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Original Article

Digital Transformation of Public Libraries in the Information Age

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ABSTRACT

Digital technologies have transformed public libraries by changing how information is created, stored, accessed, and shared. Traditional libraries are evolving into digitally enabled knowledge centers through the adoption of information and communication technologies (ICT), cloud computing, artificial intelligence, digital repositories, mobile services, and online platforms. This transformation helps libraries meet the growing demand for anytime, anywhere access to information. Digital services such as e-books, electronic databases, virtual reference systems, and digital archives improve accessibility and user engagement. However, libraries also face challenges including infrastructure costs, staff training, cybersecurity, digital literacy, privacy protection, and intellectual property management. This study proposes a Digital Public Library Transformation Framework that integrates digital infrastructure, cloud-based systems, AI services, digital content delivery, and user-centered knowledge services. The framework aims to improve service quality, accessibility, operational efficiency, and community participation. The results indicate that digitally transformed libraries outperform traditional libraries by enhancing information access, reducing service delivery time, increasing resource usage, and promoting digital literacy and lifelong learning. The study concludes that digital transformation is essential for ensuring the sustainability and relevance of public libraries in the Information Age.

KEYWORDS

Digital Transformation, Public Libraries, Digital Libraries, Information Management, Knowledge Services, Cloud Computing, Artificial Intelligence, Information Access, Library Automation, Smart Libraries.

1. INTRODUCTION

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1.1. Background

Public libraries have always been seen as being integral to the educational process, vital to the spread of knowledge, key to cultural preservation, and essential to community development. In the past, libraries used physical collections, manual reference systems, and staff assistance to satisfy library users' information needs. But with the advent of the Information Age, the ways people access, share and use information have also changed significantly. With the growth of the Internet, mobile technologies, the cloud and digital media, the demand for instant access to information resources, remotely and personally, has grown. Consequently, public libraries are becoming great transformations from traditional information repositories to dynamic digital knowledge centers. With digital technologies, libraries have access to electronic books, electronic journals, digital archives, multimedia resources, and online learning platforms. These innovations will increase the accessibility of information, increase the efficiency of services and ensure opportunities for lifelong learning for different groups of users. Additionally, digital transformation allows libraries to better connect with their communities, foster digital literacy, and continue to be a relevant and useful part of a rapidly technoliterate world.

1.2. Need for Digital Transformation in Public Libraries

Fig 1 - Need for Digital Transformation in Public Libraries

1.2.1. Remote Information Access

In the information society user's expectation of information on demand, irrespective of place and time, has become an indispensable need in the library services. Many of the traditional libraries need physical attendance, which may be inaccessible for people who reside in far-off places or have mobility issues. Through web portal and mobile applications, digital transformation allows libraries to make catalogs, e-books, journals, databases and other materials available online. This function will improve the convenience and make information available to a broader audience.

1.2.2. Digital Content Delivery

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Digital content dissemination enables libraries to disseminate electronic resources efficiently and effectively. Printed materials have inherent disadvantages like physical availability and circulation control. Digital transformation has the potential to provide libraries with e-books, electronic journals, multimedia resources, and digital archives which can be accessed at the same time by a number of uses. This enables libraries to better serve the increasing needs for digital learning and research resources, while optimizing resource utilization.

1.2.3. Automated Library Operations

Automation is a vital part in enhancing the efficiency of library management processes. These traditional functions, such as cataloging, circulation management, inventory checking and user registration, can be labor intensive and time consuming. The impact of digital transformation on libraries embraces the concept of integrated library management systems, which automate mundane tasks, minimize operational errors, enhance service speed, and enable library staff to devote more attention to tasks that have higher value added, like providing user support and developing library programs.

1.2.4. Personalized User Services

The information services that modern users of libraries are expected to receive are tailored to their personal information needs and interests. AI and data analytics technologies are essential for implementing personalized services, and digital transformation can facilitate this. Recommendation systems can provide personalized suggestions on books, articles, and learning materials that are most relevant to a user's interests and usage of the library. Customized learning resources, search results, and notifications create a more personalized experience and satisfaction for users.

1.2.5. Cloud-Based Information Management

Cloud-based information management offers the library scalable, flexible and cost effective technological infrastructure. A traditional information system can involve substantial investments of hardware, maintenance and data storage. Cloud technologies provide libraries with safe and secure ways to store and manage digital collections, as well as high availability and reliable access. Additionally, cloud platforms offer data backup, disaster recovery, and easy integration of digital services in various locations.

