

Technologies Powering Innovations in Academic Libraries¹

By

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Introduction

Libraries are in a state of entropy. This is a situation of continuous change leading to unpredictability in the design and offering of information and library services. This is otherwise referred to as disruption. This disruption, which challenges the known ways of doing things has escalated into a global phenomenon accelerated by information and communications technology (ICT). The technology used to share and transfer information has become a phenomenon itself. It has affected the way information is generated, packaged, stored and retrieved. In all these, academic libraries have been at the forefront of experimenting with innovations which often are initiated by persons in higher education institutions.

Academic libraries are the intellectual bank of institutions of higher education. Libraries as custodians and dispensers of knowledge remain critical for the sustenance of any learning institution at all levels. From the libraries of monasteries to university libraries, researchers and intellectuals have found academic libraries most important for their enterprises. The criticality of libraries of academic institutions has led to the continuous review of processes of information service delivery and the upskilling of library staff who deliver the services. The librarian has transformed from being the sage that has all the answers to a guide by the side.

Innovations have increasingly become a signature of technologies, especially ICT which the library applies significantly. Innovation is synonymous to invention. It is a new way of doing things. A significant improvement on the way that tasks are carried out or making a marked difference in the outcome of products because of the new idea infused in the process. In libraries, innovations can be referred to as interventions that result in offering more effective services. This may be in the reduction of time to provide a service, intervention of technology to reach out to more patrons at the same time, or making the processing of library resources easier, and better administration of library personnel and services. Technology itself is the transportation tool for innovation. It is a tool that services and activities are transport upon for the realisation of work goals.

Academic Libraries

Academic libraries are libraries attached to institutions of higher education who provide resources for the furtherance of research, teaching and learning. Their mission is to provide

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staff and students with resources and spaces for the use of these resources. They exist as necessary part of the learning system. They are funded by the main institution. Staff of academic libraries have commensurate qualifications with academic staff of their institution.

Academic libraries have always been trailblazers in innovations for library practice. They take advantage of human and material resources of their parent organisations to bring about innovations that improve services. Today, academic libraries are accessible physically and virtually. The development of a nation can always be traced to the quality of resources available in their academic libraries. It is imperative therefore to ensure proper funding for academic libraries so that the quality of research and the diffusion of innovation can easily be realised in the society through the versatility of the library in its ability to make resources discoverable, accessible and usable.

Technology adoption models and theories

Technology adoption and use in libraries may appear as a normal response to the operating environment. However, some observations have been made and theoretical foundations laid which can be used to analyse the process of technology adoption and the type of technology adopted. There is the Diffusion of Innovation (DoI) theory proposed by Everett Rogers (1983, 31) which fundamentally states that:

“... three types of innovation-decisions range on a continuum from optional decisions (where the adopting individual has almost complete responsibility for the decision), through collective decisions (where the individual has some influence in the decision), to authority decisions (where the adopting individual has no influence in the innovation decision).”

Several models and other theories of technology adoption have been researched to explain how technology is adopted. They include (Taherdoost, 2018; Wibowo, 2019) the theory of reasoned action (TRA), social cognitive theory (SCT), diffusion of innovation theory (DoI), motivational model (MM), uses and gratification theory (U&G), the model of PC utilization (MPCU), and unified theory of acceptance and use of technology (Compatibility UTAUT). From the TRA are derived the theory of interpersonal behavior (TIB), theory of planned behavior (TPB), and technology acceptance model (TAM). Two models have been derived from TAM, and they are Igbaria's Model (IM) and Extension of Technology Model (ETAM). All these are used to explain how different groups and organisations respond to innovations brought about by new technology. They help in understanding the sociological, psychological, technological, and organisational factors that accelerate or decelerate the geospatial adoption of technology.

In an empirical study of technology adoption in Kuwait, Al-Fadhi, Corral, and Fox (2016) discovered that factors that led to technology adoption were the “unrestrained” availability of funds, the decision of library directors, the quest for prestige among the libraries, shortage of library staff with technology closing the gap, and believe of library staff in technology as problem solver.

According to Marikyan and Papagiannidis (2026), the following concepts play different roles in the adoption of technology. They are tabulated here for ease of reference.

