

ADOPTION AND IMPACT OF CLOUD COMPUTING IN LIBRARIES: BENEFITS, CHALLENGES, AND FUTURE DIRECTIONS

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ABSTRACT

Cloud computing has significantly transformed how libraries manage resources, offering enhanced flexibility, cost-efficiency, and scalability. This study examines the adoption of cloud computing services in libraries, evaluating their benefits, challenges, and overall impact on library operations. A survey of 125 library professionals was conducted to assess familiarity with cloud computing models (IaaS, PaaS, SaaS) and deployment strategies (Public, Private, Hybrid). The research also explores the use of cloud-based tools in libraries, including email services, data collection tools, and collaboration platforms. The demographic data from the survey includes gender distribution, age groups, and educational qualifications, with most respondents holding M.L.I.Sc or Ph.D. degrees. The findings reveal a strong adoption of cloud services, especially for email, storage, and collaboration, with most respondents highlighting benefits like cost savings, scalability, and accessibility. However, challenges such as data security, vendor lock-in, and technical expertise barriers were also identified. The study concludes that while cloud computing offers substantial benefits, continuous training, support, and a thorough evaluation of security and vendor-related issues are essential. This research offers valuable insights into the current state of cloud computing adoption in libraries and suggests strategies for overcoming obstacles to successful implementation.

Keywords: Cloud Computing, Libraries, SaaS, IaaS, PaaS, Adoption, Data Security

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1. INTRODUCTION

Cloud computing has emerged as one of the most transformative technologies of the 21st century, revolutionizing the way information is managed, stored, and accessed across various businesses (**Sharma, A 2024**). In recent years, the library sector has increasingly turned to cloud-based solutions to enhance the efficiency of their services, streamline operations, and provide better access to resources (Salama, M., & Shawish, A. 2012). Libraries, traditionally dependent on physical infrastructure for managing collections and delivering services, are now leveraging cloud computing to overcome limitations related to storage, cost, scalability, and accessibility (Gnanaprakasam, D 2023). Cloud computing, which involves the delivery of computing services over the internet, offers libraries a range of benefits, such as cost reduction, flexibility, improved data security, and the ability to support a wide range of applications and tools (**Karthika, S Et al 2024**). Libraries are adopting cloud technologies like Software-as-a-Service (SaaS), Infrastructure-as-a-Service (IaaS), and Platform-as-a-Service (PaaS) to modernize their services, from managing digital collections and cataloguing systems to providing online resources and remote access to users Yuvaraj, M. (2015; 2016). However, the adoption of cloud computing in libraries is not without challenges. Issues related to data security, privacy, vendor lock-in, and the need for specialized skills to manage cloud systems remain significant barriers for many libraries (Sivankalai, S 2021). Despite these concerns, the widespread use of cloud computing continues to grow, and it is expected to play an even more prominent role in shaping the future of library services. This research aims to explore the adoption and impact of cloud computing in libraries, with a focus on the advantages, challenges, and overall implications for library management and services (Sivankalai, S 2021). Through this study, we seek to gain a deeper understanding of how libraries are leveraging cloud technologies and the ways in which these innovations are transforming the landscape of information management and access.

2. LITERATURE REVIEW: CLOUD COMPUTING ADOPTION IN LIBRARIES

Cloud computing has gained increasing prominence in the field of library and information science over the past decade. The adoption of cloud services by libraries has been motivated by several advantages such as cost-efficiency, scalability, and accessibility, enabling libraries to provide better services to their users. This literature review examines studies published articles that focus on the adoption, impact, challenges, and advantages of cloud computing in libraries. Several studies have explored the extent to which libraries have embraced cloud computing. According to Alharbi (2017), libraries worldwide have shown significant interest in adopting cloud-based services to improve library management and reduce infrastructure costs. Libraries have increasingly turned to Software-as-a-Service (SaaS) offerings for library management systems (LMS), replacing traditional on-premise systems (Ali, N., Naveed, M., & Khan, S. A. 2024). In a 2016 study, Shaw and De Sarkar (2021) cloud-based solutions like IaaS, PaaS, and SaaS are helping libraries to modernize their services, reducing operational costs and enabling more flexible service delivery. Similarly, Sanchati and Kulkarni (2011) showed that libraries are using cloud services for data storage and email management, leading to increased efficiency and user satisfaction (Karthika, S., Balachandran, S., & Sivankalai, S. 2023). The advantages of cloud computing in libraries have been well documented.

