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Beyond Technology Adoption: Examining Institutional Barriers to Digital Transformation in Higher Education Libraries of Punjab, Pakistan

Ayesha Yaseen

Research Scholar, School of Information Management, Minhaj University Lahore, Pakistan.

Mukhtar Ahmed

Lecturer (Statistics), Govt. Graduate College (Boys), Satellite Town, Gujranwala, Pakistan.

Muhammad Nadeem Akhtar

Head, Main Library & IT Department, Ayub Agricultural Research Institute, Faisalabad, Pakistan.

Dr. Muhammad Naushad Sabzwari

Chairman/Associate Professor, School of Information Management, Minhaj University Lahore, Pakistan.

Sidra Batool (Corresponding Author)

Technical Librarian, Ayub Agricultural Research Institute, Faisalabad, Pakistan.

sidra.batool@aari.punjab.gov.pk

Hafiz Muhammad Ijaz

Scientific Officer (Statistics), Statistical Section, Ayub Agricultural Research Institute, Faisalabad, Pakistan.

Muhammad Waqas

Research Scholar, Department of Public Administration, Government College University Faisalabad, Pakistan.

Ghulam Farid

Senior Librarian, Shalamar Medical & Dental College, Lahore & PhD Scholar, Institute of Information Management (IIM), University of the Punjab, Lahore, Pakistan

bcs@yahoo.com

Misbah Jabeen

Department of Information Management, University of Home Economics, Lahore, Pakistan

misbah.jawwad@yahoo.com

ABSTRACT

Digital transformation has reshaped the role of higher education libraries from traditional physical repositories into digitally enabled environments that support preservation, discovery, access and dissemination of scholarly resources. However, successful digitization of library collections is not merely dependent on technology acquisition; it requires appropriate digital infrastructure, skilled human resources, strategic planning, financial sustainability, institutional support, maintenance capacity and consideration of intellectual property and preservation issues. This study investigates the challenges faced by higher education libraries in implementing digital content management and digitization initiatives in Punjab, Pakistan. A quantitative survey

research design was employed using a structured questionnaire developed from existing literature and validated through expert review, pilot testing and reliability analysis. The study population consisted of 77 HEC Recognized public and private universities in Punjab and responses were obtained from 62 university libraries. Data were collected through an online questionnaire and analyzed using descriptive statistics in SPSS 21. The reliability analysis demonstrated acceptable internal consistency, with Cronbach's alpha values ranging from 0.772 to 0.861 across the study dimensions. Findings revealed that digitization implementation remains uneven among university libraries, with many institutions either not initiating digitization or operating at early stages, while only a small number had fully functional digital systems. The major barriers identified included inadequate technological infrastructure, limited availability of digitization equipment, software related challenges, financial constraints, human resource deficiencies and insufficient strategic planning. Among these challenges, software upgrading, technological resource limitations, financial constraints and inadequate system availability emerged as the most critical concerns. The study further highlighted the importance of staff training, professional expertise, institutional planning and effective management support for successful digital transformation. It concludes that sustainable digitization requires an integrated institutional approach rather than technology adoption alone. The study recommends developing formal digitization policies, ensuring dedicated funding, strengthening library-IT collaboration, enhancing professional development opportunities, establishing systematic content selection and preservation practices and continuously monitoring digital services. These findings provide practical guidance for university administrators, policymakers and library professionals to develop sustainable digital transformation frameworks for higher education libraries in Pakistan.

Keywords: Digital Transformation; Digitization; Higher Education Libraries; University Libraries; Digital Content Management; Digital Repositories; ICT Infrastructure; Digital Competencies; Pakistan.

Introduction

The rapid advancement of information and communication technologies (ICTs) has significantly transformed higher education institutions worldwide by reshaping teaching, research, administration, knowledge management and academic communication. Universities increasingly rely on digital technologies to improve access to information, enhance operational efficiency, support scholarly communication and develop innovative academic services. However, digital transformation extends beyond the adoption of technological tools; it represents a comprehensive institutional change involving technological infrastructure, organizational processes, human capabilities, leadership commitment and strategic planning (Kumar et al., 2023; Singun, 2025). Unlike simple digitization, which mainly focuses on converting analogue materials into digital formats, digital transformation involves redesigning institutional processes, developing new capabilities, improving service delivery and establishing sustainable digital ecosystems. Therefore, successful digital transformation requires integration between technological investment, organizational readiness and workforce competency.

