Artificial Intelligence in academic library strategy in the United Kingdom and the Mainland of China

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A B S T R A C T

There is growing recognition of the value of applying Artificial Intelligence (AI) in libraries. This study explores how academic libraries have responded to this opportunity at the level of strategy, what is the status of the application of AI, if any, and what are the different emphases of development comparing the UK and China. The data for the study was strategy documentation from high-ranking universities and their libraries. The sample consisted of the top 25 universities from the United Kingdom and top 25 from the Mainland of China according to the QS world university rankings. Explicit mention of Artificial Intelligence and related technologies is rarely found in strategic plans of universities in the UK but most Chinese universities mention them in their vision statements which focus on the development of new majors and research of the technology. Though several libraries have already implemented applications based on AI or claim to be "smart" or "intelligent" most academic library strategic plans or agendas do not emphasize AI. This is one of the first studies to explore the current status of AI applied in academic libraries as a sector and to compare experiences internationally.

Introduction

It has been suggested that the rapid development of Artificial Intelligence (AI) is causing a scientific and technological revolution and industrial transformation (Phillips & O'Toole, 2014; Spille et al., 2018). Many aspects of our daily lives are undergoing tremendous change due to technologies such as speech recognition, face recognition, computer vision, natural language processing, machine translation, virtual assistants, and intelligent search. AI has shown promising applications in diverse areas such as transportation, health care, and manufacturing, through autonomous driving technology, medical assisted diagnosis, satellite positioning, and robots. It has been seen as heralding the arrival of the 4th Industrial Revolution (Ocholla & Ocholla, 2020) and part of a digital transformation (Hanelt et al., 2021).

In response countries around the world have identified the development of AI as a national strategic priority (OECD, 2023). In 2019, the US government signed an Executive Order on *Maintaining American Leadership in Artificial Intelligence*, which pooled federal government resources to develop AI (Presidential Document of America, 2019). The next year, the European Union issued a white paper *On Artificial Intelligence - A European approach to excellence and trust*, advocating the

establishment of an outstanding and trusted AI ecosystem based on legal regulation (Tiple, 2020). The UK Government (2021) has an AI strategy, as do important UK national institutions such as National Health Service England (2020) and the UK's main research funding body UKRI (2021). In recent years, the Chinese government has also released a series of policies to promote AI research and implementation and put the construction of AI-based smart libraries on the agendas in some key public libraries (The State Council of China, 2021a).

Although the idea of applying AI to libraries has been considered since at least 1985, the last five years have seen a wave of intensified interest. Inevitably some people have expressed the fear that robots and intelligent agents might supersede the professional roles of librarians. In practical terms, however, take-up in the sector seems to have been relatively slow (Cox, 2021). Given the call of other demands, resource limitations, and perhaps a certain caution in the acceptance of new technologies, it is not hard to understand that only when new technologies are saturated in the market and patrons have access to them in multiple ways, will libraries consider introducing them (Wheatley & Hervieux, 2019). The prudent response to AI can be seen to echo the patchy character of past library automation and digitalization process, such as the spread of research data management practices (Huang et al.,

2021; Wheatley & Hervieux, 2019). In addition, librarians' lack of knowledge of AI, how to integrate AI with the library's existing systems and services, and the high cost of AI products all pose challenges to the adoption of AI in the library (Buhe, 2017; Deng & Yang, 2021; Li et al., 2022). However, on the whole, libraries and librarianship still seem to hold a positive attitude towards the potential changes brought by AI, and the library could take the initiative to adopt AI in a safe, responsible and effective way to improve its working and user services.

Most previous studies in the debate about AI are based on the experience of a particular library or in a single country or region, and rarely consider activity across the sector and in two countries at the same time from different cultural contexts. The UK could be seen as the birthplace of Artificial Intelligence, and remains a world leader in specific application areas such as healthcare and financial technology, as well as in the development of AI ethics, governance, and security frameworks. AI is a focus of research funding (UKRI, 2021). China also attaches great importance to the improvement of cultural and social services while developing the economy and technology. In the library and information services area, building the functional smart library and providing efficient public services have become one of the country's long-term goals (The State Council of China, 2021b, 2021a). Since 2018, the annual project guidance of The National Social Science Fund of China (2018) has emphasized the research and application of AI in the library and information management discipline.

In a context of change and uncertainty the topic of strategy is of increasing importance. Many institutions are placing greater emphasis on strategy, on envisioning a desired future state, and planning to realize this vision. For libraries a key issue is to position themselves appropriately in relation to wider institutional priorities (Cox, 2018). This can be a form of passive alignment, seeking to demonstrate the library's contribution to the organizational mission, or even proactive in attempting to take a leadership role on campus in certain areas. Examining US library strategies, Saunders (2015) discovers a focus on collections, physical space, collaboration and instruction. Interestingly technology was relatively little mentioned in the plans she examined. Yet given the strategic emphasis placed on AI today it becomes of interest to understand how university libraries have reacted to the current trends of AI from a strategic perspective, how AI and related technologies are being used in academic libraries, and interpret the different approaches to adopting emerging technologies between two very different contexts: the UK and China.

