Information Research - Vol. 31 No. iConf (2026)

University libraries in transition: Understanding challenges and dilemmas of service transformation in the AI era

Hanyu Miao, Zengmin Wang, and Lihong Zhou

DOI: https://doi.org/10.47989/ir31iConf64281

Abstract

Introduction. With the rapid development of artificial intelligence (AI), university libraries are caught in a dilemma between transformation and maintaining the status quo. While the latter is reasonable, the transformation is considered imperative but multidimensionally challenging.

Method. By employing a meta-analysis qualitative approach, interview data of 16 librarians and 24 researchers from 2 case studies were analysed to identify the challenges of the transformation in university library services.

Analysis. Adopting the actor network theory (ANT) as a basic framework, the thematic analysis reveals the challenges from 5 nonhuman actors and 4 human actors (including policies, finance, infrastructure and software, AI algorithms, ethics, administration, library, database agents, and users).

Results. The inductive coding analysis identified 28 challenges of university library services transformation. Based on the findings, this study proposed a model of conflict among actors.

Conclusion(s). The identified challenges provide useful theoretical and practical evidence for optimising AI-driven transformation of university libraries. Moreover, the case setting is based in China, but the findings offer useful insights and indications that can be shared across international borders.

Introduction

A library is a means of access to information, ideas, and works of imagination (IFLA, 2003). In universities, it is a common idea that libraries are deemed as one of the most valuable and important resources (Chen and Zhou, 2021). University libraries are typical knowledge-based organisations, documentation, and information centres, as they fulfil a pivotal role in supporting research and knowledge generation (Li et al., 2009; Peng et al., 2022).

The literature suggests that university libraries could play a vital role by developing effective and methodical services to underpin scholarship and research across all disciplines. (Kennan, 2014; Zhou et al., 2019). As specified by the International Federation of Library Associations and Institutions (IFLA), university libraries should provide (1) open access transformation; (2) open access publishing; (3) open data management; (4) open educational resources; (5) open source environments; (6) open science policies; (7) e-research support; (8) copyright legislation; (9) new shapes of library management; (10) information literacy, and (11) advanced skills and further training of library staff.

With the development of technology, artificial intelligence (AI) has emerged as a pivotal technological advancement over recent years (Yoon, 2025). The rapid development of AI and the expanding research landscape have given library services an entirely new dimension (Shah et al., 2025). For example, some scholars found that AI has strong positive effects on innovative reference services, collection management, promotion of library products, and alignment of library services with the industrial revolution for the transformation of library systems (Çakmak and Eroglu, 2025; Tawalbeh, 2025; Vrindha and Syamili, 2025).

Although AI could play a crucial role in future library services, university libraries tend to face some unique pedagogical and technological challenges, including funding constraints and fears of job replacement among library staff (Ali et al., 2024). On the other hand, AI also poses several potential threats to the library, including the challenges of misinformation and related ethical issues (Lamichhane, 2024). Consequently, despite initial efforts by some libraries to integrate AI into their services, the extent of progress varies significantly across institutions. It is evident that university libraries are confronted with numerous challenges in their transformation, necessitating careful consideration.

Confronted with the dilemma of transformation, scholars have advocated for change management as an analytical framework to address such issues across diverse disciplines, including economics, public administration, cultural studies, and education. (Seles et al., 2018; Smit, 2021; Mainardi, 2025). However, against the backdrop of the significant changes brought about by the AI era, discussions on the transformation of university library services are rather limited. To address this research gap, this study aims to delineate challenges impacting the transformation of university library services and analyse their interdependent dynamics in shaping service evolution. Thus, this study poses the following research questions:

RQ1: What are the challenges to the transformation of university library services?

RQ2: What framework can be drawn from RQ1?

RQ3: What practical strategies can be formulated to address these challenges effectively?

Research methodology and design

Research design

A case study is an important and ever-growing part of multiple scientific and scholarly literature (Schubert, 2015), which is expected to capture the complexity of representative cases (Sneed et al., 2020). The primary aim of a case study is to reveal the intrinsic mechanisms of a phenomenon

through a thorough examination of typical instances, rather than to pursue statistical representativeness (Benbasat and Wang, 2005). To answer our research questions, and considering the exploratory nature of this study, a case study approach is employed.