University libraries are among the major institutional units experiencing this transformation. Traditionally, academic libraries focused on collecting, organizing, preserving and providing

access to printed resources. However, technological developments have transformed libraries into digitally enabled knowledge centers that provide electronic resources, institutional repositories, online catalogues, digital archives and remote information services. This transformation has expanded the role of librarians from traditional collection managers to digital information specialists responsible for managing electronic resources, metadata, digital preservation, repositories and technology supported services. Khoeini et al. (2024) highlighted that digital transformation in university libraries consists of interconnected dimensions, including digital culture, digital librarians, digital services, technological infrastructure, institutional support, work process transformation and strategic planning. Thus, library transformation requires simultaneous development of technology, human expertise and institutional structures rather than technology adoption alone.

Digitization represents a fundamental component of library transformation and refers to the conversion of analogue materials into digital formats that can be stored, processed, retrieved and accessed through electronic systems. In academic libraries, digitization commonly involves books, manuscripts, theses, dissertations, photographs, journals and archival collections. However, successful digitization extends beyond scanning and conversion activities. It requires systematic processes involving material selection, copyright assessment, metadata creation, quality control, digital storage, preservation planning and user access management. Lopatin (2006) identified project management, financial sustainability, content selection, legal considerations, metadata development, interoperability and preservation as major challenges associated with library digitization projects. Despite these challenges, digitization provides significant benefits by improving remote access to scholarly resources, preserving fragile collections, increasing institutional visibility and promoting knowledge dissemination.

Institutional repositories have become an essential component of academic library digitization strategies because they enable universities to collect, organize, preserve and disseminate scholarly outputs, including research articles, theses, dissertations, conference proceedings and historical collections. However, sustainable repository development requires appropriate software platforms, metadata standards, reliable storage infrastructure, technical expertise and long-term preservation strategies. Digital collections require continuous management because technological changes may affect accessibility, compatibility and usability over time. Research from Pakistan indicates that university libraries recognize the importance of digital repositories but continue to face challenges related to financial support, technological infrastructure, skilled personnel and institutional policies (Ameen & Rafiq, 2009; Rafiq & Ameen, 2014).

Despite the advantages of digitization, sustainable implementation remains challenging, particularly in developing countries where academic libraries often experience limitations in resources and institutional capacity. Effective digitization requires continuous investment in hardware, software, storage systems, technical support, staff training and preservation mechanisms. Technological challenges include software selection, interoperability, system maintenance and infrastructure limitations, whereas human resource challenges involve insufficient digital competencies, limited training opportunities and shortage of specialized expertise among library professionals. Institutional barriers include weak policies, inadequate

strategic planning, limited leadership support and competing organizational priorities. Khan and Bhatti (2017) emphasized that modern digital librarians require competencies beyond traditional library practices, including digital repository management, electronic resource management, metadata creation and technology-based services. Similarly, Rafiq et al. (2018) identified inadequate funding, shortage of skilled professionals and technological limitations as major barriers affecting digitization initiatives in Pakistani university libraries.

In Pakistan, higher education institutions have gradually adopted digital technologies through automated library systems, electronic resources and institutional repositories. However, digitization development remains uneven because universities differ in technological readiness, financial capacity, professional expertise and institutional commitment. Earlier research on digital library development in Pakistan emphasized that successful implementation requires technological resources, financial investment, professional skills and organizational support (Ameen & Rafiq, 2009). Subsequent studies examined digitization capability, digital resource requirements, sustainability and development frameworks in Pakistani university libraries (Rafiq & Ameen, 2012, 2013, 2014, 2016). These studies provide valuable insights; however, most focused on individual aspects of digitization rather than examining the combined technological, human, strategic, operational and financial barriers influencing digital transformation.

Although previous research has contributed to understanding digital library development and sustainability in Pakistan, limited empirical evidence exists regarding the interconnected challenges affecting digitization implementation in higher education libraries of Punjab. Contemporary digital transformation research demonstrates that technological problems are closely linked with organizational strategy, human capability, leadership support and financial sustainability (Khoeini et al., 2024; Kumar et al., 2023; Singun, 2025). Therefore, a comprehensive examination of multiple dimensions is required to understand the barriers affecting sustainable digital transformation in university libraries.

This study addresses this research gap by investigating digitization challenges in higher education libraries of Punjab, Pakistan, with particular emphasis on software selection problems, human resource limitations, strategic planning barriers, software maintenance issues and overall implementation challenges.

Research Questions

1. What software related problems affect digitization initiatives in university libraries?
2. What human resource challenges influence digitization implementation?
3. What strategic planning barriers affect digitization projects?
4. What software maintenance problems exist in university libraries?
5. What overall challenges influence digitization processes?