1.2.6. Digital Literacy Programs

As society becomes increasingly dependent on digital technologies, libraries play a crucial role in promoting digital literacy. With digital transformation, libraries can provide online training sessions, webinars, tutorials, and other interactive learning opportunities that teach users important technological skills. These programs help people become effective users of digital tools, access to online information, and the digital economy, and narrow the digital divide in communities.

1.2.7. Community Knowledge Sharing

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Digital technologies provide new means of community working together and sharing knowledge. Traditional community engagement activities can be challenging due to physical space and attendance limitations. Libraries can support these initiatives in virtual spaces such as online forums, virtual events, digital repositories, and collaborative platforms to promote wider participation and exchange of knowledge, experience, and local information. Such an expansion of links improves the library's status as a place for learning and socializing and fosters a sense of community.

1.2.8. Data-Driven Decision-Making

Data-driven decision making allows libraries to analyze data on operational and user performance to enhance services and resources. Digital transformation offers insights into resource utilization, user behavior, the demand for services, and the impact of programs. Library administrators can use these data to make decisions on collection development, service improvement, technology investments, and strategic planning. This evidence-based approach improves organizational efficiency and helps to ensure ongoing enhancement of library performance.

1.3. Challenges in Traditional Library Systems

A variety of problems beset traditional public library systems that hinder their ability to provide for the changing information needs of today's society. A major constraint is the physical access, which may be limited as users have to come to the library premises at specific times of the day to access library resources and services. Manual cataloging and classification is time consuming and labor intensive, leading to inefficiency and human error. Administrative functions including circulation control, stock control and record keeping consume a lot of resources and involve significant human effort. Another problem with information retrieval is that the information it can retrieve is not necessarily quick or accurate from traditional retrieval approaches, particularly in large collections. Moreover, many traditional libraries provide access to limited digital services and their users are unable to use the resources remotely or benefit from the latest information technologies. Library systems and databases are not interoperable, making it difficult to share and collaborate between institutions. One of the primary challenges for users is the lack of interactive digital platforms and services, as well as online learning opportunities. In addition, physical collections, infrastructure and staffing are associated with high costs. Other data security and privacy issues arise from legacy approaches to managing data and inadequate cybersecurity protocols. A lack of use of advanced technologies, including cloud computing, artificial intelligence, big data analytics and mobile applications, is also a major obstacle to innovation and modernization of services. The increasing volume of information and the evolving expectations of the user toward a digital environment make it difficult for traditional library systems to meet growing requirements for efficient, scalable and user-centred services. These restrictions underscore the pressing need for digital transformation efforts to overcome these challenges and foster a more accessible, efficient, and technologically advanced library experience. The resolution of these challenges is critical to the continuity of the public library's relevance, efficacy and ability to serve the community's education, research, lifelong learning and development needs in the Information Age.

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2. LITERATURE SURVEY

2.1. Evolution of Public Library Systems

Public libraries systems have evolved through the decades as information management practices have evolved over the same period of time, all influenced by the advances of technology and expectations of users. The public library's traditional use was as a repository of print information, with the user having to use manual catalog and physical collections to obtain information. In the late twentieth century the availability of large quantities of information resources caused problems of cataloging, circulation and collection management, which resulted in the development of Library Automation Systems. In the 1980s and 1990s a new important technological development was Integrated Library Management Systems (ILMS), which allowed library data to be cataloged, processed for acquisitions, circuled and user information to be handled in an automated way. These systems helped to increase the efficiency of operations, decrease administrative burden and increase information accessibility. With the advent of the internet, library modernization was further speeded up through the implementation of Online Public Access Catalogs (OPACs), remote database access and Digital Information Services. Later, digital library programs helped institutions to digitize significant collections and to make scholarly, cultural and educational resources available online. A recent study has emphasized that the modern library is no longer a repository of information but is becoming a vibrant, active, learning environment for collaboration, community, lifelong learning and digital literacy. In the modern times public libraries have become hybrid spaces, where physical and digital services complement each other, and where the physical and digital information resources and emerging technologies are equally accessible to everyone.