A study by Eneh Et al (2024) emphasized the significant cost savings achieved by libraries through the use of cloud-based applications such as Google Drive, Dropbox, and cloud-based email services. The scalability of cloud services, which allow libraries to expand or reduce their capacity based on demand, has been another frequently cited benefit (Sivankalai, 2021). Additionally, cloud computing provides a ubiquitous environment, allowing library staff and users to access resources from anywhere, which enhances the user experience (Scale, M. S. E. 2010). Assessing the impact of cloud computing and web collaboration on the work of distance library services. *Journal of Library Administration*, 50(7-8), 933-950. Moreover, cloud computing has facilitated the creation of paperless environments in libraries, reducing the need for physical infrastructure and improving sustainability (Sivankalai, S Et al 2021). This shift towards digital resources also supports multi-user access, enabling better collaboration among library users and staff (Diffin, J., Chirombo, F., & Nangle, D. 2010). While cloud computing offers several advantages, libraries face challenges in adopting these technologies. A significant concern is data security and privacy. Studies by Azem Qashou Et al (2025) highlighted that the risk of data breaches and loss of control over sensitive user data remains a barrier for many libraries considering cloud solutions. Furthermore, vendor lock-in is another concern. Libraries may become reliant on a single cloud service provider, limiting their flexibility and increasing the long-term costs associated with changing providers (Singh, S Et al 2016). Mabawonku Et al (2024) also found that technical issues, such as limited internet bandwidth and lack of technical expertise, hinder the full integration of cloud computing in libraries, especially in developing regions. Additionally, the initial cost of cloud adoption, including migration and training costs, can be a significant obstacle, particularly for smaller libraries with limited budgets (Díaz, M., Martín, C., & Rubio, B. 2016). The impact of cloud computing on library services has been largely positive, particularly in terms of improving operational efficiency. Libraries using cloud-based systems report better data management, faster processing of requests, and enhanced collaboration among staff members (Wang, D., Zhong, D., & Li, L. 2022). Cloud computing also allows libraries to offer enhanced remote access to resources, which is particularly important in the context of the COVID-19 pandemic, when many libraries transitioned to virtual services (Mavodza, J. (2013). Conversely, studies also suggest that not all libraries benefit equally from cloud computing. Larger libraries with more resources are more likely to adopt cloud services, while smaller libraries face barriers related to cost and technical expertise (Ali, O Et al 2021).

Recent trends suggest that the role of cloud computing in libraries will continue to expand. Advances in AI and machine learning integrated with cloud platforms are expected to revolutionize library services, including personalized user experiences and improved search capabilities (Odularu, O. I. 2025). Furthermore, hybrid cloud models, which combine private and public cloud services, are emerging as a popular option for libraries looking for greater control over their data while still leveraging the flexibility of the cloud (Mir, M. H., Thaliyan, D., & Senthilkumar, K. R. 2025). The adoption of cloud computing in libraries has proven to be beneficial in many ways, from reducing costs to improving accessibility and user engagement. However, challenges such as data security, vendor lock-in, and technical expertise remain barriers to full adoption. Continued research is necessary to address these concerns and explore emerging trends such as hybrid cloud models and AI integration. As cloud computing technology continues to evolve, it is expected that libraries will increasingly embrace these solutions to enhance service delivery and meet the changing needs of their users.