Literature Review

Digitization in academic libraries is a complex transformation process involving collection assessment, technical conversion, metadata creation, digital access, preservation and governance. Although digitization begins with converting analogue resources into digital formats, sustainable digital collections require appropriate planning, financial resources, technological infrastructure, skilled personnel and institutional policies. Previous research

identifies project management, funding, content selection, copyright management, metadata development, interoperability and preservation as major components influencing the success of digitization projects (Lopatin, 2006). Therefore, the availability of scanners, repository platforms, or storage systems alone cannot ensure successful digital transformation unless supported by effective organizational processes and long-term sustainability strategies. Research from developing countries demonstrates that digitization challenges are interconnected rather than limited to technological issues. Studies conducted in Pakistani university libraries have identified inadequate infrastructure, financial limitations, insufficient professional expertise and weak policy frameworks as major constraints affecting digital library development (Rafiq et al., 2018). Similarly, research on digital preservation highlights that institutional commitment, administrative support, sustainable funding and appropriate technological resources are essential for maintaining digital collections over time.

Technological infrastructure represents one of the fundamental requirements for digitization. Academic libraries require reliable hardware, including computers, scanners, cameras, servers, storage systems and network facilities, along with appropriate software platforms for managing digital objects, metadata and preservation activities. The selection of suitable repository software is particularly important because digital collections require interoperability, scalability, security and long-term accessibility. Although platforms such as DSpace have become widely adopted for institutional repositories, effective implementation depends on institutional capacity, technical expertise and continuous system maintenance.

Previous studies have reported that technological limitations remain significant barriers in academic libraries. Liu (2004) highlighted that outdated equipment; poor quality scanning systems, inadequate hardware and weak technical infrastructure negatively affect digitization quality. Similarly, Belcher and Sexton (2008) emphasized that insufficient financial resources often prevent institutions from acquiring modern ICT equipment required for digital projects. Evidence from Nigerian university libraries further demonstrated that inadequate funding, limited ICT expertise and insufficient technical support create difficulties in establishing sustainable digital collections (Balogun & Adjei, 2019). These findings correspond with the present study, where technological resources, software upgrading and system availability emerged as major challenges among university libraries in Punjab.

Human resource capacity is another critical factor influencing digitization success. Digital transformation requires librarians to develop competencies in digitization workflows, metadata creation, institutional repositories, database management, digital preservation and technical troubleshooting. Mathews and Pardue (2009) emphasized that librarians require ICT expertise in areas such as web technologies, system applications, software management, learning management systems, digitization and RFID based services to remain effective in modern information environments.

Evidence from Pakistan indicates that ICT competencies among library professionals remain uneven. Abbas and Siddique (2020) examined ICT skills among university library professionals in Punjab and highlighted the need for strengthening digital competencies. Similarly, Ahmad and Rehman (2016) reported that library and information science professionals in Khyber

Pakhtunkhwa possessed relatively stronger skills in library management systems but demonstrated moderate competency in areas such as digitization, institutional repositories, cloud computing and advanced digital services. These findings indicate that although librarians recognize the importance of digital technologies, continuous professional development is necessary to improve advanced digital skills.

Training and adaptive capability are therefore essential components of digital transformation. Adzic (2013) emphasized that technical staff or system engineers should provide practical training and supervision during digitization activities, particularly for equipment operation and workflow management. Similarly, Balogun and Adjei (2019) found that insufficient ICT staff created difficulties in managing digitized collections because successful digitization requires specialists capable of handling computers, scanners, databases, servers and digital preservation systems. Training enhances employees' knowledge and skills, improves adaptive performance and enables organizations to respond effectively to technological change (Tabiu et al., 2018; Charbonnier Voirin & Roussel, 2012). Therefore, human resource development should be considered a continuous organizational investment rather than a one-time intervention.

Strategic planning and institutional governance are equally important for sustainable digitization. Digital projects require formal policies that define collection selection criteria, copyright responsibilities, metadata standards, preservation procedures, access conditions and long-term maintenance responsibilities. Balogun and Adjei (2019) reported that the absence of digitization policies created uncertainty regarding which records should be selected, how digitization activities should be prioritized and how resources should be managed. Similarly, Adeagbo et al. (2017) emphasized that successful digitization requires detailed planning, including workflow development, cost estimation, resource allocation, preservation preparation and financial planning.

Leadership and institutional commitment also influence digitization outcomes. Karugu et al. (2018) identified leadership challenges and bureaucratic decision-making processes as barriers affecting digital initiatives, while Blair (2005) highlighted that unclear governance structures can limit coordination and project implementation. These findings demonstrate that digitization requires not only technical expertise but also strategic leadership and institutional commitment. Financial sustainability remains one of the most persistent barriers affecting digital transformation. Digitization requires investment throughout the entire lifecycle of digital resources, including acquisition of equipment, software development, storage management, technical support, migration and preservation. Bailey Hainer and Urban (2004) and Belcher and Sexton (2008) identified lack of financial resources as a major obstacle affecting digital projects. Similarly, Anyaoku et al. (2018) found that although African university repositories adopted digital preservation practices, many institutions continued to experience difficulties due to insufficient long-term funding and shortages of technically skilled personnel.

