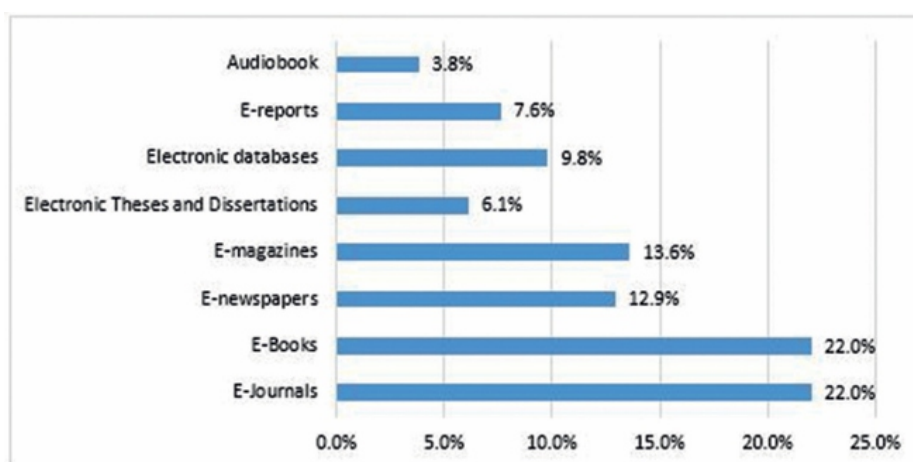
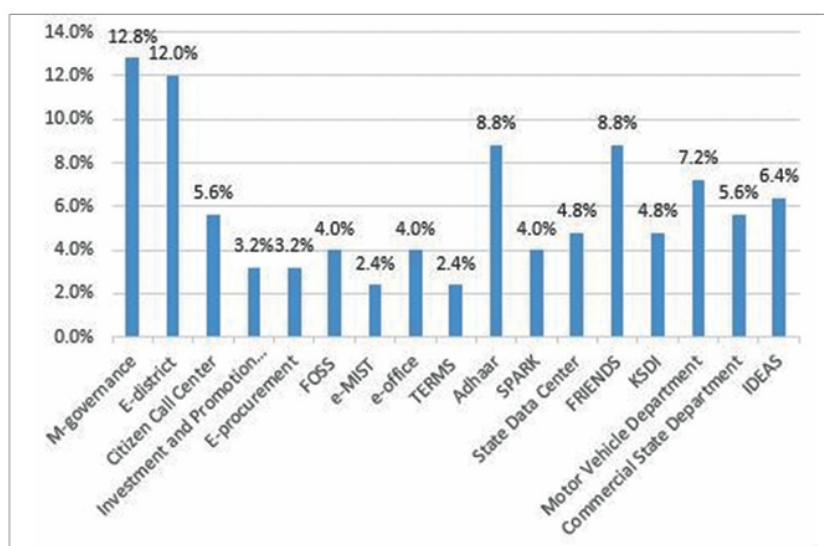**Figure 2. E-resources provided in the library.**

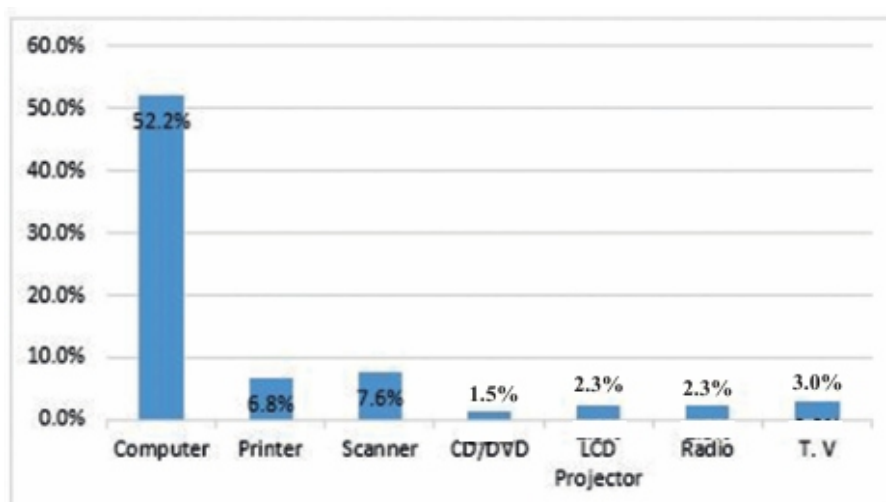**Figure 3. E-resources services provided by the library.**

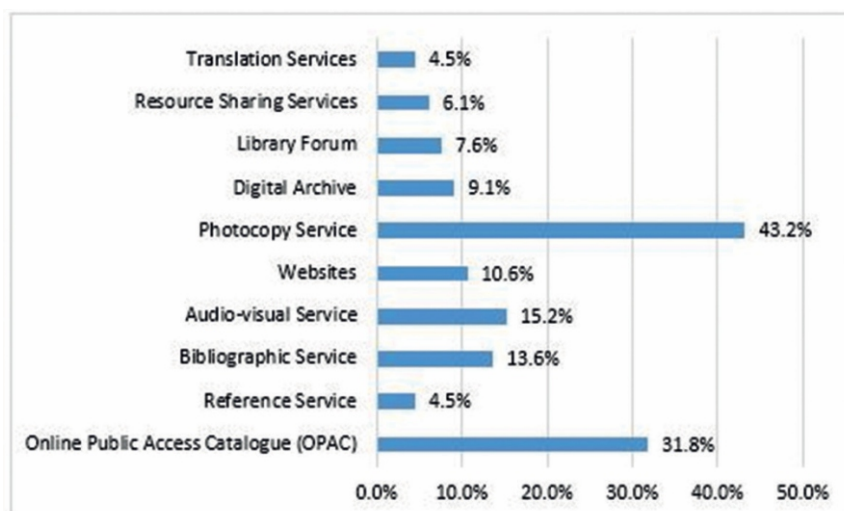**Figure 4. Usage of digital devices in the library.**

Figure 5. Digital services provided by the library.

that decline in physical media usage, such as CDs/DVDs, LCD projector, radio and TV are possibly due to the availability of online resources and streaming services.

5.8 Digital Services

Figure 5 represents digital services provided by the library. Out of 132 respondents, less than half of the respondents, 57 (43.2 %), are aware of the availability of photocopy services in the library, and 42 (31.8 %) respondents were aware of the online public access catalogue (OPAC). Few of the respondents, 20 (15.2 %), were aware of audio-visual services, followed by 18 (13.6 %) with bibliographic services and 14 (1.6 %) with websites. It shows the photocopy service and OPAC as the most widely used digital services, followed by the audio-visual service, bibliographic service, and websites. The library can leverage these services to allocate resources effectively and cater to the diverse needs of its users.

Table 4. Factors causes of digital divide

S. No	Factors	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Mean
1	Gender	5 (3.8%)	14 (10.6%)	11 (8.3%)	10 (7.6%)	13 (9.8%)	1.11
2	Physical disability	5 (3.8%)	20 (15.2%)	12 (9.1%)	7 (5.3%)	4 (3.0%)	1.20
3	Lack of physical access	14 (10.6%)	23 (17.4%)	9 (6.8%)	5 (3.8%)	2 (1.5%)	1.52
4	Lack of ICT skills	21 (15.9%)	27 (20.5%)	8 (6.1%)	1 (.8%)	2 (1.5%)	1.83
5	Attitudinal factors	12 (9.1%)	21 (15.9%)	10 (7.6%)	4 (3.0%)	2 (1.5%)	1.39
6	Relevant content	7 (5.3%)	17 (12.9%)	14 (10.6%)	3 (2.3%)	4 (3.0%)	1.17
7	Age	13 (9.8%)	17 (12.9%)	11 (8.3%)	8 (6.1%)	5 (3.8%)	1.42
8	Illiteracy	16 (12.1%)	25 (18.9%)	8 (6.1%)	2 (1.5%)	4 (3.0%)	1.61

5.9 Factors of Digital Divide

Table 4 analyses respondents' views on factors that cause the digital divide in society. The higher mean value of the causing factor of the digital divide is lack of ICT skills (1.83), followed by illiteracy rate (1.61), lack of physical access (1.52), age (1.42) and attitudinal factors (1.39). It is revealed that the most critical factor for the digital divide is the lack of ICT skills and the illiteracy rate. The non-parametric test is used to find the significance of factors causing the digital divide and the users' residences. The p-value of the factors driving the digital divide and the place of the users is 0.030, which is less than 0.05. Therefore, there is a significant difference between the factors that contribute to the digital divide and the residences of the people.

6. CONCLUSION

The public libraries in Kerala actively participate in society's development by offering ICT and internet facilities to library users. The ICT services are reaching people, and they benefit from it. The study revealed that library users are not aware of ICT and internet services provided by the library and use photocopy and OPAC services. The users use the internet in the library for education, reading news, and employment. They use the computer from the library to access e-journals and e-books provided by the library. The motive of the user to use the internet in the library is it gives a pleasant environment to work. The main factor of the digital divide is lack of ICT skill, illiteracy and lack of ICT access. The library activities are essential to the sustainability of the people by encouraging them to participate in educational, cultural and social activities. The digital divide is an increasing societal issue that

exacerbates the disparity between those with and without access to information. The public library can effectively contribute in bridging the digital divide through ICT services. The library can organise several awareness programs for users, which helps to overcome various issues faced by the users from society.

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His contribution to the paper are: Conceptualised the study and its framework, designed the research methodology and the final proof correction

Assessment and Practice of Information and Research Literacy Skills Among Students in Indian Higher Education Institutions

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A B S T R A C T

The study presented and focused on the process and implementation of the information and research literacy program, the level of awareness among students and research scholars, and their potential after receiving information and research literacy training. The purpose of this study is to learn more about user's information and research literacy skills when it comes to various information sources and services. The essential component of information literacy provided students with a significant amount of insight into the practical instructional methods they could use to use the information sources without difficulty. The aim of this study is to assess the level of information and research literacy among students in Indian higher education institutions and to identify areas for improvement. The study found that while students have basic knowledge of information and research literacy, they struggle with more advanced research skills such as finding, evaluating, and synthesising information. To separate the content, a list of 33 topics was used, covering the majority of topics to measure the awareness of information and research literacy skills and how to overcome their improper implementation among students and research scholars. The study highlights the need for institutions to prioritize the development of these skills through targeted training and practice opportunities.

