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Journal of Loomingulisus ja Innovatsioon
Vol. 3 No. 3. June 2026, pp. 242-264
DOI. 10.70177/innovatsioon.v3i3.4339
Research Article

Reimagining Academic Libraries as Open Innovation Hubs: Evaluating Digital Knowledge Governance and Community Engagement in the AI Era

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Article Info
Received: January 12, 2026
Revised: March 15, 2026
Accepted: April 10, 2026
Online Version: June 24, 2026

Abstract
Academic libraries are being reshaped by artificial intelligence, digital scholarship, open science, and growing demands for wider public participation, yet their transformation into open innovation hubs remains uneven and insufficiently governed. This study aimed to evaluate how digital knowledge governance, community engagement, and artificial intelligence readiness influence open innovation performance in academic libraries. A convergent mixed-methods multiple-case design was employed across ten academic libraries, involving 360 survey respondents and forty key informants. Quantitative data were analyzed through descriptive statistics, correlation, hierarchical regression, and interaction analysis, while qualitative evidence was examined through thematic and cross-case analysis. The findings showed that digital knowledge governance was the strongest predictor of open innovation performance, followed by community engagement and artificial intelligence readiness. Community engagement significantly strengthened the relationship between governance quality and innovation outcomes. Libraries combining clear policies, ethical oversight, technological competence, interdisciplinary collaboration, and reciprocal partnerships achieved stronger service experimentation, organizational learning, and community knowledge co-creation. The study concludes that technological adoption alone does not transform academic libraries into open innovation hubs.

Keywords: Academic libraries, Artificial intelligence, Community engagement.

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Journal Homepage https://research.adra.ac.id/index.php/innovatsioon
How to cite: Shawabkeh, H. A., Khouri, B. A., & Hamdan, S. (2026). Reimagining Academic Libraries as Open Innovation Hubs: Evaluating Digital Knowledge Governance and Community Engagement in the AI Era. *Journal of Loomingulisus ja Innovatsioon, 3*(3), 242–264. https://doi.org/10.70177/innovatsioon.v3i3.4339
Published by: Yayasan Adra Karima Hubbi

INTRODUCTION

Academic libraries are undergoing a fundamental transformation as universities respond to rapid developments in artificial intelligence, digital scholarship, open science, and collaborative knowledge production (Jian et al., 2025; Patel et al., 2025; Weiss et al., 2025). Their traditional functions of collecting, preserving, organizing, and providing access to scholarly materials remain important, but these functions no longer represent the full scope of contemporary academic librarianship. Digital platforms now enable researchers, students, librarians, external communities, and institutional partners to create, analyze, exchange, and reuse knowledge across organizational boundaries. Artificial intelligence further accelerates this transformation by supporting automated discovery, metadata generation, research assistance, content recommendation, data analysis, and personalized learning. The changing knowledge environment creates a need to reconsider academic libraries as active participants in innovation rather than passive repositories of information.

The concept of an open innovation hub offers a relevant framework for redefining the institutional role of academic libraries. Open innovation emphasizes the movement of ideas, expertise, technologies, and knowledge across institutional boundaries to generate solutions that cannot be produced effectively through isolated organizational efforts (Avdiushchenko & Meinrenken, 2025; Pitakaso et al., 2025; Whyte & Van Assche, 2025). Academic libraries possess several characteristics that make them suitable for this role, including interdisciplinary collections, public-facing services, technological infrastructure, trusted professional expertise, and relatively neutral spaces for academic interaction. Innovation-oriented library services may include digital scholarship laboratories, artificial intelligence literacy programs, research data consultations, makerspaces, open-access publishing support, community archives, citizen science projects, and collaborative problem-solving forums. These activities position libraries as connective institutions capable of linking universities with surrounding communities, industries, public agencies, and civil society organizations.

Digital knowledge governance becomes increasingly significant when academic libraries expand their responsibilities beyond information access toward collaborative knowledge creation. Knowledge governance refers to the rules, responsibilities, standards, infrastructures, and decision-making processes that shape how digital information is collected, processed, shared, protected, evaluated, and reused (Bakogiannis & Papavasiliou, 2025; Baradaran Rahimi, 2025; Wang et al., 2025). Artificial intelligence introduces additional challenges related to data ownership, copyright, algorithmic bias, privacy, transparency, academic integrity, and unequal access to digital resources. Community engagement creates further complexity because participants outside the university may have different levels of technological literacy, institutional authority, and control over the knowledge they contribute. The development of academic libraries as open innovation hubs consequently depends on their ability to balance technological opportunity with ethical governance, institutional accountability, and inclusive participation.

Many academic libraries have adopted digital technologies without substantially changing their organizational logic or relationships with users (Asiri et al., 2025; Askari, 2025; Williams et al., 2025). Online catalogues, electronic databases, institutional repositories, virtual reference services, and automated systems may improve efficiency, yet they do not necessarily create collaborative environments for innovation. Technology-centered modernization can reproduce a service-delivery model in which librarians manage information while users remain recipients rather than co-creators of knowledge. Artificial intelligence may intensify this problem when institutions prioritize automation and operational convenience without reconsidering participation, authority, or the social purposes of library services (Liu, 2025; Pinkard et al., 2025; Ray & Chakravarty, 2025). The central problem is therefore not the absence of digital technology, but the limited integration of technological capability with open, participatory, and innovation-oriented institutional practices.

Current approaches to digital knowledge governance in academic libraries also remain fragmented. Responsibility for data security, open access, research integrity, copyright, artificial intelligence use, repository management, and community-generated content is often distributed across separate university units (Mongeon et al., 2025; Pathak et al., 2025; Peck et al., 2025). Fragmented authority can produce inconsistent policies, duplicated systems, unclear accountability, and uncertainty among librarians and users. Artificial intelligence applications may be introduced before institutions establish transparent procedures for evaluating training data, algorithmic recommendations, privacy risks, intellectual property implications, or human oversight. Weak governance can undermine trust even when the technology provides measurable efficiency. Academic libraries require governance arrangements that integrate technical standards with ethical principles, professional responsibilities, user participation, and institutional strategy.