Software maintenance and long-term preservation represent additional challenges. Digital collections require continuous upgrading because technological changes can affect file formats, accessibility, compatibility and security. Ahmad and Rehman (2016) noted that managing digital resources requires specialized expertise because access to digital objects depends on complex

hardware and software environments. Eyekpegba (2009) further emphasized that lack of stakeholder involvement and inadequate user education can reduce the effectiveness of digital information services.

The digitization process also involves challenges related to content selection, preservation, ethical issues and user access. Selection criteria are important because inappropriate choices may result in resources being digitized that have limited long term value or accessibility problems (Ahmad & Rehman, 2016). Madge and Robu (2019) emphasized that future digital library development requires attention to resource diversity, digital tools, information access and dissemination strategies. Ethical concerns also influence digitization decisions, including copyright, ownership, privacy and responsible dissemination of digital materials (Manžuch, 2017).

Digital preservation studies further demonstrate that sustainable management requires appropriate policies, skilled personnel, financial support and preservation frameworks. Matlala (2019) found that university archives faced challenges related to limited digital preservation expertise, inadequate policies, insufficient funding, outdated technologies and shortages of ICT specialists. Similarly, studies of special collections and rare books have identified metadata deficiencies, unstable digital platforms, inadequate search functionality and insufficient user-oriented services as important challenges affecting digital access and preservation (Zlatkova & Angelova, 2019).

Overall, the literature demonstrates that digitization challenges are multidimensional, involving technological, human, financial, strategic and operational factors. However, previous studies have often examined individual aspects of digitization rather than integrating these dimensions within a single framework. Therefore, the present study contributes by examining software related issues, human resource challenges, strategic planning barriers, maintenance problems and overall digitization challenges in higher education libraries of Punjab, Pakistan.

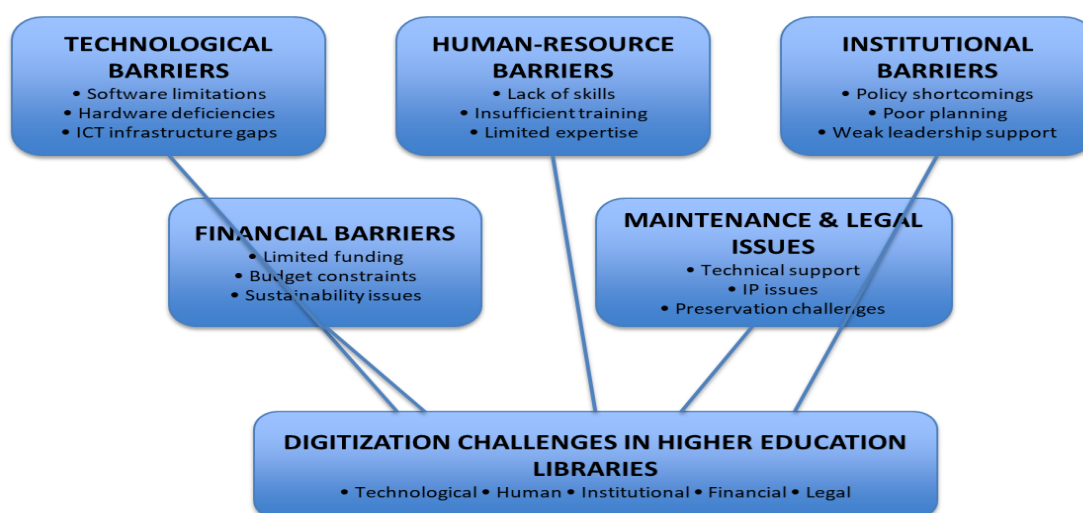


Figure. Conceptual Framing of Digitization Barriers in Higher Education Libraries

Research Gap

Previous research in Pakistan has examined various aspects of digital library development, including the potential of digitization, ICT competencies of library professionals, digitization

capabilities, standardization requirements, sustainability issues and general barriers affecting digital transformation. However, most existing studies have focused on specific dimensions or national level perspectives, providing limited empirical evidence on the combined technological, organizational and operational challenges affecting university libraries within a specific regional context. Despite increasing recognition of the importance of digital transformation in higher education libraries, limited research has systematically investigated the interconnected challenges faced by university libraries in Punjab, Pakistan. In particular, insufficient attention has been given to the combined influence of software selection, hardware and technological infrastructure, human resource capabilities, strategic planning, digital content management systems and overall implementation barriers. Therefore, this study addresses this research gap by providing a province level empirical investigation of digitization challenges among higher education libraries in Punjab. By examining multiple dimensions simultaneously, the study contributes a comprehensive understanding of the factors that influence successful digitization implementation and provides evidence-based recommendations for developing sustainable digital library frameworks in Pakistan.

