Adoption of Artificial Intelligence in Public and Private Libraries of China: Determinants, Challenges, and Perceived Benefits

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Recommended citation:

Li, Danyang (2024). "Adoption of Artificial Intelligence in Public and Private Libraries of China: Determinants, Challenges, and Perceived Benefits". *Profesional de la información*, v. 33, n. 4, e330416.

https://doi.org/10.3145/epi.2024.ene.0416

Manuscript received on July 13th 2023

Accepted on June 12th 2024

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Abstract

Artificial intelligence (AI) has much significance in different industries, including education. Due to increasing technological advancement, universities show their growing concerns about adopting several facilities linked with AI, specifically in their library management systems. Motivated by such an emerging trend, this research was conducted to examine AI adoption in both public and private libraries in China. The study explored the existing landscape of AI-powered services in libraries, the perception of AI benefits, challenges related to AI adoption, and key determinants of such adoption for the targeted libraries. Using a questionnaire technique, the study collected data from different public and private libraries for which a sample of 154 respondents was finalized over the time span of 4.5 weeks. The analysis of the collected data shows that both the situations of launching and planning to launch different AI-related services were observed in Chinese libraries. Moreover, participants also confirmed several benefits of AI, including the enhancement of library operations by improving search accuracy, automating repetitive tasks, offering personalized resource recommendations, revealing usage trends through analytics, curating digital collections, improving cataloging, digitizing rare materials, and providing quick responses via chatbots, thereby allowing librarians to conduct their other more complex tasks. Additionally, the study confirmed several challenges associated with AI adoption. The results also revealed that along with other factors, the support from university administration, maturity and reliability of AI applications, and training and human resource management are positive and significant determinants of AI adoption. On the contrary, funding/cost associated with implementation and innovative services/alignment with technological trends reflected negative coefficients for AI adoption in Chinese libraries.

Keywords

AI Adoption, Public-private Libraries, China, Emerging Technologies.

1. Introduction

The fourth industrial revolution, driven by advanced technologies like artificial intelligence (AI) and the Internet of things, is reshaping industries and educational systems to adapt and embrace innovations (**Tella; Ajani**, 2022; **Shahroom; Hussin**, 2018). AI has changed the way businesses and machines operate in today's world (**Gursoy *et al.***, 2019). AI has much potential for businesses and organizations, and is widely used to drive digital transformation of many business processes (**Brock; von Wangenheim**, 2019). It has also brought together different parts of production (**Gursoy *et al.***, 2019), and has been effectively utilized for economic growth (**Jacques *et al.***, 2021). As per an estimate, by 2030, more than 70% of companies would use the AI platforms, which could add an extra $13 trillion to the global economy and help it grow by about 1.2% each year (**Asim *et al.***, 2023).

In the context of universities and specifically the libraries, in response to the AI revolution, librarians have adapted to new technologies that improve their work and field of librarianship (**Hervieux; Wheatley**, 2021). Using AI in libraries can help to recreate resources digitally; hence, it has transformed all its operations and is now an important tool for libraries (**Jianjun *et al.***, 2021). It has helped libraries find new ways to support learning for everyone. AI has even facilitated libraries to provide constant access to a growing collection of full text online resources (**Okunlaya *et al.***, 2022). However, with the rise of AI, libraries will become more complex and need to be more advanced, critical and innovative in its operations (**Huang *et al.***, 2022).

China, with one of the oldest libraries in history, has a long tradition of books and libraries, and has witnessed different stages of its development (**Baye; Yusuf**, 2023). These stages can be grouped into five periods: ancient libraries, modern libraries, post-modern libraries, contemporary libraries, and post-contemporary libraries (**Yi**, 2013). Research on the history and evolution of libraries in China has not been the focus of recent studies, therefore, it has always remained a weak area in this domain of Chinese libraries and librarianship (**Wang *et al.***, 2010). Previous research has focused only on topics like policies and regulations for different types of libraries, how libraries play a role in the economic development of western regions, strategies for developing libraries in communities and rural areas, libraries branding knowledge (**Gao *et al.***, 2009). Additionally, there are a lot of writings about the history and development of libraries in China. Some researchers focus on how to divide the development of libraries into different time periods, while others focus on the development of library during each specific period (**Liao**, 2009). A few researchers have studied library development historically (**Huang *et al.***, 2009), but very scant research is available taking into account artificial intelligence adoption in libraries (**Zoé**, 2023).

There is a dearth of studies on the examining the impact of artificial intelligence in public and private libraries of China. While China has witnessed fast growth in economy, science, technology, education and culture, libraries too have faced both opportunities and challenges in the wake of artificial intelligence. Hence, in order to improve all types of libraries, and derive inspiration from both success and failures of the past, and to fill this literature gap, the current study examined the adoption of artificial intelligence in public and private libraries in the context of China and focused on determinants, challenges, and perceived benefits of the AI revolution.