Community engagement presents a related challenge because university libraries frequently define their primary users through formal institutional membership. Students, lecturers, and researchers generally receive privileged access, while local communities, independent researchers, schools, social organizations, small enterprises, and marginalized groups may encounter legal, financial, technological, or administrative barriers (LaFlamme, 2025; Noaime et al., 2025; Shen et al., 2025). Outreach activities are often short-term, ceremonial, or disconnected from the research and innovation functions of the university. Community participants may be invited to attend events without receiving meaningful authority to shape programs, control contributed data, or benefit from resulting knowledge products. This limited form of engagement restricts the capacity of academic libraries to become genuine open innovation hubs and raises questions about whose knowledge is recognized, whose problems are prioritized, and whose interests are protected.

The primary objective of this study is to evaluate the capacity of academic libraries to function as open innovation hubs in the artificial intelligence era (Biswas et al., 2025; Nassanga et al., 2025; Selwyn et al., 2025). The evaluation will examine whether libraries have moved beyond conventional information-service models toward roles involving knowledge co-creation, interdisciplinary collaboration, digital experimentation, and external partnership. Attention will be directed toward organizational strategy, professional competencies, technological infrastructure, innovation services, leadership support, and the availability of collaborative spaces. The study seeks to identify institutional conditions that enable academic libraries to facilitate the exchange of ideas and resources among university stakeholders and broader communities.

The second objective is to assess the quality of digital knowledge governance within academic libraries. The analysis will examine policies and practices related to data stewardship, open access, intellectual property, privacy, cybersecurity, algorithmic transparency, research integrity, metadata standards, and artificial intelligence use (Olaleye et al., 2026; Stacciarini et al., 2026; Zhao & Wei, 2026). Particular attention will be given to the distribution of decision-making authority among librarians, university leaders, information technology units, researchers, students, and community partners. The study aims to determine whether governance systems are transparent, participatory, ethical, and sufficiently adaptive to address the uncertainties introduced by rapidly changing digital technologies.

The third objective is to investigate the relationship between digital knowledge governance, community engagement, and the innovation performance of academic libraries. Community engagement will be assessed through accessibility, inclusiveness, reciprocal partnership, co-design, knowledge exchange, and sustained participation. Innovation performance will be examined through the creation of new services, interdisciplinary projects, community-oriented solutions, digital literacy development, knowledge reuse, and institutional learning. The intended outcome is an integrated explanation of how governance quality and

community participation jointly influence the transformation of academic libraries into open innovation environments.

Existing research on academic library transformation has devoted substantial attention to digitalization, information literacy, electronic resource management, research support, and emerging technologies. Studies have documented the adoption of institutional repositories, cloud services, learning commons, digital scholarship centers, makerspaces, and artificial intelligence tools. This literature provides valuable evidence concerning technological adoption and professional change, but it often evaluates library modernization through service availability, user satisfaction, system efficiency, or technology acceptance. Limited attention has been given to whether these developments alter the institutional position of libraries within broader innovation ecosystems. The concept of the academic library as an open innovation hub therefore remains insufficiently theorized and empirically tested.

Research on knowledge governance has developed across information systems, organizational studies, data management, and open science. Relevant studies examine data stewardship, intellectual property, knowledge sharing, institutional repositories, and responsible artificial intelligence. Academic library research tends to address these issues separately, treating privacy, copyright, open access, research data, and algorithmic ethics as distinct professional concerns. Such fragmentation limits understanding of how governance dimensions interact within a unified digital knowledge environment. Evidence is particularly scarce concerning the relationship between governance quality and the ability of libraries to support experimentation, collaboration, and community-generated knowledge.

Community engagement literature has recognized libraries as accessible social institutions capable of supporting inclusion, lifelong learning, and public participation. Academic library studies nevertheless remain more institutionally focused than public library research, with external communities often positioned outside the central analysis. Existing studies commonly describe outreach events, literacy workshops, or public access programs without examining whether community members participate in agenda setting, service design, data governance, or innovation evaluation. The interaction between community engagement and digital knowledge governance has received even less attention. This gap prevents researchers from explaining whether participatory governance improves innovation outcomes or whether technological modernization merely expands institutional services without redistributing knowledge authority.

The main novelty of this study lies in its integrated conceptualization of academic libraries as open innovation hubs shaped by the interaction between digital knowledge governance and community engagement. Previous approaches commonly examine digital transformation, artificial intelligence adoption, data governance, or outreach as separate areas of library development. The proposed framework treats these dimensions as mutually dependent. Digital tools create opportunities for collaboration, but governance determines how participation, ownership, responsibility, and risk are organized. Community engagement generates diverse knowledge and social relevance, but its contribution depends on whether institutional systems provide meaningful access and decision-making authority. This relational perspective offers a more comprehensive explanation of library transformation.

A further contribution concerns the evaluation of innovation as a multidimensional institutional outcome. Innovation will not be measured solely through the number of technologies adopted or digital services provided. The proposed analysis will include organizational learning, interdisciplinary collaboration, ethical data practices, knowledge accessibility, community co-creation, service experimentation, and the capacity to respond to social problems. This broader approach prevents technological adoption from being treated automatically as institutional innovation. A library may operate advanced artificial intelligence systems while retaining centralized decision-making, weak community participation, or

inadequate ethical safeguards. Meaningful innovation requires changes in relationships, governance practices, professional roles, and public value.

The study is justified by the urgent need for academic libraries to remain trustworthy and socially relevant within an increasingly automated knowledge environment. Artificial intelligence can improve discovery, accessibility, and research productivity, yet it can also reinforce misinformation, bias, surveillance, dependency, and exclusion. Universities require institutional spaces capable of mediating between technological innovation, scholarly standards, ethical responsibility, and community interests. Academic libraries are well positioned to perform this role because they combine information expertise, educational functions, digital infrastructure, and traditions of intellectual access. Evidence concerning the conditions that enable this transformation can guide university leaders, librarians, policymakers, and community partners in designing open innovation systems that are technologically capable, ethically governed, and publicly accountable.