Material and Methods

This study employed a quantitative survey research design to examine digitization challenges faced by higher education libraries in Punjab, Pakistan. The approach was selected because it enabled systematic measurement of the prevalence and intensity of barriers related to software selection, hardware and infrastructure, human resources, strategic planning, software maintenance and overall digitization implementation. The study population consisted of HEC recognized public and private sector universities in Punjab, Pakistan. A total population sampling approach was adopted to achieve comprehensive coverage and data were obtained from 62 university libraries, including 40 public sector (64.5%) and 22 private sector (35.5%) institutions. Data were collected through a structured questionnaire developed from previous digitization and digital library research. The instrument covered five major dimensions: software selection problems, hardware and infrastructure challenges, human resource issues, digital content management software problems and overall digitization challenges. Responses were measured using a Likert scale format. The questionnaire was validated through literature review, expert evaluation and pilot testing. The reliability of the instrument was assessed using Cronbach's Alpha, with values ranging from 0.772 to 0.861, indicating acceptable internal consistency across all dimensions. The highest reliability was observed for overall digitization challenges ($\alpha = 0.861$), while digital content management software problems showed the lowest value ($\alpha = 0.772$). All constructs exceeded the recommended threshold of 0.70, confirming the reliability of the measurement instrument. Data were collected from professional library staff involved in library operations and digitization activities. The collected responses were analyzed using SPSS, applying descriptive statistical techniques, including frequencies, percentages, mean scores, median and mode, to identify the extent and intensity of digitization challenges among university libraries.

Table 1. Respondent Profile and Digitization Status of University Libraries

Category	Sub Category	Frequency (%)
University Sector	Public Universities	40 (64.5%)
	Private Universities	22 (35.5%)
Professional Designation	Chief Librarian	9 (14.5%)
	Deputy Chief Librarian	4 (6.5%)
	Senior Librarian	10 (16.1%)
	Librarian	20 (32.3%)
	Assistant Librarian	19 (30.6%)
Qualification	PhD	4 (6.5%)
	Mphil	32 (51.6%)
	BS/Master	25 (40.3%)
Digitization Status	Digitization Started	24 (39%)
	Digitization Not Started	38 (61%)
Current Stage	Not Started	18 (29.0%)
	Initial Stage	20 (32.5%)
	Middle Stage	20 (32.5%)
	Fully Functioning	4 (6.0%)

The study received 62 responses from 77 contacted universities (80.51% response rate). The sample mainly consisted of experienced library professionals from public sector universities.

Table 2. Major Technological, Software and Infrastructure Challenges Affecting Digitization

Challenge Area	Key Indicators	Mean Score / Evidence
Hardware limitations	Lack of digital cameras, scanners, servers and digitization equipment	29 libraries lacked eye scanners; 31 lacked handheld scanners; 21 lacked servers; 39 lacked digital cameras
Software and system issues	Software upgrading requirements	3.88
	Technological development support	3.80
	Web management support	3.75
	System availability according to requirements	3.61
Software support problems	Financial issues for software purchase	3.50
	Technical assistance availability	3.45
Infrastructure planning	Complete infrastructure planning problems	3.70

The findings indicate that technological capacity remains a major barrier. Universities face shortages of digitization equipment, limited software support and difficulties maintaining appropriate digital infrastructure.

Table 3. Human Resource, Strategic and Institutional Challenges in Digital Transformation

Challenge Dimension	Major Issues	Mean Score
Human Resource Challenges	Lack of orientation about new developments	3.82
	Problem solving expertise	3.80
	Day to day issue solving skills	3.77
	Lack of training facilities	3.67
	Lack of trained professionals	3.59
Strategic Planning Challenges	Infrastructure planning for digitization	3.70
	Decisions regarding retrospective document uploading	3.69
	Strategy development difficulties	3.56
	Lack of digitization planning	3.48
Institutional/Funding Challenges	Software upgrading	3.88
	Technological resources	3.87
	Financial resources	3.87
	Limited management interest	3.79
	Preservation cost concerns	3.77
	Intellectual property concerns	3.75