2. Literature Review

Experts have not agreed on one exact definition of artificial intelligence (**Hellwig *et al.***, 2018). In its initial stages, **McCarthy** (2007) defined AI as the science of creating intelligent machines, especially computer programs, that can solve many problems and achieve goals just like humans achieve. **Tredinnick** (2017) described AI as a group of technologies that allow computers to make smart, flexible decisions in unpredictable situations. In short, AI was seen a science where computers could imitate human intelligence to solve problems. However, in recent times, AI has been given a broader meaning, where the focus is on how machines work like humans by imitating intelligent human behavior, such as decision-making or problem-solving (**Hashemi *et al.***, 2021; **Hashemi Fotemi *et al.***, 2024). AI has two main parts: machine learning and deep learning. Machine learning allows computers to make decisions for each task. It involves creative programs that can easily analyze data (**Edgcomb; Zima**, 2019). Machine learning technologies in AI include various tools like robots, text analysis data, and pattern recognition (**Mukhamediev *et al.***, 2022). Deep learning is the branch of a learning machine that focuses on complex network layers. These networks learn to recognize the data and understand how the human brain works. In deep learning, information-connected units are called neurons (**Hou**, 2022). Deep learning allows machines to solve complex problems using large sets of unrecognized data (**Chauhan; Singh**, 2018).

The main goal of universities is to be a leader in research and to create a supportive environment for learning. Universities and libraries play a crucial role in teaching and research. Therefore, it is important to explore the use of artificial intelligence in universities and libraries. AI can help users access resources freely, even during disruptions (**Folorunso; Momoh**, 2020). Research has documented several types of AI-based services, including automatic cataloging and classifications for automatic indexing (**Huang**, 2024; **Mogali**, 2014; **Omame; Alex-Nmecha**, 2020). A virtual references chat is a popular AI tool that gives users quick answers to questions (**Arora**, 2024). Universities and libraries use virtual assistants to respond to users (**Zimmett**, 2020). Virtual assistant applications became available to the public in 2011 when Apple introduced Siri, changing the smartphone industry with voice technology.

Libraries professionals, too, have recognized virtual assistants (**Hoy**, 2018). **Asemi *et al.*** (2021) suggested that expert systems are useful at university levels because they intimate the work of libraries. Augmented intelligence, which combines human and AI capabilities, is an interesting area of AI (**Wójcik; Kula**, 2021). **Harisanty *et al.*** (2023) argued that various AI solutions could assist university libraries with routine tasks. However, libraries remain cautious about using AI. Few researchers have conducted studies to explore libraries' views on using AI in libraries. In a study, **Cox *et al.*** (2019) found that library directors and professionals in the UK believe AI significantly makes impact on its services. **Ali *et al.*** (2020) conducted a study on major libraries of Pakistani universities and found that libraries were using AI-based services. In another study, **Ali *et al.*** (2024) interviewed five modern libraries from Pakistani universities to explore

AI services, and found that AI adoption was slow because of limited funds and staff.

Along with the qualitative research, a few studies and surveys were conducted to understand the views of AI in different countries. **Lund *et al.*** (2020) shared an online questionnaire through various lists and found that early users have positive opinions about using AI libraries. Later, **Huang** (2024) used a questionnaire to study how Taiwanese university libraries adopt AI applications. The study found that Taiwanese university libraries use various AI services, such as robots, automatic indexing, natural language processing (NLP), smart data analysis, book loans, and face recognition to check books in and out. In a recent study, **Abayomi *et al.*** (2021) looked how Nigerian university libraries view the use of AI in libraries, their biggest concern was losing jobs, which made them hesitate to accept AI.

While technology offers great potential, it also presents challenges for organizations to adopt AI. These challenges include issues with technology. In university libraries, ethical issues, understanding AI decisions, and maintaining data have been highlighted (**Talley**, 2016). **Talley** (2016) also pointed out risks like fear of job loss, high cost of adoption, privacy concerns, and legal challenges related to using AI. According to **Johnson and Verdicchio** (2017), two main factors cause anxiety about AI namely ignoring the human role, and misunderstandings about technology development. **Miao** (2019) explored AI's ethical issues, especially human rights, and suggested that researchers should include ethical principles when designing AI systems. The Ex Libris White Paper highlighted three main concerns for library professionals: fear of being replaced by AI, loss of human creativity, and empathy. **Omame and Alex-Nmecha** (2020) identified more challenges with AI, such as the need for advanced technical knowledge, lack of funding, high costs for developing and maintaining systems, and a shortage of AI experts.

The above cited research shows that studies have been conducted to examine how AI technologies are being used in libraries worldwide. Most of these studies are based on a literary approach. However, a few studies used a quantitative method, which involved collecting the quantitative data (**Hussain; Ahmad,** 2024) while two others used a qualitative approach (**Ali *et al.***, 2020; **Ali *et al.***, 2023). The current research contributes to the domain of library studies which explored the adoption of artificial intelligence in Chinese public and private sector universities' libraries, and examined the existing landscape of AI-powered services, perception about AI benefits, challenges related to AI Adoption, and determinants of AI Adoption.

3. Research Methods

This study adopted a quantitative research design to examine the AI adoption in public and private libraries of universities in China. The quantitative approach suited this study as it focused on the AI adoption and its key determinants, along with several associated challenges and benefits prevalent in the existing landscape of AI-powered services in libraries. The sample of the strategy was drawn from different public and private libraries associated with the universities in different regions of China. A total of 250 copies of questionnaire were distributed among different public and private sector libraries in China over 4.2 weeks. However, due to the busy schedule and other related obligations of the universities, only 178 copies were returned, out of which 24 copies of questionnaires were rejected due to invalid responses. A final sample of 154 participants was found as valid for analysis purposes, showing a valid response rate of 61.6%.