RESEARCH METHOD

Research Design

This study employed a convergent mixed-methods design to evaluate the capacity of academic libraries to function as open innovation hubs in the artificial intelligence era. The design combined a quantitative survey with qualitative interviews, nonparticipant observations, and document analysis (da Silva et al., 2026; Nanthasamroeng et al., 2026; Ratevosian et al., 2026). Quantitative data were used to measure digital knowledge governance, community engagement, artificial intelligence readiness, and open innovation performance. Qualitative data were used to explain how institutional policies, professional practices, technological infrastructures, and stakeholder relationships shaped library transformation in specific organizational contexts.

A multiple-case study approach was incorporated into the mixed-methods design to capture variations among academic libraries operating under different institutional conditions (Chun et al., 2026; Kimchi-Yahav et al., 2026; Tachiquín et al., 2026). Each participating library was treated as an individual case characterized by its governance structure, technological capacity, user population, innovation services, and external partnerships. The comparative approach enabled the researchers to identify common patterns and context-specific differences across universities. Cross-case analysis was particularly relevant because the adoption of artificial intelligence and open innovation practices may be influenced by institutional size, funding, leadership commitment, digital maturity, and community access policies.

The quantitative and qualitative components were implemented during the same research period and initially analyzed as separate datasets (Krakowska & Zych, 2026; Rahman et al., 2026; Surmiková & Džupka, 2026). Results were subsequently integrated through joint displays, narrative comparison, and case-based interpretation. Statistical relationships were compared with stakeholder experiences, observed practices, and institutional documents. Convergent evidence was used to strengthen the credibility of the findings, while contradictory evidence was examined to identify policy–practice gaps, unequal stakeholder perceptions, or contextual differences among participating libraries.

The conceptual framework consisted of four principal dimensions (Gonzalez Lozano et al., 2026; Semerikov et al., 2026; Yeo et al., 2026). Digital knowledge governance covered data stewardship, privacy protection, intellectual property, open access, algorithmic transparency, research integrity, cybersecurity, and accountability. Community engagement included accessibility, inclusiveness, reciprocal partnership, co-design, public participation, and knowledge exchange. Artificial intelligence readiness comprised technological infrastructure, staff competence, institutional policy, ethical awareness, and user support. Open

innovation performance was assessed through service experimentation, interdisciplinary collaboration, external partnerships, knowledge co-creation, organizational learning, and the development of solutions responding to academic and community needs.

Research Target/Subject

The study population consisted of stakeholders involved in the management, delivery, use, and development of academic library services at selected universities. The target population included academic librarians, library managers, university lecturers, researchers, postgraduate and undergraduate students, information technology personnel, research-office representatives, and external community partners. Community partners included representatives of schools, nonprofit organizations, local government agencies, professional associations, independent research groups, and social enterprises collaborating with university libraries.

Ten academic libraries were selected through purposive and maximum-variation sampling. Institutional selection considered university type, geographical setting, library size, digital infrastructure, artificial intelligence adoption, open-access services, and history of community engagement. Eligible libraries were required to provide digital information services, employ professional library personnel, and operate at least one program related to digital scholarship, research data, open access, artificial intelligence literacy, community outreach, makerspaces, or collaborative knowledge creation. Libraries undergoing major organizational restructuring or unable to provide institutional documentation were excluded from the study.

The quantitative sample comprised 360 respondents distributed across the participating institutions. The sample included 80 librarians and library managers, 70 lecturers and researchers, 180 students, and 30 representatives of community or institutional partner organizations. Proportionate stratified sampling was used to ensure that the perspectives of major stakeholder groups were adequately represented. Respondents were required to be at least eighteen years old and to have used, managed, supported, or collaborated with the academic library during the preceding twelve months.

The qualitative sample consisted of forty key informants selected through purposive and criterion-based sampling. The informants included ten library directors or senior managers, ten librarians responsible for digital services or research support, eight lecturers or researchers, six student representatives, and six external community partners. Informant selection was based on direct knowledge of library governance, artificial intelligence adoption, digital knowledge services, or collaborative programs. Qualitative recruitment continued until the interviews generated recurring explanations and no substantially new themes emerged.

Research Procedure

Quantitative data were collected using a structured questionnaire developed from established concepts in knowledge governance, community engagement, responsible artificial intelligence, open innovation, and academic library transformation. The questionnaire consisted of six sections covering respondent characteristics, digital knowledge governance, community engagement, artificial intelligence readiness, organizational capability, and open innovation performance. All principal constructs were measured using a five-point Likert scale ranging from 1, representing strongly disagree, to 5, representing strongly agree.

Digital knowledge governance was measured through statements concerning policy clarity, data ownership, privacy, cybersecurity, copyright, open-access management, algorithmic accountability, ethical review, and stakeholder participation in digital decision-making. Community engagement items assessed physical and digital accessibility, inclusiveness, responsiveness to community needs, continuity of partnerships, knowledge reciprocity, co-design, and stakeholder influence over programs. Artificial intelligence

readiness was measured through infrastructure availability, staff competence, institutional guidance, ethical awareness, technical support, and capacity to evaluate artificial intelligence outputs.

Open innovation performance was measured through the development of new services, experimentation with digital tools, interdisciplinary projects, collaborative research support, community-based knowledge production, knowledge reuse, external partnerships, and organizational learning. Several negatively worded items were included to reduce acquiescence bias. Demographic and institutional questions were added to examine whether perceptions differed according to stakeholder group, frequency of library use, institutional role, length of involvement, and prior experience with artificial intelligence tools.

Content validity was evaluated by five experts in library and information science, knowledge management, digital governance, artificial intelligence ethics, and community engagement. The experts assessed item relevance, linguistic clarity, conceptual coverage, and contextual suitability. A pilot test involving forty respondents from academic libraries outside the main sample was conducted to identify ambiguous wording and estimate completion time. Construct validity was examined through exploratory and confirmatory factor analysis. Internal consistency was evaluated using Cronbach's alpha and composite reliability, with coefficients of 0.70 or higher considered acceptable.