2.2. Digital Libraries and Information Management

Digital libraries have emerged as a basic infrastructure in information management today and they offer an effective way for storing, organizing, preserving, and disseminating digital resources. Digital libraries are different from traditional libraries as they are mainly based on electronic collections and provide access to electronic books, journals, multimedia materials, institutional repositories, and archival collections from anywhere and anytime. Research studies show that digital repositories can greatly increase the access to the resources, enabling the sharing of knowledge by collaboration and enabling the long-term preservation of valuable information assets. The advent of cloud computing technologies has also broadened the capacity of digital libraries by offering scalable storage frameworks, adaptability of resources, higher reliability, and lower operational expenses. Metadata standards like Dublin Core and MARC are used in modern information management systems to produce consistent descriptions, classifications and retrieval of information resources across different platforms. Using semantic web technologies and ontology-based systems, the search results are more accurate by grasping the contextual relationships of information objects. Moreover, content management systems enable efficient storage, editing and sharing of digital collections. With these developments, information management practices in libraries have changed significantly, allowing for the efficient management of large-scale information and information resources that can be accessed by users in a fast, accurate, and personal manner.

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2.3. Emerging Technologies in Library Services

Emerging technologies are transforming the way libraries provide library services by ushering in intelligent, user-focused and data-driven services to improve the efficiency and quality of library services. Artificial Intelligence (AI) technologies are being more commonly used to automate repetitive tasks, make it easier to find information and create personalised user experiences. AI recommendation systems can leverage user data to better understand their content preferences and recommend relevant items to help users stay engaged and satisfied when they use the library. Predictive analytics uses Machine Learning algorithms to predict resource needs, optimize library collection development, and plan for better services. Chatbots and virtual assistants can offer 24/7 reference services, answering user queries, helping them search information, and navigating them around the library. By leveraging the power of Big Data Analytics, libraries can dissect vast amounts of user interaction data, making informed decisions and optimizing resources. In addition, Internet of Things (IoT) technology can enable smart library environments with automated inventories, real-time tracking of assets, environment monitoring and intelligent space utilization. These technologies have been shown to enhance the accessibility, performance and user experience by allowing for adaptive services, delivering information before it is even requested, and managing library resources more efficiently. New technologies are essential to revolutionizing old service models and delivering intelligent knowledge ecosystems in the future.

2.4. Research Gap and Motivation

Library digitization and technological innovation efforts have come a long way since the early days of the Internet, but the focus in previous studies has been largely on individual technological implementations, and not on the digital transformation itself. There are many studies that analyze a particular aspect like digital repository, cloud computing, AI applications, or information retrieval systems separately, without taking into account their integration with a holistic library ecosystem. This in turn poses challenges for public libraries in the coordination of technological investments, management of digital infrastructures, measuring performance impacts, and providing sustainable services. Additionally, there has been very little research exploring the joint effect of emerging technologies, digital services, user engagement tools and organizational change on the effectiveness of a library. While many frameworks exist, they often do not provide a consistent model for embedding AI-based services, cloud-based platforms, AI analytics services, digital content management systems and performance assessment methods. Lacks of comprehensive transformation models make it difficult for creating completely intelligent and user-centered public library spaces. To address these constraints, the present study argues for the development of a holistic framework for Digital Public Library Transformation (DPLT), which brings together the latest technology elements, digital service innovations, intelligent information management, and performance evaluation mechanisms. The overall objective of the proposed framework is to offer a structured development pathway to support public libraries in the sustainable transformation process, enhance their accessibility, efficiency, user satisfaction and dissemination of knowledge capabilities.

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3. METHODOLOGY

3.1. Digital Public Library Transformation Framework

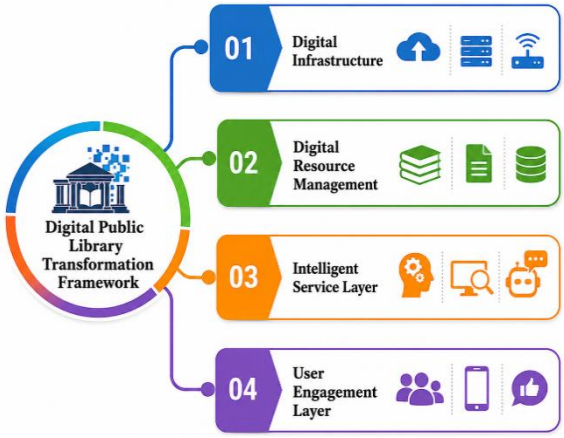

Fig 2 - Digital Public Library Transformation Framework

3.1.1. Digital Infrastructure

The Digital infrastructure is the base layer of the proposed Digital Public Library Transformation Framework. This layer comprises cloud computing platforms, advanced network connections, digital storage solutions, and cybersecurity systems, all essential for enabling the provision of contemporary library services. Cloud-based infrastructures offer scalable computing resources and flexible storage options, allowing libraries to handle extensive collections of digital materials efficiently. Reliable network connections provide constant access to the Internet and its services, and sophisticated security protocols like encryption, authentication, and access control safeguard sensitive user information and digital collections. A strong digital information infrastructure provides the technological platforms that will enable intelligent library functions and future technological growth.

