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REVIEW ARTICLE

Transforming Academic Libraries for Digital-Native Users: A Review of ICT-Enabled Facilities, Services and the Commons Model in India

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ABSTRACT

Academic and research libraries are shifting from traditional, collection-centred environments to technology-enabled, user-centred spaces and services in response to changing learning and information-seeking behaviours. This paper reviews emerging ICT-enabled facilities and services, focusing on digital-native users and the development of Information, Learning, and Research Commons. Literature was reviewed using Google Scholar and other academic sources, with particular attention to Indian studies and international literature for broader context. The review identifies a shift towards integrated physical and virtual environments, including virtual reference, research support, institutional repositories, research data management, bibliometric services, and e-learning support. The commons model facilitates the integration of technology, spaces, services, and user support for learning, research, collaboration, and creativity. However, adoption in Indian academic and research libraries remains limited due to infrastructure, financial constraints, staff competencies, institutional support, and awareness. The review concludes that flexible, collaborative, technology-driven, and user-centred environments are increasingly essential for meeting digital-native users' expectations and sustaining library relevance.

KEYWORDS

• Academic libraries • Information and Communication Technology • Information Commons • Learning Commons • Digital natives • Generation Z • Emerging technologies

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INTRODUCTION

Academic libraries have undergone significant transformation, evolving from traditional facilities and services to technology-driven environments. Over the past two decades, libraries have embraced technologies ranging from computerized catalogues to AI, social media, workstations, and advanced research services, while collections have increasingly shifted to electronic formats. Digital Natives possess distinct skills and academic needs, requiring libraries to provide technology-enabled facilities and services to remain relevant in a rapidly changing environment.

While most libraries provide reading halls, carrels, and comfortable seating, these facilities primarily support individual academic work. However, newer generations, particularly Generation Z, prefer collaborative learning, group work, and multitasking. Libraries therefore need to reassess whether their spaces and services meet these evolving preferences. For Digital Natives, technology is an integral part of everyday life rather than a barrier.

In the current academic environment, upgrading library technologies is essential to maintaining relevance. With attention spans changing across generations, engaging students and attracting them to information literacy programmes has become increasingly challenging. Libraries must understand users' needs and technological expectations to provide fast, accessible, and user-friendly services. The availability of advanced technologies can encourage students to use the library more frequently. However, library professionals must carefully select technologies that complement library services and collections and support, rather than distract from, the library's core mission.

Purpose

Selecting appropriate technology is a significant challenge for librarians due to the wide range of costly options and limited budgets. This literature review examines established and emerging technology trends to help library professionals make informed decisions, particularly those working independently in academic libraries.

Methodology/approach

Google Scholar was used to identify relevant literature using keywords related to recent ICT trends in academic and research libraries in India, along with searches on Digital Natives' user behaviour. The review was limited to studies published from 2021 onwards. Both Indian and international studies were identified, and content analysis was used to synthesize the findings.

Limitation

Indian case studies were primarily selected for the core topic, while global literature was considered to understand Digital Natives' behaviour and the concept of 'commons'. No regional filtering was applied.

The study focuses on technologies directly used by library users, such as Wi-Fi, eBook readers, e-reference services, video stations, and 3D printers. Staff-oriented technologies that indirectly support users, such as library management and e-resource management systems, are excluded.

Analysis

The literature reviewed was predominantly international, with very limited research from the Indian context. Globally, libraries are increasingly adopting the 'commons' model to meet the changing needs of newer generations, closely linked to the growing role of ICT in library planning, design, and services. This review examines the concept and need for commons, its international implementation, its emerging presence in India, and broader ICT-driven trends shaping academic libraries for Digital Natives.

Origin and Definition of the 'Commons' Concept

(Barton, 2018) traces the concept of 'Commons' in Library and Information Science to the traditional village commons—shared spaces for community interaction. The concept emerged in academic libraries in the USA during the 1990s, though it is unclear whether it spread through diffusion or parallel development (Daniels et al., 2010).

(Beagle, 1999) described the Information Commons (IC) as both a digital environment providing integrated access to services and a physical facility combining workspace with technology-enabled services. The concept subsequently evolved into different forms, including the Information Commons, Learning Commons, Research Commons, and Creative

Commons, serving technology, learning, research, and creative needs respectively.

Need for Commons: Changing Roles and User Expectations

The role of library and information science professionals is evolving beyond technological competencies toward designing innovative facilities and services that meet the changing needs of the Net Generation. (Brophy, 2007) emphasizes the need for information professionals to adapt to user expectations, embrace partnerships, and collaborate across disciplines to support learning, teaching, and research.