Qualitative data were collected through a semi-structured interview guide, a nonparticipant observation protocol, and a document-review matrix. The interview guide explored institutional strategy, decision-making authority, artificial intelligence use, data governance, professional competence, ethical challenges, community participation, partnership arrangements, service innovation, and perceived barriers to transformation. Probing questions were used to obtain examples of policy implementation, stakeholder conflict, organizational learning, and differences between formal institutional commitments and actual library practices.

The observation protocol was used to record the availability and use of digital laboratories, collaborative spaces, makerspaces, assistive technologies, artificial intelligence services, public-access facilities, and community-learning activities. Attention was also given to staff–user interaction, stakeholder participation, technological accessibility, and the practical implementation of ethical or privacy safeguards. The document-review matrix covered strategic plans, artificial intelligence policies, data-management guidelines, privacy statements, open-access policies, partnership agreements, annual reports, service evaluations, training materials, and records of community programs.

Instruments, and Data Collection Techniques

The research process began with the identification and mapping of academic libraries that met the institutional selection criteria. Preliminary information was obtained from university websites, library reports, institutional repositories, professional library networks, and direct communication with library administrators. Formal research permission was requested from each participating university and library. A local contact person was appointed at each institution to facilitate access to respondents, institutional documents, and scheduled library activities.

Ethical approval was obtained from the relevant institutional research ethics committee before data collection. Participants received an information sheet describing the purpose of the study, research procedures, voluntary nature of participation, confidentiality measures, and intended use of the findings. Written or electronic informed consent was obtained from every participant. Personal identifiers were removed from survey files and interview transcripts, while institutional names were replaced with codes when anonymity was required.

The questionnaire was distributed through a secure online platform and, where necessary, printed copies were provided to participants with limited digital access. Reminder messages

were sent through designated institutional coordinators to improve the response rate without pressuring potential participants. Completed questionnaires were screened for missing values, duplicate submissions, extreme response patterns, and insufficient completion time. Cases containing substantial missing data or evidence of inattentive responding were excluded before statistical analysis.

Descriptive statistics were used to summarize respondent characteristics and the distribution of the principal variables. Reliability analysis and factor analysis were conducted before testing the hypothesized relationships. Pearson correlation analysis was used to examine associations among digital knowledge governance, community engagement, artificial intelligence readiness, and open innovation performance. Hierarchical multiple regression or structural equation modeling was applied to determine the direct and indirect contributions of the principal constructs. Interaction analysis was conducted to assess whether community engagement strengthened the relationship between digital knowledge governance and open innovation performance.

Institutional type, library size, technological maturity, respondent category, and frequency of library use were included as control variables where appropriate. Statistical assumptions involving normality, linearity, homoscedasticity, independence of residuals, and multicollinearity were assessed before inferential results were interpreted. Statistical significance was determined at the 0.05 level, while confidence intervals and effect sizes were reported to support substantive interpretation.

Data Analysis Technique

Qualitative interviews were conducted face-to-face or through secure video-conferencing platforms and lasted approximately forty-five to seventy minutes. Interviews were audio-recorded with participant permission and transcribed verbatim. Nonparticipant observations were conducted during digital literacy training, research consultations, community workshops, innovation activities, or collaborative meetings. Relevant institutional documents were collected with formal authorization and organized according to institution, document type, policy area, and publication date.

Qualitative data were analyzed through reflexive thematic analysis. The analytical process involved transcript familiarization, initial coding, category development, theme construction, and cross-case comparison. Deductive codes were derived from the conceptual framework, including data stewardship, transparency, privacy, co-creation, accessibility, artificial intelligence ethics, institutional support, and innovation capacity. Inductive codes were developed to capture unexpected experiences, organizational tensions, and locally specific practices emerging from the data.

Research credibility was strengthened through data triangulation, member checking, peer debriefing, and maintenance of an audit trail. Selected interview participants reviewed summaries of their statements to verify interpretive accuracy. Two researchers compared coding decisions and discussed differences until conceptual agreement was achieved. Reflective notes were maintained throughout the research process to document analytical choices and possible researcher assumptions.

Quantitative and qualitative results were integrated during the final interpretation stage. Joint displays were developed to compare statistical patterns with interview themes, observations, and documentary evidence across the ten institutions. Convergent findings were interpreted as mutually reinforcing evidence, while divergent findings were examined in relation to stakeholder position, institutional culture, policy implementation, and technological capacity. The final analysis identified the governance and engagement conditions under which academic libraries were most capable of becoming ethical, inclusive, and sustainable open innovation hubs.

RESULTS AND DISCUSSION

Administrative records from the ten participating academic libraries showed considerable variation in institutional size, technological maturity, community programming, and artificial intelligence adoption. The libraries collectively served approximately 146,300 registered users and employed 237 professional and supporting staff members. Institutional reports documented 128 digital literacy activities, 42 artificial intelligence literacy workshops, 76 active external partnerships, and 31 collaborative innovation projects during the preceding academic year. Seven libraries maintained institutional repositories integrated with research-data services, six had formal guidelines governing artificial intelligence use, five operated digital scholarship laboratories or makerspaces, and four had established community advisory mechanisms. Three libraries were classified as having advanced digital maturity, four demonstrated intermediate maturity, and three remained at an emerging stage.

Table 1. Institutional Characteristics of the Participating Academic Libraries

Institutional Characteristic	Advanced-Maturity Libraries (n = 3)	Intermediate-Maturity Libraries (n = 4)	Emerging-Maturity Libraries (n = 3)	Total
Registered users	61,800	56,700	27,800	146,300
Library staff members	94	91	52	237
Digital literacy activities	51	49	28	128
AI literacy workshops	23	14	5	42
Active external partnerships	31	29	16	76
Collaborative innovation projects	16	11	4	31
Libraries with formal AI guidelines	3	2	1	6
Libraries with community advisory mechanisms	2	2	0	4
Libraries operating digital laboratories or makerspaces	3	2	0	5
Libraries providing research-data services	3	3	1	7

Secondary evidence indicated that technological availability was more widespread than participatory governance. Eight libraries had experimented with generative artificial

intelligence for reference assistance, metadata enrichment, research discovery, or user education, but only six had adopted written institutional guidance addressing privacy, academic integrity, algorithmic accountability, or human oversight. Community-oriented activities were documented in all ten institutions, although sustained co-designed programs were found in only five. Most outreach activities took the form of short courses, public seminars, school visits, and digital literacy workshops. Programs involving community partners in agenda setting, content production, service evaluation, or data governance remained comparatively limited.