3. RESEARCH METHODOLOGY

The research methodology used in this study employs a quantitative approach to explore the adoption and impact of cloud computing in libraries. A structured questionnaire was designed to gather data on library professionals' familiarity with cloud computing services, usage patterns, and perceptions of its advantages and disadvantages. The questionnaire was distributed to a sample of 125 respondents, selected from various libraries. The questions were structured to assess both general awareness and practical usage of cloud services, such as IaaS, PaaS, and SaaS, as well as specific cloud-based tools used in libraries like Gmail and Google Drive. The data collected through the survey were entered into SPSS (Statistical Package for the Social Sciences) and Microsoft Excel for analysis. Descriptive statistics were used to calculate the mean and standard deviation for each variable, which helped identify the frequency and variability in the responses. Additionally, cross-tabulation techniques were used to examine potential relationships between library characteristics and cloud computing adoption. The research also explored perceptions of the advantages and disadvantages of cloud computing, using Likert-scale questions (e.g., "Agree," "No Idea," "Disagree") to measure respondents' attitudes. The findings were then analyzed to identify trends, such as the high usage of cloud-based services like Gmail and Google Drive, along with common concerns such as data security and vendor lock-in. The results provide a comprehensive view of how cloud computing is integrated into library operations and its perceived benefits and challenges.

4. RESULT AND DISCUSSION

The figure 1 presented highlights the gender distribution of respondents regarding the adoption and impact of cloud computing in libraries. A majority of the respondents (60%) are female, while 40% are male. This suggests that the topic may resonate more with females in the library field, which could reflect a trend in the workforce or interest levels in technology-related initiatives. Understanding the perspectives of both genders is crucial, as it can offer a more comprehensive view of the benefits and challenges that cloud computing brings to libraries. The future direction of cloud adoption could benefit from gender-inclusive strategies in library management and technology integration.