(Sinclair, 2007) argues that the traditional library model, centred on print collections, large reading rooms, carrels, and book stacks, is increasingly unsuitable for the digital age. Libraries should instead become flexible spaces that support learning, collaboration, and research.

(Head, 2016) highlights the need to transform libraries into open, adaptable learning environments integrating information, technology, and user engagement. Libraries should connect physical and virtual environments and provide varied spaces for collaborative and individual study, services, and faculty–student interaction.

Despite technological advances, many libraries still reflect print-based models that do not adequately support contemporary learning and collaboration. This creates a gap between users' technology-oriented expectations and existing library services and policies. (Thomas & McDonald, 2005) emphasize the need for library leadership to respond proactively to these changing expectations.

(Khoo et al., 2016) examined library spaces, places, and technology areas to identify patterns of use. The study distinguished physical space from users' perceptions and actual use, finding that libraries increasingly combine quiet study, group discussion, technology, social interaction, and services. Such "third paradigm" spaces support users' academic, social, and everyday activities.

Drivers for the Development of Information Commons

The literature identifies the new digital environment as the primary driver behind the emergence of Information Commons. (Schader, 2014) also highlights student diversity, emphasizing the need for flexible approaches rather than a one-size-fits-all model. (Bonnand & Donahue, 2010) identify new pedagogical approaches and the growing integration of technology in education as key factors, while (Barton, 2018) also points to student retention and the need to remain relevant to the Millennial generation.

Design Principles for Library Spaces

Even when library buildings were being designed some thirty years ago, architect Faulkner-Brown (1979) proposed ten principles for academic library planning, emphasizing flexibility, accessibility, comfort, security, and economy. These principles were later updated by McDonald (2007) and Edwards (2009), reflecting libraries' continuing adaptation to changing user needs. The commons emerged as part of this adaptation to the digital generation (Latimer, 2011).

(Cox, 2023) identifies key considerations for post-COVID library design, including user well-being, sustainability, equality, diversity and inclusion, and decolonisation. The study also emphasizes co-designing spaces with students and integrating emerging technologies such as IoT, data-driven technologies, AI, and immersive technologies to create responsive and future-oriented library environments.

Implementation Framework for Commons Facilities

The literature identifies key steps for planning a commons facility: assessing stakeholder needs and existing conditions, evaluating funds and staffing, training staff, identifying suitable space, and acquiring necessary technology, resources, and furniture. After implementation, continuous evaluation is essential to assess impact and maintain relevance.

(Van Wyk & Kadzenga, 2016), based on Farber's four-stage model, outline a cyclical approach applicable to commons facilities. Stage 1: Essential conditions involves assessing stakeholder needs. Stage 2: Conceptual framework includes open, virtual, physical, and investigative learning spaces that support flexible, technology-rich individual and collaborative learning. Stage 3: Implementation involves staffing, resources, and space preparation. Stage 4: Analyse, evolve and adopt requires continuous evaluation

and adaptation to technological changes, supported by proactive staff.

INTERNATIONAL CASE STUDIES

The literature identifies several case studies of libraries with commons facilities, focusing on their planning, use, and evaluation, including Vancouver School (Forgeron et al., 2014), the University of New England (Paton & Moore, 2014), and Oregon State University's Valley Library (Middleton, 2014). Four prominent examples are discussed.

University of Southern California, US

USC is regarded as an early adopter of the Research Commons and has subsequently developed several Information Commons across its campus.

University of Cape Town (UCT), South Africa

UCT's Research Commons serves postgraduate students and academic staff with technology-enabled workstations, study carrels, seminar rooms, printing facilities, reference resources, and dedicated staff. Evaluation found the facility to be well used and valued by researchers (Daniels et al., 2010).

Victoria University, Australia

Victoria University transitioned from an Information Commons to a Learning Commons focused on supporting learning. It provides undergraduate and postgraduate students with personalised academic assistance, online resources, workshops, and study facilities. The enhanced spaces were well received and better addressed student needs, with feedback used for continuous improvement (Schader, 2014).

(Bennett, 2015) notes that the decline of collection-driven space pressures requires libraries to reconsider planning priorities. He emphasizes stronger collaboration between librarians and information technologists in designing Information Commons.

Notre Dame de Namur University (NDNU), US

NDNU used patron input to transform its traditional library into an Information Commons through observations, surveys, interviews, and comment boards. Users primarily viewed the library as a study space but wanted more group-study areas, power access, and quieter environments while retaining physical collections. The findings supported the need for a collaborative Information Commons better suited to contemporary learning (McCrary, 2017).