The concentration of artificial intelligence workshops and collaborative projects in advanced-maturity libraries reflected differences in infrastructure, staffing, and institutional support. Libraries with dedicated digital scholarship personnel were able to move beyond basic electronic services toward experimentation with research-data visualization, generative artificial intelligence, digital humanities, and collaborative learning platforms. Intermediate libraries demonstrated selective innovation, usually in areas connected to information literacy and repository management. Emerging libraries relied heavily on general university information technology units and lacked specialized personnel capable of assessing artificial intelligence tools independently. This distribution suggests that innovation capacity was influenced not only by access to technology but also by organizational competence and decision-making autonomy.

The discrepancy between technological experimentation and formal governance indicated that adoption frequently preceded institutional regulation. Several libraries introduced artificial intelligence-supported services through pilot projects or individual staff initiatives before university-wide policies had been established. Such experimentation generated practical learning, but it also created uncertainty concerning data privacy, authorship, copyright, output verification, and responsibility for inaccurate recommendations. Community engagement displayed a similar pattern because many libraries offered public-facing activities without formal mechanisms for incorporating community perspectives into program design. Institutional openness was therefore more visible at the level of service access than at the level of shared authority.

Respondent-level data were obtained from 360 participants, consisting of 80 librarians and library managers, 70 lecturers and researchers, 180 students, and 30 external community or institutional partners. Digital knowledge governance received an overall mean score of 3.62, indicating a moderately positive assessment. Privacy and cybersecurity achieved the highest governance score, while algorithmic transparency recorded the lowest. Artificial intelligence readiness reached a mean of 3.55, with infrastructure and access to digital tools evaluated more positively than staff competence and ethical guidance. Open innovation performance received a mean score of 3.60, suggesting that participants recognized evidence of service experimentation and collaboration but perceived less progress in community-based knowledge co-creation.

Table 2. Descriptive Statistics for the Principal Research Variables

Variable and Dimension	Mean	Standard Deviation	Minimum	Maximum	High-Category Respondents (%)
Digital knowledge governance	3.62	0.58	1.72	4.93	49.7
Policy clarity and accountability	3.44	0.68	1.40	5.00	42.2
Privacy and cybersecurity	3.78	0.61	1.80	5.00	58.6

Open access and data stewardship	3.69	0.64	1.60	5.00	53.1
Algorithmic transparency	3.27	0.76	1.00	5.00	32.5
Community engagement	3.48	0.64	1.50	4.94	43.6
Accessibility and inclusion	3.71	0.62	1.80	5.00	55.8
Reciprocal knowledge exchange	3.45	0.71	1.20	5.00	41.7
Community co-design	3.31	0.75	1.00	5.00	34.4
Partnership continuity	3.46	0.69	1.25	5.00	42.8
Artificial intelligence readiness	3.55	0.67	1.35	4.95	46.4
Technological infrastructure	3.74	0.66	1.50	5.00	57.2
Staff competence	3.43	0.73	1.20	5.00	40.3
Ethical and institutional guidance	3.33	0.79	1.00	5.00	35.8
User education and support	3.69	0.68	1.40	5.00	53.9
Open innovation performance	3.60	0.61	1.55	4.95	48.9
Service experimentation	3.76	0.64	1.60	5.00	57.5
Interdisciplinary collaboration	3.63	0.67	1.40	5.00	50.3
Community knowledge co-creation	3.32	0.78	1.00	5.00	35.6
Organizational learning	3.68	0.65	1.50	5.00	52.8

Stakeholder comparisons revealed meaningful differences in the assessment of institutional performance. Librarians reported the highest average scores for digital knowledge governance and artificial intelligence readiness, whereas external community partners provided the lowest scores for community co-design and influence over decision-making. Students evaluated accessibility and artificial intelligence user support relatively positively but expressed greater uncertainty regarding data privacy and the reliability of algorithmically generated information. Lecturers and researchers recognized improvements in research-data support and open-access services, although they reported inconsistent guidance on copyright, authorship disclosure, and acceptable artificial intelligence use. These differences indicate that institutional insiders perceived governance arrangements more positively than stakeholders with less direct access to decision-making processes.

Pearson correlation analysis demonstrated statistically significant positive relationships among digital knowledge governance, community engagement, artificial intelligence readiness, and open innovation performance. Digital knowledge governance had the strongest bivariate relationship with open innovation performance, ($r = .64$), ($p < .001$). Community engagement was also strongly correlated with innovation performance, ($r = .59$), ($p < .001$), while artificial intelligence readiness produced a slightly lower but still substantial relationship, ($r = .55$), ($p < .001$). Digital knowledge governance was positively related to community engagement, suggesting that libraries with clearer policies, accountability structures, and data-management practices were more likely to support inclusive and reciprocal engagement.

Table 3. Correlations Among the Principal Research Variables

Variable	1	2	3	4
1. Digital knowledge governance	1.00			
2. Community engagement	.51***	1.00		
3. Artificial intelligence readiness	.57***	.44***	1.00	
4. Open innovation performance	.64***	.59***	.55***	1.00

*Note. N = 360. ***p < .001.*

Hierarchical multiple regression analysis was used to determine the contribution of the principal variables to open innovation performance. Institutional type, library size, respondent category, frequency of library use, and digital-maturity level were entered as control variables in the first model and explained 13% of the variance. The addition of digital knowledge governance, community engagement, and artificial intelligence readiness increased the explained variance to 57%. The interaction between digital knowledge governance and community engagement contributed a further four percentage points, producing a final (R^2) of .61. Digital knowledge governance remained the strongest direct predictor, followed by community engagement and artificial intelligence readiness.