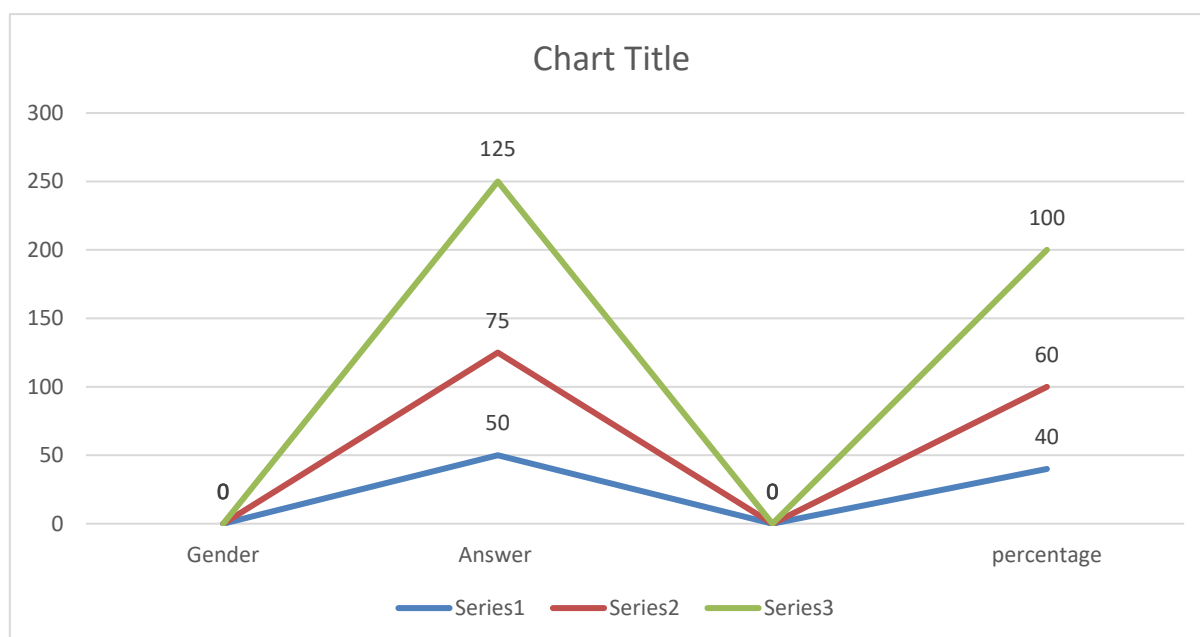


Fig. 1 Gender Distribution Cloud Computing Adoption in Libraries

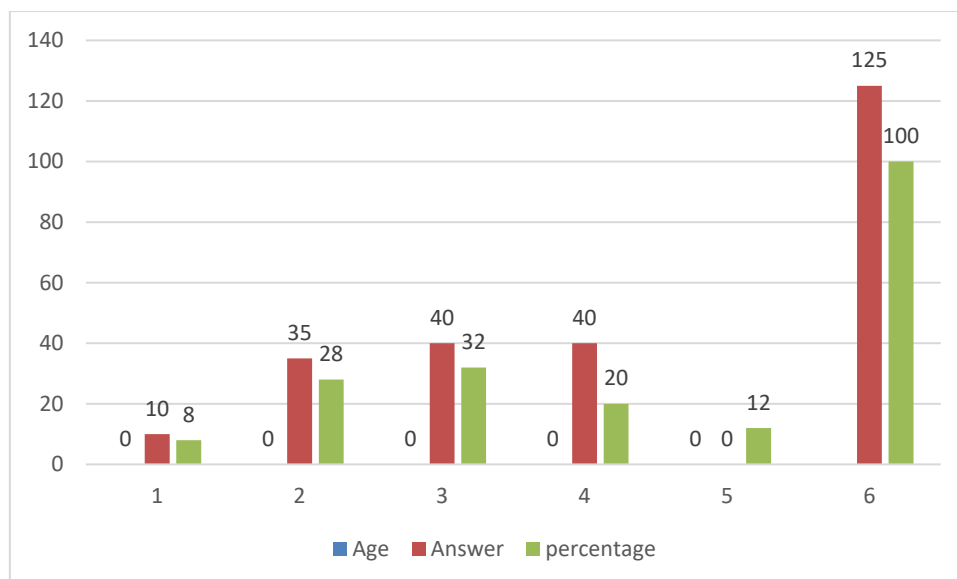


Fig. 2 Age Distribution Cloud Computing Adoption Libraries

The age distribution figure 2 reveals that cloud computing adoption in libraries is most prevalent among professionals aged 26-45, with the highest percentage in the 36-45 age range (32%) followed by 26-35 (28%). These age groups likely represent individuals in mid-career stages, more engaged in technological advancements. The 45-55 group accounts for 20%, while 18-25 respondents are only 8%, possibly due to fewer decision-making roles among younger individuals. Interestingly, the 56 and above age group shows no adoption, possibly due to resistance or lack of familiarity with cloud technologies. This suggests targeted initiatives are needed for different age demographics.