SKILLS AND COLLABORATION FOR COMMONS STAFF

A recurring theme in the literature highlights the skills and collaborative roles required of library professionals in delivering commons services. Learning Commons staff should be approachable, recognisable, and able to provide services and referrals. (Bennett, 2015) emphasizes collaboration with technology and teaching departments and with students, including the use of trained student "rovers" to support library services.

(Delaney & Bates, 2015) advocate viewing emerging technologies as opportunities and adopting the role of embedded librarians who build close relationships with specific user groups and provide customised information services. Similarly, (O'Kelly et al., 2015) describe a peer research consultancy at Grand Valley State University, where trained students assist fellow students with research. The service was well used because students could comfortably seek help from their peers.

Framework and Features of Commons Facilities

While planning collaborative space at Nanyang Technological University (NTU) Libraries, (Choy & Goh, 2016) emphasize that collaborative library spaces should address activities such as brainstorming, project work, presentations, writing, problem-solving, peer learning, and informal interaction. They identify four space types: collaboration, sanctuary, interaction, and community spaces. (MacWhinnie, 2003) describes the Information Commons as an integrated space combining technology, reference services, workstations, electronic resources, productivity software, printing, scanning, and technical and research assistance. It may also include collaborative areas, multimedia workstations, technology-enabled classrooms, and group study spaces that support learning, research, and collaboration.

(Archambault & Justice, 2017) examined users' furniture preferences and engagement with technologies, resources, and activities in the Information Commons at Loyola

Marymount University. (Barton, 2018) similarly identifies a wide range of facilities across three academic libraries and proposes a framework comprising **physical space**— welcoming, flexible, technology-rich areas— and **virtual space** providing infrastructure and continuous access to learning resources.

(Yoo-Lee et al., 2013) found that libraries need to balance social and quiet spaces while regularly reassessing user needs and adapting librarians' roles. (Bennett, 2006)advocated shifting from viewing students as information consumers to learners and redefining library service spaces as learning spaces. (Spencer & Watstein, 2017) further emphasize using learning theory to design technology-enabled spaces that support creativity, exploration, innovation, and informal learning. (Latimer, 2011) argues that library spaces should remain flexible and user-centred while supporting multidisciplinary collaboration.

(Chao et al., 2019) examined a modular BYOD space at Pennsylvania State University designed to support studying, collaboration, and social interaction. Similarly, (Dominguez, 2016) studied library space usage and user interactions to identify needs and improve existing facilities.

The Indian Scenario

It can be assumed from the literature that the concept of 'Commons' has yet to fully enter the Indian scenario, though some Indian authors have identified the need for user-centred change and for collaboration strategies to develop innovative library facilities and services. Writing on the Indian context, (M. Kumar, 2009) frames the focus as user-centred change and participation in the creation of content and community. (Trivedi, 2010) notes that the compression of data storage is enabling the publication and storage of digital information, with telecommunications facilitating the storage, retrieval, use and exchange of digital resources. (Vasanthi, 2001) argues that collaboration is itself a strategy to extend library access, share the costs of library collections and services, and develop an academically and economically sustainable model of scholarly communication — all of which point toward ICT as the connective infrastructure that Indian libraries still need to build out.

Changing Needs of Digital Natives: Characteristics, Behaviour and Expectations

(Prensky, 2001) the American writer and education speaker, introduced the term 'Digital Natives' to describe those born after 1980 who grew up with internet technology, distinguishing them from 'Digital Immigrants' who adapted to digital technologies later. He argued that early technological exposure shaped digital natives' thinking and created a generational gap between students and teachers.

In India, (A. Kumar & A, 2025) identify Generation Z as the first generation to grow up with the internet, while noting that Generation Alpha's behaviour is still emerging. These generations expect quick, simplified information, requiring libraries to adapt services and technologies to remain relevant. Suggested strategies include social media integration, social listening, user-oriented physical and virtual spaces, and dedicated teams to understand youth behaviour.

(Thangavel et al., 2021) note that Millennials and Gen Z are comfortable navigating large volumes of information due to early exposure to ICT. (Kushwaha, 2021) identifies online learning, video lectures, and digital education as important aspects of Gen Z's lifestyle.

(Vitvitskaya et al., 2022)found that ICT has significantly influenced digital-native students' learning behaviour. They frequently use social networks, adapt quickly to new technologies, multitask, and engage in self-directed learning while preferring flexible, practical learning approaches. However, digital distractions can also affect attention and social interaction. The study emphasizes innovative, technology-enabled learning environments, principles that are equally relevant to engaging digital-native users in libraries.

