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Integrating ICT in libraries: adapting information services for future e-learning users

Research – Full text

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Abstract

While digital transformation in education is accelerating, academic libraries will reorgan-ize their roles to support further information needs in an interactive e-learning environ-ment. In this article, we will explore how libraries can manage and adapt information ser-vices for future users using information and communication technology (ICT) integration. The focus is on the development of response-user-centric services that meet the require-ments of digital learners in both formal and informal educational attitudes. This study ex-plores the application of ICT tools, including AI-controlled search engines, virtual refer-ence services, learning analytics, immersive technologies to promote access to information, promoting digital literacy, and supporting collaborative learning. Additionally, strategies for embedding library resources into learning management systems and e-learning plat-forms are being considered to provide seamless academic support. The results highlight the importance of adaptability, employee training, and political development to ensure that they remain a key partner in the education ecosystem. Ultimately, this study illuminates the po-tential for transformation of ICT-enabled library services in maintaining dynamic, integrat-ed, and future learning environments.

Keywords
Information services, Information Technology, E-Learning, Digital Transformation

Introduction

The rapid development of digital technology has dramatically changed the educational landscape, requiring parallel transformations in the provision of information services in academic libraries. When institutions move to interactive e-learning models and hybrid education formats, libraries will need to redefine their traditional roles to meet the dynamic expectations of future users. At the heart of this transformation is the effective integration of Information and Communication Technology (IKTS), which allows libraries to expand reach, improve user commitment, and ensure seamless access to a variety of learning resources. In the context of interactive e-learning, libraries are not a single repository of books and magazines. ICT tools such as AI-powered search engines, virtual reference chatbots, digital repositories, online tutorials, and immersive learning environments (such as VR/AR) revolutionize [Nader, F. (2023).]the way students interact with information. Not only can these technologies require personalized learning experiences, they can also enable users to provide the key capabilities of 21st century [Georgarakou, R. (2023).] digital literacy. This paper explores how libraries manage and adapt services to support the future of education by embedding ICTs in their operations, lessons and support systems. It examines strategic implementation of technically enhanced services in academic and public library systems, examines how libraries will become proactive in supporting e-learning platforms, and integrate into institutional learning management systems (LMS), and meets the needs of investigating an increasingly wide range of remote learners. Digital strategies can be addressed through research into best practices and future-oriented strategies that are excluded by prerequisite strategies. Enabled access and fellow creators on tomorrow's learner educational trip.

Meaning of E-Learning

E-learning or electronic learning refers to the provision of educational content and lessons through digital technology and the Internet. [Blanchard, C. (2021),]This allows learners to access their computers, tablets, or mobile devices from their mobile devices anytime, anywhere, anywhere. E-learning is either fully conducted in an online environment or integrated into a blended learning model that combines approaches and instructions. Large and different groups of learners.

E-learning supports a variety of formats such as video lectures, live webinars, discussion forums, learning management systems (LMS), digital libraries, and AI-powered learning assistants. It is often used in schools, universities, corporate training, and lifelong learning initiatives.

Statement of the Problem

A rapid shift to digital and interactive e-learning environments allows you to access, consume and access information. However, many academic and public libraries continue to function in traditional service models that do not perfectly match the development of learners' needs in the 21st century. Information and communication technology (ICT) is increasingly affecting the delivery of educational preparation, and there is a growing gap between user expectations and the capabilities of library services, real-time, flexible, and personalized learning experiences. Furthermore, the lack of clear strategies and guidelines for embedding ICTs in library operations

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has hindered the library's role as an active partner in the e-learning ecosystem. This study attempts to address core issues. How can the library effectively manage and adapt information services to support future users in an interactive e-larning environment through ICT integration? The aim is to examine obstacles, opportunities, and best practices that could lead to libraries to become dynamic digital response institutions that meet the educational requirements of current and future generations.