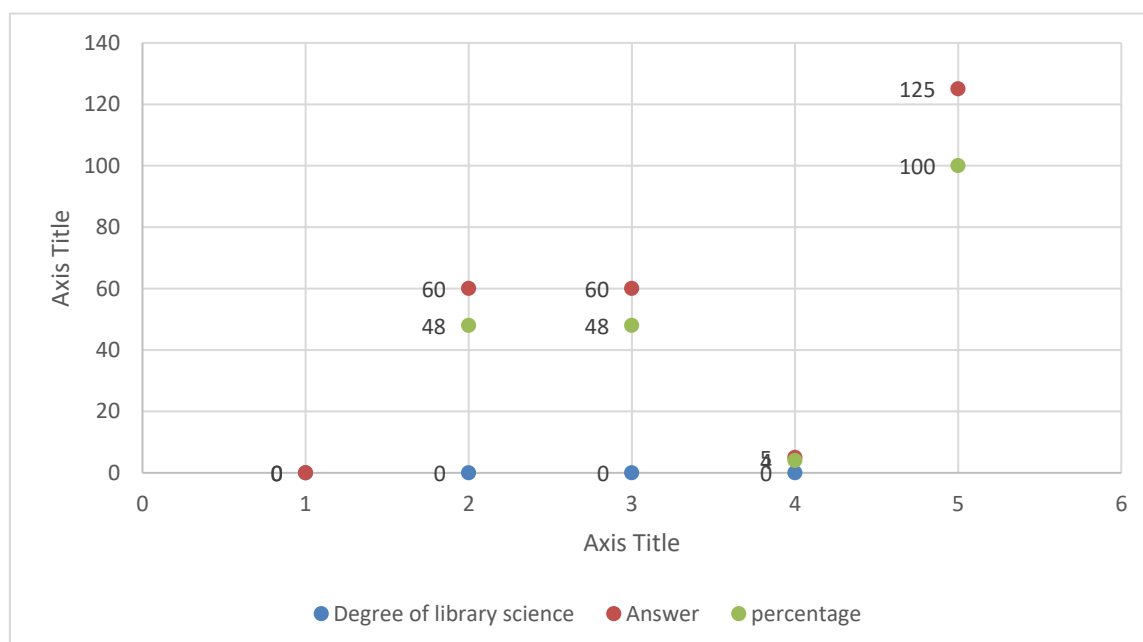


Fig. 3 Degree Distribution Cloud Computing Adoption Libraries

The figure 3 on the degree distribution of respondents shows that a significant portion of individuals involved in cloud computing adoption in libraries holds advanced qualifications in library science. The majority (48%) possess an M.L.I.Sc (Master of Library and Information Science) or a Ph.D. (48%). These individuals are likely to be in more senior or specialized roles within library management. Only 4% of respondents have an Other qualification (such as C.L.I.S), suggesting a smaller but still relevant group with alternative backgrounds. The data highlights that advanced degrees are common among those engaged in cloud computing adoption in libraries.

Table 1 provides insights into respondents' familiarity with cloud computing service and deployment models. In terms of service models (IaaS, PaaS, SaaS), 60 individuals have no experience, while 25 are already using them. The mean score of 2.16 suggests a moderate level of familiarity, with a standard deviation of 1.22 indicating varied responses. For deployment models (Public, Private, Community, Hybrid), 40 have no experience, and 35 are using them, with a mean score of 2.4, showing slightly greater familiarity. The standard deviation of 1.2 indicates a similar level of variation in responses for deployment models.

Table 1. Experience with Cloud Computing Service and Deployment Models

Experience with Cloud Computing Service	No Experience	Only Heard	I Know about it	Already Using it	Total	Mean	Standard deviation
Experience with cloud computing service models like IaaS, PaaS, SaaS	60	10	30	25	125	2.16	1.22
Cloud computing deployment models like Public, Private, Community, Hybrid Cloud	40	30	20	35	125	2.4	1.2

Table 2. Usage of Cloud-Based Services in Libraries

Cloud based services in Library	Yes	No	Total	Mean	Standard deviation
Cloud based mailing services - Gmail	90	35	125	1.72	0.45
Cloud based social networking (Facebook, Instagram)	80	45	125	1.64	0.48
Cloud based video services (Vimeo, You tube)	70	55	125	1.56	0.4972
Cloud based file sharing (Google drive)	80	45	125	1.64	0.48
Cloud based data collection (Google forms)	90	35	125	1.72	0.45
Cloud based event calendar (Doodle, Google Calendar)	50	75	125	1.4	0.49
Cloud based Spreadsheet, word file online editing services(Google docs)	70	55	125	1.56	0.4972
Cloud based editing and storage of Image (Picas)	80	45	125	1.64	0.48

Table 2 presents the usage of various cloud-based services in libraries. The data indicates that certain services are more commonly adopted than others. For example, cloud-based mailing services (Gmail), data collection tools (Google Forms), and file-sharing services (Google Drive) have the highest usage, with 90 users for each, showing a strong preference for these platforms (mean of 1.72). Cloud-based social networking services like Facebook and Instagram, along with cloud-based editing services such as Google Docs and Picas, have moderate usage, with means ranging from 1.56 to 1.64, indicating a good level of adoption among library professionals. On the other hand, cloud-based event calendar tools like Google Calendar have the lowest usage, with a mean of 1.4. The standard deviations, ranging from 0.45 to 0.4972, suggest that responses are fairly consistent across all services, with only slight variations in usage patterns. Overall, libraries show significant engagement with popular cloud-based services, especially for communication and collaboration.