Current ICT Trends in Indian Academic Libraries

(Jinendran Jain & Kumar Behera, 2023) argue in their review that Library 4.0 is not a distant dream but an imminent reality, with many forward-thinking professionals envisioning libraries transitioning toward fully digital collections. They describe the current stage as that of a hybrid library, blending traditional and digital elements, and identify four components essential to developing such a

library: library collections, library spaces, futuristic technologies, and information services. Remaining relevant, on this view, requires refurbishing all aspects of the library — developing collections that resonate with digital natives and their preferred modes of online access, re-envisioning physical facilities around electronic resources and their access, and ensuring services are technology-driven and responsive to current needs.

(Gaikwad & Bilawar, 2023), in *Transforming Academic Libraries: Exploring Emerging Trends and Technologies*, examine how emerging technologies are reshaping academic libraries. Their literature-based study highlights how ICT has expanded access to real-time, remote, and user-centred services. Technologies such as AI, big data, IoT, blockchain, augmented reality, robotics, expert systems, and the semantic web are transforming library operations, resource management, and service delivery. However, adoption remains more advanced in developed countries, while India faces cost and infrastructure-related challenges.

(R. Kumar & Gupta, 2022) examine how technological innovation has reorganised library resources and services and evaluate user satisfaction with these changes, focusing on the transformation of traditional systems into more technology-driven, user-oriented services — digital resources, remote access, and improved service delivery mechanisms. Using a user-survey approach, they find that this restructuring has significantly enhanced accessibility, efficiency and overall user experience, with most users satisfied, particularly regarding ease of access to electronic resources and improved infrastructure, though the study also identifies a need for better user awareness, training, and more efficient resource-discovery tools.

(Faizan & Munshi, 2025) examine the effectiveness of integrated ICT-based library services at IIT libraries from the users' perspective, focusing on their role in enhancing academic access, user satisfaction and overall library performance. Using a quantitative survey of 277 users — undergraduate, postgraduate and research scholars — they find that the IIT library's advanced ICT infrastructure significantly supports academic and research activities, with research scholars benefiting most, followed by postgraduates and undergraduates. Overall satisfaction is high, though a notable proportion of users report difficulty locating specific information, underscoring the continued importance of better information-retrieval systems alongside ICT integration.

(Poluru et al., 2022), in "Emerging Trends in Libraries of Design Institutes: A Case Study," examine how academic libraries at design institutes across the USA, Canada and Mexico are adapting to emerging technological and service-oriented trends. Through a qualitative content analysis of 13 institutions, the study finds that modern libraries widely offer OPAC, remote access, interlibrary loan, open educational resources, and research-support tools including data services, citation assistance and reference-management systems, alongside enhanced user engagement through instructional programmes, virtual consultations and research guidance. Infrastructure trends include collaborative spaces, digital labs and assistive facilities, while archival services focus on digital preservation and cultural-heritage access; key emerging trends identified include artificial intelligence, open access, data-driven services, and inclusive access for diverse users.

EMERGING ICT-ENABLED LIBRARY SERVICES

Virtual Reference Service

(Sinhababu & Kumar, 2021) surveyed the state of virtual reference services (VRS) and traditional reference services within institutions under the Chandigarh Region Innovation & Knowledge Cluster (CRIKC), finding that approximately 84.3% of libraries offered online reference services through email and web forms. The study also explored librarians' perceptions of VRS and found Synchronous Virtual Reference Services (SVRS) viewed as more effective than asynchronous or traditional methods, as they enable more timely responses to user enquiries, within a study population that was primarily research-focused and actively involved in research assistance and consultation.

Research Support Services

(Padhan & Naidu, 2022) examined the websites of the top 25 Higher Education Institutions in India ranked under the NIRF 2021 Research category, finding that over 50% showcase institutional repositories (IRs), electronic theses and dissertations (ETDs), and detailed

faculty research profiles, though fewer than 40% provide information about staff available to assist with research queries or direct links to research tools and services. Despite this gap, libraries are generally well equipped to support research, offering e-journals, citation and bibliographic databases, economic and financial data sources, and tools such as language support, plagiarism detection and reference-management software, often with clear guidance through features such as 'Ask the Librarian,' FAQs, and self-help guides.

(Singh & Madhusudhan, 2022), in "ICT-Based Research Support Services in Academic Libraries: A New Frontier to Enhancing Research Integrity and Productivity," show that research support services (RSS) have become a crucial function of modern libraries, aiming to enhance research output, visibility and data management in higher education. They discuss a wide range of ICT-enabled services — institutional repositories, open-access publishing, research data management, plagiarism detection, bibliometric analysis, e-resource discovery, virtual labs and current-awareness services — and emphasise the library's role in developing research policies, managing the research data lifecycle, and providing 24/7 digital access to resources and support tools. Although such services remain at a developing stage in many Indian institutions, the authors find they are gradually gaining importance in promoting collaborative research and digital transformation, contributing significantly to research productivity, integrity and accessibility.