Concept	Variable	Brief definition
Performance Expectancy	Independent	The degree to which an individual believes that using the system will help him or her to attain gains in job performance.
Effort Expectation	Independent	The degree of ease associated with the use of the system.
Social Influence	Independent	The degree to which an individual perceives that important others believe he or she should use the new system.
Facilitating Conditions	Independent	The degree to which an individual believes that an organisation and technical infrastructure exist to support use of the system.
Behaviour Intention	Independent/dependent	A person's subjective probability that he will perform some behaviour.
Use Behaviour	Dependent	The actual use of the system/technology.
Experience	Moderator	The passage of time from the initial use of technology by an individual.
Voluntariness of Use	Moderator	The degree to which use of the innovation is perceived as being voluntary, or free will.
Hedonic Motivation	Independent	The fun or pleasure derived from using a technology, which has been shown to play an important role in determining technology acceptance and use.
Price Value	Independent	A consumer's trade-off between the perceived benefits of the applications and the monetary cost of using them.
Habit	Independent	The extent to which people tend to perform behaviours automatically.

They are applicable to the adoption of technology in libraries.

Technologies driving innovations in libraries

Technologies in libraries continue to evolve as librarians seek ways to improve in the processing of resources and the provision of effective services to patrons at their different

levels. According to Jost (2016), the following milestones represent technology adoption in libraries.

Year	Innovation
1852	Charles Coffin Jewett, Librarian and Assistant Secretary of the Smithsonian Institution visualizes a union catalog of libraries in the United States.
1876	Melvil Dewey develops Dewey Decimal classification system.
1880	Dr. John Shaw Billings, Head of the Library of the Surgeon General's Office developed a punch-card system to analyze medical and demographic data.
1897	Herbert Putnam develops the Library of Congress classification system.
1950	King County Library system (Seattle, WA) purchases an IBM punch card system for cataloguing.
1957	Ralph H. Parker pioneers the use of a punch-card system for acquisitions at the University of Missouri.
1963	The Library of Congress issued its first report on automation entitled "Automation and the Library of Congress" and the American Library Association formed the Association of Research Committees on Automation.
1967	OCLC established by Fred Kilgour in Dublin, Ohio.

This trajectory suggests clearly that whatever the innovation had been in libraries, it was triggered by the desire to improve on the provision of services. The creation of codes to represent subjects in building classification systems by Melvil Dewey in 1876 is a major landmark. This facilitated the use of the punch card system for the circulation of materials, marking a significant leap in the use of technology and is arguably the turning point in the deployment of technology and innovations that is witnessed today. from the punch card system of 1950 to the main frame computer to the desktop and then laptop, and now mobile devices. Today, library resources are listed online, can be discovered, and accessed full text.

Library automation was also accelerated as library collections grew, personnel grew, but funding could not match up in the 1960s. So, there was a greater push for the introduction of technology that could play certain routinised roles and cut down on the cost of personnel, yet get the work done and reach more patrons.

This has led to the transformation from manual cataloguing and classification systems to the digitisation of cataloguing processes, including classification. This was the beginning of library automation and the suggestion of the long-debated idea of a paperless society which has yet to be realised. However, what is witnessed today indicates that technology improvement will always require adjustments and adaptation. Adjustments in work processes, and adaptation for more effective delivery of services.

The development of the Ohio College Library Center (OCLC) in the United States of America in 1967 to serve as a state-wide bibliographic database had a snowball effect. It transformed to an international database reaching out to the world and accessible worldwide. The Research Libraries Information Network (RLIN) and the Western Library Network (WLN) followed this.

To accelerate the use of these databases was the development of bibliographic standards which was used to share library records between libraries. Thus, in 1961 the Machine-Readable Cataloging (MARC) format was developed, and it soon became the standard for all American libraries. This also meant that records of catalogs could be shared easily and respective libraries could contribute to the growing national and international cataloging databases.

Jost (2016) also noted that the Northwestern University in the United States experimented with the Northwestern Online Total Integrated System (NOTIS) in 1968 and it became the first integrated library system which was deployed to automate technical services including cataloguing, circulation, classification, acquisitions and serials. The successful deployment of NOTIS led to more integrated systems arriving at the market with vendors offering solutions as stand-alone or integrated online for groups of libraries. Since then, more library solutions have been arrived at by librarians taking advantage of technologies. It is now a global enterprise with experts upgrading, devising and delivering more excellent solutions not only for local consumption, but global effect.