Literature review

As early as the 1980s, the library community began to pay attention to the potential applications of robots and artificial intelligence. Chen and Chen (1992) proposed that with the increasing quantity of books and other literature, Expert Systems based on AI should be made use of to process documents in batches and realize automatic processing for classification, cataloguing, indexing, and abstracting of documents. However, the possibility of the sustainable development of Expert Systems which use specialized knowledge to deal with complex problems has been doubted due to the expensive expertise required, the time-consuming development process, and the limited scenarios of application. Veaner (1985) believed that the assistance of robots could be leveraged to alleviate library collection management tasks which are labor-intensive, and recommended that the library community should post a systematic watch on AI which might have a greatly different definition and scope from his time. With the development of natural language processing technology and the gradual reduction of hardware costs such as computer processor chips, semantic analysis was seen as having a bright future (Chen & Chen, 1992). It is only much more recently with the continuous enrichment of the definition of AI, the development of technology itself, and the successful application of AI in other fields, that the advocacy for AI application has emerged in higher education and libraries.

A study of the future plans of UK academic libraries in 2017 suggested that the use of AI in libraries was not yet widespread, but that the library community believed that AI adoption was a major issue (Pinfield et al., 2017). Another early study selected a total of 25 influential and top-ranking research-intensive universities from the United States and Canada as a research sample to investigate how they were responding to the increasing use of artificial intelligence technology and research, through the analysis of the official website of universities and their libraries (Wheatley & Hervieux, 2019). The results came as a surprise to the authors, that there was almost no presence of AI in the study sample, and that university or university libraries rarely mentioned AI in their strategic plans. Though it was noted that almost all universities were offering AI courses in departments and schools of computer science and mathematics. At the same time, some university libraries offered programming and services related to AI, data visualization, and 3D printing, but few libraries focused on educating patrons on AI or updated current library standards in relation to concerns brought on by AI (Wheatley & Hervieux, 2019). Over the next few years, the penetration of AI into other fields is likely to have encouraged libraries to accelerate their acceptance of AI. As library patrons are exposed to AI products in the rest of their lives, libraries are prompted to accelerate the pace of introducing AI in their own services (Hervieux & Wheatley, 2021). Library directors, library commentators and experts in education and publishing began to hold a positive attitude and agree that AI and related technologies can help libraries move forward to smart libraries from multiple perspectives, in terms of resource discovery, virtual intelligent agents, machine readable collections, and so on (Cox et al., 2019). Reports from OCLC (Padilla, 2019) and Library of Congress (Cordell, 2020) were critical landmarks in this process of defining responsible AI use in libraries.

From the perspective of 2023, there is emerging a better picture of the range of AI applications and implications for libraries (Cox & Mazumdar, 2022; Hervieux & Wheatley, 2022). There are direct uses in library services, such as knowledge discovery or chatbots, and libraries can also develop services to support communities of data scientists, and there is also a role for libraries in promoting understanding of AI as part of information literacy (Cox & Mazumdar, 2022). Thus the University of Rhode Island Library created an *Artificial Intelligence Lab* which provides intelligent experimental space and services for staff, students, and the community (Kim, 2019). The Lab is supported by librarians and professors from different departments and the library has emerged as the leader and become a successful case in involvement with AI. Chatbots or Virtual Agents (VA) developed based on MSN, WeChat, and other apps can provide intelligent consulting such as search, navigation, and reminders (Li et al., 2022), and such VAs based on Machine Learning (ML) and Natural Language Process (NLP) most common appearance of AI in the academic library. Physical Robots, based on AI and Radio-frequency Identification (RFID) technology, have been developed for picking, moving, and inventory of books or items autonomously without human intervention (Fan & Shao, 2018), and other robots with functions like autonomous navigation, routine clerical and manual task handling, and assistance in the education of students and patrons are being developed in some pioneer libraries (Vlachos et al., 2020). The National Science Library of Chinese Academy of Sciences (NSLC) constructed an open data ecosystem with big data and AI as the main technologies, which consists of a National Science and Technology Innovation Database, a new generation of AI tool platforms, and AI services system for knowledge management, knowledge discovery, intelligent analysis, and technological decision (Qian et al., 2021).

Although AI in libraries is often talked about as inevitable, there are still challenges in the process of introducing AI and a lag behind the development of frontier industries (Li et al., 2022) as well as concerns around ethics. Most AI projects in libraries rely on the introduction of mature products from commercial companies, which cannot be easily integrated with the library's existing system or services. New intelligent service projects are self-contained and require high-intensity technical

support that most libraries do not have (Cox et al., 2019). There is a long way to go to achieve the "smart" or "intelligent" library and efforts are still needed in the aspects of AI technology itself, the application of AI in libraries, and the librarians' knowledge about AI. As well as these implementation barriers there are significant concerns around the ethics of AI even in library contexts: such as concerns for privacy and around bias and intelligibility.

This study explores how academic libraries are responding to AI which is increasingly ubiquitous in our lives, and answers these research questions:

1. How, if at all, is AI being included in university library strategies in the UK and China?
2. What evidence is there for sector-wide adoption of AI in academic libraries in the UK and China?
3. How do the paths of development between the two countries differ?

Methodology

High-prestige universities possess more abundant funding and, arguably, have a greater ability to take risks. As a consequence, their libraries may be more innovative in accepting cutting-edge concepts or new technical applications (Massis, 2018). Hence, the study selected as its sample the top 25 universities in the UK, and the top 25 in the Mainland of China, based on the QS World University Rankings 2022 (see Table 1). Also, given the need for library strategies to align to university strategies it made sense to analyze both together (Cox, 2018). Given the different official languages of the two countries, the study reviewed research articles published in English and Simplified Chinese, as well as the website search keywords.