3.1.2. Digital Resource Management

Digital Resource Management is the organization, storage, preservation and accessibility of digital information resources in a library environment. This layer consists of digital repositories, electronic books, online databases, institutional archives, and metadata management systems. Digital repositories enable the preservation and sharing of scholarly and cultural resources; e-books and online databases offer easy access to a range of information sources. A metadata management system improves the ability to discover resources and provides accurate classification, indexing and retrieval of digital content. By implementing efficient resource management, libraries can ensure well-organized digital collections and offer users easy access to information, no matter their location.

3.1.3. Intelligent Service Layer

The Intelligent Service Layer brings in the latest technologies including Artificial Intelligence and data analytics to enrich the library services and user experiences. The AI recommendation engine

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can leverage user preferences and usage patterns to offer personalized recommendations for content usage, boosting utilization and user satisfaction. Virtual reference systems and intelligent chatbots provide immediate help, addressing user queries and assisting with information retrieval. Search optimization technologies help to enhance the accuracy of information retrieval and to shorten the search time; user analytics technologies provide valuable information about the use of services and user behavior. This smart layer makes conventional library services adapt and respond to the changing needs of its users and create an environment of information.

3.1.4. User Engagement Layer

The User Engagement Layer is about improving interactions with and between libraries and their users, using digital tools and interactions. Users can access library resources, manage library accounts and be notified from anywhere using mobile applications. E-learning platforms facilitate education and skill development through digital learning and training resources, enabling access to e-learning both in the classroom and online. Community portals foster cooperation, information sharing and communication between library users, teachers, and scholars. In addition, digital literacy programs enable users to acquire key technological and information management skills needed in a digital world. This layer aims to enhance the engagement of the community and to keep digital library services accessible, inclusive and user-centred.

3.2. Data Acquisition and Digital Resource Management

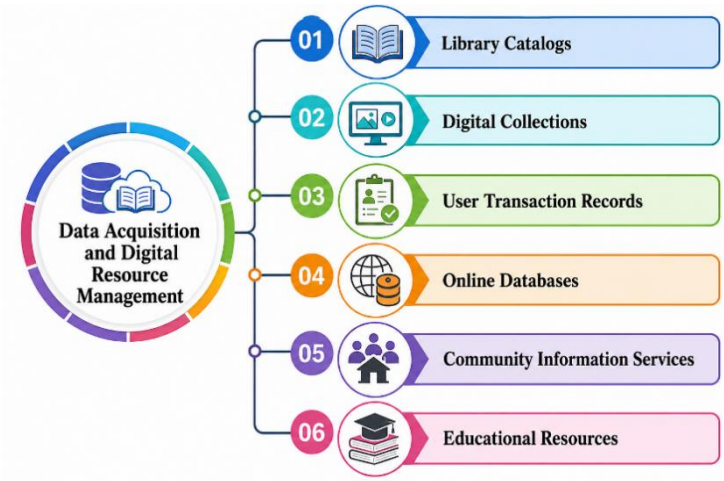

Fig 3 - Data Acquisition and Digital Resource Management

3.2.1. Library Catalogs

Data is one of the most fundamental sources in the digital public library arena, and library catalogs are one of them. They provide bibliographic details of books, journals, magazines, multimedia resources and others in Library. Modern digital catalogs offer structured information like author names, publication information, subject classifications, keywords, and availability status. This data enables efficient organization and search of resources as well as efficient collection management. Libraries can maintain accurate information retrieval, enhance user access to available resources, and accurately follow up on the catalog through ongoing updates.

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3.2.2. Digital Collections

Digital collections are the electronic collections comprising of e-books, research papers, manuscripts, images, audio recordings, videos, and institutional papers. The collections offer the user access to valuable information resources, his/her geographical location notwithstanding. Information from digital collections assists libraries in tracking access to their resources, determining the most popular content areas, and fine-tuning collection development plans. Good management of digital collections can also enable long-term preservation and contribute to the dissemination of knowledge in a variety of communities of users.