It is worth noting that this research adopted a qualitative meta-analysis approach. Meta-analysis is an analytical process of integrating, comparing, and synthesising qualitative research findings to generate interpretive results (Erwin et al., 2011; Hareket and Kartal, 2021). A meta-analysis combines the research findings from multiple qualitative studies to generate a more robust interpretation (Willig and Wirth, 2018; Hareket and Kartal, 2021). In this study, previously completed case studies investigating services from four university libraries were drawn on.

Data collection

Data for this study originates from two relatively independent case studies in a broader research project that investigates the development of research support services in China's university libraries to facilitate AI for science (AI4S) projects. Initially, this project was not primarily focused on challenges. However, during data collection, nearly every respondent from the two case studies cited developmental challenges as their most pressing issue. Given this consistent feedback, the present analysis takes a strategic pause to integrate the results from two case studies already conducted within the larger project. This paper thus performs a meta-analysis of secondary data to explicitly identify the challenges and strategies associated with transforming library services.

The semi-structured question script was mainly about the respondents' understanding of the conditions in terms of internal conditions, external environment, and stakeholders in the AI era. Interviews from two case studies were conducted in December 2024 and July 2025. Meanwhile, having received formal approval from the university, this interview firmly respects and protects the legitimate rights and interests of the students, and strictly abides by the *Law of the People's Republic of China on Scientific and Technological Progress*. Following a purposive sampling strategy, we recruited participants via professional networks and direct invitations, ensuring representation from both university libraries and researchers. At the beginning of every interview, the participant was consulted about whether the use of a digital recorder could be accepted. The participants were assured that they could stop the recorder whenever they felt uncomfortable. A total of 16 librarians and 24 researchers were approached and interviewed. The demographic profile of the participants is illustrated in Table 1 below.

Characteristic	Category	Number	Percentage
Gender	Female	23	57.50%
	Male	17	42.50%
Role	Librarian	16	40.00%
	Researcher	24	60.00%
Academic background	Social science	27	67.50%
	Natural science	10	25.00%
	Medical Science	3	7.50%

Table 1. Demographic profile of interview participants.

Data analysis

For the data analysis, MAXQDA 2022 was used to facilitate the analysis of interview data. In the pre-analysis, the research team found that Actor Network Theory (ANT) can be applied in the data analysis. ANT conceptualises networked action as a process of assembling human and non-human entities linked by a given situation, and these entities are connected through constant translations (Latour et al., 2005). Moreover, ANT is essentially a theory of change; its focus is not on the structure of associations, but on their dynamics (Venturini, 2010). As AI continues its rapid, transformative development (Gibney, 2024), ANT emerges as a pertinent framework for

investigating AI ecosystems; by framing networks as dynamic, contentious multiplicities, ANT elucidates the complex practical mechanisms through which practices, corporeal entities, and identity formations are organised and reorganised (Fenwick, 2010).

In the research, the ANT framework (Figure 1) was converted into a preliminary set of codes in the early stages. Throughout the data analysis, these codes were reconceptualised, expanded, and revised according to the statements, interpretations, and perspectives of the individual interview participants.

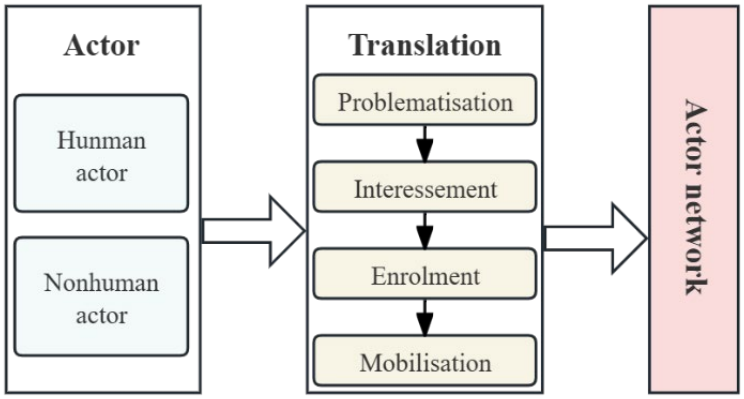

Figure 1. The model of ANT.