Research Objectives

The primary aim of this study is to explore how libraries can effectively manage and adapt their information services to meet the evolving needs of future users within interactive e-learning environments, through the integration of information and communication technologies (ICTs). To achieve this, the study will pursue the following specific objectives:

1. **Examine the current state of library information services** in relation to digital transformation and the demands of e-learning environments.
2. **Evaluate the key information and communication technologies** that can enhance library services and support interactive, user-centered learning.
3. **Investigate best practices and successful models** of ICT integration in academic and public libraries that support e-learning.
4. **Assess the changing information needs and expectations** of learners in digital and remote learning contexts.
5. **Suggest strategic approaches and frameworks** for libraries to future-proof their services and remain relevant in digitally driven educational ecosystems.

Literature Review

ICT has revolutionized the way libraries are stored, called, and spread information. Tools such as Integrated Library Systems (ILS), Cloud-based digital repositories, virtual reference services (such as chatbots), and AI-controlled search engines are centrally important for modern library services (Yu, D. (2023).). ICT also enables real-time collaboration, supports remote learning, and provides interactive experiences through multimedia, augmented reality (AR), and virtual reality (VR) tools (Cepeda-Carrión, G. (2015).). These technologies make information more accessible, personalized and committed, especially for online learning. Integrating library services on e-learning platforms such as Learning Management Systems (LMS) improves educational experience through the integration of information capabilities, research skills, and accessibility into the learning process (Alasiry, A. (2020).). Research highlights the importance of seamless integration. This integration allows learners to access library content, citation tools and academic support without leaving their digital learning environment. The library also introduces educational modules, webinars and digital tutorials to support online education. This includes budgetary restrictions, inadequate infrastructure, shortages of professionals, and resistance to change (Bhusan Ray (2017),). Moreover, the digital gap still limits access to some municipalities and raises concerns about justice and inclusion. There is also an increasing need for guidelines and training programs to ensure effective implementation and

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sustainable use of ICT tools in library settings. With learners who become autonomous and digital, libraries will turn into user-centric service models. According to Usman, M. (2022). ,the future of libraries relies on their ability to understand and respond to further developed information needs, learning behaviors, and digital preferences. This includes providing personalized services, mobile access and integrated designs to a wide range of learning populations, including students with disabilities and people from remote locations.

The literature reveals a clear trend: libraries must evolve beyond traditional functions to remain relevant in digital and e-learning contexts. ICTs offer powerful tools to modernize services, but their integration must be strategic, user-focused, and inclusive. This review establishes a foundation for further investigation into how libraries can adapt effectively, ensuring their role as critical educational partners in a technology-driven future.

Research Methodology

This study adopts a mixed-methods research design**,** combining both qualitative and quantitative approaches to provide a comprehensive understanding of how libraries can integrate Information and Communication Technologies (ICT) to support future e-learning users. The quantitative component focuses on assessing the current level of ICT adoption and user satisfaction, while the qualitative component explores librarians' and users' perceptions, challenges, and best practices in adapting library services for digital learning environments.

Population and Sampling

The study targets two primary groups:

Library staff and administrators in academic and public libraries.

Library users, including students and faculty members engaged in e-learning activities.

A stratified random sampling technique will be used to ensure representation across different types of libraries (university, public, and specialized). A total of 100–150 participants are expected for the quantitative survey .

Data Collection Methods

Survey Questionnaire:A structured questionnaire will be administered to library staff and users to gather data on the extent of ICT use, types of digital services offered, user satisfaction, and perceived challenges.

The questionnaire will include both closed-ended (Likert scale) and open-ended questions.

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Document Analysis: Policy documents, ICT plans, and usage reports from libraries will be reviewed to identify institutional strategies and trends in ICT adoption.

Data Analysis

Quantitative data from the survey will be analyzed using **descriptive statistics** (percentages, means, and frequencies) and **inferential statistics** (such as chi-square tests or correlation analysis) to examine relationships between ICT adoption and user satisfaction.

Validity and Reliability

To ensure reliability, the questionnaire will be **pilot-tested** with a small group of respondents to refine ambiguous questions. Triangulation of methods (survey, interview, and document analysis) will enhance the validity and credibility of the findings.

Ethical Considerations: Ethical clearance will be obtained from the relevant institutional review board. Participants will be informed of the study's purpose, and their consent will be sought before participation. Confidentiality and anonymity will be strictly maintained throughout the research process.

Limitations: Possible limitations include limited access to certain library records, response bias in self-reported data, and varying levels of ICT infrastructure among institutions that may affect comparability.