Keywords: Information literacy; Information skills; Library instructor; Library tutorials; Research literacy

Introduction

Information literacy refers to the skills and knowledge required to declare the information required for a task, then locate, comprehend, evaluate, and use that information efficiently and effectively while remaining within moral and professional boundaries. Defining the target criteria can make it easier to develop several tactics suited for achieving high-essential results. The higher education institution's library system must keep an effective way of communicating with its students to fulfill its mission of providing prominent resources and services.1 On the other hand, academic libraries must improve the quality of the services and resources they provide to continue existing in this precious environment. Information literacy programs are mainly dependent on the library's essentials. It is essential to assess and evaluate a library service and its resources from the student's perspective because university library systems have a variety of resources and distribute the services to the students based on the resources. As a result, it is very important to evaluate the service provided by the library from the student's perspective. In addition, the library must understand its students and their needs in order to provide a user-centric service. A user survey is one of the most important tools for assessing and evaluating library services. It is not possible to assess a student's dynamic needs without conducting user surveys to determine user needs

and reading interests.2 Learning new skills, which have the biggest priority in today's information overload environment necessitated by information literacy, which is required for success in academics and the workplace. When students develop analytical, evaluative, and critical thinking abilities as part of their information literacy education, they have the opportunity to reflect on their knowledge and the learning process. Instead, information and research literacy abilities have the power to change a learning process into one that allows students to engage in self-directed, lifelong learning. In terms of developing skills, the most important thing is that skills used in many different courses or degree programs, as well as in professional settings.3

1.1 Why Information Literacy Become Important

Information literacy is a crucial skill in higher education because it empowers students to effectively find, evaluate, and use information in their academic and professional lives. In an age where access to information is easy, it's more important than ever to be able to differentiate between credible and unreliable sources. Possessing information literacy skills helps students make informed decisions and effectively communicate their ideas and research findings. Furthermore, information literacy is a key competency that employers look for in job candidates, making it a valuable skill to have in the current job market. By developing information literacy skills, students are better equipped to succeed in their academic and professional pursuits. UNESCO and IFLA have emphasised the development of instructional methods for information literacy adopted by various institutions worldwide by developing standards and guidelines in this regard. The foundation for lifelong learning is information literacy. The basic rules of information literacy are the same for all subjects, levels of education, and types of learners.4

As per the basic guidelines in academic librarianship, the instructor's conversations about information and research literacy focused on the individual's skills to effectively access and implement information, which has prompted discussion about what information and research literacy is and how it is described and practiced in education settings. On the one hand, many believe that information and research literacy should be skills- based literacy, which case it is equivalent to the information skills required to find information. According to the opposing viewpoint, information literacy is viewed as a complex phenomenon that catalysis educational growth. This represents the research and critical thinking processes that academic librarians and educators are familiar with and understand most of the time. In the same way, the literature talks about how information and research literacy taught and whether it should be a part of a discipline or a separate specialisation.5

1.2 Influential Role of the University Library System
in Information and Research Literacy

Information and research literacy has become more important in today's scenario; it has a broader concept with many curriculum and application options. The basic concept of information literacy is to educate students on how to access library resources from different clusters. If we look back at the library's history, they always focused on the search process and provided the basic root of the information, which could be helpful to the students. The preparation of search information in the right direction has become important for libraries. Libraries care more and more about making sure that search results are organised logically.6

Information and research literacy programs offered by university libraries can play a vital role in helping students and faculty develop the skills they need effectively find, evaluate, and use the vast amounts of

information available to them. These programs can include instruction on topics such as search strategies, database navigation, and citation management, as well as workshops and one-on-one consultations. By providing access to these resources, university libraries can help ensure that students and faculty have the knowledge and skills they need to succeed in their academic and professional pursuits.7 To know about the student's status in the information and research literacy program, which the central library teach to the university student across the country. All the central university library systems are well equipped with their resources and services and libraries have departmental libraries as well. Usage of library services static has become high every year. The predominant mission of the university library has to be to develop a user-friendly system. They provide quality information at a quick finger-point, a lifelong learning phase with knowledgebased to excel in the teaching-learning environment. The nation's development and research contributions have become important aspects.

1.3 Impact of Technology on Information and Research Literacy

Digital literacy has evolved and has become a core competency for all learners, regardless of subject areas and age levels. The number of researchers and students who use technology is at an all-time high. Because of this, it is important to create curriculums for digital literacy that can encourage this use and help students reach their learning goals.8 Web 2.0 and AI tools presented a new dimension in the way researchers create, review, annotate, reuse, and represent information and has led to innovations in research communication practices.9 Gunasekera noted that surveys are essential to validate and increase library services and usage and understand how individuals transfer information. Researchers must conduct user studies to learn how people use libraries and why, as well as to identify which groups borrow what sorts of resources and develop strategies for promoting library use amongst those groups. In the information and research literacy program, the students' unsure minds brainstormed and realised that it was significant for their academic function.10

2. REVIEW OF RELATED LITERATURE

The review of related literature on information and research literacy is an important step in understanding the current state of knowledge on the topic. This literature review aims to examine the existing research on information and research literacy skills among students and research scholars in higher education institutions. There are a variety of studies used to form opinions on current information and research literacy practices, and library instruction programs are available.

A recent study by Ward, K.L., et al.11 assess the research literacy training, study participants in a chiropractic programme had their information literacy levels evaluated to the clinical and medical professionals. The findings stated that the students did top on standard 3 of the ACRL (average score: 67 %) and the lowest on standard 2 (average score: 59 %), which measures one's capacity to obtain information. The study recommends the inclusion of library professionals in the teaching and orientations. Eriksen12 argues for a new definition of research literacy for professionals that balances practical knowledge and evidence-based practice. A craft model of professional practice to replace the art/science divide and views research literacy as a virtue that upholds the integrity of the subject of expertise. The virtue serves a set of sensibilities that enable information professionals to incorporate evidence-based research tools into practice in a cooperative and situationally aware manner.

According to a study by Hatlevik13, et al. selfefficacy plays a significant effect on student motivation and learning outcomes. The study examines how ICT used to contextualise students' self-efficacy; a theoretical model was constructed and tested from the sample of fifteen countries. Information literacy

proficiency clearly linked to students' ICT self-efficacy when other student traits and backgrounds taken into account. Evans, C.14, et al. explores the value of incorporating research into the classroom and the advancement of research literacy in early career teachers (ECT). The study places a strong emphasis on the need for teachers to conduct research to support their instruction and work with their students to hone their research abilities. In order to eliminate unequal learning results, the paper also emphasises the significance of encouraging a critical pedagogical approach as a component of an inclusive pedagogy. Policy, collaboration, and professional developments highlighted in the study as important variables that affect the genuine incorporation of research literacy into teaching. Squibb & Mikkelsen15 suggested TRAIL (Teaching Research and Information Literacy) programme at the University of California, Merced has introduced courses by way of a curriculum developed by librarians and writing faculty. Students surveyed at the end of their first semester of college about their perspectives and the consequences of adopting the curriculum into the course syllabus. The ability to learn and seek, in particular the information literacy and critical thinking skills of pupils, taken to the next higher level with the help of TRAIL project. Tang & Chaw16 The findings of digital literacy were examined and presented, with proper information management, critical thinking skills, and advanced online habits being highlighted as some of the most important takeaways. The quality of learning skills required for this particular work assessed by looking at four different aspects of digital literacy: the foundations, knowledge, central competencies, and mindsets and perspectives. They are all the bridge between the students and instructor. Baykoucheva17, et al. recommendations for information and research literacy teaching were laid out for a partnership between the course instructors and a head librarian

(chemistry). Using a bibliographic management application, the model's IL education helps students locate scientific materials and the properties of chemical substances. Faceto-face training combined with online instructions on a LibGuides page specifically created for each course in the model. To apply the model, the chemistry librarian and course instructors worked closely together. Coats, J.V.18, et al. discuss the significance of involving community members in community-based participatory research (CBPR) and the absence of community involvement in the interpretation and dissemination of research findings. The article proposes a conceptual model for improving collaborations and partnerships between community partners and academic. It involves the creation of a public health training programme that equips local residents to work in tandem with academic researchers. While extensive study of this topic, a decade old study also found by Tuñón19 highlights the difficulties in preparing PhD candidates in education to use internet resources for their literature review process. The study was conducted at Nova Southeastern University's Programmes for Higher Education in both face-to-face and online formats. The study addresses the use of WebCT versus standard web pages and web board discussions, incorporating active learning, pacing and structuring delivery, catering to the needs of various learners, assessing learning outcomes, and the effect of working in collaboration with an academic programme on the design process.

3. OBJECTIVES OF THE STUDY

The main objectives of this study is to address the information and research literacy provided by university libraries in the diverse needs of student's tutorials at the university. In order to obtain the aim of this study, the university librarie's research on information literacy are to help students and faculty find, evaluate, and use information more effectively and efficiently, as well as to contribute to the field of information literacy as a whole.

- To evaluate the existing tutorials and their competencies to teach the information literacy tutorials module

- To find out how the tutorial is covering the students' needs for online information literacy.
- To determine the top ten subject-based tutorials that meet the student's needs.
-To determine the participants' degree of satisfaction with the coverage of the information literacy programme offered by the university
- To suggest ways to improve how libraries work and how well the respondents can find and use information.

4. RESEARCH METHODOLOGY

  The research methodology for data collection on information and research literacy among higher education students and researchers can involve a multi-step process and a combination of qualitative and quantitative research methods. The researcher conducted a mixed-methods survey using online as well as printed questionnaire tools to select students from a larger population group across the Indian higher education system. The population was divided into strata based on academic level, such as undergraduate (UG), postgraduate (PG), and research scholars (RS), and conducted among the students and researchers at 18 universities and 8 institutes of national importance across the country. The institution where the survey was carried-out was chosen using a set of predefined criteria to ensure a diverse sample of participants, as well as providing information, research literacy orientation, and formal sessions for their students and research scholars. The online and printed questionnaires were sent to 243 students and research scholars, and 203 questionnaires were returned or received from participants. Out of all the received questionnaires, inaccuracies were identified in the fourth questionnaire. For data analysis, all the valid 193 returned questionnaires were coded, and statistical methods were used to make sure that they were all the same. The male frequency was 104 (53.9 %), while the female frequency was 89 (46.1 %). The male presentations were high as compared to the females.

5. DATA ANALYSIS AND INTERPRETATION

The research methodology designed to provide a comprehensive and valid picture of the information and research literacy skills and practices of students and research scholars in higher education in India. The study will also look into how hard it is for users to find and get the information they need for their teaching and research. Many academic libraries offer information and research literacy tutorials, such as workshops, library orientations, LibGuides and handout to help students develop these skills and competencies. Table 1 listed below the gender representation of data for the student category. Out of 193 respondents, 35 (18.1 %) were male undergraduates followed by 26 (13.5 %) females; postgraduate students, 49 (25.4 %) male students followed by 41 (21.2 %) females; and research scholars, 20 (10.4 %) followed by 22 (11.4 %) females. A list of tutorials used to measure the awareness and evaluation of information and research literacy among the undergraduate, postgraduate and research scholars given in Table 2. The library tutorials examined for this study

Table 1. Demographic representation of the participants

Category of the students	Gender	N	% of total N
Undergraduate	Male	35	18.1%
	Female	26	13.5%
Postgraduate	Male	49	25.4%
	Female	41	21.2%

Research scholar	Male	20	10.4%
	Female	22	11.4%
Total	Male	104	53.9%
	Female	89	46.1%
	Total	193	100.0%

covered a wide range of skills and topic areas, but there was a lot of variation in how much attention paid to each topic among users. The information divided into 33 categories, covering most of the aspects of information and research literacy provided by the library. Although the essential information and research literacy skills and subject areas covered by the library's information literacy program and online tutorial, this study examined diverse topics in students' skill sets for awareness of information literacy in their academia. There was little consistency in how different institutions approached the subjects. The total 33 major topics created from the content and coverage listed down by topic. Table 2 and Figure 1 shows that, most of the topics reached 50 % coverage among UG students only. Fair use policy, CRAAP Test, etc., Information life cycle, Creative Commons and Search Strategies: Proximity found to be less than below 50 %. Among PG students, most of the topics reached 50 % coverage except Fake news/ Misinformation, Search strategies: Proximity found with below 50 %. Additionally, in case of RS all the topics covered more than 50 % of the coverage.