Findings

Since ANT emphasises the agency of both human and nonhuman actors, this study identifies five nonhuman actors and four human actors. Moreover, through four translation steps of problematisation, interessement, enrolment, and mobilisation, the inductive coding analysis identified 28 challenges of university library services transformation. The dimensions and challenges are shown in Table 2.

Actors	Dimensions	Challenges
Nonhuman actor	Policies	• Lack of development direction • Vague details and regulations • Inadequate promotion and publicity
	Finance	• Limited funding • Inefficient use of funds
	Infrastructure and software	• Burdensome access • Insufficient computing power • Restricted functionality
	AI algorithms	• Lack of innovation • Inaccuracy • Uncredibility • Algorithmic bias • Data leakage
	Ethics	• Ethical and privacy concerns • Value alignment • Responsibility acknowledgement
Human actor	Administration	• Inadequate attention • Poor interdepartmental cooperation
	Library	• Lack of professional expertise • Insufficient staffing • Poor team organisation • Risk of job displacement
	Database agents	• Knowledge monopolisation • Highly pricing
	Users	• Limited information literacy • Unwillingness to AI utilisation • Rapidly changing needs • Concerns about over-reliance

Table 2. Interview Theme Coding.

Challenges in nonhuman actors

As highlighted by some scholars, nonhuman actors are a decisive factor influencing the success of transformation (Magnani, 2012). Nonhuman actors can belong to the material, natural, and symbolic worlds, taking the form of organisations, materials, technologies, regulations, and so on (Cannors et al., 2024). Five dimensions of nonhuman actors are identified and analysed:

- Policies
- Finance
- Infrastructure and software
- AI algorithms
- Ethics

According to the observation and interview data, the absence of supportive policy frameworks poses a fundamental challenge to the AI transition in libraries. The lack of a clear strategic vision (Interview 26) and detailed implementation guidelines (Interview 29) has resulted in uncoordinated development and inefficient resource allocation. This directly exacerbates financial constraints, including both insufficient funding (Interview 4) and suboptimal investment distribution (Interview 15), which collectively stifle innovation. Furthermore, inadequate promotion of AI services has led to low awareness and engagement among users and staff (Interview 34), hindering the adoption and impact of AI transformations.

From the micro perspective, libraries face considerable technological barriers that impede their AI integration. Outdated infrastructure with limited computing capacity (Interview 33), alongside software with restricted functionality and cumbersome authentication processes (Interview 36, 40), severely affects system performance and usability. However, the most critical obstacles lie in the perceived deficiencies of AI algorithms and associated ethical concerns. These algorithms are often viewed as lacking innovation (Interview 3), producing inaccurate outputs (Interview 7), and being unreliable for academic purposes (Interview 8). Issues such as algorithmic bias (Interview 27) and risks of data leakage (Interview 19) undermine trust and present serious ethical dilemmas. Additionally, a fundamental tension exists between AI's rationalised logic and the humanistic values central to library services (Interview 27), while unclear accountability mechanisms for errors or biases (Interview 30) further erode confidence in AI-supported operations. Additionally, a librarian from the technical department shared an interesting viewpoint:

> At present, it remains a stage of meticulous consideration for the further development of AI. Given that there is no mature and particularly excellent product available, we are engaged in research and waiting patiently. If there emerges a particularly useful AI, I believe libraries will also embrace it (Interview 28).

Challenges in human actors

A well-trained, efficient and hospitable team of stakeholders in the library is essential to promote the transformation of university library services. Functioning as a complex ecosystem of interdependent actors (Barnaud et al., 2018), the transformation of library services faces a convergence of challenges to service transformation from across this system. This study points out the following four human actors, which can be delineated from the supply side as well as the demand side.