Examining the Current State of Library Information Services in Relation to Digital Transformation and the Demands of E-Learning Environments

Current Strengths of Library Information Services-- The digital transformation of education has deeply influenced the structure, delivery and expectations of library services. With learning increasingly shifting online, libraries are challenging themselves to develop from traditional resource-centric institutions into dynamic, user-oriented digital hubs. In this section, the current status of library information services was considered and assessed the extent to which it met the growth requirements of the e-learning environment.[Pham, H. T. (2019).] The improved resource digitization of academic and public libraries expanded its digital collections and accessed e-books, academic journals, multimedia resources and institutional repositories. We implemented digital tools such as live chat, email support, virtual consultation, and AI chatbots to support users without the need for physical presence. These services support just-in-time learning and provide flexible learning plans that are extremely important in an e-learning environment. Direct to the course and research tutorials. The Online Information Capability Program offers webinars, video tutorials and online workshops to develop digital and research skills. These programs are often self-adapted.

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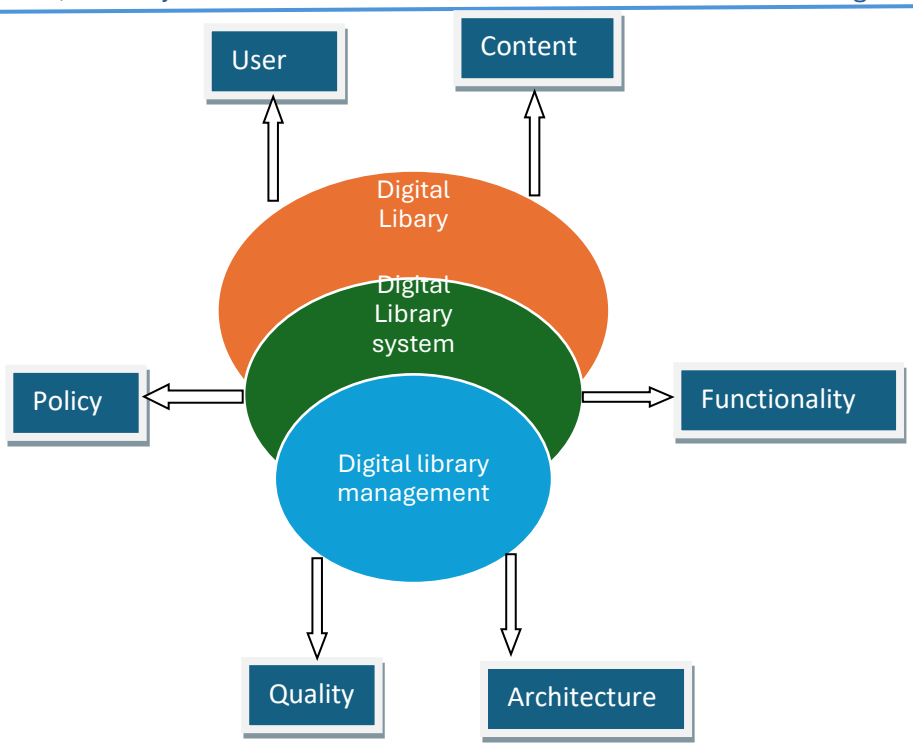

Figure.1. Digital library as a three-tier construction

Identified Gaps and Challenges-- Inconsistent introductions at institutions, some libraries embrace digital transformation, while others have developed in the development of infrastructure regional and fundraising to do so effectively. It spanned the experience. Designed Data Analytics User Behavior Library Data Analytics Digital Tools[Penfold, P. (2023).] for User Interaction with Data Analytics Digital Tools, there is no option to improve services based on usage trends and learning patterns.