The items of the questionnaire focused on the key variables of the study namely the landscape of AI-powered services in libraries, perception of AI benefits, challenges related to AI adoption, and determinants of the adoption and implementation of artificial intelligence services. The items for the existing landscape of AI-powered services in libraries were divided into measurement scales of launch and aim to launch. The Respondent's perception of AI benefits was measured on a 5-point scale, entitled as strongly disagree=1 and strongly agree=5. The items under challenges related to AI Adoption were also measured using the same 5-point scale. The questionnaire also collected information related to the demographic factors of the respondents including age, gender, university type, designation, and working experience. Lastly, the study conducted a regression analysis to examine the relationship between AI adoption and its determinants.

4. Results

4.1. Demographic Analysis

The demographic analysis showed the distribution of the sample across factors like gender, age, university type, designation, and working experience (years). The gender factor showed that over all 110 male and 44 female participants participated in this study, with a percentage share of 71% and 29%, respectively. The age distribution revealed a mixed range of participants. The majority of respondents fell within the older age brackets. For example, participants aged above 40 years made up the largest group comprising 68 (44.2%) respondents, followed by 48 (31.2%) respondents in the 36–40 years category. The 31–35 years group was represented by 24 (15.6%) respondents, the 26–30 years age group showed an overall 12 (7.8%) respondents, and only 2 (1.3%) participants were younger than 25 years. This distribution shows that the study engaged a relatively experienced and mature group of respondents, having a larger share in terms of male respondents those above 40 years.

Regarding the type of university, the public-sector universities were represented by 102 (66.2%) respondents while there were 52 (33.8%) respondents affiliated with private universities in China. This reflects a higher participation rate from public institutions, which could suggest their more active involvement or availability in artificial intelligence-related developments in libraries. In terms of job roles, the demographic analysis shows a wide range of designations among participants of this research. The largest group comprised Assistant Librarians (62 respondents, 40.3%), followed by Librarians (46 respondents, 29.9%), Chief Librarians (20 respondents, 13%), Deputy Chief Librarians (18 respondents, 11.7%), and finally, the smallest group of Senior Librarians (8 respondents, 5.2%).

The last demographic factor of respondents' working experience showed that 85 (55.2%) respondents, covering a majority of the total sample, had more than 15 years of experience, which reflects a huge professional exposure to AI of the current sample. This was followed by 30 (9.5%) respondents with 11–15 years of experience, 24 (15.6%) respondents in 6–10 years category, and finally, 15 respondents (9.7%) in 1–5 years of experience category. This implies that individuals who participated in the study had extensive work experience in library management. Table 1 summarizes these findings.

Table 1: Demographic Factors.

Category	Description	Frequency	Percentage (%)
Gender	Male	110	71.4
	Female	44	28.6
Age	Less than 25 years	2	1.3
	26–30 years	12	7.8
	31–35 years	24	15.6
	36–40 years	48	31.2
	Above 40 years	68	44.2
University Type	Public	102	66.2
	Private	52	33.8
Designation	Chief Librarian	20	13.0
	Deputy Chief Librarian	18	11.7
	Senior Librarian	8	5.2
	Librarian	46	29.9
	Assistant Librarian	62	40.3
Work Experience (Years)	1–5 years	15	9.7
	6–10 years	24	15.6
	11–15 years	30	19.5
	Above 15 years	85	55.2

4.2. Landscape of AI-powered Services in Libraries

Table 2 portrays the existing landscape of AI-powered services in libraries. The distribution provides information whether the university has launched the related AI services or aims to launch them in future. The first factor is *Text-to-speech and speech-to-text technologies* for promoting resources, for which 74 (48%) respondents informed that their institution had launched such services, while 80 (51.9%) respondents believed that their university was aiming to launch the same in the coming years. The second factor named as *Voice-activated search through Google Assistant* had been launched in different public and private universities in China, as narrated by 64 (41.6%) respondents, while 40 (26%) respondents indicated that their institutions were planning to implement it soon.

The *RFID systems for self-service checkouts and security* was found to be adopted by 55 (35.7%) institutions while 39 (25.3%) respondents reflected plans for future implementation of similar services. The data analytics function for effective collection management was agreed upon by 50 (32.5%) respondents as having been implemented in their respective institutions. On the other hand, 37 (24.1%) respondents shared that their institutions planned to launch the same facility in future. The *QR and barcode systems for patron identification* was also found to be implemented in 46 (29.9%) institutions while 22 (14.3%) institutions had devised plans for future adoption of same services in their organization (either public or private or both). The factor of adopting *AI-powered services in Chinese libraries, including Translation services* for multilingual resources, was found in place in 46 (29.9%) institutions while 30 (19.5%) institutions reported plans to launch this service soon. Lastly, *AI-driven indexing tools for automatic keyword assignmen*t have also been implemented in 40 (26%) institutions, as confirmed by their respondents, while 26 (16.9%) respondents mentioned plans for future adoption by their institution. Table 2 and Figure 1 summarizes this information about the existing landscape of AI powered services in the Chinese private and public sector libraries

Table 2: The Existing Landscape of AI-powered Services in Libraries.