Table 1
Sample universities.

QS rank	Universities from the UK	QS rank	Universities from China
2	University of Cambridge	12	Peking University
4	University of Oxford	14	Tsinghua University
6	Imperial College London	34	Fudan University
8	UCL	42	Zhejiang University
15	The University of Edinburgh	46	Shanghai Jiao Tong University
28	The University of Manchester	94	University of Science and Technology of China
37	King's College London	133	Nanjing University
56	The London School of Economics and Political Science (LSE)	194	Wuhan University
61	University of Bristol	212	Tongji University
64	The University of Warwick	217	Harbin Institute of Technology
78	University of Southampton	226	Southern University of Science and Technology
81	University of Glasgow	262	Beijing Normal University
86	University of Leeds	267	Sun Yat-sen University
91	University of Birmingham	302	Xi'an Jiaotong University
92	Durham University	306	Huazhong University of Science and Technology
96	The University of Sheffield	307	Tianjin University
96	University of St Andrews	355	Beijing Institute of Technology
114	University of Nottingham	378	Nankai University
122	Newcastle University	396	Shandong University
125	Queen Mary University of London	406	Sichuan University
146	Lancaster University	406	South China University of Technology
162	University of York	422	Shanghai University
163	The University of Exeter	422	Xiamen University
166	Cardiff University	428	University of Science and Technology Beijing
179	University of Bath	443	Beihang University (former BUAA)

A website search was conducted between 15th December 2022 and 30th January 2023, using two search engines, Bing.com and Baidu.com and applying a site-restricted search approach. The search keywords included Artificial Intelligence (人工智能), Machine Learning (机器学习), deep learning (深度学习), AI hub (AI中心), robot (机器人), and the Simplified Chinese counterparts are shown in the brackets. In addition, the study also checked whether there are AI institutions, departments, or courses in the universities. The needs of large majors or disciplines teaching AI are bound to have an impact on library services, such as collecting.

The authors collected materials or documents that reflected the universities and their libraries' strategic priorities or key areas of development in future years, such as strategic plans, visions, development programmes, agendas, and statements which can be found on the official websites of both universities and libraries. A simple content analysis approach was used to discover the appearance of AI-related keywords as above in documents of strategy or vision or plan, and the word frequency was recorded.

As the study sought to interpret the topic from the academic libraries' perspective, the paper also explored the websites of sample libraries to examine whether AI applications such as intelligent virtual agents have existed or are planned to implement in the future. Though developing for decades, there is no unified and standard definition of AI, and various scholars and institutions have their interpretations (Cox & Mazumdar, 2022). For librarians, artificial intelligence may be confused with the concepts of library automation, intelligent or smart library, as a consequence of lacking knowledge and lower perceptions of AI. So, it is understandable that libraries take automatic products as AI and advertise services as AI which might not be considered such. Furthermore, not all the robots and chatbots which are beginning to be used in libraries are based on AI (Cox & Mazumdar, 2022). Hence, during the search for AI-related or intelligent products or services in the libraries, the authors collected all the items which were claimed to be intelligent products or services, and did not identify strictly whether those items are based on AI technology or not, then showed all of them in the next section.

Findings

AI in universities

According to the results of the website study, all the sample universities have future strategic plans, however, the time span of each strategy is different, ranging from 4 to 10 years, most commonly 4 to 6 years. They also vary in style and approach: from high-level visions to detailed plans. The strategy documents collected were relatively new, and the strategic plans of 38 of the universities had been released after 2020, so could be expected to reflect current thinking about AI since this date is after the major national policy was released in both countries. The authors conducted a content analysis of those strategic plans and counted the word frequency of AI-related keywords (see Table 2). The results showed that AI/ML was mentioned in the strategies of 24 universities, 3 of which were from the UK and 21 were from China, the total number of times that AI-related words appeared in the documents is 171, 3 % (5 out of 171 times) are from British universities and 97 % (165 out of 171 times) are from Chinese ones, the maximum is 22 which from the Fudan University, and the average value is 3.4, which might imply the unevenly distributed of these words in the strategies. However, the content mentioned about AI/ML was about the development of AI majors, disciplines, and colleges, which was less directly relevant to the application of AI in the university library. However, it was also found that 5 universities have set out the goal of building smart libraries in the vision section of their strategies.

With the rapid development of artificial intelligence technologies and the demand for AI professionals in various industrial sectors, universities around the world have been offering AI-related courses which aim to promote the cultivation of AI professionals. Nearly every

Table 2

AI in universities and libraries.