Table 3. Library Adoption and Impact of Cloud Computing Services

Cloud Computing Services	Yes	No	Total	Mean	Standard deviation
Library have web based library management software	60	65	125	1.48	0.498
Library provide remote access facility	75	50	125	1.6	0.49
Library use any third party cloud computing services	80	45	125	1.64	0.48
Cloud computing is useful for library	105	20	125	1.84	0.3667
By using cloud computing in your library, pattern of work is changed	85	40	125	1.68	0.4664
cloud computing improves existing library services	110	15	125	1.88	0.325
users increased by introducing the cloud based services	95	30	125	1.76	0.4281
Specific IT team to manage cloud based library services?	60	65	125	1.48	0.498
Cloud computing make any complication in your library services	40	85	125	1.32	0.4664
Attended any training of cloud computing	30	95	125	1.24	0.4281
Institute take interest for cloud computing implementation in library	70	55	125	1.56	0.4972

Table 3 highlights the adoption and impact of cloud computing services in libraries. The data reveals a generally positive view of cloud computing's role in library services. A significant portion of libraries uses third-party cloud services (80 responses, mean 1.64) and provides remote access (75 responses, mean 1.6), indicating a strong embrace of cloud solutions. Furthermore, 105 respondents believe cloud computing is useful for libraries, with a high mean score of 1.84, and 110 agree that it improves existing services (mean 1.88). The use of cloud computing has also led to changes in work patterns (mean 1.68, 85 responses) and increased user engagement (mean 1.76, 95 responses).

However, challenges exist, as 40 respondents feel cloud computing complicates services (mean 1.32), and only 30 have received cloud computing training (mean 1.24). Overall, the data suggests a favorable perception, though barriers like training and complications remain. The standard deviations show slight variation in responses across these factors.

Table 4. Perceived Advantages of Cloud Computing

Advantages of Cloud Computing	Agree	No Idea	Disagree	Total	Mean	Standard deviation
Cost Saving	75	35	15	125	2.48	0.7031
Ubiquities (Location, Time, Device independent)	85	30	10	125	2.6	0.6325
Scalability	80	40	5	125	2.6	0.5643
Storage	100	20	5	125	2.76	0.5154
Easy in use	95	25	5	125	2.72	0.5306
Paperless environment	95	25	5	125	2.72	0.5306
Multi User can Access	95	25	5	125	2.72	0.5306
Reliability & Security	83	40	2	125	2.648	0.5105

Table 4 outlines the perceived advantages of cloud computing, based on user responses. The data indicates strong agreement on several benefits, with the highest mean score for "Storage" (2.76), reflecting a consensus that cloud computing provides significant storage advantages. Similarly, "Easy to use" and "Paperless environment" each have a mean score of 2.72, suggesting widespread approval of these benefits. "Multi-user access" also shares the same score, emphasizing cloud computing's collaborative features. "Reliability & Security" is also highly rated, with a mean of 2.648, showing that users see cloud computing as both reliable and secure. "Ubiquities" and "Scalability" both scored 2.6, highlighting the importance of cloud computing's flexibility and accessibility. "Cost Saving" has a mean of 2.48, suggesting that while it is recognized as an advantage, it might not be as universally acknowledged. The relatively low standard deviations (ranging from 0.5154 to 0.7031) indicate that the responses are generally consistent across the sample.

Table 5 highlights the perceived disadvantages of cloud computing, with users identifying various challenges. The most notable disadvantage is being "Dependent on service provider," with a mean of 2.52, indicating significant concern about reliance on external providers. Similarly, "Vendor lock-in" and "Technical problems" each have a mean score of 2.36, suggesting that users are aware of the risks of long-term commitments to specific vendors and the technical issues that may arise. "High bandwidth" and "Data security" (leakage of confidential data) also scored relatively high, with means of 2.4 and 2.44, respectively, indicating concerns about the need for adequate bandwidth and the potential for security breaches. "High cost" is noted as a disadvantage with a mean of 2.32, reflecting the perception that cloud computing may be expensive. The standard deviations, ranging from 0.574 to 0.74, show moderate variation in responses, indicating mixed opinions on the extent of these disadvantages.