Technology Description	Launched	Percentage	Planning to Launch	Percentage
Text-to-speech and speech-to-text technologies for promoting resources	74	48.1	80	51.9
Voice-activated search through Google Assistant	64	41.6	40	26.0
RFID systems for self-service checkouts and security	55	35.7	39	25.3
Data analytics for effective data collection management	50	32.5	37	24.1
QR and barcode systems for patron identification	46	29.9	22	14.3
Translation services for accessing multilingual resources	46	29.9	30	19.5
AI-driven indexing tools for automatic keyword assignment	40	26.0	26	16.9

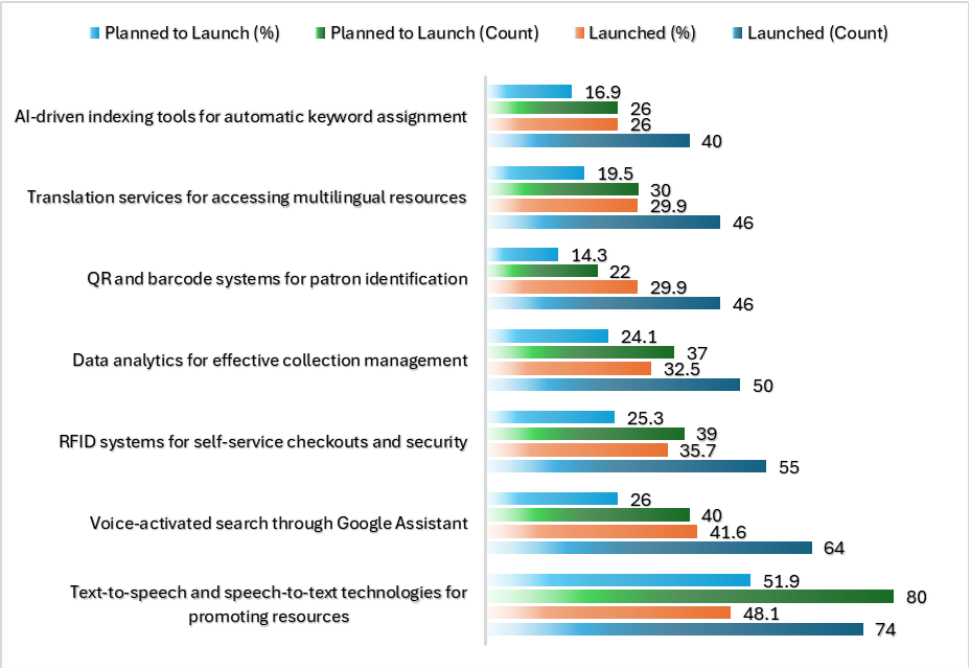

Figure 1: AI Status in Public and Private Libraries in China.

4.3. Perception of AI benefits

The study also found out respondents' perception about AI benefits in public and private libraries, using a five-point Likert scale of Strongly Disagree, Disagree, Neutral, Agree, and Strongly Agree. A total of 9 benefits were identified for which the respondents' perception levels were measured. The results for the first benefit statement *AI enhances the accuracy and efficiency of library searches*, show that only 5 (3.2%) respondents each strongly disagreed and disagreed, while 10 (6.5%) respondents were neutral, 32 and 102 respondents or 20.8% and 66.2% of the total respondents, agreed and strongly agreed about the role of AI in enhancing the accuracy and efficiency of library searches. For the second benefit statement, *AI automates repetitive tasks, freeing librarians for complex work,* a very small number of 4 and 6 or 2.6% and 3.9% respondents strongly disagreed and disagreed respectively. Meanwhile, 8 (5.2%) respondents were neutral, 22 (14.3%) agreed, and 114 (74.0%) strongly agreed with this statement that AI automates repetitive tasks, freeing librarians for complex work.

The output of the third statement, *AI recommendations help users find relevant resources*, revealed that 6 (3.9%) respondents strongly disagreed, 5 (3.2%) respondents disagreed, 12 (7.8%) respondents remained neutral, 24 (15.6%) respondents agreed, and 107 (69.5%) respondents strongly agreed with the benefit of AI recommendations helping users find relevant resources. The fourth statement *AI analytics reveal insights into library usage trends* drew a response of 5 (3.2%) respondents as strongly disagree and 7 (4.5%) respondents as disagree, while 11 (7.1%) respondents were neutral, 21 (13.6%) respondents agreed, and 110 (71.4%) respondents strongly agreed with the role of AI analytics in revealing insights into library usage trends. The results of fifth statement, *AI aids in curating digital collections, & increasing resource access*, only 4 (2.6%) respondents opted each strongly disagree and disagree, 15 (9.7%) respondents were neutral, 27 (17.5%) opted for agree, and 104 (67.5%) respondents opted for strongly agree to the statement that AI aids in curating digital collections and increasing resource access.