To check the first hypotheses i.e. related to the information literacy skills and its aspects with among UG, PG and RS, we have conducted ANOVA test.20 The below table provides information on the coverage of topics in online library tutorials, with evaluations of the topics by UG, PG, and RS participants. It shows the topic, the average score by participant group, the F-value, and the p-value. The F-value and p-value suggest whether the difference between the mean scores for each topic is significant for the different student groups. The results from the analysis show in table 3 that the the UG, PG, and RS groups.

The topics where significant differences observed include Databases search, Search strategies: Facets/limiters, Locating the resources /Access, Catalog Search/discovery, Search strategies: Keyword/ subject, Evaluation of Information, and many others. These findings suggest that there is a difference in the level of understanding and competence among the groups in these topics. It is important to note that the significance level of p-value <0.05 indicates that the observed differences are statistically significant and highly unlikely to occur by chance. This highlights the need for targeted training and support to help the groups who are not as proficient in these areas to improve their skills. On the other hand, no significant difference observed in the mean scores for the topics such as searching for Information, Searching the Web, Fake news/Misinformation, and Using archives and findings aids. This indicates that the groups have a similar level of understanding and competence in these topics, which is a positive outcome. The results of this analysis provide valuable insights into the strengths and weaknesses of the UG, PG, and RS groups in terms of their online library tutorial skills. These insights can be used to design and implement tailored training programs to help the groups improve their skills in the areas where they need more support.

Table 2. Coverage of topics in research and information literacy

Coverage of topics in online library tutorials	UG	%	PG	%	RS	%
Searching for information	54	88.52	87	96.67	37	88.10
Databases search	43	70.49	83	92.22	41	97.62
Search strategies: Facets/limiters	54	88.52	89	98.89	40	95.24
Locating the resources /access (reading call, physical layout, availability, ILL, etc.)	60	98.36	81	90.00	42	100.00
Catalog search/discovery	42	68.85	80	88.89	41	97.62
Search strategies: Keyword/subject	54	88.52	77	85.56	39	92.86
Evaluation of information	60	98.36	69	76.67	34	80.95
Citing sources	55	90.16	80	88.89	34	80.95
Search strategies: Boolean	23	37.70	87	96.67	40	95.24
Scholarly v. popular resources	56	91.80	71	78.89	42	100.00
Authority	54	88.52	81	90.00	41	97.62
Search strategies: Phrases	55	90.16	80	88.89	40	95.24
Use of citation tools	54	88.52	77	85.56	42	100.00
Orientation/ assistance	60	98.36	69	76.67	41	97.62
Gathering background context	42	68.85	80	88.89	39	92.86
Search strategies: Truncation	34	55.74	86	95.56	26	61.90
Finding peer review	44	72.13	78	86.67	29	69.05
Searching the web	54	88.52	81	90.00	31	73.81
Awareness of plagiarism	58	95.08	80	88.89	40	95.24
Defining a research topic	56	91.80	68	75.56	39	92.86
Reading citations	45	73.77	69	76.67	39	92.86
Choosing databases	52	85.25	80	88.89	38	90.48
Distinguishing primary/secondary sources	49	80.33	77	85.56	29	69.05
Understanding copyright Bias	53	86.89	65	72.22	40	95.24
Developing research questions	54	88.52	88	97.78	38	90.48
Fair use policy	26	42.62	81	90.00	37	88.10
CRAAP Test, etc.	23	37.70	80	88.89	24	57.14
Understanding peer review	37	60.66	77	85.56	40	95.24
Information life cycle	27	44.26	69	76.67	23	54.76
Creative commons	19	31.15	80	88.89	28	66.67
Fake news/ misinformation	51	83.61	44	48.89	31	73.81
Using archives and findings aids	37	60.66	65	72.22	28	66.67
Search strategies: Proximity	29	47.54	39	43.33	31	73.81

The coverage of topics in library tutorials for UG tends to be more basic and introductory, focusing on the fundamentals of library research and information literacy. On the other hand, PG and RS require more in-depth and specialised knowledge, thus the library tutorials for these groups often cover advanced topics such as database searching techniques, systematic review methods, and literature synthesis. In addition, the library tutorials for PG and RS often include modules on interdisciplinary research, information management, and publication ethics, which not typically covered in library tutorials for undergraduates. These more advanced library tutorials designed to equip post-graduates and research scholars with the necessary skills and knowledge to effectively navigate the complex information landscape and advance their research objectives. Furthermore, the level of interactivity in the library tutorials for undergrads generally lower compared to post-graduates and research scholars. This is because under-graduates tend to have limited experience with library research and information literacy, thus the tutorials designed to be more straightforward and easy to follow. On the other hand, post-graduates and research scholars have a greater level of experience and knowledge in library research, thus the tutorials for these groups often include interactive elements such as quizzes, simulations, and case studies to challenge
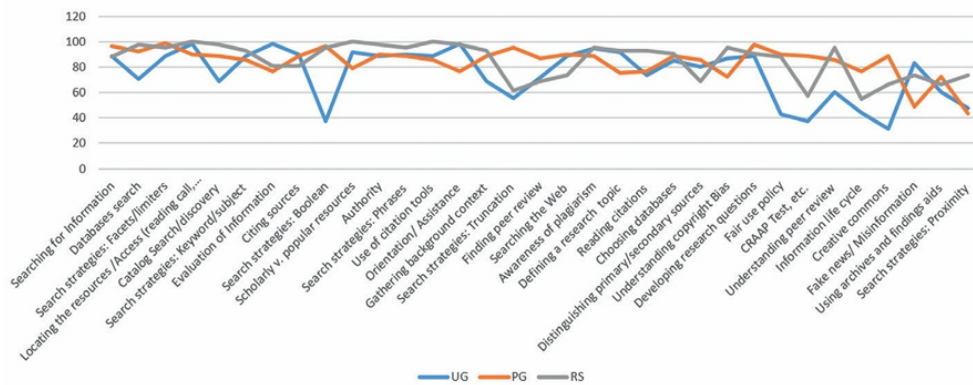
Figure 1. Coverage of topics in online research and information literacy.

Table 3. ANOVA result: Coverage of the topics in research and information literacy tutorials

S. No.	Coverage of the topics in research and information literacy tutorials	UG	PG	RS	F-Value	p-value
1	Searching for information	3.3752	2.5577	3.9874	3.3255	0.0951
2	Databases search	3.0572	3.8464	3.6581	3.9458	0.0068
3	Search strategies: Facets/limiters	3.6879	4.6305	2.5051	4.4060	0.0019
4	Locating the resources /access (reading call, physical layout, availability, ILL, etc.)	3.6875	3.0997	4.4766	3.0865	0.0086
5	Catalog search/discovery	3.3309	4.7883	2.7668	3.7935	0.0073
6	Search strategies: Keyword/subject	2.2048	3.8400	3.0610	4.6093	0.0052
7	Evaluation of information	2.7768	3.9566	4.0948	3.7929	0.0055
8	Citing sources	3.1605	2.4918	2.7114	4.9174	0.0353
9	Search strategies: Boolean	3.2601	4.2305	3.2423	3.0518	0.0054
10	Scholarly v. popular resources	3.5681	2.6025	4.4758	4.5597	0.0076
11	Authority	2.1679	3.8233	4.8444	3.8688	0.0006
12	Search strategies: Phrases	2.5101	2.2861	2.3993	4.4004	0.0008
13	Use of citation tools	3.2401	3.0976	2.5528	4.5269	0.0015
14	Orientation/ assistance	2.5994	4.8081	3.8214	4.4320	0.0090
15	Gathering background context	4.7275	3.3769	2.3074	4.9535	0.0060
16	Search strategies: Truncation	3.5804	2.6209	4.5441	4.9131	0.0004
17	Finding peer review	4.7891	3.5770	3.3083	4.9091	0.0087
18	Searching the web	2.5980	4.8617	4.4707	40.8307	0.0971
19	Awareness of plagiarism	4.8082	2.6243	2.8423	4.6301	0.0038
20	Defining a research topic	3.6610	4.4478	2.0687	3.5033	0.0062
21	Reading citations	2.0442	3.4502	2.0386	3.3430	0.0006
22	Choosing databases	4.1614	2.7282	4.4086	4.2564	0.0288
23	Distinguishing primary/secondary sources	2.3189	4.7501	3.8755	4.7313	0.0037
24	Understanding copyright Bias	3.5275	2.7633	2.5055	3.5806	0.0009
25	Developing research questions	3.5347	3.1380	2.7010	3.2418	0.0006
26	Fair use policy	2.5902	3.1500	3.7027	3.7329	0.0099
27	CRAAP Test	4.8139	2.7878	2.1257	3.3247	0.0018
28	Understanding peer review	3.1914	4.7708	3.3869	3.7182	0.0341
29	Information life cycle	4.5138	2.7418	2.9358	3.2703	0.0008
30	Creative commons	2.7857	3.3841	4.3352	3.6764	0.0294
31	Fake news/ misinformation	2.9908	2.3581	3.0353	4.2492	0.0618
32	Using archives and findings aids	3.3717	3.0926	2.0322	3.3176	0.0895
33	Search strategies: Proximity	4.5381	4.9678	2.1658	3.5930	0.0455

their existing knowledge and skills. In conclusion, the coverage of topics in library tutorials tailored to meet the specific needs and requirements of different student populations. Under-graduates receive introductory and basic instruction in library research and information literacy, while post-graduates and research scholars receive advanced training in interdisciplinary research, information management, and publication ethics. These library tutorials play a critical role in preparing students for academic success and research excellence. The results of the Chi-Square test stated in the appendix on 33 topics in the library's tutorials. The results show that, there were no significant difference in the awareness of information literacy skills and its aspects between male and female students in regards to topics, such as searching for information, gathering background context, awareness of plagiarism, reading citations, choosing databases, distinguishing primary and secondary sources, and recognising fake news and misinformation. The p-value for these topics is greater than 0.05, indicating that there is no significant difference in the awareness of these topics between male and female students. The results of the Chi-Square test suggest that male and female students have similar levels of awareness when it comes to information and research literacy and its aspects. This could be due to a variety of factors, including equal access to library tutorials, similar levels of engagement with the tutorials, and similar educational experiences that emphasise the importance of information literacy.21 Additionally, it is possible that the library tutorials designed in a way that was accessible and relevant to both male and female students, thereby promoting equal levels of awareness. It is also possible that cultural and societal factors play a role in promoting information literacy skills among both male and female students, further contributing to the similarity in their levels of awareness. However, for the remaining topics, the p-value found to be less than 0.05, which shows there is a significant difference in the awareness of these topics among males and females. The differences in awareness are due to the students' experiences, their engagement with the library tutorials, or their learning styles.

Additionally, it is possible that gender-based biases or preconceptions are affecting the students' awareness of these specific topics. Further, the research conducted to determine the root causes of these differences in awareness, in order to address any potential disparities and promote equal understanding of information literacy skills and its aspects among both male and female students. The Chi-Square hare result analysis of the data indicated in the appendix reveals the high level of dedication to the information literacy program and the difficulties of the instructor's task. Therefore, it looks like there are many ways in which teaching practices made better. Instructional goals and methods are an essential part of determining student achievementand the efficiency of an educational strategy. In light of this conclusion, the study results indicated that assessment and evaluation still carried out in a primarily advisory capacity. When there is no systematic linkage of learning outcomes with the information literacy skills instructor, the return on investment of instructional work is questionable. As a result, administrators may have trouble sustaining instructional efforts. In addition, promotion of educational possibilities still done in a much more unstructured manner, indicating that this domain has room for improvement.