University	The frequency of AI-related keywords in		Service/Products/Collaborations in libraries
	University strategy	Library strategy	
University of Cambridge	0	0	–
University of Oxford	0	0	Some data mining tools, including ML tools.
Imperial College London	1	0	–
UCL	2	0	–
Peking University	11	–	Automated Storage and Retrieval System (AS/RS)
Tsinghua University	1	–	Smart talking robot Xiaotu (2012), Intelligent Q&A System (2020)
The University of Edinburgh	2	0	Hosting events
The University of Manchester	0	0	–
Fudan University	22	–	Enquiry robots, hosting events
King's College London	0	0	–
Zhejiang University	2	–	Hosting events, AI search engine
Shanghai Jiao Tong University	12	0	Future Library Intelligent Service Joint Research and Development Centre, Intelligent Book Inventory Robot
The London School of Economics and Political Science (LSE)	0	–	–
University of Bristol	0	0	–
The University of Warwick	0	0	–
University of Southampton	0	–	–
University of Glasgow	0	–	–
University of Leeds	0	0	–
University of Birmingham	0	–	–
Durham University	0	–	–
University of Science and Technology of China	0	–	Enquiry robots, hosting events
The University of Sheffield	0	0	–
University of St Andrews	0	–	–
University of Nottingham	0	0	–
Newcastle University	0	0	–
Queen Mary University of London	0	0	Resource guides of machine learning and artificial intelligence.
Nanjing University	3	–	Nanjing University Library Service Platform, next generation library manage system, Intelligent Inventory Robot (launched in May 2017), Intelligent enquiry, Collection indoor positioning.
Lancaster University	0	0	–
University of York	0	–	–
The University of Exeter	0	–	–
Cardiff University	0	–	–
University of Bath	0	–	–
Wuhan University	12	–	The library has partnered with Baidu - the world's largest Chinese language

Table 2 (*continued*)

University	The frequency of AI-related keywords in		Service/Products/Collaborations in libraries
	University strategy	Library strategy	
			search engine company, to build the AI library.
Tongji University	7	–	–
Harbin Institute of Technology	10	–	Hosting smart library forum.
Southern University of Science and Technology	2	–	–
Beijing Normal University	0	0	–
Sun Yat-sen University	3	–	–
Xi'an Jiaotong University	10	0	Intelligent assistants
Huazhong University of Science and Technology	1	–	–
Tianjin University	0	–	Intelligent assistants
Beijing Institute of Technology	1	0	Hosting events, Intelligent assistants
Nankai University	12	–	Intelligent enquiry based on apps in mobile phone.
Shandong University	0	–	–
Sichuan University	6	–	Intelligent enquiry
South China University of Technology	13	–	–
Shanghai University	21	–	–
Xiamen University	4	–	–
University of Science and Technology Beijing	1	–	–
Beihang University (former BUAA)	12	–	Intelligent assistants

Note: "-" means strategies or products or services are not found or not available.

university in the sample has introduced such courses on AI, and some universities have established AI research institutes or departments. Others have established an AI/ML curriculum in the department of Computer Science or Data Science, and all implemented AI research or learning centers most of which are located in academic departments rather than in the library.

AI in libraries

The analysis showed that 19 libraries have strategic plans, of which 15 plans are officially released documents and 4 plans are in the form of visions or agendas. Keyword searches found that none of the strategic plans mentions AI/ML. 18 libraries have already introduced AI applications or offer AI services, or more accurately, some intelligent services, including 2 in the UK and 16 in China. As shown in Fig. 1, there are 9 libraries that provide intelligent virtual agents, enquiry robots, or Chatbot services, but most of these services are based on a dataset of previous Q&A, which are not strictly AI agents. The authors found one real AI based smart talking robot developed by Tsinghua University Library from the literature review, not website exploration (Yao et al., 2015). The robot Xiaotu had been pre-trained with a significant volume of data and was able to learn from communication data to improve its answers continuously. After being put into use for some years, certain users discovered the robot's self-learning and self-improvement features, and intentionally fed the robot with false data, resulting in some toxic language expressions in its answers. As a consequence of a growing number of wrong answers, the library had to stop using the robot for enquiry or chatting. However, several years after that, the library improved and upgraded Xiaotu, the first-generation robot, and launched the Intelligent Question and Answer System, an information service
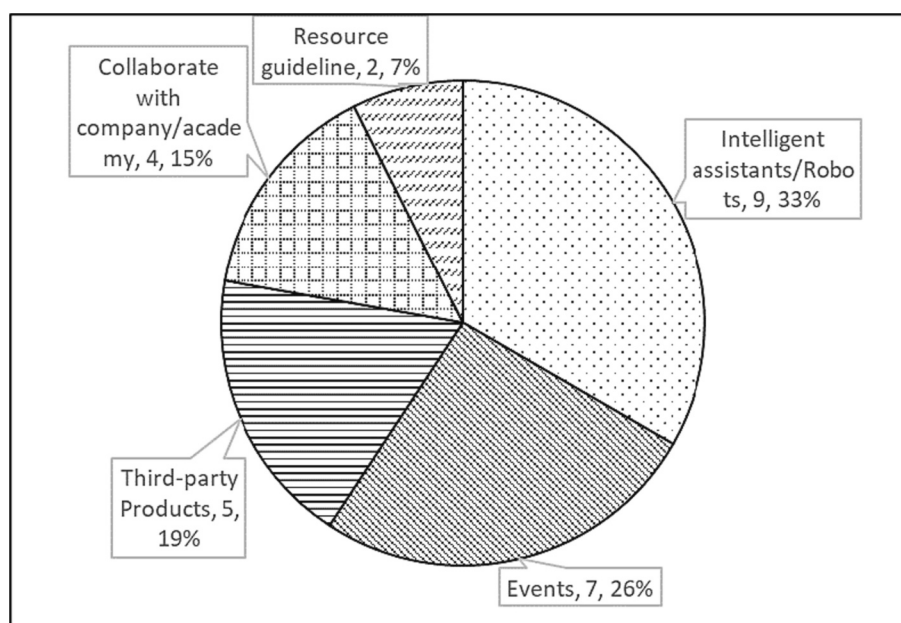
Fig. 1. AI services in academic libraries.

conversation system (Tsinghua University Library, 2021).