The results of the sixth statement, *AI improves the cataloguing and classification of materials* indicated opinion of 3 (1.9%) respondents and 6 (3.9%) respondents for strongly disagree and disagree options respectively. Moreover, 10 (6.5%) respondents showed a neutral concern, 25 (16.2%) respondents agreed, and 110 (71.4%) strongly agreed with the role of AI in improving the cataloguing and classification of materials. The results of the seventh statement *AI personalizes the library experience based on user behavior*, a small number of 5 (3.2%) respondents and 8 (5.2%) respondents claimed strongly disagree and disagree option respectively. A total of 14 (9.1%) respondents were neutral, 19 (12.3%) respondents agreed and 108 (70.1%) respondents strongly agreed with the benefit of AI personalizing the library experience based on user behaviour. The results of the eighth statement, *AI tools digitize and preserve rare library materials*, revealed that 14 (9.1%) respondents strongly disagreed and 15 (9.7%) respondents disagreed. Additionally,13 (8.4%) respondents remained neutral, 20 (13.0%) respondents agreed while a large majority of 63 (40.9%) respondents strongly agreed that AI tools effectively digitize and preserve rare library materials. The final statement focused on AI chatbot responses, and collected opinion of the respondents on the statement, *AI chatbots provide quick responses to user inquiries*, a total of 13 (8.4%) respondents strongly disagreed and 17 (11.0%) respondents disagreed, while 9 (5.8%) respondents remained neutral. Notably, 23 (14.9%) respondents agreed and 91 (59.1%) respondents strongly agreed that AI chatbots offered quick responses to user inquiries. Table 3 summarizes all these findings in a tabular form.

Table 3: Respondent Perception of AI Benefits (n=154).

Benefit	Strongly Disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly Agree (%)
1. AI enhances the accuracy and efficiency of library searches.	5 (3.2%)	5 (3.2%)	10 (6.5%)	32 (20.8%)	102 (66.2%)
2. AI automates repetitive tasks, freeing librarians for complex work.	4 (2.6%)	6 (3.9%)	8 (5.2%)	22 (14.3%)	114 (74.0%)
3. AI recommendations help users find relevant resources.	6 (3.9%)	5 (3.2%)	12 (7.8%)	24 (15.6%)	107 (69.5%)
4. AI analytics reveal insights into library usage trends.	5 (3.2%)	7 (4.5%)	11 (7.1%)	21 (13.6%)	110 (71.4%)
5. AI aids in curating digital collections, increasing resource access.	4 (2.6%)	4 (2.6%)	15 (9.7%)	27 (17.5%)	104 (67.5%)
6. AI improves the cataloguing and classification of materials.	3 (1.9%)	6 (3.9%)	10 (6.5%)	25 (16.2%)	110 (71.4%)
7. AI personalizes the library experience based on user behavior.	5 (3.2%)	8 (5.2%)	14 (9.1%)	19 (12.3%)	108 (70.1%)
8. AI tools digitize and preserve rare library materials.	14 (9.1%)	15 (9.7%)	13 (8.4%)	20 (13.0%)	63 (40.9%)
9. AI chatbots provide quick responses to user inquiries.	13 (8.4%)	17 (11.0%)	9 (5.8%)	23 (14.9%)	91 (59.1%)

4.4. Key challenges related to AI adoption

A few key challenges related to AI adoption and implementation in both public and private universities of China were also identified and presented in Table 4. The results of the challenge named as *requirement for a highly networked and integrated environment*, using the frequency distribution show that 49 (31.8%) respondents strongly agreed whereas 30 (19.5%) respondents agreed with the statement. This means that over 50% of respondents agreed with requirement for a highly networked and integrated environment. The other results showed that 12 (7.8%), 18 (11.7%) and 25 (16.2%) respondents strongly disagreed, disagreed and remained neutral respectively, with this statement. The results of the next statement about *lack of budget* showed that 66 (42.9%) respondents strongly agreed and 40 (26.0%) agreed, constituting a majority (68.9%) recognized that budget constraints were a significant challenge. On the other hand, 10 (6.5%), strongly disagreed, and 16 (10.4%) disagreed and 22 (14.3%) strongly disagreed, disagreed and remained neutral respectively, with this statement. For the statement of *High cost of AI technologies*, a striking 107 (69.5%) and 5 (3.2%) respondents strongly agreed and agreed that the cost of AI technologies was a barrier. A small portion of 8 (5.2%) respondents strongly disagreed, while 14 (9.1%) and 20 (13.0%) respondents disagreed and stayed neutral respectively.

The statement, *High cost of support services for AI technologies,* was supported by 66 (42.9%) and 50 (32.5%) respondents who strongly agreed and agreed respectively that support services for AI technologies were costly. In contrast, 6 (3.9%), 10 (6.5%) and 22 (14.3%) opted for strongly disagreed, disagreed, and neutral options respectively. The next statement, *Inadequate technological resources for promoting AI in libraries,* was supported by more than half, 89 (57.8%) respondents who strongly agreed that inadequate resources were a hindrance. Additionally, 34 (22.1%) respondents agreed to this constraint. Only a smaller portion of 10 (6.5%), 11 (7.1%) and 19 (12.3%) respondents strongly disagreed, disagreed and stayed neutral respectively. The statement related to *Lack of technical staff* was also supported by 52 (33.8%) and 55 (35.7%) respondents who strongly agreed and agreed respectively. Meanwhile, 12 (7.8%), 15 (9.7%) and 20 (13.0%) respondents strongly disagreed, disagreed, and remained neutral to the issue of lack of technical staff.