The study received responses from 62 university libraries out of 77 contacted institutions, representing an overall response rate of 80.51%. The participating institutions included both public and private sector universities, with public sector universities contributing the majority of responses (64.5%), while private sector universities accounted for 35.5%. The respondent profile indicates that the study captured perspectives from experienced library professionals directly involved in university library operations. Librarians constituted the largest respondent group (32.3%), followed by assistant librarians (30.6%), senior librarians (16.1%), chief librarians (14.5%) and deputy chief librarians (6.5%). Regarding academic qualifications, more than half of the respondents possessed MPhil degrees (51.6%), followed by BS/Master level qualifications (40.3%), while PhD qualified professionals represented 6.5% of participants. The professional experience profile further demonstrated that most respondents had substantial practical exposure, particularly those with 6–10 years (33.9%) and 11–15 years (32.3%) of experience. These characteristics indicate that the findings were obtained from knowledgeable professionals with direct understanding of library management practices and digitization activities. The findings revealed that digital transformation in university libraries of Punjab remains at an early developmental stage. Among the 62 participating libraries, only 24 institutions (39%) had initiated digitization activities, whereas 38 libraries (61%) had not yet started formal digitization processes. The assessment of digitization maturity demonstrated uneven progress, with 18 libraries (29%) reporting no digitization activity, 20 libraries (32.5%) operating at the initial stage,

20 libraries (32.5%) functioning at the middle stage and only four libraries (6%) reporting fully developed digitization systems. These findings suggest that although universities recognize the importance of digital transformation, practical implementation remains limited due to technological, financial and organizational constraints. The small proportion of fully functioning digitization systems highlights the gap between institutional awareness and actual implementation capacity. Technological infrastructure emerged as one of the major challenges affecting digitization initiatives. The equipment assessment showed considerable shortages among university libraries, particularly regarding essential digitization tools. Specifically, 29 libraries lacked eye scanners, 31 lacked handheld scanners, 21 lacked servers and 39 reported the absence of digital cameras. These limitations indicate that many institutions face difficulties in establishing complete digital workflows involving scanning, storage, preservation and access. Software related challenges were also prominent, with software upgrading identified as the most significant concern, followed by technological development support, web management support and availability of systems according to institutional requirements. Financial difficulties associated with software acquisition and maintenance, along with limited technical assistance, further affected the sustainability of digital systems. Overall, the findings demonstrate that successful digitization requires continuous investment in infrastructure, software improvement, technical support and system maintenance rather than one time technology adoption. Human resource capacity was identified as another critical factor influencing digital transformation. Respondents reported that insufficient professional development, limited technical expertise and inadequate training opportunities created significant barriers to digitization. Among human resource challenges, lack of orientation regarding new technological developments represented the most prominent concern, followed by limited problem-solving expertise and inadequate day to day technical skills. Lack of training facilities, shortage of trained professionals and insufficient software related training were also identified as important issues. These findings indicate that digital transformation requires librarians to develop competencies beyond traditional library practices, including digital repository management, metadata creation, software administration, troubleshooting and digital preservation. The results further demonstrate that technology adoption without corresponding human resource development may limit the effectiveness and sustainability of digitization initiatives. The findings also highlighted the importance of strategic planning and institutional management in successful digitization. The most significant strategic challenge was inadequate planning for complete digitization infrastructure, followed by uncertainty regarding decisions related to retrospective document uploading. Additional concerns included difficulties in developing digitization strategies, selecting materials for digitization, obtaining project guidance and establishing comprehensive digitization plans. These findings suggest that many university libraries lack structured digitization roadmaps defining priorities, workflows, responsibilities and long-term sustainability mechanisms. Therefore, effective digital transformation requires not only technological resources but also institutional policies, leadership commitment and systematic planning. The overall assessment of digitization challenges demonstrated that barriers are interconnected and extend beyond technological limitations. Software upgrading emerged as the most critical challenge, followed

by technological resources, financial resources and availability of systems according to institutional requirements. Other important concerns included competing institutional priorities, availability of skilled human resources, limited management interest, preservation and management costs of digital objects, development of digitization policies and procedures and intellectual property concerns. Additional challenges included information technology issues, document uploading difficulties, provision of digital reading materials and selection of materials for digitization. Collectively, the findings from the original 23 tables demonstrate four interconnected dimensions of digital transformation barriers: technological barriers related to infrastructure, software limitations and system sustainability; human resource barriers associated with skills, training and professional development; strategic barriers involving planning, policies and institutional coordination; and financial and managerial barriers related to funding limitations, competing priorities and leadership support. Therefore, digital transformation in Punjab University libraries should be understood not merely as a technology adoption process but as a broader institutional transformation requiring coordinated technological investment, human resource development, strategic planning and sustainable financial commitment.

Discussion

The findings of this study demonstrate that digitization challenges in higher education libraries extend far beyond the acquisition of technological equipment. Although software upgrading, technological resources, financial resources and system availability emerged as the most prominent challenges, their association with human resource limitations, management support, strategic planning and preservation requirements indicates that digitization is fundamentally an institutional transformation process rather than a purely technical activity. The results suggest that acquiring scanners, software platforms, or digital storage systems does not automatically ensure successful digital transformation unless libraries also possess skilled personnel, sustainable funding mechanisms, effective maintenance strategies, clear policy frameworks and structured implementation plans. This interpretation supports previous evidence from Pakistan showing that digitization barriers involve interconnected technological, financial, human and policy related factors rather than isolated technical limitations (Rafiq et al., 2018). Similarly, research on digital preservation has emphasized that institutional policies, administrative support, financial capacity and technological readiness collectively determine the sustainability of digital initiatives. Therefore, the Punjab findings reinforce the broader socio institutional perspective that successful digitization requires coordinated development of technology, people and governance structures.