3.2.3. User Transaction Records

User transaction records include data about borrowing, downloads of resources, search usage, requests for resources to be reserved, and user interactions with digital services. These records offer a lot of information on how users use the site, what they enjoy and do not enjoy, and what they need. Libraries can leverage transaction data to gain insights into usage patterns, optimize resource allocation, make more personalized recommendations, and better quality library services. Good record keeping also enables evidence-based decision making, helps ensure appropriate levels of privacy and data security.

3.2.4. Online Databases

Online databases are one of the important sources of scholarly, scientific, educational and professional information that can be accessed through online library platforms. The databases are filled with journals, conference papers, research papers, reports, and references from different fields. The data collected from database use enables libraries to measure the effectiveness of the subscriptions, to know the interest of the users in the research carried out and to contribute to academic and educational activities. Online databases can also be integrated, greatly enriching the extent and quality of information in a library.

3.2.5. Community Information Services

Community information services are ways to disseminate locally relevant information to help in social, cultural, educational, and civic involvement activities. Services can include government announcements, job information, public health information, local events and community development resources. The information collected through community information services allows libraries to be community knowledge centres and meet the information needs of diverse communities. This information adds to the library's ability to promote social inclusion and community empowerment.

3.2.6. Educational Resources

Resources for education are digital learning resources, online courses, training materials, tutorials, academic content, and instructional multimedia resources. These resources are used in

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formal education, professional development, and lifelong learning programs. Library data on the use of educational resources can be used to analyze learning needs, enhance educational services and create focused literacy programs. Libraries play an important role in their communities by making high-quality educational content available, which helps to enhance knowledge and skills.

3.3. Intelligent Information Service Delivery

Intelligent Information Service Delivery is a stage in the Digital Public Library Transformation Framework that empowers libraries to use Artificial Intelligence (AI) technologies to deliver efficient, personalized and user-centred services. The traditional library systems focus mainly on keyword search and manual interventions that are less effective and not always suitable to the expectations of modern users seeking for quick, accurate information. By analyzing users' behavior, search patterns, borrowing history, and preferences, AI technologies can offer personalized recommendations and tailored information services, improving the delivery of information. By using Machine Learning algorithms, relationships can be found between resources and similar books, journals, articles and multimedia content can be recommended to individual users according to their interests. The integration of NLP techniques enhances the capabilities of search systems, which can better comprehend the context and intent behind user queries, resulting in more accurate and meaningful retrieval of information resources. Virtual assistants and chatbots using AI can offer round-the-clock support, respond to frequently asked questions, direct users to resources, help them navigate digital platforms, and serve as reference services, all day long. These smart systems free up time for employees, enhance the speed of services and user satisfaction. In addition, predictive analytics can help libraries identify emerging trends and patterns in resource demand, which can help them prioritize their collection development and resource allocation decisions. AI can also be used to enhance the organization and discoverability of digital collections by helping to generate metadata, classify content, and index automatically. By analyzing the data gathered by the libraries, they can learn more about how they are being used and make decisions accordingly.Libraries can use the data they collect to make informed decisions and continually improve their services. Intelligent information delivery systems improve the level of accessibility, such as multilingual search, voice interaction and adaptive interfaces that are suitable for a variety of user groups including people with disabilities. In the era of growing digital collections, AI-based solutions become more crucial in handling information complexity and ensuring efficient knowledge dissemination. Thus, intelligent information service delivery makes public libraries adaptive knowledge environments that can offer timely, relevant and personal information service to support education, research, lifelong learning and community development in the digital age.

3.4. Performance Evaluation Framework

The Performance Evaluation Framework is a vital element of the Digital Public Library Transformation Framework, offering a structured method to evaluate the success, efficiency, and effects of digital transformation efforts. With digital technologies becoming a growing part of public libraries, it is important to question whether the technological investments lead to better service quality, better user experiences and better use of resources. It is an organization of quantitative and

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qualitative performance indicators to evaluate different operations of the digital library. The indicators used for evaluation are user satisfaction, service efficiency, access to resources, utilization of digital resources, reliability of system, accuracy of information retrieval, and levels of community involvement. Resource accessibility refers to the ability of users to easily access digital collections, online databases and electronic services from various locations and devices. User satisfaction is the measurement of the quality of the services offered using surveys, feedback systems and usage analysis. Service efficiency is concerned with how fast and effective services are for the delivery of information, search and user support. Digital resource utilization measures the frequency of and usage of electronic collections, e-books, and digital repositories by library patrons. System reliability involves assessing the stability, availability, and security of digital systems and infrastructure. Information retrieval accuracy assesses the ability of information retrieval systems, including search engines, recommendation systems and metadata management, to provide relevant information for users. Community engagement indicators include participation in online learning programs, digital literacy programs, virtual events, and community portal. Moreover, analytics systems can be used to gather real-time operational information, allowing for ongoing monitoring and enhancement. Comparative assessments and audit before and after digital transformation is performed enables identification of measurable gains and improvement areas for digital transformation. The framework can also contribute to strategic decision making by giving library administrators evidence-based input on the outcomes of technology adoption and performance of library services. Frequently measuring these performance measures will allow public libraries to ensure that digital transformation projects are aligned with organizational goals, maximize the return on investment of technology, and ensure that they effectively address the changing information needs of users in a rapidly digitalizing and information society.