Knowledge and skills set

The requirement for the technologies to advance is the necessary skills acquisition by library staff. At every point of the deployment of technology and innovation, library staff have had to adjust by learning how to operate the new system. The knowledge and skills varied with the type of technology, but basically, knowledge of subject headings which facilitated classification schemes, then the manipulation of technological devices such as the computers and how to communicate with other librarians and libraries.

The conversion of manual cataloguing and classification systems required skills in coding and use of computer devices for storage and use of databases. The ability to communicate online also required skills in typing and use of email systems, the identification of modules in integrated library systems and relationships within the databases. These skills are still required today even when more library resources are now digitised.

The digitisation of resources, starting with the card catalogue required retrospective conversion of the catalogue. The core skills requirement for the retrospective conversion of the catalogue is the competency to scan, use digital bibliographic databases and subject headings. Work processes and workflows continue to evolve at the introduction of innovations in the library setting a dynamic library work environment. And, since the change in innovation is more dynamic today than a decade ago, librarians require constant upgrading of competencies for general and specific roles in library services.

The skills that the librarian requires to be effective are evolving. They include literacy in many areas (Pierre-Robertson, 2025): information literacy, digital literacy, digital media literacy, internet literacy, technology literacy, computer literacy, computational literacy, critical literacy, algorithmic literacy, and transliteracy. All these areas of competencies are evolving and there is need to keep learning and training. The skills sets are not only for librarians, but for patrons who must be trained on-site and online.

The innovations and necessary skills have been tabulated here.

Innovation	Skill and Knowledge (competencies)
Main frame computer	Computational
Minicomputer	Computational
Desktop computer	Computer literacy
Laptop computer	Computer literacy
Mobile devices	Computer and Navigational skills
Manual cataloguing	Bibliographic and Cataloguing skills
Manual classification	Ontologies
Digitisation of classification systems	Ontologies, Hyperlinks, Subject disciplines and Workflows
Subject Headings	Coding, Subject disciplines, Ontologies
Digitisation of library resources: Conversion from atom-based Born digital	Scanning, Metadata, hyperlinks, and Use of computers
Webpages	Navigation, Web design
Indexing	Ontologies, Subject disciplines
Subject/word search	Refining search terms, Subject disciplines
Electronic access to and retrieval of library resources	Information Literacy
Optical Character Recognition (OCR)	Digitisation, Subject disciplines, and Scanning
Radio Frequency Identification (RFID)	Cataloguing, Classification skills and Digitisation
Internet of Things (IOT)	Algorithmic literacy and Computational skills,
Virtual Reality	Algorithmic literacy, Computational literacy, Digital literacy and Information literacy
Augmented Virtual Reality	Algorithmic literacy, Computational literacy, Digital literacy and Information literacy
Robotics	Algorithmic literacy, Computational skills, Digital skills
Automation	Computational skills, Digitisation
Drones	Algorithmic skills and Computational skills
Cloud computing	Computational skills and Database design
Big data analytics	Computational skills and Database design
Generative Artificial Intelligence (AI)	Algorithmic literacy, Criticality, machine learning
Metaverse	Computational skills and Web design

Institutional readiness

Driving and embracing innovations in academic libraries requires institutional support. The main institutional leadership must buy into the projects because the success or failure of an academic library rubs on the memory of the institution. Moreover, innovations usually require massive funding for space and human resources which only the institution can adequately mobilise and provide for. Budgets for innovations could exceed the normal funding model for the library. Funding requires advocacy or advancement by the Advancement Office of the

institution. Alumni and philanthropists could be a veritable source of funding, and it is the institution that has the authority to mobilise funds from these potential sources.

There are also philanthropists who focus on funding the advancement of learning. Such benefactors can be mobilised by the advancement office of a higher institution that requires support. Another funding source is consortia. When institutions form a consortium, the benefits go beyond lower pricing to include donations and joint initiatives. In Nigeria, the Nigerian University Libraries Consortium (NULIB) is a veritable group that should be empowered to intervene on technology costs for libraries and not limited to books and journals.