(Das & Banerjee, 2021) examine how academic libraries enhance research activity by developing and improving research support services, showing that libraries are evolving from traditional information providers into active partners across the entire research lifecycle — offering research data management, bibliometric and citation analysis, open-access support, scholarly-publishing assistance, research consultation, and guidance on research tools. They find significant global growth in RSS but uneven implementation, with developed countries adopting more advanced services than developing regions, and identify major challenges including lack of user awareness, limited resources, technological constraints, and skill gaps among library professionals — pointing to the need for strategic planning, user education, collaboration, and adoption of emerging technologies such as artificial intelligence.

Research Data Management

While research data management support is currently available in only a few libraries, the overall infrastructure suggests Indian higher education institutions are increasingly aligning with global standards, moving toward the kind of robust research support environments already established through dedicated research commons in Western institutions. (Lakshmipathi & Senthilkumar Dr, 2021) explore how academic libraries can strengthen their role in supporting research through research data management (RDM) and evolving service models, noting that increasing requirements from funding agencies and institutions for data preservation, sharing and open access are pushing libraries from traditional roles into active partnership across the research lifecycle. Effective research support, they argue, spans three stages — pre-project planning and guidance, active-research data organisation, storage and analysis support, and post-project data preservation and access — built on core components such as data-management planning, repositories, metadata creation and data curation. The study stresses collaboration among libraries, researchers and institutions, and the need for new librarian competencies in data management, project coordination and digital skills, while noting challenges including researcher reluctance to share data, lack of infrastructure, and the need for institutional policy.

Mobile Applications

Mobile apps are increasingly being adopted by academic libraries in India to enhance services and meet user needs. A survey of Indian libraries found that 27 institutions had developed dedicated library apps, primarily offering e-resources, reference queries and SMS alerts (Vysakh & Babu, 2022). First-generation IIT libraries have significantly integrated mobile technology, establishing high-tech infrastructure to deliver services (Margam & Singh, 2024); however, mobile-based services are not yet pervasive among academic libraries in India generally (Bhoj, 2021). Despite these challenges, there remain clear opportunities for libraries to develop apps that satisfy users'

information needs (Vysakh & Babu, 2022).

E-Learning Support Centre

The literature identifies the e-learning support centre as a further emerging service area within ICT-enabled academic libraries, alongside virtual reference, research support, research data management, and mobile applications.

Future Trends

A range of emerging technologies can help libraries re-engage digital natives and improve service effectiveness. (Nepali & Tamang, 2022) note that technologies such as Augmented Reality (AR), Artificial Intelligence (AI), gamification, and robotics can support services including shelf navigation, document discovery, advanced reference assistance, and sustainable practices, enhancing user experience.

(Jha, 2023) highlights AI's potential across library functions through expert systems, neural networks, fuzzy logic, image processing, natural language processing, speech recognition, and robotics. Examples include virtual reference chatbots, Yewno Discovery for data visualisation, and robotic scanning systems.

Specific technologies identified in the literature for near-future library adoption include:

- Augmented Reality (AR): Aurasma, Layer, Google Goggles, libARi, ShelvAR
- Artificial Intelligence (AI): Rasa, an AI-powered open-source conversational platform
- Gamification: tools such as Elements
- Robotics: robots for housekeeping activities, assisting users, providing reference service, managing circulation records, and delivering books

CONCLUSION

Taken together, the literature shows that the commons model — from information commons through learning, research and creative commons — is fundamentally a response to the digital environment and to the expectations of digital-native users, and that its success depends on sustained investment in ICT infrastructure, staff skills, and cross-departmental collaboration. Libraries today need to collaborate and offer their stakeholders facilities and services suited to the current digital environment in order to remain relevant in today's world; much as Darwin's theory of survival of the fittest applies in nature, libraries that fail to adapt their technology, spaces and services to the needs of the millennial and Gen Z/Gen Alpha user risk losing relevance altogether. While the concept of the commons and its associated ICT-driven services remain comparatively underdeveloped in the Indian context, current research signals a clear and accelerating shift — through virtual reference, research support and data management services, mobile applications, and emerging technologies such as AI, AR, IoT and robotics — toward the kind of technology-rich, user-centred academic library already well established internationally.

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