The statement related to *High cost of maintenance of AI technologies*, was supported by 77 (50.0%) and 31 (20.1%) respondents who strongly agreed and agreed respectively that maintenance costs were a challenge. However, a small portion of 5 (3.2%), 16 (10.4%) and 25 (16.2%) respondents preferred to strongly disagree, disagree and remain neutral. The next challenge of *Integration with existing systems, was* strongly agreed upon by 93 (60.4%) and agreed upon by 24 (15.6%) respondents. A small number 7 (4.5%), 10 (6.5%) and 20 (13.0%) respondents strongly disagreed, disagreed, and remained neutral to the issue of integration with existing systems. The concern for the *Lack of support from the university administration* was strongly agreed upon by a large majority of 132 (85.7%) and agreed upon by 24 (15.6%) respondents. Only 8 (5.2%), 12 (7.8%) and 21 (13.6%) respondents strongly disagreed, disagreed, and remained neutral to the issue of lack of support from the university administration. Finally, *Ethical and legal risks while adopting AI* was considered a significant challenge by 103 (66.9%) of respondents who strongly agreed and 10 (6.5%) who agreed. However, a small proportion of 6 (3.9%), 15 (9.7%) and 19 (12.3%) respondents strongly disagreed, disagreed, and remained neutral to the issue of ethical and legal risks while adopting AI.

Table 4: Key Challenges Related to AI Adoption (n=154).

Challenge Description	Strongly Disagree (Count)	Disagree (Count)	Neutral (Count)	Agree (Count)	Strongly Agree (Count)
1. The requirement for a highly networked and integrated environment	12 (7.8%)	18 (11.7%)	25 (16.2%)	30 (19.5%)	49 (31.8%)
2. Lack of budget	10 (6.5%)	16 (10.4%)	22 (14.3%)	40 (26.0%)	66 (42.9%)
3. High cost of AI technologies	8 (5.2%)	14 (9.1%)	20 (13.0%)	5 (3.2%)	107 (69.5%)
4. High cost of support services for AI technologies	6 (3.9%)	10 (6.5%)	22 (14.3%)	50 (32.5%)	66 (42.9%)
5. Inadequate technological resources for promoting AI in libraries	10 (6.5%)	11 (7.1%)	19 (12.3%)	34 (22.1%)	89 (57.8%)
6. Lack of technical staff	12 (7.8%)	15 (9.7%)	20 (13.0%)	55 (35.7%)	52 (33.8%)
7. High cost of maintenance of AI technologies	5 (3.2%)	16 (10.4%)	25 (16.2%)	31 (20.1%)	77 (50.0%)
8. Integration with existing systems	7 (4.5%)	10 (6.5%)	20 (13.0%)	24 (15.6%)	93 (60.4%)
9. Lack of support from the university administration	8 (5.2%)	12 (7.8%)	21 (13.6%)	24 (15.6%)	132 (85.7%)
10. Ethical and legal risks while adopting AI	6 (3.9%)	15 (9.7%)	19 (12.3%)	10 (6.5%)	103 (66.9%)

4.5. Determinants of AI Adoption

The final stage of analysis in this study focused on testing the key determinants of the adoption and implementation of artificial intelligence among public and private sector libraries in China. The results are presented in Table 5 using the beta coefficient, standard error, and both t and p-values. The findings considered determinants like the role of funding and associated costs, support from university administration, library system providers' intentions to integrate AI, librarians' willingness and experience, the maturity and reliability of AI applications, innovative services aligned with technological trends, availability of human resources, and user acceptance in terms of attractiveness, functionality, and convenience as among the determinants whose impact on AI adoption was checked and tested.

The results of the first determinant of *Funding/cost associated with implementation* was found negatively linked with AI adoption. This relationship was reflected in the coefficient of 00342, which determined that an overall -0.342% change in the AI adoption was attributed to such cost or funding factor among the libraries in public and private universities. The t-value of -4.56 confirmed that the impact of funding/cost associated with implementation was adversely related to AI adoption. This means that a one-unit upward shift in the funding cost related to implementation was causing a decline in the adoption of AI. This suggests that when the cost of implementing artificial intelligence in libraries increases, it brings several associated challenges that can slow its adoption. For example, limited number of budgets means universities might focus their spending on other areas, leaving less room for the projects entitled as AI adoption, specifically in the libraries.

The higher costs could also make university administrators less likely to support such initiatives, and library system providers might hesitate to add features linked with artificial intelligence to their products if they think demand will drop. The other factors include that Librarians, too, may be less inclined towards adopting AI if they feel the financial burden is not defining any worth it. Additionally, with less funding and lack of financial resources, both the public and private libraries might struggle to bring in advanced, reliable AI technologies or train the staff needed to run these systems effectively. The given justification reflects that, in turn, this might lead to AI services that are not as attractive or easy to use, making it harder for users to accept and appreciate the technology. Therefore, the results are quite logical, showing that funding/cost for implementing AI is highly linked with AI adoption in targeted libraries.

The second factor of *support from the university administration* was found positively related to AI adoption. The given coefficient confirms that there is an upward shift of 0.295% in AI adoption as long as the university administration is supportive and cooperative for such projects. Additionally, the support from university administration (both public and private ones) is key to successfully bringing AI into libraries. The 0.295% increase in AI adoption shows that when the university leadership is on board and willing to help, AI projects are much more likely to take off. This support could mean providing funding that aligns policies while reflecting great commitment toward new technologies. With the administration behind them, libraries can overcome financial hurdles and feel more confident about moving forward with AI. Overall, it has been determined that the university's endorsement makes it easier and more likely for AI to be adopted in both public and private sectors.

The third factor *Library system providers' intentions to integrate AI in their products* was found insignificant determinant of the AI adoption for similar libraries among public and private sector universities. This is because the standard error was high, the t-score was low, and the p-value was also above 0.05% significance level.