Adaptation to E-Learning Demands-- The rise of distance learning at events such as the Covid-19 pandemie has accelerated not only the relocation of digital services, but also the structural weaknesses of digital readiness. The libraries began redefine the service model and encouraged a flexible, user-oriented approach to satisfy online learning. Information services remain uneven in their adaptation to the digital age. A library that is proactive in the introduction of digital conversions is well positioned to support interactive e-learning environments. However, challenges related to infrastructure, training, personalization and guidelines integration must be addressed to ensure that all users benefit from modern library services in an increasingly online education environment.[ROFFE (2002),]

Evaluation of Key Information and Communication Technologies (ICTs) for Enhancing Library Services

Integrated Library System (ILS) and Software Features for Library Management: Automation and Optimization of Core Library Processes such as Catalog, Distribution, Retrieval, User Management: Improve Efficiency, Improve Resource Emissions, Support Remote Access to Library Catalogs. Integrated functions for Learning Management Systems (LMS): Embed library resources, tutorials, and research equipment directly within the LMS

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platform (Moodle, Canvas, Blackboard, etc.). Encourage students to address library services as an important part of their research and improve their research skills. Digital Repository and Institutional Archive Features: Store and provide access to digital science work, papers, papers, data records and multimedia. dspace, printings. Virtual Reference and Chatbot Services[Saifuzzaman, M. (2021).]Features: Provides real-time or asynchronous help via live chat, email, and AI-powered chatbots. Increases accessibility of professional assistance, supports personalized help, and extends service time beyond traditional libraries. Example: AI chatbots can handle FAQs to support users who support resource discovery and information. Promote mobile technology and applications: Activate access to library catalogs, digital resources and services via smartphones and tablets. It supports walking learning and is aimed at users who prefer mobile platforms. Improve convenience and commitment, especially among technically experienced learners.

Multimedia and Interactive Content Platform Features: Integrate videos, podcasts, interactive tutorials and webinars into your library offers. Supports a variety of learning styles and boosts commitment through rich and interactive content. It elicited self-defined and experimental learning. Artificial Intelligence (AI) and Tools Features for Machine Learning:[Pange, J. (2022).] Analyze user data to provide personalized recommendations, automate content and improve search capabilities. If resource discovery improves, the learning path adapts and automatically becomes a routine task. Example: AI-driven services search engines and recommendation systems improve user-centered service delivery. Virtual Reality (VR) and Augmented Reality (AR) Functions (AR): Provides immersive experiences such as virtual tours through libraries, 3D visualization of content, or augmented learning AIDS. Improve engagement, support experimental learning, and make complex concepts more accessible. Cloud Computing Services Features: Host digital collections, support collaborative platforms, and enable remote access to resources. Provides scalable and inexpensive memory and services with improved collaboration capabilities. Data Analysis and User Behavior - Tracking Tools [Khan S.A.. (2023)].

Functions: Collect and analyze usage data to understand user requirements and optimize service delivery. It enables evidence-based decisions, improves user experience, and identify service gaps. Libraries that strategically apply and integrate these technologies can turn into dynamic learning hubs that effectively support interactive, user-centric e-learning environments. However, successful implementation depends on factors such as motivation for infrastructure, staff experts, and ongoing evaluation.

Investigation of Best Practices and Successful Models of ICT Integration in Libraries Supporting E-Learning

Seamless Integration with Learning Management Systems (LMS): Embed library resources, research guidelines and educational materials directly into LMS platforms such as Moodle, Blackboard, and Canvas. The University of Edinburgh integrates its digital library services into the LMS, allowing students to access resources, chat with librarians, and complete modules for information capabilities without leaving the learning platform.[Murodkasimova, S. K.

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(2021).] It provides learners with access to direct context-related information resources, encourage engagement, and efficient research habits. Virtual Reference and Chat Services: Implement a virtual reference switch around the clock. This is occupied by a librarian or AI chatbot to provide immediate support. AskLapl Service from New York Public Library provides live chat and e-mail support, and is always assisting users with research inquiries. Support distance learners, provide flexible schedules, and ensure that support from the library is always accessible.

Development of Digital Literacy and Information Skills Programs: Using AI and personalized learning technology: Using AI tools to personalize resource recommendations and automate routine tasks such as catalog search and FAQ responses. Georgia Tech Library uses AI-controlled chatbots to assist users in enquiries and guide students to relevant resources. Improve your user experience and improve efficiency through timely and personalized support. Fast design for mobile access and responsiveness:[Cooke, J.(2000).] Design library websites and digital resources to use mobile principles to ensure user friendliness across your device. The British Library mobile app provides access to digital collections, personalized bookmarks and event information. It mainly meets the requirements of learners who access smartphones or tablets and increase accessibility. Joint learning rooms and maker space: Creating digital and physical cooperation with technologies such as VR, 3D printing, and multimedia processing tools. The University of Toronto Library has an increase in learning where technology and group research areas are integrated to support interactive learning projects. It promotes experimental learning, creativity, peer collaboration, and key elements of modern e-learning.