In many cases, institutions need to create special budgets to accommodate innovations that require the redesign of library structures which had existed before the innovation. Remodelling and appropriate furnishing of new spaces are necessary, which the normal library budget cannot fund. Budget for the creation of spaces for virtual reality, gamification, computer laboratory, computer workshops, video conferencing, augmented virtual reality, podcasting and open, group, and individual spaces are usually not in the original plan of most libraries constructed in the last two decades. Podcasting, for example, has become a growing need in online communication as it aids digital learning and inclusiveness. It makes for the transmission and replay of lectures and personal and group studies. It also supports the maximisation of faculty when staff are thinly spread. To accommodate these innovations, the library plan would require modification which only the institutional leadership can approve.

Additional budget for subscription to new software, renewal and insurance is also critical and the library budget usually cannot accommodate this. The same goes with seamless internet connectivity. This is key for all recent technology mediated innovations. Connecting the library to the institutional buildings for discoverability and easy access to and retrieval of library resources requires funding support from the parent institution.

Library readiness

The academic library, as the main beneficiary of innovations, must demonstrate preparedness for change. Change is triggered by several factors which include innovations, budget cuts, personnel cuts, social and political activities of government. The library leadership must take the lead in advancing change. There must be change in attitude of staff. There may be need for reorganisation of library spaces. There will always be need for staff training and re-training. Staff redeployment based on adaptation to change for seamless transition to the adoption of innovation is a necessity.

Preparing staff for the introduction and sustenance of innovation is critical for any academic library. The legitimacy of academic libraries depends on the adaptability of her staff to dynamic situations. The staff are the pace setters. They are the face of the library. Their attitude to work and the dynamic environment of work can project the library in different directions. When library staff demonstrate competencies and readiness to work and to receive and attend to patrons in meeting their needs, the academic library becomes a place of interest, a focal point that attracts users and innovations.

The professionalism of the staff is further tested in their ability to provide leadership for the best possible environment for research and learning in critical moments. One of the first concerns of the library leadership should be the current competencies of staff and their readiness for change. It is noteworthy that the rate of change in the industry is usually ahead of the academic and professional trainings earlier received. So, library staff must keep updating their knowledge to adapt to trends in the industry. It also implies that information and library training institutions and professional associations must adjust to the dynamic technologically environment as it impacts practice.

Some library staff may be excellent in their present situation but not ready for change. It is imperative therefore for the library leadership to introduce the new expectations for staff in a general meeting. This may be followed up with a workshop or seminar where the new change is introduced and tried out, especially if it is the use of technology or software. This may be devolved to sections of the library where specific responses are required. For instance, at the introduction of a new library management system (LMS), library staff who are direct line officers should all be available and inducted. Other staff could be present, but the direct staff should be present and learn and do hands-on training. There should be a general training introducing the LMS since all staff would have to interact with the system at one time or the other, thereafter the sectional staff.

The reorganisation of library spaces is fundamental in adopting or adapting innovation. It is itself innovation in the use of library spaces as the spaces respond to technological innovations. For instance, in making the library more technologically and internet ready, there may be need for adjustments in the use of library spaces by providing technological infrastructure such as the laying of cables to make internet access by wire possible. There may also be a need to provide more public-access computers. The provision of ergonomic seating facilities that meet the need of individuals and groups using multimedia is paramount in adopting technological innovation for the digital natives whose use of technology is 'natural', and they prefer both individual and group study spaces.

Then, the space for the physically challenged so that they can explore fully resources of the library. Chairs and tables must be adjusted to meet the need of the physically challenged. Provision should be made for the hearing challenged with adequate space and noise suppressors when they listen to audios or watch audio-visuals. All these require special equipment, and the library must make provisions for this.

The library may also have to review its budget to ascertain the cost of innovation wholistically, that is, in terms of personnel recruitment and training, materials, and all necessary adjustments such as modification of structures that must be made. New structures may also be built. The library budget alone is definitely not able to support innovation, and this is the reason the budget must be reviewed to seek for alternative means of raising funds for the innovation.

On the human relations part, the library leadership must brief staff on what innovations the library is responding to and what the expectations are for staff. When the staff are properly briefed, they are more likely going to support the change by making the necessary

adjustments. More importantly, for innovation to be easily embraced, library staff should be part of the initial process of seeking innovation. When library staff are engaged at the incubation stage, they are most likely going to be supportive of any innovation.