The fourth factor of AI adoption dealt with *librarians' willingness and experience* which received a coefficient of 0.248, reflecting a positive change. The resulting amount of the t-value as per the given output is found as 3.134, leading to a p-value of 0.002. It confirms that Librarians' willingness and experience lead to higher levels of AI adoption among the public and private sector universities' libraries. The explanation to this finding determines various insights. Librarians' willingness and experience has been regarded as among the essential role players for successfully integrating AI into library management systems. When librarians are excited about adopting new and advanced technologies and possess the skills to use them effectively, they can drive initiatives for the AI tools. Additionally, such steps help educate colleagues, coworkers, and users about the benefits linked to the adoption of artificial intelligence. Their positive attitude can encourage confidence among other staff members and university administration, therefore, as a result, making it easier to secure support and resources for the AI-based projects. Additionally, experienced librarians can better understand the specific needs of their libraries and customize AI solutions to enhance library services, making the overall implementation smoother and more effective. Ultimately, involvement in such activities can create a more innovative and responsive library environment, leading to improved user services by adopting AI.

The fifth factor of AI adoption is the *maturity and reliability of AI applications*, showing a coefficient of 0.215 with a p-value of 0.018. This coefficient confirms that the maturity and reliability of AI applications is positively linked with AI adoption among China's public and private sector universities' libraries. AI applications' maturity and reliability seem crucial for university libraries' utilization. When tools linked with artificial intelligence show their track record of being stable and effective enough, public and private sector librarians feel more at ease about using them. This level of trust

in using the given AI applications and technologies is important because it removes the worries about possible issues or glitches linked with the adoption of artificial intelligence. As a result, reliable AI applications can help to provoke the libraries to invest in and adopt these technologies while knowing that they will improve their services Additionally, when both the public and private sector libraries experience positive results from by using AI applications, it can encourage them to look for even more effective AI-based solutions. Therefore, the positive connection between the maturity and reliability of AI applications and their subsequent adoption seems quite logical.

Conversely to our expectations, the results of the sixth factor *Innovative services/alignment with technological trends* showed an insignificant and negative coefficient in showing the effect on adopting artificial intelligence among the libraries in China.

The seventh factor of the study *Training and human resources management* received coefficient of 0.175, which confirms a positive connection with AI adoption. The specific effect of 0.175 claims that keeping the rest of the factors and error terms constant, a change of 0.175% in AI adoption is attributed to training and human resource management among the targeted universities of China. This also means that when universities in China aim to improve their training programs for the employees and effectively manage their staff, they are likely to see a significant increase in the adoption of technologies related to AI. Moreover, by investing in HRM and training, librarians and staff can gain the skills and knowledge they need to embrace AI, making them more willing to adopt and effectively use these tools in their libraries. This highlights how important it is to focus on people for successfully integrating AI. Additionally, a well-trained and highly skilled staff can better understand the specific needs of library users and customize AI applications to meet those needs efficiently. Meanwhile, continuous and consistent professional development in AI also helps create a culture of innovation within both the public and private sector libraries. When the staff and employees of such libraries feel confident and informed about new tools, they are more likely to try them out and develop creative solutions that will effectively enhance library services.

The last and eighth factor among the key determinants of AI adoption was *Acceptance by users (e.g., attractiveness, function, convenience).* This determinant is linked with the coefficient value as lower than to what we have found in terms of standard error. Consequently, a low coefficient and higher standard error generate a lower t-statistics of 0.429, where the p-value is also above 0.05% level of significance. Therefore, this finding does not favor the claim that a significant relationship exists between user acceptance (e.g., attractiveness, function, convenience, and AI adoption for the public and private sector libraries. Table 5 and Figure 2 present these findings in a graphic form.

Table 5: Determinants of AI Adoption.

Determinants	Coefficient (β)	Standard Error	t-value	p-value
1. Funding/cost associated with implementation	-0.342***	0.075	-4.56	0.000
2. Support from university administration	0.295***	0.085	3.471	0.001
3. Library system providers' intentions to integrate AI in their products	0.120	0.150	0.800	0.424
4. Librarians' willingness and experience	0.248***	0.079	3.134	0.002
5. Maturity and reliability of AI applications	0.215**	0.091	2.361	0.018
6. Innovative services aligned with technological trends	-0.080	0.150	-0.533	0.596
7. Training and Human Resource Management	0.175**	0.086	2.028	0.045
8. Acceptance by users (e.g., attractiveness, function, convenience)	0.075	0.175	0.429	0.668