The human resource findings highlight the critical role of professional competency in sustaining digital transformation. The results indicate that lack of orientation regarding technological developments, limited problem-solving expertise; insufficient technical skills and inadequate training opportunities represent significant barriers. These findings suggest that digitization generates continuous operational requirements rather than a onetime implementation challenge. Library professionals must continuously adapt to new software systems, manage digital repositories, resolve technical problems, maintain metadata quality and support digital

preservation activities. Previous research from Pakistan has similarly identified digital competency development as an important concern among university librarians, emphasizing the need for continuous professional development rather than occasional training interventions. International evidence also demonstrates that successful digital transformation depends on competent staff, management support and opportunities for continuous skills development. Therefore, the findings support the need for institutional training frameworks that integrate digital competencies into professional development strategies for academic librarians. The results further demonstrate that strategic planning and governance significantly influence digitization outcomes. Challenges related to infrastructure planning, retrospective document selection, strategy development and project guidance indicate that many institutions face uncertainty regarding priorities, workflows and long-term implementation approaches. These issues suggest that digitization decisions are not only technical but also managerial and strategic. Libraries require clear policies defining collection selection criteria, responsibilities, copyright management, preservation procedures and sustainability mechanisms. Previous research on digital curation and preservation in Pakistan has similarly reported that awareness of digitization concepts does not always translate into formal institutional policies. The present findings reinforce the importance of developing comprehensive digitization strategies supported by leadership commitment, institutional coordination and clearly defined operational procedures. Financial sustainability emerged as another major determinant of successful digitization. Although financial resources were identified as a significant challenge, the findings also highlight concerns regarding preservation and management costs of digital objects. This distinction indicates that respondents were concerned not only with the initial investment required for digitization but also with the recurring costs associated with storage, system upgrades, technical support, migration and long-term preservation. Digital collections require continuous financial commitment throughout their lifecycle; therefore, project-based funding alone may not be sufficient to maintain sustainable digital services. Previous studies have similarly emphasized that inadequate financial resources and limited administrative support restrict digital preservation and transformation initiatives. The findings from Punjab therefore indicate that universities need long term financial planning mechanisms that consider both implementation and maintenance requirements. The results also demonstrate that digitization involves important intellectual property and preservation considerations. Intellectual property concerns and digital object management costs were among the notable challenges identified by respondents, highlighting that digitization does not end with the creation of digital copies. Sustainable digital collections require appropriate copyright management, metadata standards, preservation strategies, storage planning and future accessibility mechanisms. Earlier digitization literature has identified legal issues, copyright management, metadata development, interoperability and preservation as essential components of successful digital projects (Lopatin, 2006). Therefore, university libraries must adopt comprehensive digitization frameworks that address the entire lifecycle of digital resources rather than focusing only on scanning and storage activities.

The findings from Punjab also demonstrate similarities with international experiences in developing higher education environments. Studies from Uganda have identified inadequate ICT infrastructure, limited funding, insufficient digital skills and shortages of competent staff as major barriers affecting university library digital transformation. Similarly, research from India has highlighted the importance of institutional policies and strategic support in overcoming digital library development challenges. The convergence of findings across different contexts suggests that digital transformation in resource constrained higher education systems requires coordinated institutional capacity rather than isolated technological investment. Despite differences in national environments, libraries face common challenges related to infrastructure readiness, professional competencies, governance and sustainability. Overall, this study contributes empirical evidence that digitization challenges in Punjab University libraries represent a multidimensional institutional transformation issue. The findings demonstrate that technology, human resources, strategy, finance and governance are interconnected components of successful digital transformation. Consequently, universities seeking sustainable digital library development should adopt integrated approaches that combine technological investment with professional development, policy formulation, strategic planning and long term financial commitment.

Theoretical and Practical Implications

Theoretical Implications

This study contributes to the understanding of digital transformation in academic libraries by supporting a socio technical perspective in which technological, human, organizational, financial and governance factors interact to influence digitization readiness. The empirical findings demonstrate that successful digital transformation cannot be explained through technological availability alone; rather, it depends on the alignment between digital infrastructure, professional competencies, institutional planning, financial capacity and administrative support. The study therefore provides empirical support for viewing digitization readiness as a multidimensional construct involving interconnected institutional capabilities. However, because the study adopted a descriptive research design, it does not establish causal relationships among these dimensions. Instead, the findings provide an evidence-based interpretation of the different factors that collectively shape digitization challenges within higher education libraries. This contributes to the broader digital transformation literature by demonstrating how socio technical conditions influence the progress and sustainability of digital initiatives in resource constrained academic environments.