This research shows that undergraduates, postgraduates, and research scholars should be the primary focus of information literacy instruction. This population of students primarily been reached through formal and informal information literacy opportunities offered by librarians. The library does make an effort to ensure that its students are familiar with information literacy. The utilisation of databases, various search tactics, general library use, and online catalogues are frequently the focal points of training. The idea reflects the required abilities, but they also constitute the central focus of learning programs. The majority of instruction is skills-based, which inculcates the high demand for information technology. The underlying ideas presented in the framework for information literacy in higher

education have not been implemented as of yet. Although some students have reported topics such as usage of prominent databases, open access publishing, images, fair use, citation metrics, and bibliography, the concepts have defined using various sources.

6. OPPORTUNITIES AND STRATEGY FOR IMPROVEMENT

The evaluation of students' learning and the effectiveness of instruction done by the librarian using a wide range of strategies. However, the primary data sources for the measurement and evaluation depend primarily on students' reviews and user feedback to measure student's learning and on evaluations for feedback when determining the quality of the instruction. According to this study, academic librarians continue to have difficulty evaluating the quality of education and programs. To overcome these problems of improper implementation of an information and research literacy program in higher education, the following steps could be taken

7. CONCLUSION

Information literacy considered as a key component of high practice in academic institutions, universities, and research organisations and librarians are the principal instructors to provide information literacy. Libraries offer tutorials and other self-paced instruction materials in classrooms as well as on their websites to make information literacy instruction more accessible to students and allow them to access these tutorials in a flexible and convenient way. The variety of tutorials available likely covers a wide range of topics, and the

Upgradation of information literacy modules	• Clearly define the goals and objectives of the IL program, and align them with the overall mission of the institution. • Engage all stakeholders, including students, faculty, and librarians, in the development and implementation of the program to ensure its success. • Provide adequate resources and support for the program, including funding, staffing, technology, and training. • Develop a comprehensive and integrated curriculum that incorporates IL skills into courses across all disciplines.
Skilled librarian/instructor required to deliver information literacy sessions	• The implementation of an IL program requires a skilled and knowledgeable team, including librarians, instructional designers, and technology specialists. • The information literacy program's frequent scheduling of sessions across the cources and implement the standard modulesof Information Literacy. • Formal training needed to academia and skilled library professionalrequired to conduct the training and orientation sessions. • Effective planning and strategy required to balance between instruction and other library responsibilities. • Proper scheduling and managing conflicts with other classes or obligations
Smooth implementation of information literacy instruction	• Proper orientation and hands on training provides to use library resources or accessing information re- sources. • Institutions can offer flexible scheduling and instructional materials that can be easily integrated into existing coursework • Institutions can create a cross-functional team and take student wish to develop and implement information literacy programs. • Institutions can allocate a portion of their budgets specifically for information literacy initiatives. • Sufficient funding is necessary to support the development and implementation of the IL program, as well as the ongoing maintenance and improvement of the program.

Allocation of funds and infrastructure support	• Adequate technology, including hardware and software, is necessary to support the delivery of IL programs and to ensure that students have access to the information they need.
	• A dedicated and well-equipped space, such as a library or learning commons, needed to provide students with access to information and technology resources.
	• Institutions can provide professional development opportunities for faculty to help them understand the importance of information literacy and incorporate it into theircourses.
	• The IL program team should receive ongoing professional development to stay current with developments in the field of information literacy.
Resistance to change and coordination	• Proper coordination between different departments, libraries, and other stakeholders required to implement effective of information literacy programs.
	• Assessment and evaluation needed to check the effectiveness of the IL program and to make ongoing improvements.
	• Collaborate with other institutions and organisations to share best practices and resources.

information literacy instruction provided by the library is an effective tool for helping students develop the skills they need to find, evaluate, and use information effectively. Studies have shown that library instruction can improve student's ability to locate and use information resources, as well as their understanding of the research process. However, there are also challenges to providing information literacy instruction, such as limited resources and a lack of student engagement. To address these challenges, librarians and educators may need to explore new and innovative ways of delivering instruction, such as online tutorials and interactive workshops. Additionally, more research needed to better understanding the factors that influence student attendance and engagement in information literacy instruction, and to develop effective strategies for addressing these issues.

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She reviewed, edited, and gave an overview and constructive ideas of this research.

Appendix: I

Chi-Sq result on the coverage of the topics in research and information literacy tutorials

Variable	Gender		N^2 Value	df	p-value
	Male	Female			
Searching for information					
Yes	92	81	0.4905	1	0.06509
No	12	8			
Databases search					
Yes	87	75	0.2598	1	0.00312
No	17	14			
Search strategies: Facets/limiters					
Yes	99	83	0.4858	1	0.00090
No	5	6			
Locating the resources/access (reading call, physical layout, availability, ILL, etc.)					
Yes	98	81	0.6819	1	0.00324
No	6	8			
Catalog search/discovery					
Yes	79	66	0.8277	1	0.00166
No	25	23			
Search strategies: Keyword/subject					
Yes	67	59	0.5996	1	0.00382
No	37	30			
Evaluation of information					
Yes	57	49	0.9742	1	0.00281
No	47	40			
Citing sources					
Yes	51	46	0.6601	1	0.0008
No	53	43			
Search strategies: Boolean					
Yes	49	45	0.7651	1	0.00151
No	55	44			

Scholarly v. popular resources

Yes	42	41	0.3579	1	0.00874
No	62	48			

Authority

Yes	69	63	0.7139	1	0.00069
No	35	26			

Search strategies: Phrases

Yes	47	41	0.4818	1	0.00053
No	58	48			

Use of citation tools

Yes	39	43	0.5169	1	0.0000
No	65	46			

Orientation/ assistance

Yes	93	76	0.4856	1	0.0026
No	11	13			

Gathering background context

Yes	68	49	0.9152	1	0.07408
No	36	40			

Search strategies: Truncation

Yes	39	51	0.2758	1	0.00074
No	65	38			

Finding peer review

Yes	59	55	0.7684	1	0.00092
No	45	34			

Searching the Web

Yes	65	56	0.3589	1	0.08430
No	39	33			

Awareness of plagiarism

Yes	63	47	0.8562	1	0.0860
No	41	42			

Defining a research topic

Yes	39	37	0.2809	1	0.00097
No	69	52			

Reading citations

Yes	59	44			
No	45	47	0.4981	1	0.0614

Choosing databases

Yes	39	26			
No	65	63	0.6271	1	0.09171

Distinguishing primary/secondary sources

Yes	68	48			
No	36	42	0.0386	1	0.08873

Understanding copyright bias

Yes	74	59			
No	30	30	0.0125	1	0.0043

Developing research questions

Yes	76	59			
No	28	31	0.9571	1	0.0021

Fair use policy

Yes	59	58			
No	45	31	0.9304	1	0.0023

CRAAP Test

Yes	85	68			
No	19	21	0.4349	1	0.0000

Understanding peer review

Yes	34	38			
No	70	50	0.9277	1	0.0022

Information life cycle

Yes	85	76			
No	19	13	0.0856	1	0.0003

Creative commons

Yes	74	43			
No	30	46	0.8188	1	0.00401

Fake news/ misinformation

Yes	86	82			
No	18	7	0.9691	1	0.0611

Using archives and findings aids

Yes	71	59	0.2637	1	0.0030
No	33	30			

Search strategies: Proximity

Yes	67	62	0.0468	1	0.00030
No	37	27			

Enabling OpenAthens-Single Sign-On (SSO) Remote Access Authentication to e-Resources: A Case Study

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A B S T R A C T

Accessing the library's subscribed electronic resources remotely by users has always been a challenge for the library. KMC Health Sciences Library, Manipal relied on proxy-based authentication to remotely cater its e-resources to library users. To enhance the secure usage of electronic resources and to provide user-friendly authentication, the library has considered a Single Sign-On (SSO) remote access through OpenAthens. The article demonstrates the setup process of OpenAthens and the various steps involved in the transformation of the library from proxy-based authentication. The single sign-on setup at the library has benefited users in having a single set of credentials to access all the library e-resources, reducing the hassle of remembering multiple login credentials. Features such as cloud hosting, granular usage reports, and the admin dashboard gave complete hold on the usage of library e-resources. Although OpenAthens has its merits, the setup process involved challenges in the integration of existing librarysubscribed e-resources. This article provides insight into the step-by-step process of enabling OpenAthens, addresses troubleshooters, and makes recommendations to libraries looking towards SSO remote access.

Keywords: Proxy; Electronic resources; Secure usage; KMC health sciences library; MAHE

Introduction

Academic libraries advocate for a well-equipped library and resources made available to their patrons around the clock. Print resources in academic libraries are only available to users during the library's operating hours. As a result, digital resources have become increasingly important in academic libraries. Digital resources are explained in simple terms as an acquisition of knowledge to promote learning and enhance the quality of life by relying on digitally convenient books, journals, magazines, newspapers, and other materials using information communication technology tools1. Digital resources have revolutionised the traditional library system; the speedy nature and the comprehensive access to the updated information in a global manner caught the interest of patrons. Digital resources give a greater emphasis on access and not on collection6.

1.1 Remote Access Service

A library provides a variety of services to the endusers, and a remote access service is one such servicethat allows patrons to retrieve library materials away from the library premises. A remote access service is a process of connecting remote users to the library subscribed resources mediated through an

application or VPN (a virtual private network). Authentication in the library helps maintain and manage information for customers managing the information to customers by providing services such as uninterrupted access without compromising security, standards, and privacy4. Patrons can access library-subscribed electronic resources using a local area network on a computer steadily within the campus. However, providing remote access to distant users who reside away from the campus to access library's subscribed content is restricted due to copyright issues and vendor agreements.

1.2 Authentication Methods

1.2.1 Proxy Authentication

Proxy-based authentication mechanisms are widely used in libraries nowadays because of their ease of adoption. The proxy systems are cost-effective and help libraries secure their subscribed content5. Proxy-based authentication system uses a computer/ application as a gateway between the client and server. When a client sends a request for information, the proxy application detects the client's identity, acts as a gateway, and processes the request7. (Iles, 2015). Examples include EZ Proxy, WAM Proxy, Oracle Proxy.

1.2.2 Non-Proxy Authentication

There are many non-proxy authentication systems, which can be either single-factor or multifactor systems, such as a biometric system or login through Facebook. A popular non-proxy authentication system that has been widely discussed around the world in recent years, is single sign-on access.10 Single sign-on access is a valueadded service provided by the libraries to allow end-users to get their hands-on library electronic resources, which are licensed and subscribed content using a single set of credentials. Examples include OpenAthens, FusionAuth, Duo Security, Jump Cloud.