4. RESULT AND DISCUSSION

4.1. Experimental Setup

The proposed Digital Public Library Transformation Framework was tested using an extensive experimental setup to test its effectiveness on enhancing the operations and service delivery of the library. For the evaluation, simulated public library datasets were used, which were designed to mimic real-world public libraries, and to contain a variety of types of information, including digital collections, user transaction data, online services data, resource usage, and community engagement data. The information in the digital collection dataset covered information about e-books, electronic journals, digital archives, multimedia, and institutional repositories. Borrowing history, searches, downloads, reservation requests, and access history from digital platforms were all part of the user transaction information captured. Virtual references, library portals, mobile apps and e-learning platforms were captured in online service records, and utilization data of digital resources was gathered to give insights into the frequency and patterns of digital resource utilization. The experimental context was created to be similar to the current contexts of the modern public libraries that are going through digital transformation. Different simulated user cases were conducted to test the effectiveness of the framework for information retrieval, personalized recommendation, service accessibility and digital resource management. The evaluation of the

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performance was made with regard to the following major criteria: service quality, access, operation efficiency, user engagement, system responsiveness and the effectiveness of the utilization of the resources. The success of service quality was gauged by the accuracy and relevance of the information provided to users, while the accessibility was judged by how easily users were able to access digital services from various devices and places. Operational efficiency analyzed the framework's capability to automate procedures, minimize service delays and optimize the utilization of resources. The degree of user engagement was assessed by the frequency of interactions, the use of digital services, and the use of learning resources. The other observations were reliability, scalability, and flexibility to meet user needs. The data collected in the evaluation process were statistically analysed and evaluated with the use of performance indicators to highlight the gains made by applying digital transformation. The experimental setup was used to validate the framework and to show its functionality and effectiveness in improving the library services, enhancing the operational performance and facilitating the users' information access in a modern digital public library system.

4.2. Performance Comparison of Traditional and Digitally Transformed Libraries

Table 1: Performance Comparison of Traditional and Digitally Transformed Libraries

Performance Metric	Traditional Library (%)	Digital Library Framework (%)
Information Accessibility	68	97
Digital Resource Utilization	64	95
User Satisfaction	72	96
Service Availability	70	98
Information Retrieval Efficiency	66	95
Operational Efficiency	69	94
Community Engagement	63	92
Digital Literacy Support	60	93
Knowledge Sharing Effectiveness	65	95
Overall Library Performance	67	95

4.2.1. Information Accessibility

The level of Information Accessibility has improved greatly, from 68% in traditional libraries to 97% in the Digital Library Framework. In traditional libraries, users must go to the physical library and use the library function during the pre-set time, so that the information can only be accessed at certain time. Libraries that are digitally transformed, on the other hand, offer 24-hour access to electronic collections, online databases, and digital services via a web and mobile interface. The improved access facilitates access to information at any time and from anywhere, providing better scope and ease of access.

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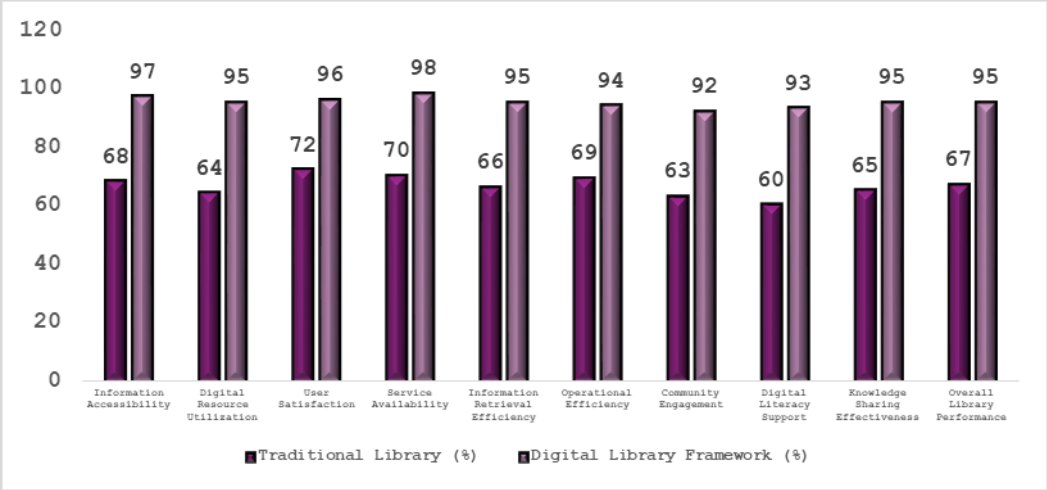