In the sample, seven libraries held AI-themed forums, lectures, seminars, etc., and two libraries provided AI-related resources, such as the introduction of AI/ML tools, and AI/ML-related resource navigation and guidelines. Four libraries cooperated with third-party companies or academic departments to participate in the development and application of AI products, or to introduce intelligent products. Nanjing University Library has made the most outstanding achievements, participating in the development of AI-related products such as the intelligent inventory robot, Nanjing University library service platform, prototype of next-generation intelligent library management system, and so on. Peking University Medical Library introduced the Automated Storage and Retrieval System (AS/RS) after the rebuilding and redesigning project of its main body, which frees up space from bookshelves for users. Wuhan University Library has worked with Baidu Inc., the largest Chinese search company, to build an AI library, but no further details or implementation steps can be found on the website.

Discussion

Strategies of universities and libraries

Even if AI is mentioned in the strategic plans of some universities, this mainly refers to the development of majors in AI and has little to do with the library or the application of AI to university operations. What is interesting is that most universities (88 %, 21 out of 24 universities) that mention AI in their strategies are from the Mainland of China, while AI/ML or relevant keywords are sporadic in strategies collected from the sample British universities. This phenomenon may be related to the different approaches of the two countries' universities in drafting future strategies. We have a very small sample in our study but it appears that the strategic plans of Chinese universities are typically concrete plans with detailed roadmaps in every discipline, which also emphasize the majors and institutional structures that need to be developed as priority in the next few years, such as research on new technologies. In contrast, the strategic plans of British universities appear to consist of a vision and mention aspirations including high quality, impactful research, excellent student experiences, global reach, and a civic role, with, as emerging themes, an emphasis on well-being and equality, diversity, and inclusion. They say far less about specific majors and technologies.

In addition, we suggest that the research and development of AI-related technologies and products have been highlighted at the Chinese national strategic level, so vigorously promoting the development of AI in every sector including HE. The circumstances in the UK are subtly different. Although the government has in recent years embraced AI as an engine for industrial development (Wang, 2022) and issued the AI Roadmap to further clarify the UK's AI development strategy and priorities (Office for artificial intelligence, 2021), universities have autonomy in developing their values, principles, characteristics, and development priorities, and do not unquestioningly pursue technological hotspots or show evidence of being strongly influenced by government policy.

Consistent with Saunders' (2015) findings that technology is rarely the focus of library plans, neither British nor Chinese universities mention the application of AI in libraries in their strategic documents. This does not mean, however, that universities or academic libraries are not interested in AI. Quite the contrary, several UK universities in the sample published digital strategies, which do not necessarily mention AI/ML either, but that does show that some institutions are thinking in terms of fundamental digital transformations. The University of Leeds (2021) has released digital strategies that directly talk about support for research areas including high-performance computing, artificial intelligence/deep learning, Internet of Things, robotics, etc. Similarly, the *Digital Strategic Delivery Plan* from the University of Nottingham (2021) defines digital as an effective combination of organizational and technological processes to generate value, which organization and technology are key elements. Since digital technology refers to a wide range of technical solutions including analytics, data visualization, and decision logic, and so on, it can be seen that the attractions of emerging technologies to universities do exist, with an emphasis on digital skills. Therefore, it is worth considering whether the focus of the future strategy will shift from AI to digital as a whole, and digital transformation as a cultural and workforce priority as much as a technological one (Brooks & McCormack, 2020; Iosad, 2020; Skelton, 2023).

Service and products in libraries

Although the study expanded the search from AI-related services to intelligent services during the explorations of libraries' websites, few applications, products or services based on artificial intelligence or

machine learning could be found in the sample academic libraries, which suggests the slow progress of their adoption. Several libraries claim to have developed intelligent virtual agents or chatbots, but only the smart talking robot Xiaotu developed by Tsinghua University Library and the book inventory robots developed by Nanjing University Library are real AI products. The former is based on Natural Language Processing (Yao et al., 2015), the latter has combined robot technology and RFID (Fan & Shao, 2018; Ni, 2017), and the rest use little artificial intelligence technologies. In most cases, the automatic reply agents or robots can only deal with some simple enquiries which are phrased in a standard way. When facing more complex questions, since they do not have the ability to process natural language they cannot respond directly to requests.

Comparison of the two countries

There is an obvious difference in that all the eight libraries making available intelligent enquiry or assistants or chatbot services are from China, and the British libraries have not yet created such services. But we cannot conclude that the introduction of intelligent assistants or chatbots in the British academic library lags behind that of China, because the previous literature review section shows that artificial intelligence originated in the UK, and China often appears to lag behind European and American countries in many aspects including library and information science sector (such as in the case of RDM (Huang et al., 2021). The efficiency of chatbots applications in the library is still controversial. Although stakeholders are inclined to introduce chatbot technology to deliver diverse services (Kaushal & Yadav, 2022), there is lacking user experience to evaluate the applications. Studies have proved that chatbots are not very successful in library application in the North American context (Lin, 2022). Another issue is how to collect user behavior data which is used to train the machine to make the robot-human communication more in line with user habits (Yang & Deng, 2021). Since mature AI products are relatively expensive (Cox et al., 2019) and require a large scale of training data and a certain number of technical professionals, the overall cost may outweigh that of librarians to carry out consulting services by themselves. Therefore, it may be that Chinese libraries are still in the early stages of introducing chatbots, while British libraries may have already reached a realization that they are not effective.