2. LITERATURE REVIEW

Inman and Tatterson8 opined that Open Athens authentication allowed remote access to library resources and its introduction increased the number of users, and the article found that most users happened to be graduates. Li,11 et al. pointed out that Open Athens offered userfriendly access to the off-campus users. Open Athens provided benefits such as searching through the library we bsites, continuous access, and single institutional login credentials to access library subscribed resources securely. Ruenz17 compared the user experience of using EZ Proxy and Open Athens and found that Open Athens provided a superior online experience. The article concluded that Open Athens maintenance is easier compared to EZ Proxy. Romano15 and Jayakanth,9 et al. explained that the Open Athens system provided benefits like single sign-on, customisation, and detailed reports of usage. The author also emphasised that Open Athens mitigated user privacy issues faced while using EZ Proxy and provided secure authentication, seamless user experience, and complete
control by providing accurate statistics of remote users.

Rosenfeld J. & Enoch T.16 elaborated on managing the EZ Proxy server. The article was based on a discussion done in the workshop about the service's ins and outs. Here, detailed data on the usage of the EZ Proxy server was given, and methods that can be used to bridge the gap between the patrons and the accessibility of this service and to identify the concerns regarding the security of the system. Colquitt3 depicted that diverse resources are required to provide information for various subject field users and information services to access international journals are dispensed through EZ Proxy. The study discussed the problems associated with accessing international journals and how a single sign-on system provided seamless access to remote users. Nurse13 et. al. and Clamon T.2 analysed library resource data

of EZ Proxy and Open Athens systems to find the extent of use of online library resources by distance learners. In his conclusion, the author highlighted that Open Athens reduced thechallenges faced by university libraries in understanding the shift from print to digital resources and competed with standard digital libraries of the world. Radha & Reddy14 stated that the technologies are based on a single sign-on approach. With the help of the single sign-on method, the user can get permission only once for all the software available on the applications and the user needs to log in only once for all the sessions and not multiple times. The author concluded that there is an increase in productivity as mobility increases. Mikesell12 examined the experiences of libraries in implementing a proxy-based authentication system. The article brings up various problems involved in implementation and solutions to the issues that the colleges have undertaken during the process of implementation.

3. BACKGROUND OF THE STUDY

Remote access to library subscribed resources was introduced in KMC Health Sciences Library, Manipal Academy of Higher Education (MAHE), Manipal, way back in 2013. Library resource access service provision away from college premises i.e., Off-campus remote access was enabled through EZProxy authentication. EZProxy allows patrons to access library subscribed resources securely. It is a web proxy server used by libraries to give access to users residing away from the campus using an IP address of their personal computers to authenticate the restricted access of the library content. EZProxy is a URL rewriting program; it works by altering the URLs within the web pages provided by the vendors of the subscribed resources.19

The proxy-based solutions have some limitations, such as:
- Only the "organisation" is recognised
- All users are anonymous members of the organisation
- No categorisation of users is possible
- No granularity of statistics
- Users must register for personalisation, e.g., saved searches
- No accountability if users breach the license agreement To overcome the limitations of EZProxy the library is now looking to upgrade to enhance the quality of the remote access service provided to the users.

4. PROBLEM STATEMENT

The KMC Health Sciences Library has considered implementing Open Athens SSO based remote access to library subscribed content securely to authentic patrons. The enabling process is complex and novel to the librarians as academic libraries are still on the verge of developing. The study elaborates the enabling process and challenges encountered during the implementation and paves a way to easy understanding to those librarians looking to facilitate SSO through Open Athens in their respective libraries. The present study is entitled "Enabling Open Athens
Single Sign-On (SSO) Remote Access Authentication to e-Resources: A Case Study".

5. OBJECTIVES

To explain the rationale for choosing SSO over proxy authentication in KMC Health Sciences Library, MAHE, Manipal.
- To describe the migration process from proxy authentication to SSO, specifically via OpenAthens.
- To analyse the challenges encountered during and after the implementation of SSO via Open Athens.
- To discuss the benefits of Open Athens after the implementation of SSO.

6. METHODOLOGY

The methodology involved conducting a literature search on institutions that have implemented Open Athens, to identify best practices and potential challenges. In addition, the KMC Health Sciences Library's librarian was consulted to gather information on the library's collection and the reasons behind the decision to upgrade from the existing proxy authentication system. Finally, input from experts was sought to evaluate the suitability of Open Athens for the library's collection and services.

7. DISCUSSION

The technological advancements in the library have changed drastically to provide better services. This section elaborates in detail on the setup process of Open Athens and highlights various challenges and benefits encountered in the process.

7.1 SSO Vs. Proxy

The proxy authentication implementation process was complicated, especially integrating the electronic resources for patrons' access and the librarian had no control over the unauthentic usage. It is imperative to know the added advantages of SSO over Proxy. The differences gave a clear idea of why SSO has been the chosen one (Se well, 2008)18. Table 1 depicts the merits of SSO compared to Proxy-based authentication available in the market.

7.2 Why Choose Open Athens

The leading SSO access authentications in the market are Open Athens and Shibboleth. Shibboleth is an open source software package system for federated identity management in libraries. Even though both are SSO authentication systems, Open Athens has marginal advantages over Shibboleth in adoption in the KMC Health Sciences Library. Table 2 elaborates on the reasons for choosing Open Athens over Shibboleth.

7.3 Open Athens

Open Athens is provided by JISC, a non-profit British information technology company, and is a popular identity and resource access management service used in libraries. It offers a single sign-on service, enabling end-users to log in just once with a single set of credentials to access all the library subscribed electronic resources. Open Athens is a value-added service that reduces the hassle of logging in multiple times on different databases and allows remote access.

Table 1. Comparison of features between SSO and Proxy

Features	SSO	Proxy Authentication
Single Sign-on Access	✅	❌
SSO with federated resources	✅	❌
Creating user groups	✅	❌
Admin dashboard	✅	❌
Two-factor authentication	✅	✅
Personalization	✅	❌
User Management	✅	❌
Cloud hosting	✅	❌
IP Recognition	❌	✅

	OpenAthens	Shibboleth
Permission sets	✓	✗
SAML integration	✓	✗
Resource link generator	✓	✗
Statistics by individual user	✓	✗
Statistics by user groups	✓	✗
Statistics of resource usage	✓	✗
Statistics reporting	✓	✓
Global standards	✓	✗
User friendly	✓	✓
Setup process	simple	IT help required
Maintenance	Lifetime	One time
Updates	Continuous	Manually updated

Table 2. Comparison of features between Open Athens and Shibboleth

Features	OpenAthens	Shibboleth
Single Sign-on Access	✓	✓
Support	✓	✗
Statistics of the individual user	✓	✗
Statistics of resource	✓	✓
Cloud hosting	✓	✗
Admin dashboard	✓	✗
Maintenance	✓	✗
Global standards	✓	✓
Interoperability	✓	✓
User friendly	✓	✗

8. OPEN ATHENS SETUP

The Open Athens setup process was initiated with suggestions from the experts, checking out the reviews, and considering the merits of Open Athens. The library has decided to contact the Open Athens team to conduct a meeting to discuss setup requirements.

8.1 Account Creation

The setup process of Open Athens began with creating an account; there is a provision to register using the existing institutional directory or create a new account. KMC Health Sciences Library uses Azure active directory as an identity provider and this active directory is used to integrate with Open Athens.

8.2 Azure Integration/ User Integration with Open Athens

Open Athens account creation was completed, and the integration of the Azure directory was next in line. Integration of the directory was no easy task and it required technical support help for configuring. Following are the steps in configuring the Azure directory to Open Athens:
- The configuration process began with access to the Azure portal and OpenAthens admin interface, and access to the domain was kept ready.

- To add the new application in Open Athens, the active directory was clicked, and enterprise applications were chosen, followed by all applications.
- Metadata as an XML link from the certificate section from Azure is saved.
- Users and groups are created to set up authorised members that can access Open Athens.
- Open Athens settings are configured by logging in to the admin domain.
- To manage the connections, a saved azure XML metadata link is added as a SAML connector.
- Display the name for the mapping field entered using UPN (user principal name), which is Azure's standard value.
- A unique subject name ID is set to generate the link.
-The link from the relying party tab is copied and saved to finish the final steps of setup.
- To complete the azure integration, the single sign-on mode is selected and the link from the party tab is added and saved.

8.3 Creating User Attributes
User attributes refer to the library user groups. The technical department of the library does attribute mapping; in the KMC Health Science Library, there are mainly two attributes created that are custom-made.
- Faculty attribute
- Student attribute
The permission sets of the users and their identities are added in bulk copying from spreadsheets of the active directories and there is also provision for individual add-ons by the librarian.

8.4 Resource and Tool Integration
The names of databases and the links, content providers of journals/books, and their emails are provided. The e-resource providers are contacted by Open Athens to make it part of the access via Open Athens.

8.5 Re-Director Links
Re-director links enable users to access resources directly on the landing page once they have signed in. In cases where resources are not compatible with Open Athens, the links are integrated with an IP redirector bypass. Open Athens provides a link generator for redirector links, which enables librarians to maintain a single set of links for both remote and on-site access. This is done by encoding a specified target URL and adding it to the domain address.

8.6 Trial Access
The trial was provided to the library for three weeks; during this period, the library was allowed to check for functionality and smoothness of the workflow. Trial access included an admin and limited users to monitor the ease of accessing the library subscribed content remotely.

8.7 Live Setup
The integration of users and subscribed resources was completed during the trial period and the live setup was made available to the registered users on 1 October 2021. The users are informed about the OpenAthens setup in the library. The users were sent a personal mail explaining how to access e-resources using Single signon via OpenAthens, a step-by-step manual is provided along with the link to access OpenAthens. For additional assistance, contact details were provided in the manual.
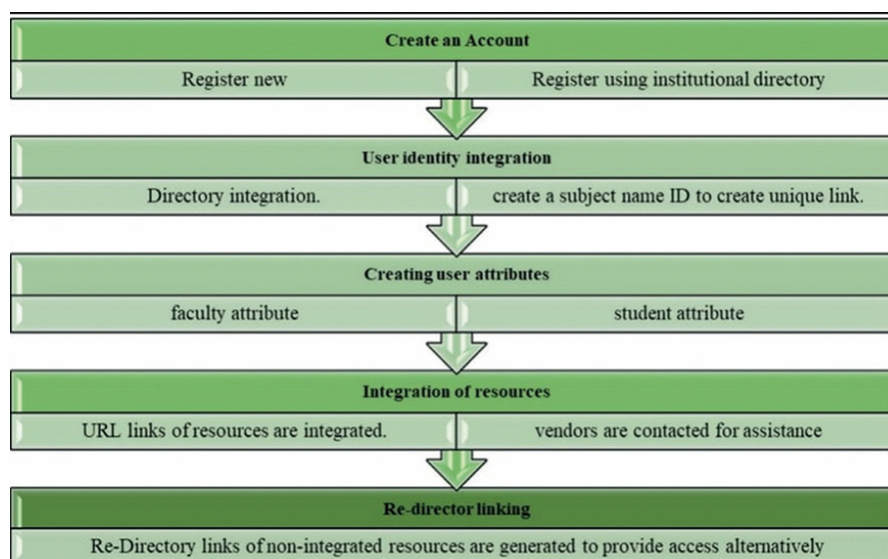
Figure 1. Re-director link generator.

Figure 2. Steps involved in OpenAthens setup.

9. CHALLENGES

Implementation of Open Athens in the library involved various challenges during the implementation and postimplementation as well. The transformation from proxy to single sign-on required the collaboration of the institution's IT staff and technical support from the service provider.

9.1 Challenges during the Setup Process

- Generation of re-director links and adding resource URLs by proxy links was a complicated process and needed technical support to complete the process.