Table.1. Digital literacy instrument grid

Aspects of Digital Literacy Skills	Indicators of Digital Literacy Skills
Searching on the internet	Develop procedures for searching for information on the internet
	Collect information from the internet effectively and efficiently
Hypertext Navigation	Understanding direction (navigation)
Evaluating information	Clarify the validity and validity and completeness of the referenced information content
	Assess the suitability of the referenced information content
Synthesizing information	Building knowledge from referenced information content

Open Access and institutional repositories that develop and maintain digital repositories for storage worldwide. The Mitspace repository provides open access to a variety of scientific research that supports the spread of knowledge and e-learning resources. It promotes open

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education, improves research visibility, and supports student learning with authentic materials. Through continuous training and development, they invest in ongoing professional development to keep employees up to date with new ICT and e-learning pedagogy.[TOWNLEY (2003).] Digital Library Federation offers workshops and webinars to help librarians develop their skills to provide digital services. Make sure your employees can effectively and innovatively support library services with a rapidly evolving digital landscape. Institutions prioritizing accessibility, continuous personnel development, and innovative service models will serve as exemplary models for libraries of the future. These best practices not only improve access to resources, but also promote autonomy, cooperation and digital capabilities from learners.

Assessing the Changing Information Needs and Expectations of Learners in Digital and Remote Learning Contexts

View in the direction of immediate and on-demand access execution: Learners are increasingly looking forward to access around the clock digital library resources, including e-books, magazines, databases, and multimedia content. Long distance and asynchronous time planning requires flexible availability that physical libraries cannot provide. Libraries should prioritize expanding their digital collections and ensure a stable, user-friendly online access platform. Prioritizing an Integrated Seamless Learning Experience[Weggen, CC(2000).]

Expectations: Students want to seamlessly integrate library resources into their learning environments. Drive libraries and work closely with your education technology team to embed resources and tools directly into your course management system. Increased demand for personalized adaptive resources - Learning expectations expect tailormade recommendations, tailormade support, and adaptive learning materials that meet individual knowledge and learning objectives. Specialized experiences improve commitment[White,G.(2003).] and improve learning outcomes. Introducing AI-controlled search engines, chatbots and recommended systems to meet the needs of their own users. Want to interactive and multimodal content: In addition to traditional text-based resources, learners are looking for videos, podcasts, interactive tutorials, simulations and virtual labs that work with virtual labs to understand multimodal content. Enrich your study materials.

Supports the need for digital capabilities and research skills. Remote learning requires guidelines when evaluating digital sources, avoiding misinformation and mastering research methods. Digital environments allow learners to expose themselves to vast amounts of information with different reliability. Increased demand for virtual workshops, tutorials and online support students focused on information capabilities.[Wang, Y. H. (2020).] Improved communication and collaboration tools: Learners hope that the library will support collaborative learning through access to virtual learning groups, forums and digital work areas in general. Social interaction and support with the same age remains a critical component of effective learning, not from afar. The library includes a collaborative platform that promotes commitment through the digital community. Accessibility and Inclusiveness Requirements: Remote learning environments must cater to a wide range of learners, including obstacles, language barriers, or limited technical access. Educational equity requires accessible design and availability of resources. The library invests in accessible platforms, screen reader

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compatible content and multilingual resources. Data Protection and Data Security Expectations[WANG (Meri-Yu).2004]: Learners need to ensure that their data and online activities are protected when accessing the Digital Library Services. Increased awareness of concerns about digital data protection in online learning environments. The library uses robust security protocols and transparent data protection guidelines. Learners' information needs and expectations in digital and distant contexts have evolved considerably into flexible, personalized, accessible services that seamlessly integrate into learning trips. To effectively support these changing requirements, libraries must use innovative technologies, expand digital offers and provide robust support for digital literacy. The realization of these expectations is inherently important to improve learner engagement, autonomy and success in an increasingly digital educational environment.