A promising area of the application of AI is knowledge discovery of content such as large-scale image collections, sound collections, handwritten text, etc., where AI can efficiently describe content at scale (Cox & Mazumdar, 2022). However, for academic libraries it is logical to assume that these may not be so central issues compared to delivering book and journal content to students, where library catalogues already perform adequately. This is another possible reason for AI not to have developed very far to date. We see much more innovation in these areas from national libraries which have large unique collections requiring advanced search (Lorang et al., 2020; Qian et al., 2021). It may be that we are too early in the cycle of AI adoption to expect to see more reference to it in strategies.

Though not using the same terminology, the sample universities from the two countries both mentioned concepts or terms which are more wide-ranging than AI, for example, "digital strategy" or "transformation" in some Britain universities, and "intelligent libraries" in Chinese ones. These concepts are closely connected to a diverse spectrum of newly emerging technologies that include but are not limited to AI. Hence, universities and libraries may locate AI as a part of a wider digital transformation strategy or one of the approaches to achieve an intelligent library but not the center of a strategy, which is in line with the lack of AI-related keywords in university strategic plans.

The similarity between the two countries is that there are various challenges in the process of introducing AI in the library, such as the lag of development behind frontier economic industries (Li et al., 2022) and the lack of funds and professional skills which are necessary for applying

AI products. We can speculate that slow progress in adopting AI may reflect that libraries from both countries seek relatively easy and feasible ways to follow the trend of AI and progress smart library goals, with limited funds and human resources.

Challenges of applying AI in academic libraries

AI has significant technical barriers for libraries, e.g. it may be hard to apply algorithms trained on contemporary material to historic collections because they have different characteristics. An algorithm trained on contemporary images may be less effective with historic images, for example, because many objects such as buildings, décor and clothing look different. Significantly, from the authors' experience most UK academic libraries also lack large technical development teams and tend to buy off-the-shelf solutions. This is partly because IT departments tend to control technical development and also because libraries' identities focus on other things such as access to content. Also, the application of technologies entails risk. By reputation libraries have often been seen as somewhat risk averse (e.g. Joint, 2007) though we know of no systematic study of this. Libraries probably adopt a more professional approach to risk management today, but our results can be seen as reflecting a degree of risk aversity with a concentration on delivering reliable services at scale. Most AI products manufactured by commercial companies are not easily integrated with the library's existing systems and services which seems a common issue when introducing new products in academic libraries (Kaushal & Yadav, 2022). The new intelligent service projects are self-contained and require a high level of technical support that most libraries are not able to supply. A few libraries with strong technical resources cooperate with a third party to develop products suitable for their libraries, but these may be difficult to diffuse widely. Ultimately, echoing Saunders' (2015) findings, academic libraries have many priorities which compete with applying the latest technologies and tend to focus on the roles in user education and traditional services, such as the managing and access to collections, and maintenance of physical and virtual learning space and this may lead to hesitancy in keeping up with technologies that are partly suspected of being hype.

An overabundance of caution?

The technical and resourcing overhead of AI partly helps to explain the limited academic library engagement with AI reported in this study, but other factors such as mindset may also come into play. A cautious library stance towards technological change has been noted and this has deep roots. Almost five decades ago, Lancaster (1978) expressed frustration at what he saw as a "myopic" view in the library profession towards the future and in particular the coming shift from print to digital formats and communications. He observed a sense of denial, with the profession seeming to have its "head in the sand". More generally, there are questions about the level of attention which academic libraries afford towards appreciating and anticipating radical change. Their laudable commitment to service brings a risk that resources are prioritised towards internal processes rather than external engagement, with a focus on the immediate term at the expense of future thinking. The emphasis on collections and space over technology in the 63 academic library strategies studied by Saunders (2015) reflects a strong internal focus. Budd (2018) has identified a librarian tendency towards linear thinking, seeing related issues in isolation, and failing to connect developments in the outside world with the local environment. This can make it difficult to contemplate and appreciate the scale of change potentially associated with AI.

The struggle to understand AI may be linked to a recent finding that only 16 % of US academic library directors in a 2022 survey (Hulbert, 2023) agreed that their library had a clear vision of futureproofing that takes into account technological and socio-political trends. This finding, unlikely to be exclusive to academic library leadership in the US,

indicates a lack of confidence which could be holding back a deeper engagement with, and strategic commitment towards, AI. Another inhibiting factor may be an overly conservative approach to discontinuing past activities and the library literature contains few references to Peter Drucker's concept of planned abandonment (Martin & Sheehan, 2018). A tendency to continue with services of interest to dwindling audiences can consume resources otherwise available for experimentation and exploration (Stoffle et al., 2008). The concerns of the library profession with the ethical implications of AI are well-founded. Librarian values of privacy, intellectual freedom, neutrality, transparency, equality and diversity are all at risk of compromise through AI or ML. Anxiety about AI technologies and their consequences may be a further source of hesitation towards, and refrain from, deeper engagement by academic libraries.