- Administration
- Library
- Database agents
- Users

The transformation towards AI-enabled services is significantly constrained by multifaceted challenges within the supply-side ecosystem. At the administrative level, the absence of strategic prioritisation and cohesive policy frameworks (Interview 34), coupled with siloed organisational communication (Interview 2), results in uncoordinated development and inefficient resource allocation. Within libraries themselves, chronic understaffing (Interview 38), outdated internal structures (Interview 33), and a training deficit that fails to keep pace with technological demands (Interview 25) leave librarians overwhelmed and anxious about role obsolescence (Interview 26). Externally, commercial pressures from profit-oriented database agents further restrict progress; their business models rely on restrictive licensing and prohibitively high costs (Interview 4, 38), which stifle equitable access to knowledge and create interoperability barriers that hinder the development of integrated AI services (Interview 30). As one interviewee aptly stated:

> Perhaps the database-level scientific open system is not yet so open, resulting in limited access channels. No matter how good the algorithmic foundation of AI services is, the limited resources and acquisition channels will restrict the functionality (Interview 38).

On the demand side, user-related factors present profound adoption barriers. A significant digital literacy gap (Interview 1) and a deep-seated reluctance to cede research tasks to algorithms (Interview 33) reflect concerns that AI could undermine critical engagement and promote over-reliance on technology (Interview 27). Moreover, user expectations are shaped by comparisons

with sophisticated commercial AI platforms, leading to perceptions that library-offered AI tools are less competitive or professional (Interview 24), which further diminishes engagement and trust for university library services. For instance, an interviewed researcher offered the following statement.

> If I were able to utilise the AI services offered by the library over an extended period, I am certain that the content and services it generates would satisfy my requirements. Nevertheless, it appears that the library lacks such capabilities at present. Moreover, the AI that is currently prevalent in the market already meets my daily needs. Therefore, why should I invest time in trying out something new in the library? (Interview 32)

Discussion

As demonstrated in the findings, 28 challenges of university library services transformation were addressed by 9 actors. However, these challenges are not independent of each other. As illustrated in the following figure, the challenges posed by both human and nonhuman actors converge at several critical and often contested Obligatory Passage Points (OPPs)—fundamental dilemmas that the entire network must collectively resolve to enable transformation.

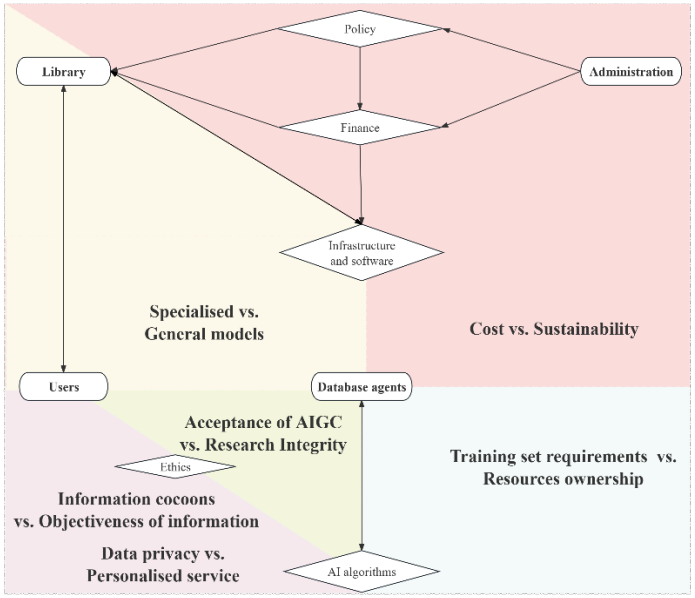

Figure 2. The model of conflict zones.

Conflict zones

The tension between cost-effectiveness and service sustainability engages the broadest spectrum of stakeholders, encompassing both human actors (administrative bodies, libraries, and database agents) and nonhuman elements (policy frameworks, financial systems, and infrastructure and software). The presence of multiple stakeholders has heightened the intricacy of this conflict zone's dynamics. Policies without specific direction and regulations are responsible for inefficient utilisation of funding, which tends to aggravate the funding limitation. On the other hand, high pricing from database agents makes the situation more severe for the available funding to be used by libraries for infrastructure maintenance and software.