- Integrating bulk user identity using Azure active directory raised concerns about security issues which took weeks to resolve.

- A custom-made OpenAthens sign-in page had to be created for the recognition of the institution as drop-down information.

- Generation of re-director links to the resources that are not compatible with Open Athens needed technical

- Despite the migration to Open Athens, the proxy system is still in use as a backup mechanism.

9.2 Challenges after the Setup

- Updating the users about the migration to Open Athens and educating them about the transformation was a mammoth task for library staff.
- Inadequate staff training and insufficient time for the process of implementation and the complexity of the process of generating re-director links baffled the library staff.
- Integration of resources into Open Athens from the publisher's end created a barrier to information access to the users.
- No intimation has been provided for the resources access snapping out of Open Athens unless the user finds it and updates the library staff.
- Not all platforms support Open Athens. So, the library staff had to find alternatives to keep up with the workflow.

With all the challenges mentioned during the setup process and post-setup, Open Athens has been successfully enabled and provides a user-friendly experience.

10. POST-ENABLING BENEFITS

Open Athens was set up in the library aided in following additional benefits to overall service improvement.
- Single login credentials to all the library-licensed subscribed content made librarians' work easier.
- Admin has complete control over library resource management and user management without contacting IT support.
- Digital library resources are securely accessed by authentic users only.
- Detailed statistics of users reduced the hassle of unauthorised access.
- Granular usage statistics of resources helped the library in better purchase decisions.
- Cloud-based hosting saved space and eliminated complications associated with server maintenance.
- Personalisation of the admin page helped in creating user attributes.
- User-friendly interface where the user gets to search the required documents directly from search engines.
- Constant support from the Open Athens technical team helped maintain uninterrupted library workflow.

11. RECOMMENDATIONS

- Libraries looking to install the Open Athens system should create a checklist to ensure the setup process doesn't disrupt electronic resource access in the library.
- Check if the library needs an upgrade.
- Verify if there are enough resources to integrate with Open Athens.
- Inform the vendors and the publishers about the revamping process of the library authentication system and seek their support in integrating.
- Create user attributes and merge pre-existing user directories with Open Athens.
- Always have a backup mechanism to support the library during the enabling process.

12. CONCLUSION

Open Athens is a world standard remote access authentication system for academic libraries. Enabling Open Athens has improved service quality of remote access service in KMC Health Science Library and served patrons with secure usage of subscribed and licensed resources of the library appropriately.

Despite the challenges faced in enabling Open Athens, the setup has enabled the librarian to have complete control over the library electronic resources. The patrons now enjoy seamless access to all subscribed content without compromising their privacy with single login credentials. The findings of the study may motivate librarians who are looking to implement Open Athens for more secure usage of electronic resources in academic libraries.

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He has reviewed the manuscript in this study.

Mapping and Visualisation of Global Research Output on Military Stealth Technology

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A B S T R A C T

Military stealth technology is crucial in modern combat, allowing military vehicles to be more survivable and less detectable. The primary objective of this study is to map and visualise the global research output on military stealth technology in order to acquire insights into the research landscape, identify relevant trends, and facilitate informed decision-making. This study was mainly focused on the mapping and visualisation of global research output on military stealth technology. For conducting the study, data was collected from the Scopus database covering the period from 2001-2021. A total of 299 articles with 1764 citations were found during the search. The majority of papers (74.25 %) were published in a multi-authored mode. The overall collaborative index was 2.84. Professors Zhang X and Zhang Y of China were named top contributors, each with seven papers and 139 and 121 citations, respectively. China leads the list of contributing countries, with 108 papers and 731 citations, followed by the United States (51), India (19), the United Kingdom (12), and South Korea (7). As per keyword analysis, "military applications," "radar," and "military vehicles" were the biggest hotspots. The findings revealed that Asian countries are increasingly dominating their western counterparts in global research publications on stealth technology. This scientometric analysis contributes to a better understanding of how countries are implementing new technologies for military assets. Furthermore, it may assist scientists in identifying core areas of interest and future research directions in the field, as well as library professionals in selecting appropriate resources.

Keywords: Military stealth technology; Research output; Scientometrics study; Visualisation; Collaborative coefficient; Mapping; Collaboration; Innovation; Decision support

Introduction

Stealth technology has transformed modern combat, allowing military aircraft, ships, and ground units to operate with reduced detectability and enhanced survivability. The global pursuit of breakthroughs in military stealth technology has resulted in a broad and diversified body of research done by scientists, engineers, and defence organisations worldwide. Mapping and visualisation approaches have evolved as effective tools for gaining insights into this vast research environment and comprehending the global distribution of knowledge in this discipline. With the rapid development of radar technology in the 1930s

and 1940s, radar was widely used to detect, locate, track, warn, and destroy enemy combat assets such as aircraft, ships, and automobiles. Indeed, detection by enemy radar systems became a nation's military think tank's top priority. Complex and ever-changing international geopolitics require a nation's armed forces to be agile, well-prepared, and technologically updated so that the nation's sovereignty is never jeopardised. During a conflict, a country's plan is to decrease the loss of war assets by using advanced technology like stealth technology. This includes technology used on military aircraft, ships and missiles to make them more difficult to detect by radar, infrared, and other methods.[1] It is being viewed as the technology of future warfare. Efforts are on to incorporate stealth features in war fighting assets for a decisive advantage of one country over another.[2] Many countries are doing top-secret research on stealth technology, which is a big deal. Because of its significance, scientists are analysing published research on the topic from all over the world. This study assesses the quality of research in military stealth technology using various metrics, such as collaboration level (DC), collaboration coefficient(CC), and collaboration index (CI). The analysis includes aspects such as author collaboration, authorship patterns, and citation analysis.

2. REVIEW OF LITERATURE

The invention, improvements, applications, and difficulties of military stealth technology are frequently discussed in detail. The literature reviews must cover the following topics: historical evolution, stealth platforms, stealth technologies and methods, detection and defenses, and potential future uses. When researchers looked for information on "military stealth technology" as a general concept, they did not find much. However, when they searched for specific subtopics such as graphene, highentropy ceramics, nanoparticles, military operations, and robotics, they found a few studies using bibliometrics. Rajgoli and Laxminarsaiah[3] conducted a study on spacecraft technology from 2001-2011. Collaborative research was found in 18.15 % of articles with an average correlation coefficient of 0.87. It is believed that many authors depend on factors such as the nature of the research, financial support, the topic under investigation, and the lack of communication between researchers. Aydogdu[4] et al. carried out a bibliometric analysis of nanotechnology and its use in the Turkish defense industry. They found that the most promising applications were stealth materials, protective clothing, military force management, nanoweapons, sensor networks, efficiency, and friend or foe recognition.

Peng[5] et al. in their bibliometric analysis of graphene research papers from 1991 to 2010. They found that research in this area has grown significantly in the past five years, with the United States, China and Japan being the top countries. Collaboration is common, with two to five authors per paper. In recent years, research on high-entropy ceramics has received much attention due to their excellent environmental stability and energy conservation. A bibliometric analysis of 3177 articles covering a period between 2000-2020 by Hu[6] et al. found that China leads energy ceramics research followed by the United States and India.

Xi'an Jiaotong University has extensive publications and a high h-index, and J.W. Zhai is a well-known author. The most popular journals in this field are "Journal Ceramics International, Journal of Materials Science-Materials in Electronics and Journal of Alloys and Composites". Saritas and Burmaoglu[7] analysed how energy is used in military operations and made recommendations for future military research and development. It has been discovered that drones and robots can use cognitive and communication tools to outperform humans in certain tasks.

Gupta & Dhawan8 analysed Indian publications in robotics research from 2007-2016 using bibliometric indicators. They found that the quality of research was insufficient and advised the Indian government and industry to focus on increasing research and partnering with foreign companies and start-ups to help develop the robotics research industry in India.

3. STATEMENT OF THE PROBLEM

Military stealth technology has seen tremendous research and development activities around the world, resulting in a huge and diversified body of knowledge. There is, nevertheless, a need to gather insights into the global distribution of research output and to identify major trends and knowledge clusters within this sector. The issue addressed in this paper is the lack of a complete awareness of the global research landscape on military stealth technology, as well as the lack of adequate methods to visualise and analyse this vast body of knowledge

4. SCOPE OF THE STUDY

Mapping and visualisation of worldwide research output on military stealth technology cover a number of critical aspects linked to research output and visualisation in the field of military stealth technology. The study focuses on research output, mapping and visualisation, data analysis, geographical distribution, cooperation and knowledge networks, impact and influence, decision support and strategic insights, and so on.

5. OBJECTIVES OF THE STUDY

The main objectives of this study are to:
- Analyse the global research trends on military stealth technology;
- Find the authorship pattern and the nature of collaboration;
- Identify the most prolific authors and productive countries;
- Determine the most preferred source of publication and highly cited publications;
- Examine the keyword co-occurrence network.

6. METHODOLOGY

The Scopus database was used to obtain data for thisstudy.9 Scopus, an international multidisciplinary bibliographic database, was the target database for the search for relevant datasets.

6.1 Data Collection

The keywords used are "military stealth technology" for the years 2001 to 2021. On January 4, 2022, a search was conducted using the string "TITLE-ABS-KEY (military AND stealth AND technology) AND (LIMITTO (PUBYEAR, 2021) OR LIMIT-TO (PUBYEAR, 2001)) AND (LIMIT-TO (PUBSTAGE, "final"))", which resulted in the retrieval of 299 bibliographic records. These records were downloaded as a .csv file.

6.2 Data Analysis

The downloaded data were used with the following scientometric indicators to understand and quantify the dynamics of the collaborative nature of research in military stealth technology:
The CI is applied to calculate the average number of authors per publication and is calculated as formula suggested by Lawani10:

$$CI = \frac{\sum_{j=1}^{k} j f_j}{N}$$

where CI = Collaboration index, j = Authorship, fj= Number of j - authored research papers, N= the total Number of research papers, K = the most significant Number of authors per paper. Although simple to compute, it is difficult to understand as a degree because it has no upper limit. Further, it assigns single-authored publications with no collaboration a non-zero weight.

Degree of Collaboration (DC):

The DC metric measures the ratio of collaborative scientific articles within a specific field over the total number of scientific articles published within the same period. The formula suggested by Subramanyam11 was used in this analysis:

$$DC = \frac{Nm}{Nm + Ns}$$

where DC = Degree of collaboration, Nm = number of multi-authored papers, and Ns = Number of single papers.

Collaboration Coefficient (CC):

The CC is the ratio between the average number of authors in a publication and the proportion of articles with multiple authors. The following formulae as proposed by Ajiferuke, Burell & Tague12 was used here:

$$CC = 1 - \frac{\sum_{j=1}^{k} \left(\frac{1}{j}\right) f_j}{N}$$

where, CC = Collaboration coefficient, j = Authorship, f_j = Number of j - authored research papers, N = the total number of research papers; K = the most significant number of authors per paper. The collaboration coefficient ranges from 0 to 1, with 0 indicating single-authored papers.

6.3 Software Used for Visualisation of Results

To visually explore research trends in military stealth technology, the study utilised VOSviewer version 1.6.16, a data visualisation tool developed by (Nees Jan van Eck and Ludo Waltman). In addition, the study employed Biblioshiny, a web app included in an open-source tool called bibliometrix, created by Massimo Aria from the University of Naples Federico, for quantitative research in scientometrics.