An alternative view, and indeed mindset, would be that the ethical issues associated with AI are the very reason why academic libraries should give priority to engaging with it, thereby upholding their values strongly. Such involvement can be relatively low-cost but highly impactful and welcomed by others grappling with how to make the most of these technologies. An obvious case in point would be a deep engagement with the implications for information literacy and academic integrity of generative AI tools such as ChatGPT which are currently exercising a lot attention among academic staff. Too much caution may itself carry risk and academic libraries could be significantly disadvantaged if they fall behind the curve, leaving it to vendors to develop products, possibly with in-built bias, in areas of interest to libraries and higher education, notably rapid citation analysis and digests of the literature (Williams & Grove, 2023), as well as applications specific to libraries such as collections as data and automated generation of metadata. A stronger focus on the potential benefits of AI for academic libraries may be appropriate, noting opportunities to bring efficiency to labour-intensive operations and to divert resources to activities that can move libraries further up the institutional value chain. Embracing AI constructively but judiciously seems sensible, making time for experimentation and signaling an appreciation of the potential for profound change by giving prominence to AI in academic library strategy.

Conclusion

This study is one of the first to analyze the status of the application of AI in Chinese and British academic libraries at the sector level and explore the adoption of AI from the perspectives of strategy and practical application. In the sample of high-ranking university libraries, the authors found some applications of AI products and services. Although the types of applications are relatively simple, mainly focusing on virtual assistants, resource navigation, events or lectures, and robots, it is certain that libraries have actively explored AI in recent years. But the engagement in this emerging technical trend is uneven, some academic libraries are able to design and develop products based on AI technology while some have no information or content about AI/ML/intelligence on their websites. Librarians' application of AI seems to remain at a low level to date. We have to acknowledge a number of limitations to the study and further investigations are needed to fully understand how the use of AI is developing, in a rapidly developing context. Fundamentally, the approach we took relied heavily on material published on web sites. This does not necessarily fully or consistently represent actual activity. It is indicative of major commitments, but it may well miss many initiatives which are in their early stages. Follow up interviews with library directors or a survey would be a useful way to determine the facts here. Surveys of current practice, projects in hand and technology adopted across the sector in both countries would be very useful, as AI does start to be adopted. Also, we focused on high status institutions on the assumption that they have the resources to lead development in the sector, but it may well be that there was more activity in the large number of institutions not investigated. Studies of other institutions and, of course, in other countries are needed. It would also be useful to expand the study to discover how current change is being driven, eg whether it is on specific technologies like AI, on a wider digital transformation, or whether it is rooted in other drivers. Research to better understand how libraries develop their strategies in the context of their institution and national policy trends would also help place studies like this in context.

Libraries' attitudes towards AI can be summed up as prudent. This approach could be argued to be the optimal plan for current conditions. The library, as a function-oriented unit within the university, should choose feasible technical routes to meet the demands of its role, rather than chasing the hottest technologies indiscriminately. If new technologies, like AI/ML/NLP, can accelerate the process of achieving goals or raise the efficiency of professional processes, then active exploration is undoubtedly justified, but concrete application needs to consider other factors, such as whether there is sufficient funding, what the value generated is, what support is available from the institution, and the technical ability and skills of librarians. If there are strong barriers or well-established approaches already work well technology may not be adopted. Yet the prominence of AI in current HE agendas should prompt a level of active engagement with a stress on finding useful and ethical applications.

CRediT authorship contribution statement

Yingshen Huang: Conceptualization, Methodology, Formal analysis, Investigation, Writing – original draft, Writing – review & editing. **Andrew M. Cox:** Conceptualization, Methodology, Writing – review & editing. **John Cox:** Writing – review & editing.

Declaration of competing interest

None.

Data availability

Data summary is Appendix.

Appendix 1. The strategies of universities

University	Referencing link	Date of released	Span of the strategy	Date of found	AI-related words frequency
University of Cambridge	https://www.governance.cam.ac.uk/Pages/University-strategies.aspx	–	–	2 January 2023	0
University of Oxford	https://www.ox.ac.uk/about/organisation/strategic-plan-2018-24	Approved by Council 9 July 2018 and by Congregation on 30 October 2018	2018–2024	10 January 2023	0
Imperial College London	https://www.imperial.ac.uk/strategy/	–	2020-2025	28 January 2023	1

(*continued*)