Table 4. Hierarchical Regression Predicting Open Innovation Performance

Predictor	Standardized Beta	Standard Error	t	p
Digital-maturity level	.12	.031	2.69	.008
Library size	.05	.001	1.18	.239
Frequency of library use	.08	.019	1.92	.056
Digital knowledge governance	.34	.046	7.41	<.001

Community engagement	.29	.043	6.52	<.001
Artificial intelligence readiness	.25	.041	5.89	<.001
Governance × community engagement	.15	.038	3.72	<.001

Note. Final model: (R^2 = .61), adjusted (R^2 = .60), (F(10,349) = 54.66), (p < .001). Variance inflation factor values ranged from 1.21 to 2.18.

Moderation analysis showed that community engagement strengthened the relationship between digital knowledge governance and open innovation performance. Under high-engagement conditions, the association between governance and innovation performance was strong, (B = .67), (p < .001). Under moderate-engagement conditions, the relationship remained significant but was reduced, (B = .45), (p < .001). Under low-engagement conditions, governance continued to predict innovation performance, although the effect was substantially weaker, (B = .24), (p = .021). Clear policies and responsible data practices therefore generated stronger innovation outcomes when users and community partners participated meaningfully in service development and knowledge exchange.

Structural relationships among the variable dimensions revealed that algorithmic transparency and community co-design were more influential than their relatively low descriptive scores initially suggested. Algorithmic transparency showed a significant positive relationship with stakeholder trust, (r = .48), (p < .001), while stakeholder trust was related to continued participation in innovation programs, (r = .53), (p < .001). Community co-design was strongly associated with the perceived social relevance of new library services, (r = .61), (p < .001). Technological infrastructure contributed to service experimentation, but its direct association with community knowledge co-creation was comparatively modest, (r = .29), (p < .001). These relationships indicate that technical capacity supported innovation more effectively when combined with transparency, reciprocal participation, and shared program ownership.

Qualitative evidence from forty key informants generated six recurring themes: policy–practice alignment, librarians as institutional boundary spanners, uneven artificial intelligence competence, community participation without shared authority, ethical uncertainty, and the importance of sustained external partnerships. Policy–practice alignment was strongly evident in three advanced-maturity libraries and partially evident in four intermediate institutions. Emerging libraries frequently relied on informal decisions or university-wide policies that did not address library-specific issues. Librarians responsible for digital scholarship or community programs often acted as intermediaries among researchers, information technology units, university leaders, students, and external organizations.

Table 5. Cross-Case Profiles of Representative Academic Libraries

Case	Digital Knowledge Governance	Community Engagement	AI Readiness	Distinctive Practice	Main Constraint	Innovation Performance
Library A	High and formally integrated	High and reciprocal	High	Community co-designed digital scholarship laboratory	High operational costs	High

Library B	Moderate but fragmented	High but project-based	Moderate	Public AI literacy and citizen-science programs	Limited policy coordination	Moderate to high
Library C	High in compliance, low in participation	Low to moderate	High	Automated discovery and metadata services	Limited stakeholder influence	Moderate
Library D	Low and informally managed	Moderate	Low	Strong librarian–community relationships	Weak infrastructure and staff shortages	Moderate
Library E	Moderate and developing	Low	Moderate	Institutional repository and open-access support	Minimal external collaboration	Moderate to low

Representative case comparison showed that technological sophistication did not automatically produce the highest open innovation performance. Library A combined formal digital governance with community co-design and achieved the strongest performance across service innovation, trust, and partnership continuity. Library C possessed advanced artificial intelligence tools and strict compliance procedures but offered limited opportunities for users or community partners to influence service design. Library D lacked advanced infrastructure but maintained strong personal relationships with schools and nonprofit organizations, allowing it to sustain locally relevant programs. The cross-case pattern confirmed that innovation performance depended on the interaction between governance, technology, and participatory relationships rather than on any single institutional capacity.

Interview accounts explained that librarians frequently initiated innovation through informal experimentation before formal approval was obtained. Such initiatives included testing generative artificial intelligence for reference questions, developing research-data consultations, organizing prompt-literacy workshops, and collaborating with local schools on digital archives. Informal experimentation allowed rapid responses to emerging needs but exposed staff members to uncertainty concerning institutional responsibility and acceptable risk. Participants from libraries with clear escalation procedures and ethical review mechanisms reported greater confidence in piloting new services. Participants from weakly governed settings described reluctance to experiment because errors involving privacy, copyright, or inaccurate artificial intelligence output could be attributed to individual librarians.

Documentary and observational evidence clarified why community engagement did not consistently develop into co-governance. Institutional plans commonly described libraries as inclusive or community-oriented, but partnership agreements usually focused on activity delivery rather than shared decision-making. Community representatives were frequently invited as participants, speakers, or beneficiaries but rarely served on advisory committees or evaluation teams. Programs became more reciprocal when partners contributed local data, helped define research questions, or jointly evaluated services. Such arrangements increased

relevance and trust but required additional time, negotiation, and clarity regarding ownership of community-generated knowledge.

The integrated findings indicate that academic libraries were progressing toward open innovation roles, although the transformation remained uneven and incomplete. Most institutions had moved beyond conventional collection-centered services by adopting digital scholarship, artificial intelligence literacy, open-access support, or external collaboration. The evidence did not support the assumption that digitalization alone represented open innovation. Libraries achieved stronger innovation performance when technology was governed through clear ethical procedures and connected to meaningful stakeholder participation.

The overall pattern suggests that digital knowledge governance functions as an enabling institutional foundation, while community engagement determines the social reach and relevance of innovation. Artificial intelligence readiness increased the capacity to experiment, but transparent policies, professional competence, and human oversight influenced whether experimentation generated trust. Community engagement amplified the effect of governance because shared participation connected institutional capability with real user and public needs. Academic libraries were closest to functioning as open innovation hubs when they combined technological readiness, accountable knowledge governance, interdisciplinary collaboration, and reciprocal community partnerships.

The findings demonstrate that the transformation of academic libraries into open innovation hubs remains uneven across institutions. Most participating libraries had expanded beyond conventional collection management by introducing digital scholarship services, artificial intelligence literacy programs, institutional repositories, research-data support, makerspaces, and collaborative community activities. Digital knowledge governance, community engagement, and artificial intelligence readiness were positively associated with open innovation performance. The strongest outcomes appeared in libraries that combined technological infrastructure with clear institutional policies, capable staff, transparent decision-making, and sustained partnerships with academic and nonacademic communities.