7. RESULTS

7.1 Publication Trends in Global Research on Military Stealth Technology

Figure 1 illustrates the development of research in military stealth technology over the course of 21 years. The figure indicates that the field was in its early stages prior to 2004, with an annual publication rate of less than 5 papers per year. However, in 2004, the number of published papers experienced a significant increase, with 22 articles, which is five times more than in 2003. The rapid development of radar-related techniques led to the urgent need for stealth technology to reduce the radar echo of objects and enhance the survivability of military assets on the battlefield.13,14 The literature on military stealth technology published after 2004 does not show a steady increase, although it reached 25 in 2019 and 34 in 2020. The figure also indicates that the expanding curve shows no sign of saturation.
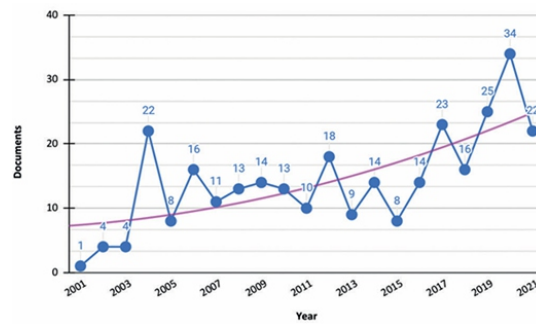
Figure 1. Growth of military stealth technology research.

7.2 Authorship Pattern and Collaborative Measures

According to Table 1, the majority (74.25 %) of publications in military stealth technology were produced through collaborative efforts, demonstrating a preference for working together rather than independently. Additionally, the study period saw a rise in DC (from 0.00 in 2001 to 1.00 in 2021), CI (from 1 in 2001 to 4.55 in 2021), and CC (from 0.00 in 2001 to 0.77 in 2021), indicating a trend towards collaborative research over time. The average CI of 2.84 during the study period indicates a good collaboration rate among authors. However, if the collection consists solely of single-authored publications, CI, DC, and CC are all equal to zero.

7.3 Top 10 Most Prolific Authors

During the period from 2001 to 2021, 785 authors were identified as contributors to research on military stealth technology. However, only 32 of these authors had published at least 3 articles on the topic. Table 2 presents a list of the most productive and prolific authors in this field. Notably, Professor Xuetong Zhang, affiliated with the Suzhou Institute of Nano-tech and Nano-bionics, Chinese Academy of Sciences (CAS), Suzhou, China, was found to have the highest research output, having authored 7 papers and amassed a total of 139 citations. He is followed by Yi Zhang, affiliated with AB Life Bio Big Data Institute, Wuhan, China, with 7 research papers and 121 citations, and then L Yang, affiliated with the Naval University of Engineering, Wuhan, China, with 6 papers and 26 citations. The first three leading authors are from China, indicating the country's military stealth technology research dominance.

Table 1. Authorship pattern and measures of research collaboration

Year	Authorship pattern					TP	CI	DC	CC
	Single author	Two authors	Three authors	Four authors	Five and above				
2001	1	0	0	0	0	1	1.00	0.00	0.00
2002	1	1	1	0	1	4	2.75	0.75	0.49
2003	2	1	0	1	0	4	2.00	0.50	0.31
2004	7	5	4	1	5	22	2.64	0.68	0.45
2005	4	0	1	0	3	8	2.75	0.50	0.38
2006	12	0	1	1	2	16	1.81	0.25	0.19
2007	3	2	2	2	2	11	2.82	0.72	0.49
2008	5	3	4	1	0	13	2.08	0.62	0.38
2009	3	3	1	3	4	14	3.14	0.79	0.54
2010	6	4	2	1	0	13	1.85	0.54	0.31
2011	4	3	1	1	1	10	2.20	0.60	0.37
2012	5	3	7	1	2	18	2.56	0.72	0.47

2013	2	1	0	5	1	9	3.22	0.78	0.56
2014	4	2	3	3	2	14	2.79	0.71	0.48
2015	1	0	2	1	4	8	3.86	0.89	0.66
2016	2	1	3	4	4	14	3.50	0.86	0.62
2017	8	3	2	5	5	23	2.83	0.65	0.46
2018	3	1	2	2	8	16	3.69	0.81	0.61
2019	3	2	6	6	8	25	3.56	0.88	0.64
2020	1	5	4	6	18	34	4.03	0.97	0.71
2021	0	0	3	4	15	22	4.55	1.00	0.77
Total	77	40	49	48	85	299	59.62	14.21	9.92

[Note* TP=Total Papers, CI=Collaborative Index, DC=Degree of Collaboration, CC=Collaborative Coefficient]

Table 2. Top 10 most prolific authors

Author	Affiliation	Papers	Citations	% of 299	Citations per paper
Zhang, X.	Suzhou Institute of Nano-tech and Nano-bionics, Suzhou, China	7	139	2.34%	19.86
Zhang, Y.	ABLifeBioBigData Institute, Wuhan, China	7	121	2.34%	17.29
Yang, L.	Naval University of Engineering, Wuhan, China	6	26	2.01%	4.33
Wang, X.	State Key Laboratory of Organic–Inorganic Composites, China	6	9	2.01%	1.5
Li, Y.	Xi'AnJiaotong University, Xi'an, China	6	9	2.01%	1.5
Tripak, J. A.	All Saints Academy, Columbus, United States	6	0	2.01%	0
Zhang, Z.	Nankai University, Tianjin, China	5	62	1.67%	12.4
Wang, J.	Wuhan University of Technology, Wuhan, China	5	39	1.67%	7.8
Liu, X.	Zhengzhou University, Zhengzhou, China	5	12	1.67%	2.4
Zhang, J.	Lanzhou University, Lanzhou, China	5	11	1.67%	2.2

**Note: Source data (https://www.scopus.com)

7.4 Co-authorship Network Analysis

Scientific collaboration often involves co-authorship, which is a highly visible and extensively studied form of collaboration within the scientific community.15 Utilising co-authorship network analysis can help identify an author's average publication and active years related to a particular subject of study.16 Figure 2 shows a co-authorship network of authors and co-authors using VOSviewer. The nodes' sizes in a network diagram are indicative of their relative frequency, whereas the links' widths denote the intensity of the connection between authors. In other words, the bigger the node, the more frequently it appears in the network, and the wider the link, the stronger the association between the authors. Yellow nodes represent authors who are actively researching military stealth technology, including Chen, J., Li, G., Li, Z., and Yang, Y. On the other hand, purple nodes represent authors, who are not currently publishing research on military stealth technology, such as Yuan, J.-T., Yang, L., Chen, X., and Lou, G. (51 & 341), India (19 & 219), and the United Kingdom (12 & 231). Chinese authors dominated stealth technology research with 36.12 % of the papers, and their contribution exceeded 48.64 % when considering only the top 10 countries. Figure 3 illustrates a map demonstrating country co-authorship, using a sample size of 299 papers. The map highlights three countries, namely, China, the United States of America, and India, which form the most prominent cluster in terms of co-authorship, comprising 59.53 % of all the publications analysed. In other words, these three countries are the most active

collaborators in terms of co-authorship, with a significant contribution to the total publications analysed. The lines connecting the spots on the map indicate the co-authorship between countries, and the distance between clusters shows the strength of co-authorship and their level of collaboration in military stealth technology research. This provides insight into international cooperation in the field. Military stealth technology research is among the most secretive state-funded research and closely guarded projects.
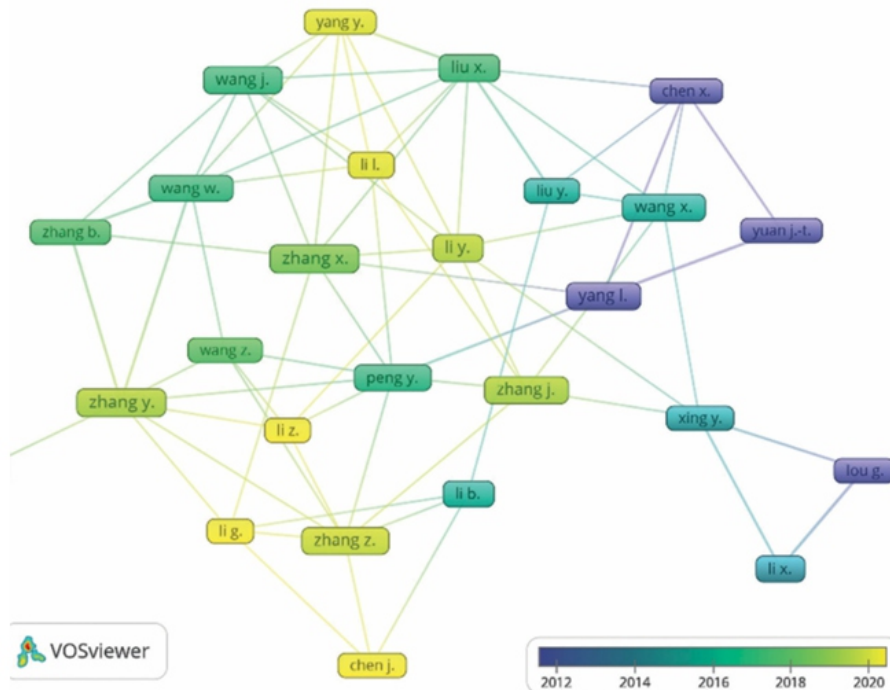

Figure 2. Co-authorship network of authors.

7.5 Geographical Distribution of Papers

Research in military stealth technology is global, with authors from 37 countries contributing to the 299 papers studied. Table 3 shows the 10 countries that have published the most papers in the field of research. The top 10 countries contributed 74.25 % of all papers, with China leading in both number of publications (108) and citations (731), followed by the United States Hence, most research results are likely to be classified in nature. This could explain the sparse distribution of co-authorship among authors from different countries.