Strategic Approaches and Frameworks for Future-Proofing Library Services in Digital Educational Ecosystems

Incorporate user-centric agile service Designaproach: Use user-centric design principles to prioritize learners' development needs and preferences. Services that support and complement this model. We will invest strongly in digital infrastructure, including cloud-based platforms, mobile accessibility and scalable digital collections. Prepare libraries to meet increasing requirements for remote and on-demand access and improve resilience to future disruptions. Approach to promote strategic partnerships and cooperation: Strong collaboration with academic departments, IT units, edtech providers and other libraries. Innovation[Zhang R. (2023).].. Continuous HR development and investment in digital capabilities: Develop a culture of lifelong learning and adaptability among library employees. Make sure your employees are empowered to effectively support state-ART services and digital pedagogy. Implement data - controlled decisions - creation. It uses analytics and user data to direct services, resource allocation and public relations development. Libraries can predict trends, optimize services and influence stakeholders. Open and interoperable technologies: Selected systems and platforms that support seamless integration into open standards and other educational technologies. Prioritize interoperability to facilitate data release and uniform user experience in LMS, repository and communication tools.

Prioritize accessibility, inclusion, and equity analytics. Violates accessibility and inclusiveness in all aspects of service design and delivery. Make sure your platform meets accessibility standards (such as WCAG), offers multilingual content, and supports a variety of learning needs. Supports learning resources with broader goals for institutional diversity and fair access to votes. Innovation with emerging technologies: research and pilot technologies such as artificial intelligence, virtual and augmented reality, blockchain for digital legal management. We will establish partnerships with Innovation Institute, high-tech startups and academic researchers. Libraries are in the foreground of educational technology trends and improve user commitment. Define digital storage and security guidelines. Protect your digital assets and user data through comprehensive storage and cybersecurity frames. Implement secure storage solutions, backup systems, and clear data protection guidelines. [Dixit 2017]Maintain trust and ensure long-term accessibility of your digital resources. Example: Digital Library Conversion Framework Vision: Library is developed as an integrated digital, digital service provider in the

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learning ecosystem. Training. Collaborations: Partnerships between institutions.Innovation: Introducing new ICT. By implementing the overall framework conditions based on user-centered design and data control decisions, libraries can maintain their important role in facilitating knowledge and learning in the digital powered education ecosystem.

Findings and Conclusion

Based on literature analysis, expert interviews, and institutional practices, several important findings on the management and adaptation of library information services related to ICT integration of interactive e-learning were developed. User-Friendly Digital Interface. Integration with Learning Management System (LMS) The successful library incorporates digital resources and services into the LMS platform to provide seamless access to content and academic support in a learning environment. Cloud-based repositories for improving (VR) and users. Virtual reference services (email, chat, video conferencing) are standard offerings to support remote learners. The need for a continuous professional development staff's capacity structure is extremely important to maintain ICT integration. Supporting user requirements during development requires training in digital tools, educational design and data capabilities. This study concludes that successful adaptation of library information services to meet the needs of future users lies in the strategic and sustainable integration of information and communication technologies. As education continues to move towards interactive and digital formats, libraries need to re-register their role as content providers as well as re-register as collaborative partners in the learning process. ICT tools provide powerful opportunities to improve access, personalize learning and promote student commitment. However, knowledge of these benefits requires thoughtful planning, functional cooperation, training courses and appropriate resource allocation. Furthermore, libraries should work to include institutional digital learning strategies to become visible and retain valuable participants for academic success.

Recommendations

Based on the findings of this study, several strategic recommendations are proposed to help libraries effectively manage and adapt their information services for future users through the integration of Information and Communication Technologies (ICTs) in interactive e-learning environments:

Libraries should establish clear, long-term strategies focused on the integration of ICT tools into their core services. Libraries should explore and adopt innovative technologies such as AI-powered chatbots, digital repositories, virtual reality (VR), and data visualization tools. Training should also include data privacy, content curation, and virtual instruction skills. Expand and enhance virtual services such as live chat, video consultations, and asynchronous help through email or discussion forums. Institutions should allocate adequate funding for ICT infrastructure upgrades, digital resource subscriptions, and staff development.

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