Digital knowledge governance emerged as the strongest direct predictor of open innovation performance. Policy clarity, data stewardship, privacy protection, open-access management, accountability, and responsible artificial intelligence practices enabled libraries to develop new services with greater institutional confidence. Algorithmic transparency received a lower descriptive score than other governance dimensions, indicating that many institutions had adopted artificial intelligence applications without establishing adequate mechanisms for explaining system functions, verifying generated content, or clarifying responsibility for errors. This imbalance suggests that technological experimentation was advancing more rapidly than institutional capacity to govern its ethical and epistemic consequences.

Community engagement also made a substantial contribution to innovation performance, particularly when stakeholders participated in designing, implementing, and evaluating library programs. Accessibility and inclusion were rated more positively than reciprocal knowledge exchange and community co-design. Many libraries had opened selected programs to schools, nonprofit organizations, local agencies, and independent researchers, but fewer had provided these groups with meaningful authority over innovation priorities. Engagement was therefore more developed as service outreach than as shared governance. The distinction is important because public participation produced stronger innovation outcomes when communities were treated as knowledge partners rather than recipients of university expertise.

Artificial intelligence readiness supported service experimentation, user education, and organizational learning, although its influence depended on governance and participation. Technological infrastructure alone was insufficient to produce strong community knowledge co-creation or sustainable institutional change. Libraries with advanced systems but limited stakeholder involvement achieved moderate rather than exceptional innovation outcomes. Libraries with less sophisticated infrastructure occasionally produced socially relevant services

through strong partnerships and adaptive professional practices. The overall pattern indicates that open innovation emerges from the interaction of technological, institutional, and relational capacities rather than from the adoption of artificial intelligence tools in isolation.

The findings correspond with scholarship that portrays academic libraries as evolving from information repositories into active partners in research, teaching, digital scholarship, and institutional innovation. Previous research has documented the growth of learning commons, research-data services, digital humanities laboratories, makerspaces, and open-access publishing support. The present study supports this broader transformation while adding a critical qualification: service diversification does not automatically establish an open innovation hub. Genuine open innovation requires institutional arrangements that permit knowledge to move across disciplinary, professional, and community boundaries through reciprocal collaboration.

The results also align with knowledge-governance research emphasizing that innovation depends on mechanisms regulating access, ownership, responsibility, trust, and knowledge exchange. Studies of digital transformation frequently identify data quality, interoperability, privacy, cybersecurity, and organizational leadership as major determinants of institutional performance (Binabid & Anteet, 2026; Richardson et al., 2026; Robson et al., 2026). The present findings reinforce these arguments by showing that governance quality predicted innovation more strongly than technological readiness alone. The contribution extends existing knowledge by positioning ethical and participatory governance not merely as risk-control mechanisms but as productive conditions that enable experimentation, institutional learning, and external collaboration.

The lower scores for algorithmic transparency and ethical guidance are consistent with concerns raised in research on artificial intelligence adoption in higher education. Academic institutions often introduce generative systems, automated recommendation tools, and data-driven services before reaching agreement on acceptable use, authorship, bias, privacy, and human oversight (Dumančić et al., 2026; Ozturkcan, 2026; Polson, 2026). The findings differ from technology-acceptance studies that primarily interpret adoption through usefulness, convenience, or user intention. Stakeholder trust in this study depended not only on whether artificial intelligence systems improved service efficiency but also on whether users understood how the systems operated and how librarians evaluated their outputs.

The community-engagement findings extend library research that traditionally distinguishes academic libraries from public libraries according to their primary constituencies. Academic libraries are commonly structured around the needs of enrolled students, lecturers, and researchers, whereas community partnerships are often treated as supplementary outreach. The present study indicates that this institutional distinction is becoming less adequate in an era of open science, citizen scholarship, and socially engaged universities. External partners contributed local knowledge, practical problems, archival materials, and alternative perspectives that increased the relevance of library innovation. The difference from conventional outreach models lies in the degree of authority granted to these partners over knowledge production and service design.

The dominance of digital knowledge governance signifies that academic library transformation is fundamentally an institutional challenge rather than a purely technological one. Artificial intelligence can accelerate discovery, metadata creation, reference assistance, and research analysis, but these capabilities become legitimate only when institutions determine how data are used, how outputs are verified, and who is accountable for harm. Governance provides the rules through which technological possibilities are translated into trusted professional practices. Weak governance leaves innovation dependent on individual experimentation and exposes both staff and users to unresolved ethical and legal risks.

The discrepancy between accessibility and community co-design signifies that openness can remain superficial. Libraries may extend opening hours, offer online resources, or organize

public workshops while retaining centralized control over agendas, platforms, and evaluation criteria. Such practices increase participation numerically but do not necessarily redistribute knowledge authority. Open innovation requires a deeper form of openness in which external actors can influence the questions being investigated, the data being collected, the services being developed, and the benefits being distributed. The findings signal that many academic libraries have opened their doors more rapidly than they have opened their decision-making structures.

The stronger perceptions reported by librarians compared with community partners signify a possible institutional blind spot. Library professionals may evaluate programs through service availability, completion rates, technological functionality, or compliance with university plans. Community participants may judge the same programs according to relevance, continuity, influence, accessibility, and reciprocal benefit. Differences between these perspectives do not necessarily indicate that one group is inaccurate. They show that innovation performance is socially situated and that institutional success cannot be assessed solely from the viewpoint of service providers.

The variation among case-study institutions signifies that there is no single linear pathway from traditional library to open innovation hub. Advanced technology may coexist with weak participation, while modest technological resources may be combined with strong local relationships. Formal governance may support responsible innovation but may also slow experimentation when procedures are excessively rigid. Informal professional initiative may generate creative services but remain vulnerable to leadership change and institutional resistance. Library transformation should therefore be understood as a negotiated process shaped by organizational culture, professional agency, technological capacity, and stakeholder power.