Practical Implications

The findings provide important implications for university administrators, policymakers and library professionals. Universities should develop formal digitization policies that clearly define collection selection priorities, institutional responsibilities, copyright and rights management procedures, metadata standards, preservation requirements and periodic review mechanisms. Such policies can provide strategic direction and prevent fragmented digitization activities. Institutions should also establish dedicated and recurring financial support for digitization projects. Funding mechanisms should not be limited to the initial acquisition of equipment but

should include software upgrades, storage requirements, technical support, preservation activities and continuous professional development. The findings further highlight the need for stronger collaboration between library and information technology departments. Joint digitization teams can improve software selection, infrastructure planning, system maintenance, troubleshooting and long-term technical sustainability. Continuous professional development should be incorporated into institutional strategies to strengthen librarians' competencies in digital repository management, metadata creation, digital preservation, software administration and emerging technologies. Furthermore, universities should adopt phased digitization roadmaps with measurable objectives, allowing institutions at different maturity levels to progress systematically. Regular monitoring and evaluation mechanisms should also be introduced to assess infrastructure development, collection growth, system performance, preservation status and user accessibility.

Recommendations

Based on the empirical findings, the study proposes several recommendations for improving sustainable digitization practices in higher education libraries. Universities should establish comprehensive digitization policies aligned with professional standards and institutional priorities. A dedicated annual budget should be allocated for digitization and digital preservation activities, covering infrastructure development, software maintenance, storage and technical support. Library professionals and technical staff should receive regular competency development opportunities focusing on digital repositories, metadata management, preservation techniques and emerging information technologies. Before selecting or upgrading digitization software, institutions should conduct systematic technology needs assessments to ensure compatibility with institutional requirements and future expansion. Universities should establish collaborative library-IT governance structures with clearly defined responsibilities for planning, implementation, maintenance and troubleshooting. Collection selection frameworks should also be developed to identify rare, fragile, high use and historically significant materials requiring priority digitization. Furthermore, institutions should implement long term digital preservation strategies, including backup procedures, migration planning and sustainability mechanisms rather than treating digitization as a onetime activity. Intellectual property and copyright issues should be addressed before digital materials are made publicly available. Finally, periodic institutional audits should be conducted to evaluate digitization maturity, equipment availability, staff competencies, policy implementation and overall system sustainability.

Limitations and Future Research

This study has several limitations that should be considered when interpreting the findings. First, the research was geographically limited to higher education libraries in Punjab, Pakistan; therefore, the findings should not automatically be generalized to all universities across Pakistan. Second, the unit of analysis was the university library, with one questionnaire representing each participating institution. Although this approach provided institutional level insights, it may not capture variations among individual staff members or departments. Third, the study employed descriptive analysis and therefore does not examine causal relationships or predictive effects among different dimensions of digitization challenges. Fourth, the findings are based on reported

institutional conditions and professional perceptions rather than independent technical evaluations or audits of library systems. Future research should extend this work through mixed method approaches combining surveys, interviews, technical assessments and repository evaluations. Comparative studies between public and private universities could further explore differences in financial capacity, policy implementation, infrastructure readiness and management support. Future investigations may also examine relationships between digitization maturity and outcomes such as research visibility, user satisfaction, accessibility, preservation effectiveness and institutional knowledge management. In addition, emerging technologies such as artificial intelligence-based metadata generation, automated classification, intelligent search systems and machine assisted preservation represent important future research directions. However, their adoption should be investigated alongside issues of governance, professional skills, ethical considerations and long-term sustainability.

Conclusion

This study demonstrates that digital transformation challenges in higher education libraries of Punjab are multidimensional and extend beyond technological adoption. Although software upgrading, technological resources, financial resources and system availability emerged as the most significant challenges, the findings also reveal substantial concerns related to human resource capacity, strategic planning, institutional management, preservation and policy development. The central contribution of this study is its institutional interpretation of digitization. The findings demonstrate that sustainable digital transformation cannot be achieved simply through the acquisition of scanners, computers, or repository software. Instead, successful digitization requires an integrated framework in which technology is supported by skilled professionals, strategic planning, institutional leadership, sustainable financial resources, maintenance mechanisms, rights management and preservation strategies. For university administrators and policymakers, the findings highlight that investments in digital infrastructure must be accompanied by investments in human capability, governance frameworks and long-term institutional capacity. By adopting a coordinated socio technical approach, higher education libraries can progress from fragmented or early-stage digitization activities toward sustainable digital knowledge environments capable of supporting research, learning, preservation and global access to academic resources.

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