Apart from staff, library leadership must engage the primary users of the library, the students and staff at the conceptual and, implementation stages. This makes the patrons to be part of the change and some of their contributions can positively affect the implementation of the innovation (Akintunde, 2016). The involvement of stakeholders, including technical staff who maintain physical structures such as architects, civil engineers and Information and Communications technology (ICT) staff will also make them to easily accept and own the innovation which is required for sustainability and improvements.

Conclusion

Technologies driving innovations in academic libraries continue to evolve. These technologies are adapted for the effective provision of library services and would continue to be improved upon. There is need of invest in human capacity development by continuously training librarians and library patrons on new innovations. Librarians must develop current competencies which can be learned online or onsite through free or subscribed services. Budgeting for training must go along with budgets for the acquisition of technology.

Remodelling of library buildings and re-assignment of roles for staff must be carried out to integrate innovations. Library training institutions and professional associations must also train professionals on the latest skills for running academic libraries in the age of technological advancement. It is a collective effort. To maximise the resources of libraries today, especially where there is budget constraint, it is imperative to form consortium for the acquisition of technology and training of librarians and library patrons. The parent institution investing in library development in the age of technological innovations is an investment for its own progress and visibility because the library projects the institution beyond constrained physical spaces to global discovery and access points. Taking advantage of innovative technologies is a signpost of a progressive academic library. Teaching and learning are enhanced, discoveries are made and human development is progressive. It is a worthy path to take. The cost is an investment.

Thank you.

References

Akintunde, S. 2016. Creative leaning space at the University of Jos: an indicative evaluation. Master of Science (MA) Dissertation, Aberystwyth University, Aberystwyth, Wales, United Kingdom, x, 81p.

Al-Fadhli, M., Corral, S. and Cox, A.M. (2016) Factors Underlying Technology Adoption in Academic Libraries in Kuwait. *New Review of Academic Librarianship*, 22 (4): 370-390. <https://doi.org/10.1080/13614533.2016.1138135> Available at <https://eprints.whiterose.ac.uk/id/eprint/94189/3/Al-Fadhli%2C%2520Corral%2520%26%2520Cox%2520%282016%29%2520postprint%5B1%5D.pdf>

Jost, R. M. 2016. *Brief history of library technology, selecting and implementing an Integrated Library System*. Chandos Publishing. Available at <https://www.sciencedirect.com/science/chapter/monograph/pii/B9780081001530000010>

Kamat, M., Kumber, M. F., and Bakshani, U. (2026). Attitude mediation in Indian academic librarians' acceptance of generative AI: A UTAUT-based study of technology adoption in Indian academic libraries. *The Journal of Academic Librarianship* 52 (4): 103256. Available at <https://www.sciencedirect.com/science/article/pii/S0099133326000583>

Lund, B. D. (2025). Diffusion of innovations: Still a relevant theory for studying library technology in the age of AI? *Library Hi Tech News*. DOI: 10.1108/LHTN-12-2024-0209 Available at <https://ci.unt.edu/computational-humanities-information-literacy-lab/doilund1.pdf>

Marikyan, D.& Papagiannidis, S. (2026) Unified Theory of Acceptance and Use of Technology: A review. In S. Papagiannidis (Ed), *TheoryHub Book*. Available at <https://open.ncl.ac.uk/> ISBN: 9781739604400 <https://open.ncl.ac.uk/theory-library/unified-theory-of-acceptance-and-use-of-technology.pdf>

Pierre-Robertson, P. 2025. Literacies. In *Encyclopedia of Libraries, Librarianship and Information Science* edited by David Baker and Lucy Ellis. Academic Press. Available at <https://www.sciencedirect.com/science/chapter/referencework/pii/B9780323956895001164>

Rogers, E. M. (1983). *Diffusion of Innovations*. The Free Press. Available at <https://teddykw2.wordpress.com/wp-content/uploads/2012/07/everett-m-rogers-diffusion-of-innovations.pdf>

Taherdoost, H. (2018). A Review of technology acceptance and adoption models and theories. *Procedia Manufacturing* 22: 960-967.

Wibowo, M. P. (2019). Technology acceptance models and theories in library and information science research. *Library Philosophy and Practice (e-journal)* 3674. Accessible at <https://scholarworks.sjsu.edu/cgi/viewcontent.cgi?article=6961&context=libphilprac>