The most intense tension within the entire configuration exists among users, database agents, AI algorithms, and ethical frameworks, generating three interconnected conflict zones: (1) the

privacy-personalisation dilemma, where data sharing requirements clash with individual rights protection; (2) the information exposure dilemma, pitting algorithmic-filtered information cocoons against users' demand for comprehensive data access; and (3) the accountability dilemma, wherein opaque algorithmic decision-making undermines ethical governance. These conflicts exacerbate information reliability risks—where algorithmic limitations foster dissemination of outdated, erroneous, or fallacious content—while insufficient user AI literacy critically undermines discernment capabilities.

The tension between database agents and AI algorithms results in the proprietary access dilemma, pitting commercial data ownership against algorithmic training necessities. The efficacy and efficiency of AI language models are critically dependent on training datasets sourced from diverse databases. Typically, greater exposure to datasets enhances the utility, credibility, and accuracy of the information they generate. However, meeting these data requirements is challenging, as disparate database agents possess heterogeneous resources and demonstrate reluctance to share proprietary rights, thereby impeding the advancement of AI algorithms.

Moreover, libraries face complex challenges in balancing user demands for specialised versus general AI models. While mature general AI applications facilitate service transformation toward AI4S, specialised models remain exploratory—requiring substantial collections and resources that intensify library-database agents' dependencies. Concurrently, rapidly evolving user requirements, particularly growing demand for research-supporting specialised models, are widening the gap between user expectations and library service capabilities.'

Practical strategies

Facing unavoidable challenges and difficulties, the transformation of library services is integral and imperative for library survival. While the tension between cost-effectiveness and service sustainability engages numerous stakeholders and complex dynamics, resolving polices and strategic planning that prioritise transition towards AI4S can significantly alleviate this tension, thereby easing—or even eliminating—many challenges in library transformation. Corresponding detailed plans and roadmaps should be drawn, including forming dedicated AI librarian teams, emphasising interdepartmental collaboration, and strengthening librarians' expertise.

While AI literacy of users poses a challenge that cannot be neglected, it can also serve as a breakthrough point for the transformation. It is evident that a balanced perspective of AI technologies and applications is highly required. On one hand, users are supposed to understand and build knowledge about these innovative creatures; on the other, they must develop their discernment skills to sift through misinformation and identify what they want. In this case, libraries should therefore design and implement diverse, engaging AI literacy programs and courses, providing users with resources and platforms to learn about AI and support their scientific journey.

Conclusions and limitations

This paper employs a case study and meta-analysis approach to gain a deep understanding of challenges in university library services transformation. The challenges and the model of conflict presented in this paper can provide some valuable insights for university libraries to embrace AI and promote transformation, thereby contributing to addressing the research gap. However, this study is not without limitations. Firstly, the model requires further revision and validation through collecting a wider range of empirical data. Secondly, the ongoing evaluation of AI and other technologies amplifies variation in how libraries adopt and adapt such tools, so that a follow-up study should be conducted. Additionally, it is expected to explore the challenges faced by more types of libraries during their transformation.

Acknowledgements

This work is supported by Key Project of the National Social Science Fund of China (2024), titled 'Research on Research Support Services of University Libraries for AI for Science (AI4S)' (Grant No. 24ATQ008).

About the authors

Hanyu Miao is a master student in School of Information Management, Wuhan University, People's Republic of China. Her research interests include the AI4S, library services and data sharing. She can be contacted at Miaohyeah@163.com

Zengmin Wang is a doctoral student in School of Information Management, Wuhan University, People's Republic of China. Her research interests including AI4S, library services, data sharing and AI ethics. She can be contacted at celinewong_0913@yeah.com

Lihong Zhou is a Professor in School of Information Management, Wuhan University, People's Republic of China. His research interests include the library services, interorganisational data sharing and medical information. He can be contacted at l.zhou@whu.edu.cn

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