The theoretical implication concerns the need to redefine open innovation within academic librarianship. Open innovation should not be reduced to the adoption of collaborative technologies or the provision of flexible spaces. The concept should encompass the governance of knowledge flows, the distribution of decision-making authority, and the inclusion of diverse knowledge holders. Academic libraries become innovation hubs when they connect information resources, digital tools, professional expertise, institutional networks, and community experience in ways that produce shared intellectual and social value.

The institutional implication concerns the need for universities to position libraries within strategic discussions about artificial intelligence, open science, research integrity, and civic engagement. Library staff should not be invited only after technological systems have been purchased or university policies have been drafted. Their expertise in metadata, information quality, copyright, privacy, access, and user education makes them essential contributors to institutional artificial intelligence governance. Formal representation on technology, research, ethics, and community-engagement committees would strengthen the capacity of libraries to mediate between innovation and accountability.

The professional implication concerns the changing competencies required of academic librarians. Information retrieval and collection management remain necessary, but they must be complemented by data stewardship, artificial intelligence literacy, algorithmic evaluation, project facilitation, community partnership, and ethical decision-making. Librarians increasingly function as boundary-spanning professionals who connect researchers, students, technology specialists, administrators, and external communities. Professional development should therefore integrate technical training with communication, participatory design, conflict negotiation, and responsible innovation.

The social implication concerns the democratic role of academic libraries in knowledge production. Artificial intelligence may widen access to information, but it can also reproduce linguistic, socioeconomic, and technological inequalities. Communities with limited connectivity, digital literacy, or institutional status may remain excluded from emerging

knowledge infrastructures. Academic libraries can reduce these inequalities by providing accessible technologies, critical literacy programs, public research support, and community-controlled knowledge spaces. Such efforts require sensitivity to local knowledge rights, data ownership, language diversity, and the risk of extracting community information without returning meaningful benefits.

The strong influence of digital knowledge governance can be explained by the uncertainty created by artificial intelligence and data-intensive services. Librarians operate in environments where technological outputs may be inaccurate, biased, proprietary, or difficult to interpret. Clear policies reduce uncertainty by defining acceptable practices, review procedures, documentation standards, and lines of responsibility. Staff members are more willing to experiment when they know how risks will be assessed and how institutional support will be provided. Users are also more likely to trust services when governance practices are visible and understandable.

The lower level of algorithmic transparency can be explained by the technical and commercial opacity of many artificial intelligence systems. Academic libraries often acquire tools through vendors or institution-wide platforms without access to complete information about training data, model architecture, or recommendation processes. Librarians may be expected to support systems they did not select and cannot fully audit. Rapid technological change further complicates the development of stable institutional policies. Governance gaps therefore arise not only from administrative delay but also from structural dependence on external technology providers.

The limited level of community co-design can be explained by institutional traditions that define knowledge expertise primarily through formal academic roles. Universities commonly recognize lecturers, researchers, and credentialed professionals as legitimate knowledge producers, while communities are positioned as research participants, service users, or outreach beneficiaries. Academic libraries may inherit this hierarchy even when they seek to become more inclusive. Co-design requires institutions to accept that external communities possess contextual, cultural, and experiential knowledge that can shape academic services and research priorities.

The interaction between governance and engagement can be explained by the reciprocal production of trust. Transparent policies and accountable leadership encourage stakeholders to contribute ideas because they understand how their input and data will be used. Meaningful participation improves governance because diverse stakeholders identify risks, access barriers, and unintended consequences that institutional actors may overlook. Low engagement weakens governance by limiting the range of perspectives involved in decision-making. Weak governance reduces engagement because participants doubt whether their contributions will influence institutional action.

Academic libraries should develop integrated digital knowledge-governance frameworks that address artificial intelligence, research data, open access, copyright, privacy, cybersecurity, and community-generated content. Fragmented policies can create contradictory responsibilities and leave staff uncertain about acceptable practice. Integrated frameworks should define human oversight, output verification, data-retention rules, vendor accountability, disclosure requirements, and procedures for addressing algorithmic harm. Regular policy review is essential because artificial intelligence applications and associated risks continue to change rapidly.

Libraries should establish permanent participatory structures rather than relying only on temporary outreach programs. Community advisory boards, user-design panels, student innovation councils, and collaborative evaluation teams can provide stakeholders with sustained influence over service development. Membership should include groups that are often underrepresented in institutional decision-making, including people with disabilities, independent researchers, local schools, nonprofit organizations, and culturally diverse

communities. Participation should be supported through accessible communication, clear authority, and transparent reporting on how recommendations are implemented.

Universities should invest in professional and infrastructural capacity without treating technology procurement as the principal indicator of progress. Staff development should cover generative artificial intelligence, data ethics, digital accessibility, algorithmic bias, participatory methods, and partnership management. Innovation funds should support small-scale experimentation accompanied by ethical review and systematic evaluation. Shared laboratories, secure data environments, open-source platforms, and interdisciplinary project teams can reduce dependence on isolated staff initiatives and commercial systems.

Future research should employ longitudinal and comparative designs to determine how academic libraries evolve as artificial intelligence becomes more deeply embedded in higher education. Repeated measurement could assess whether governance reforms produce stronger community trust, innovation continuity, and institutional learning over time. Comparative studies across national, linguistic, and institutional contexts could reveal how funding, regulation, professional culture, and digital inequality shape library transformation. Objective indicators such as partnership duration, service adoption, policy compliance, community benefit, and knowledge reuse should be combined with stakeholder perceptions to produce a more rigorous evaluation of open innovation performance.

CONCLUSION

Conclusions can be generalized findings according to research problems, can also be in the form of recommendations for the next step.

DECLARATION OF AI AND AI ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

During the preparation of this work, the author(s) used ChatGPT (OpenAI) to assist in drafting, refining, and improving the clarity and readability of the manuscript. After using this tool, the author(s) reviewed and edited the content as needed and take full responsibility for the content of the publication.

ACKNOWLEDGMENTS

I would like to thank you funding for this research. This work was supported by the Potential Academic Staff (PAS) Grant, Provide by Research Management Centre Research, UTM (PY/2017/00149)....

AUTHOR CONTRIBUTIONS

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.

Author 2: Conceptualization; Data curation; In-vestigation.

Author 3: Data curation; Investigation.

DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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