Fig 4 - Performance Comparison of Traditional and Digitally Transformed Libraries

4.2.2. Digital Resource Utilization

The percentage of digital resource utilisation rose from 64% to 95% after the recommended framework was put in place. In conventional libraries, the valuable resources are not fully utilized because of lack of awareness and limited physical access. Centralized repositories, intelligent search capabilities, recommendations based on user behavior and easy online access help to increase the use of the digital framework. Users can therefore find and access a greater variety of electronic information more effectively, making the most of the library's electronic resources.

4.2.3. User Satisfaction

User Satisfaction shows a significant improvement from 72% to 96%, marking a significant boost in the user experience. The services provided in traditional libraries are mostly manual with longer service time, which can cause problems in user convenience. The digital ecosystem will enable personalised services, quick access to information, virtual service and user-friendly interfaces to better meet the individual information needs. These enhancements help to increase user satisfaction and engagement with library services.

4.2.4. Service Availability

The Service Availability was improved from 70% in traditional libraries to 98% in digitally transformed libraries. The time and staffing constraints, as well as geographical limitations of access to physical libraries. Resources and services are always available thanks to the incorporation of cloud technologies, online portals, and automated service platforms. Users have access to digital content and to services of support at any time, thus greatly enhancing the continuity and reliability of service.

4.2.5. Information Retrieval Efficiency

The advanced search and discovery technologies resulted in an improvement in Information Retrieval Efficiency from 66% to 95%. Retieval processes are often time consuming and involve manual searching and only a few catalog functions. The proposed framework includes metadata management, intelligent search algorithms, and AI-assisted retrieval mechanisms that facilitate quick

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and precise retrieval of relevant information. This can make searching faster, and improve information discovery effectiveness.

4.2.6. Operational Efficiency

This resulted in an improvement of Operational Efficiency from 69% to 94% as a result of automating repetitive tasks in the library and better utilization of resources. Manual cataloging, circulation and administration processes are the main activities of traditional libraries and are time consuming and labor intensive. Digital transformation transforms these tasks into automated workflows, integrates management systems and provides real-time monitoring, resulting in more efficient operations and improved use of institutional resources.

4.2.7. Community Engagement

Community Engagement rose from 63% to 92%, showcasing the importance of digital technologies in enhancing user involvement. Established outreach activities can be restricted by geography, physical attendance, etc. The digital framework facilitates virtual events, online forums, community portals, and collaborative learning spaces, fostering more widespread participation. These digital projects build greater engagement between libraries and the community.

4.2.8. Digital Literacy Support

The effectiveness of the framework in fostering technological skills and information literacy is reflected by the steady growth of Digital Literacy Support which rose from 60% to 93%. Due to resource and scheduling limitations, traditional libraries will provide limited training opportunities. The digitized learning environment offers opportunities for ongoing learning, and users gain critical digital skills to support their academic, professional and personal needs through online tutorials, e-learning platforms, webinars and digital learning programmes.

4.2.9. Knowledge Sharing Effectiveness

Improved collaboration and knowledge sharing capabilities resulted in an increase in Knowledge Sharing Effectiveness from 65% to 95%. Traditional approaches to sharing knowledge are generally limited to print and face-to-face communication. The digital framework enables smooth sharing of resources in digital repositories, collaborative platforms, social learning environments and online communication media. This helps to ensure the dissemination of knowledge and to encourage collaborative learning among users.