7.6 Top 10 Highly Cited Publications

The citation of papers is an effective way to measure the impact of authors, journals, and papers. Table 4 presents the top 10 papers with the highest number of

Table 3. Top 10 countries with the most papers on military stealth technology research

Country	Papers	5 of 299	Citations
China	108	36.12%	731
United States	51	17.06%	341
India	19	6.35%	219

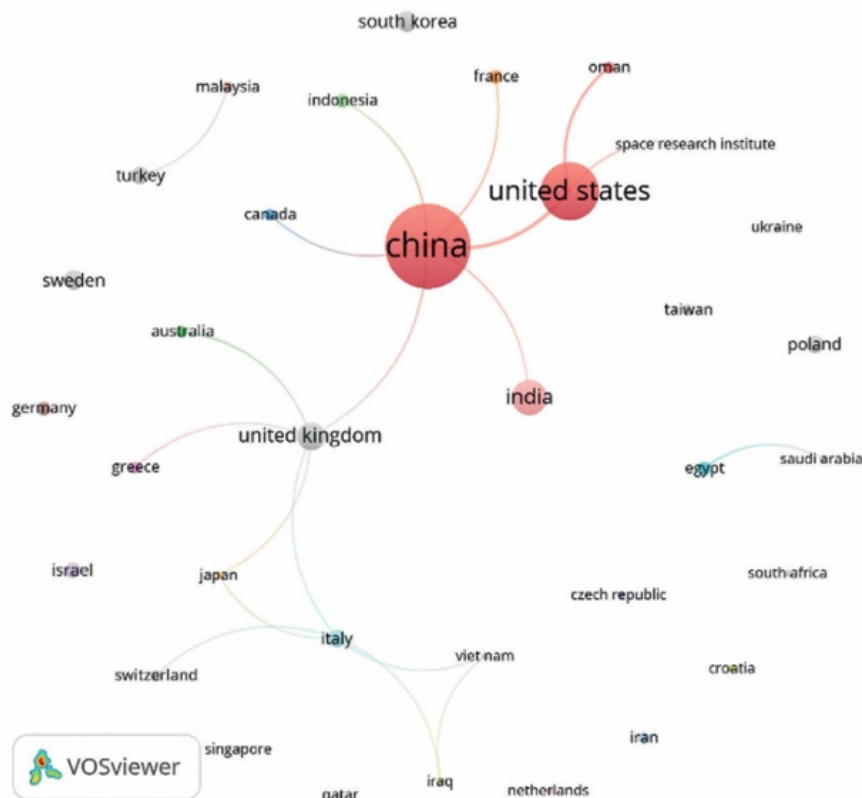| United Kingdom | 12 | 4.01% | 231 |
South Korea	7	2.34%	25
Sweden	6	2.01%	8
Poland	5	1.67%	105
Italy	5	1.67%	60
Turkey	5	1.67%	10
Israel	4	1.34%	24

Figure 3. Co-authorship by country.

citations in the field of military stealth technology. The paper titled "Nanofibrous Kevlar aerogel films and their phase-change composites for highly effective infrared stealth" has received the most citations, with a count of 121. In essence, the analysis of paper citations allows the determination of highly influential papers, and this table identifies the top 10 highly cited papers in the field of military stealth technology, with the mentioned paper receiving the highest number of citations. Researchers may include the most cited publications as references to address the knowledge gap and justify their research. This also gives a fair idea about the direction researches in the domain are heading towards.

7.7 Three-field Plot Analysis of Author, Country, and Affiliations

Figure 4 displays a three-field plot of the top 20 authors, countries, and affiliations in military stealth technology research from 2001-2021. The left, middle, and right fields represent authors, countries, and

affiliations respectively. It was observed that in a particular field, there were significant author contributions from China and the USA. Additionally, the statement identifies specific institutions, such as Nankai University, Zaozhuang University, Tianjin University's College of Precision Instrument and Opto-Electronics Engineering, the Naval University of Engineering at Beijing Institute of Technology, that made major contributions. In summa ment highlights the notable contributions of both countries and specific institutions in the field. In the figure, the size of the block represents the associational link between each element. In the left field, Zhang, X, Zhang, Y, Zhang, Z, Li, Y, and Zhang, J are all strongly associated with China. Nankai University and Zaozhuang University are strongly related to China, a highly associated country. The second-most affiliated country, the United States of America, had close ties to both the University of California and the United States Naval Academy.

7.8 Keyword Analysis
Keywords are words and phrases that capture an academic paper's essence and hint at closely related

Table 4. Top 10 highly cited publications

Title	Authors	Year	Source title	Citations
Nanofibrous kevlar aerogel films and their phase-change composites for highly efficient infrared stealth	Lyu J., Liu Z., Wu X., Li G., Fang D., Zhang X.	2019	ACS Nano	121
Integrated review of stealth technology and its role in airpower	Rao G.A., Mahulikar S.P.	2002	Aeronautical Journal	111
Multifunctional broadband microwave absorption of flexible graphene composites	Zhang K.-L., Zhang J.-Y., Hou Z.-L., Bi S., Zhao Q.-L.	2019	Carbon	105
Graphene-based Materials toward microwave and terahertz absorbing stealth technologies	Chen H., Ma W., Huang Z., Zhang Y., Huang Y., Chen Y.	2019	Advanced Optical Materials	95
New antistatic charge and electromagnetic shielding effectiveness from conductive epoxy resin/plasticised carbon black composites	Aal N.A., El-Tantawy F., Al-Hajry A., Bououdina M.	2008	Polymer Composites	70
From blackness to invisibility – carbon nanotubes role in the attenuation of and shielding from radio waves for stealth technology	Kolanowska A., Janas D., Herman A.P., Jędrysiak R.G., Giżewski T., Boncel S.	2018	Carbon	63
A survey of stealth malware attacks, mitigation measures, and steps toward autonomous open world solutions	Rudd E.M., Rozsa A., Günther M., Boult T.E.	2017	IEEE Communications Surveys and Tutorials	61
Polymer matrix composites as broadband radar absorbing structures for stealth aircrafts	Jayalakshmi C.G., Inamdar A., Anand A., Kandasubramanian B.	2019	Journal of Applied Polymer Science	51
Infrared invisibility stickers inspired by cephalopods	Phan L., Ordinario D.D., Karshalev E., Walkup Iv W.G., Shenk M.A., Gorodetsky A.A.	2015	Journal of Materials Chemistry C	46
Stealth technology for wind turbines	Pinto J., Matthews J.C.G., Sarno G.C.	2010	IET Radar, Sonar, and Navigation	43

**Note: Source data (https://www.scopus.com)

Figure 4. Three field plots for the top 20 most influential authors, countries, and affiliations.

topics, which serve as a literature summary and describe a study's focus area.17-18 3105 keywords were extracted from 299 papers. Figure 5 depicts a map that divides the keywords into six clusters namely Stealth technology (yellow cluster), military applications (dark blue cluster), military vehicles (red cluster), electromagnetic waves (purple cluster), microwaves (green cluster), and stealth (light blue cluster). 589 terms appeared twice, for a prevalence of 18.97 %. Another 98 keywords appeared more than five times, accounting for 3.11 %, whereas 28 keywords appeared more than 10 times, and only six keywords appeared more than 20 times, accounting for 0.19 %. The keywords "stealth technology", "military applications", "radar", "military vehicles", "electromagnetic

Figure 5. Keyword trends.

wave", and "meta materials" appeared more than 20 times. The keyword "stealth technology" occurs 130 times, making it the most frequently used word to represent the main subject content of the studied papers, followed by "military applications" (56 occurrences) and "radar" (32 occurrences). This map also shows that stealth technologies, military applications, and vehicles appear to be the most active research areas and hints at new research possibilities that may emerge soon.

7.9 Top Most Preferred Sources

A close scan of the bibliographic details of 299 research papers revealed the scattering of the military stealth technology-related literature across research articles (50.84 %), conference papers (29.77 %), reviews (13.04 %), short surveys (2.68 %), book chapters (1.67 %), boo dy has F-22 and F-35 stealth fighter jets, B-2 stealth bombers, and several stealth ships. The Advanced Medium Combat Aircraft (AMCA) programme is still in the detailed design stage and has a long way to go to catch up to the Chinese initiative, despite India trying to catch up by placing itself in third place after the USA in terms of the total number of papers (19) published. Turkey and Japan are other countries in this forum. In the world ofmilitary stealth technology research, secrecy and competition are the norm. This scientometric study reveals fascinating insights into authorship patterns and journal selection in this highly specialised field. It seems that researchers are moving away from general defense journals and opting for more specific subject-specific journals. Group research is dominating solo research, which may be due to the need for sophisticated laboratory setups that require significant funding and sponsorship. and as for collaborative authorship across

Table 5. Top most preferred sources

Name of the journal	Number of papers published			Total	Rank
	2001-2007	2008-2014	2015-2021		
Air Force Magazine	3	4	3	10	1
Aviation Week and Space Technology	4	6	0	10	1
Jane's Defence Weekly	7	1	0	8	2
Infrared and Laser Engineering	0	6	1	7	3
International Journal of Turbo and Jet Engines	0	3	3	6	4
Jane's International Defence Review	6	0	0	6	4
Carbon	0	0	4	4	5
Optical Technique	4	0	0	4	5
Acta Aeronautica Et AstronauticaSinica	0	2	2	4	5
Acta PhysicaSinica	0	1	3	4	5
Systems Engineering And Electronics	0	2	2	4	5

countries, it's rare to find, indicating the fiercely competitive nature of the research. After all, any significant breakthrough could mean a significant advantage in military applications.

8. DISCUSSION

This scientometric study highlights China's exceptional rise as a leading nation in military stealth technology research and application. The statistical analysis reveals China's significant investment of human capital and monetary power in this sector, resulting in a remarkable impact. Be it the highest number of citations accrued by an article (121), total research output in terms of published papers (108), total citations (731), or affiliations, the footprint of China is very much visible. The long and arduous

journey from a nation of opium eaters to a country of cutting-edge research on stealth technology is now challenging the hegemony of the USA in this domain. The result is the birth of the Chengdu J-20, Mighty Dragon, a twinjet all-weather stealth fighter aircraft for the Chinese Air Force and many stealth ships for the Chinese Navy. The USA already has F-22 and F-35 stealth fighter jets, B-2 stealth bombers, and several stealth ships. The Advanced Medium Combat Aircraft (AMCA) programme is still in the detailed design stage and has a long way to go to catch up to the Chinese initiative, despite India trying to catch up by placing itself in third place after the USA in terms of the total number of papers (19) published. Turkey and Japan are other countries in this forum. In the world of military stealth technology research, secrecy and competition are the norm. This scientometric study reveals fascinating insights into authorship patterns and journal selection in this highly specialised field. It seems that researchers are moving away from general defense journals and opting for more specific subject-specific journals. Group research is dominating solo research, which may be due to the need for sophisticated laboratory setups that require significant funding and sponsorship. and as for collaborative authorship across countries, it's rare to find, indicating the fiercely competitive nature of the research. After all, any significant breakthrough could mean a significant advantage in military applications.

9. CONCLUSION

The key findings of the study could have practical ramifications for military organisations, defense contractors, and governments. The study assists stakeholders in making informed decisions about financing, resource allocation, and strategic planning related to military stealth technology by identifying significant research centers, emerging trends, and potential gaps in knowledge. The competition among nations in military research is an ever-evolving phenomenon, and this stu dy serves as a testament to this fact. The results of this study may not be indicative of future trends, as countries can shift their focus towards research in a particular field. However, this work provides valuable insights for researchers who seek to publish their research in potential journals. Additionally, this study can aid countries in reviewing their position and performance in R&D on stealth technology, which could lead to fruitful collaborations across borders. As technology continues to advance, the need for military stealth technology will remain, and this study serves as a guide for countries to stay ahead of the curve.

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His contribution to the current study was: Data analysis and computational analysis through two major software (VOSviewer and Biblioshiny), and writing part of the article.

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1   Submitted articles should not have been previously published or be currently under consideration for publication elsewhere.

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3   All our articles are refereed through a double-blind process.

4   All authors must declare they have read and agreed to the content of the submitted article and must sign a declaration correspond to the originality of the article.

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The title should be informative. It is in both Journal's and author's best interest to use terms suitable. For indexing and word search. If there are no such terms in the title, the author is strongly advised to add a subtitle. The title should be given in English as well. The titles precede the abstract and the summary in an appropriate language.

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The article should be in English. The grammar and style of the article should be of good quality. The systematized text should be without abbreviations (except standard ones). All measurements must be in SI units. The sequence of formulae is denoted in Arabic numerals in parentheses on the right-hand side.

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The name and the number of the project or programmed within which the article was realized is given in a separate note at the bottom of the first page together with the name of the institution which financially supported the project or programmed.

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