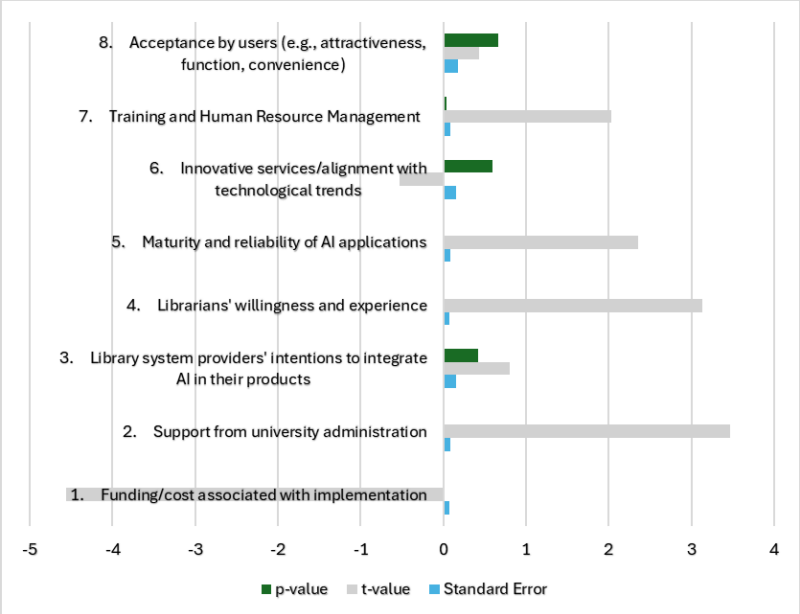

Figure 2: Determinants of AI Adoption (coefficients, standard error, and t-value).

5. Conclusion

The rise of technological advancements and innovations during the fourth industrial revolution has caught the attention of the library community. One of the most attractive and innovative technologies that emerged from such a technological revolution is artificial intelligence (AI), which has been adopted by several sectors of world economy, including education. For instance, in the context of the current study, library professionals are actively discussing how AI can be integrated with existing systems to enhance the efficiency and effectiveness of information organizations. Moreover, such integration and adoption will also help for the improvement of the quantity and quality of information services (**Lund *et al.***, 2020).

In recent years, libraries' use of applications based on artificial intelligence worldwide has grown substantially. However, a review of the existing literature reveals a big gap regarding the understanding of AI applications, specifically within the context of Chinese university libraries. Therefore, this study examined the adoption of AI applications, the related challenges, and the key determinants of AI adoption in Chinese university libraries. The study also aimed to highlight the benefits of AI adoption for implementing AI technologies in libraries. The results are based on several empirical outputs. For example, the frequency distribution of the existing landscape of AI-powered library services highlights two different scenarios regarding the Technology Description in Libraries, first showing libraries that have already launched different AI services while the second indicating those libraries that are planning to launch similar services. A variety of technologies have been launched in both public and private sector libraries, with text-to-speech and speech-to-text technologies leading at 48.1%, followed by voice-activated search (41.6%) and RFID systems (35.7%). Additionally, the frequency distribution reflects that there are plans to implement further advancements, such as text-to-speech technologies (51.9%) and voice-activated search (26%). Overall, libraries in the universities of China are found increasingly adopting several innovative solutions based on artificial intelligence in order to enhance resource accessibility and management.

The second phase of the analysis focused on the description about the AI benefits perceived upon by the participants. The survey revealed strong support for artificial intelligence in public and private sector libraries, with 86.9% believing that it enhances search accuracy and 88.3% agreeing it automates tasks. Additionally, 59.1% of participants supported AI chatbots. Hence, the overall sentiment is positive regarding the impact of artificial intelligence on library services.

The third phrase focused on shedding light on the challenges linked with the adoption of AI. The findings revealed challenges linked with AI adoption and implementation in libraries. The most significant concern was the lack of support from university administration, with 85.7% agreeing. The other findings, using the frequency distribution and percentage score, showed that the high costs of AI technologies also posed a major challenge, with 69.5% strongly agreeing to this constraint. The key challenges were found to be inadequate technological resources (57.8%) and the need for a highly networked environment (51.3%). Additionally, ethical and legal risks were acknowledged as a challenge by 66.9% out of the total 154 participants of the study. Overall, financial and infrastructural limitations were prominent obstacles to effective AI integration in China's public and private libraries.

The final phase of the results signified the determinants of the AI adoption. The results show that support from university administration, librarians' willingness and experience, maturity and reliability of AI applications, and training and human resource management were positive and significant determinants of the AI adoption. On the contrary, funding/cost associated with implementation and innovative services/alignment with technological trends reflects negative coefficients for AI adoption in Chinese libraries. The given results would like to suggest that university administration needs to review key challenges, associated benefits, and the existing landscape of AI-powered services in libraries in order to improve the adoption of AI in public and private libraries. Moreover, the administration is recommended to develop strategies for improved AI adoption, enhance support for library staff training, foster collaboration with library system providers, and increase budget allocations for AI implementation, respectively.

Like other studies, there are several limitations linked with this work. For example, this work applied descriptive statistics, frequency distribution, and simple regression analysis to examine the challenges, benefits, existing landscape of AI-powered services in libraries, and determinants of the AI adoption in the public and private libraries of China. It did not explore the advanced quantitative methods of data analysis, including measuring the variables using first- or second-order constructs. Moreover, the study also neglects the survey interview technique for examining the AI adoption trends. Meanwhile, this research did not pay attention to the readiness of AI-related technologies, robotics in libraries, green information technologies, intelligent virtual assistants or chatbots, intelligent data analytics for managing library operations, and a critical systematic review of AI applications in academic libraries. Based on all of these limitations, future studies can expand empirical estimations by using more advanced and robust methods, either by collecting primary data or through secondary online and offline resources. Moreover, the studies are also suggested to expand their focus on these set of variables to observe a better trend in AI adoption, considering different regional settings.

5.1. Acknowledgements

This work was supported by the National Social Science Fund of China (23CTQ018) and China Postdoctoral Science Foundation (2024T171088).

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