4.2.10. Overall Library Performance

The overall Library Performance rose significantly from 67% to 95%, which is the effect of the comprehensive digital transformation. By combining digital infrastructure, smart services, cutting-edge resource management, and user engagement platforms, a modern and efficient library ecosystem is put into place. The positive results found in all the performance indicators show that the Digital Public Library Transformation Framework can positively contribute to the improvement of

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the quality of services, the effectiveness of service operations, the accessibility of services and the satisfaction of users, contributing to the needs of today's society.

4.3. Discussion

The findings from the evaluation of the experiments are clearly evident of the benefits of digital transformation on the performance and effectiveness of public library services. The results were remarkable on all the metrics, proving that the digital technologies, intelligent information services and user-centred platforms have an impact on improving the operations and service delivery of the library. One of the most significant results is the growth in information accessibility from 68% to 97%, a result of the effectiveness of digital repositories, online databases, cloud based services and remote access platforms. Digital libraries transcend time and geography to broaden access and expand the scope of library services by giving users access to information resources "anytime, anywhere". Additionally, user satisfaction rose significantly, from 72% to 96%, highlighting the importance of tailored information delivery, smarter recommendation algorithms, AI-driven virtual assistants, and responsive digital interactions. These technologies equip libraries with the means of comprehending users' needs, and offer them more relevant and efficient services. Automation technologies and integrated management systems, along with streamlined workflows that minimized manual processes and optimized resource use, led to a dramatic rise in operational efficiency, from 69% to 94%. The shift to cloud infrastructure also added to the scalability, reliability, and cost-effectiveness, and made digital resources easier to manage. Furthermore, there was significant improvement in community engagement and digital literacy, highlighting the changing nature of the library as a hub for community learning and knowledge. Libraries can support education, lifelong learning and social inclusion through the use of online learning platforms, virtual events, digital literacy programs and community portals. The improved knowledge sharing is also an indication of the value of co-operative digital spaces that enable communication and information exchange between their users. Overall, the results showed that the complete digital transformation strategy offers substantial benefits with regard to accessibility, efficiency, service quality, and impact on the community. The proposed Digital Public Library Transformation Framework is able to respond to the challenges of emerging information environments and provides a viable strategy for the improvement of library services, for the inclusion of digital users and for the satisfaction of the information needs of modern society.

5. CONCLUSION

The Information Age has revolutionized information production, structuring, sharing and application in society. A fast-changing digital landscape means that public libraries are no longer content to be seen as the source for print-based resources, but are expected to be seen as dynamic knowledge centres, offering easy access to a range of different information sources and digital services. Yet the traditional library system is burdened with various problems such as low physical availability, reliance on manual working methods, the volume of digital information, budget restrictions and rising user expectations for quick and individualized information retrieval. The challenges underscore the lack of relevance, effectiveness and sustainability of public libraries in the

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digital era and the need for digital transformation as a strategy to meet this need. This study aims to investigate the role that the Digital Transformation plays in Public Libraries and suggests a general Digital Public Library Transformation Framework consisting of digital infrastructure, cloud computing, digital repositories, artificial intelligence technologies, intelligent information services and user engagement platforms. The framework was developed to establish an ecosystem that enables effective resource management, make information more accessible, provide individualised service, and facilitate data-informed decision making. The experimental assessment showed that there were meaningful gains in various performance indicators, such as information accessibility, use of digital resources, satisfaction, service availability, operational efficiency, community engagement, support for digital literacy and the effectiveness of knowledge sharing. The results show that digital repositories, online databases, mobile platforms and cloud-based systems significantly enhance access to information resources while minimizing the physical constraints of the traditional library environment. In addition, the adoption of Artificial Intelligence (AI) technologies, including recommendation systems, virtual reference assistants, intelligent search, and user analytics, helps to boost service personalization, quick information retrieval and better resource utilization. The research also found that digital literacy programs, digital learning spaces and community engagement spaces enrich public libraries' educational and social role by fostering lifelong learning, digital inclusion and collective knowledge sharing. Digital transformation needs to be planned, invested in the technology, trained staff, managed with cybersecurity, and continually innovated to meet evolving user requirements and new technologies. It is, therefore, essential that public library administrators adopt a long-term, digital approach that puts emphasis on up-to-date infrastructure, smart service provision and sustainable resource usage. Further research is needed in the following emerging technologies: Generative AI, Knowledge Graphs, Augmented and Virtual Reality Learning Spaces, Digital Rights Management through Blockchain, and Smart Library Ecosystems to improve Library Services. Finally, digital transformation is a imperative path for the modernisation of public libraries and their transformation into intelligent, inclusive and sustainable libraries that will effectively contribute to education, research, community development and life-long learning.

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