Table 5. Perceived Disadvantages of Cloud Computing

Disadvantages of Cloud Computing	Agree	No Idea	Disagree	Total	Mean	Standard deviation
Dependent on service provider	70	50	5	125	2.52	0.574
Vendor lock –in	60	50	15	125	2.36	0.686
Technical problems	65	40	20	125	2.36	0.74
High bandwidth	65	45	15	125	2.4	0.692
Leakage of confidential date (Data security)	65	50	10	125	2.44	0.637
High cost	60	45	20	125	2.32	0.733

5. FINDINGS

This study reveals several key findings regarding the adoption and impact of cloud computing in libraries:

- A significant percentage of libraries have adopted cloud-based services, particularly those related to communication (e.g., Gmail) and storage (e.g., Google Drive). The survey indicates widespread usage of these services, with a strong inclination toward Software-as-a-Service (SaaS) models for library management systems.
- The primary benefits of cloud computing for libraries include cost savings, scalability, and ease of access. Cloud-based services have allowed libraries to reduce physical infrastructure costs while offering remote access to resources and better data storage options.
- Despite the advantages, security remains a critical concern for many libraries. Data privacy, breaches, and dependency on third-party vendors were commonly cited as barriers to further adoption, particularly in public and hybrid cloud models.
- Cloud computing has had a positive impact on library operations, leading to enhanced collaboration, better resource management, and increased accessibility for users. The shift toward cloud-based systems has also changed the way library staff and users interact with resources.
- Many libraries, especially smaller ones, face difficulties in managing cloud systems due to a lack of skilled staff and the resources required for training. This can impede the effective use of cloud computing technologies.

6. RECOMMENDATIONS

Based on the findings, the following recommendations are made to improve cloud computing adoption and usage in libraries:

- **Ongoing Training:** Libraries should invest in continuous professional development programs to enhance staff expertise in cloud computing technologies.
- **Prioritize strong security measures,** including encryption, access control, and regular audits to protect data.
- **Consider hybrid cloud solutions** to balance security concerns and scalability.
- **Conduct thorough analyses** to ensure financially viable cloud adoption.
- **Collaborate with cloud providers** to access technical support and tailored solutions.

- Implement cloud services gradually, starting with non-critical systems.
- Conduct research to address evolving needs, security, and new technologies in cloud computing.

7. CONCLUSION

Cloud computing has undeniably revolutionized the way libraries operate and provide services to their users. The findings from this study indicate a high level of adoption of cloud-based services in libraries, with significant benefits in terms of cost savings, scalability, and flexibility. Cloud technologies, particularly Software-as-a-Service (SaaS), Infrastructure-as-a-Service (IaaS), and Platform-as-a-Service (PaaS), have allowed libraries to modernize their infrastructure, improve operational efficiency, and enhance the accessibility of their resources. Services like cloud storage, email management, and collaboration tools are among the most commonly adopted, contributing to increased productivity and user satisfaction. However, despite these advantages, the study also highlights several challenges faced by libraries in fully embracing cloud computing. Concerns about data security, vendor lock-in, and the need for specialized technical expertise remain significant barriers to widespread adoption, particularly for smaller libraries with limited resources. Addressing these challenges will require targeted efforts, such as improving staff training, strengthening security protocols, and exploring hybrid cloud models to balance control with flexibility. In conclusion, while cloud computing presents immense potential for transforming library services, its successful implementation depends on overcoming these challenges. Libraries must approach cloud adoption strategically, with careful planning and consideration of both the opportunities and risks involved. Continued research and development in cloud technology and its applications within libraries will further facilitate a more seamless integration of cloud computing into library management systems.

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