University	Referencing link	Date of released	Span of the strategy	Date of found	AI-related words frequency
UCL	https://www.ucl.ac.uk/strategic-plan-2022-27/	11 January 2023: UCL Strategic Plan 2022–27 published.	2022–2027	13 January 2023	2
Peking University	https://zys.pku.edu.cn/docs/20211122113124985739.pdf	October 2021	2021–2025	24 December 20222	11
Tsinghua University	https://www.tsinghua.edu.cn/info/1624/88432.htm	October 2021	2021–2025	24 December 20,222	1
The University of Edinburgh	https://www.ed.ac.uk/about/strategy-2030	Sep, 2022	Strategy 2030	13 January 2023	2
The University of Manchester	https://www.manchester.ac.uk/discover/vision/	–	–	13 January 2023	0
Fudan University	https://xxgk.fudan.edu.cn/72/e2/c12546a422626/page.htm	October 2021	2021–2025	2 January 2023	22
King's College London	https://www.kcl.ac.uk/about/strategy	–	Vision 2029	13 January 2023	0
Zhejiang University	https://www.zju.edu.cn/xxgk/2021/1117/c17948a2442763/page.htm	November 2021	2021–2025	5 January 2023	2
Shanghai Jiao Tong University	https://plan.sjtu.edu.cn/info/1011/1838.htm	October 2021	2021–2025	5 January 2023	12
The London School of Economics and Political Science (LSE)	https://www.lse.ac.uk/2030	–	LSE2030	14 January 2023	0
University of Bristol	https://www.bristol.ac.uk/university/strategy/	November 2022	2022–2030	17 January 2023	0
The University of Warwick	https://warwick.ac.uk/about/strategy/		Strategic direction to 2030	17 January 2023	0
University of Southampton	https://www.southampton.ac.uk/susdev/our-approach/sustainability-strategy.page	developed in mid-2020	2020–2025	17 January 2023	0
University of Glasgow	https://www.gla.ac.uk/explore/strategy/		2020-2025	28 January 2023	0
University of Leeds	https://www.leeds.ac.uk/about/doc/strategies-plans		2020-2030	17 January 2023	0
University of Birmingham	https://www.birmingham.ac.uk/university/our-strategy.aspx		Birmingham 2030	28 January 2023	0
Durham University	https://www.durham.ac.uk/about-us/university-strategy/		2017-2027	28 January 2023	0
University of Science and Technology of China	https://xxgk.ustc.edu.cn/13824/list.htm	December 2016	2016–2020	6 January 2023	0
The University of Sheffield	https://www.sheffield.ac.uk/vision	–	2020-2025	1 January 2023	0
University of St Andrews	https://www.st-andrews.ac.uk/about/governance/university-strategy/	October 2022	2022–2027	19 January 2023	0
University of Nottingham	https://www.nottingham.ac.uk/Strategy/Home.aspx	–	–	19 January 2023	0
Newcastle University	https://www.ncl.ac.uk/flippingbook/vision/vision-brochure/files/assets/basic-html/page-1.html	–	–	–	0
Queen Mary University of London	https://www.qmul.ac.uk/strategy-2030/	–	Strategy 2030	–	0
Nanjing University	https://xxgk.nju.edu.cn/15409/list.htm	October 2021	2021–2025	5 January 2023	3
Lancaster University	https://www.lancaster.ac.uk/strategic-planning-and-governance/strategic-plan/#innovating-for-excellence-480500-5	–	2021-2026	–	0
University of York	https://www.york.ac.uk/about/mission-strategies/vision-for-york/	October 2021	2020–2030	23 January 2023	0
The University of Exeter	https://www.exeter.ac.uk/about/strategy2030/	–	Strategy 2030	23 January 2023	0
Cardiff University	https://www.cardiff.ac.uk/about/our-profile/strategy	–	2018-2023	23 January 2023	0
University of Bath	https://www.bath.ac.uk/topics/the-university-of-bath-strategy-2021-to-2026/		2021-2026	27 January 2023	0
Wuhan University	http://info.whu.edu.cn/info/1509/22475.htm	January 2022	2021–2025	9 January 2023	12
Tongji University	http://xxgk.tongji.edu.cn/index.php?classid=3098&newsid=13654&t=show	October 2021	2021–2025	9 January 2023	7
Harbin Institute of Technology	http://xxgk.hit.edu.cn/2021/1124/c12140a265344/page.htm	October 2021	2021–2025	9 January 2023	10
Southern University of Science and Technology	https://www.sustech.edu.cn/zh/information-open.html	May 2022	2021–2025	9 January 2023	2
Beijing Normal University	http://fzghc.bnu.edu.cn/zlgh/ztgh/index.html	July 2016	2016–2020	9 January 2023	0
Sun Yat-sen University	https://xxgk.sysu.edu.cn/article/105	October 2021	2021–2025	9 January 2023	3
Xi'an Jiaotong University	http://xxgk.xjtu.edu.cn/list_lm.jsp?urltype=egovinfo.EgovCustomURl&wbtreeid=1001&type=subcattree	October 2021	2021–2025	9 January 2023	10

(*continued*)

University	Referencing link	Date of released	Span of the strategy	Date of found	AI-related words frequency
	&sccode=fzgh&subtype=3&gilevel=2&openitem=fzgh:2				
Huazhong University of Science and Technology	http://xxgk.hust.edu.cn/info/1165/1933.htm	December 2017	2017–2020	9 January 2023	1
Tianjin University	http://xxgkw.tju.edu.cn/xxfzgh/	July 2016	2016–2020	9 January 2023	0
Beijing Institute of Technology	https://xxgk.bit.edu.cn/docs/20190925095123374130.pdf	November 2018	2016–2020	9 January 2023	1
Nankai University	http://xxgk.nankai.edu.cn/_upload/article/files/3d/e1/93afde4d4a15ae2ffadaedccbf41/556aafb4-c044-4469-a27b-16dfc7f757bc.pdf	November 2021	2021–2025	9 January 2023	12
Shandong University	https://www.fzgh.sdu.edu.cn/info/1003/2428.htm	December 2016	2016–2020	9 January 2023	0
Sichuan University	https://xxgk.scu.edu.cn/_local/C/1C/36/65C5EE91E1ECF3F54D2708FEA35_1660CD61_A1993.pdf	October 2021	2021–2025	9 January 2023	6
South China University of Technology	https://xxgk.scut.edu.cn/36/list.htm	October 2021	2021–2025	9 January 2023	13
Shanghai University	https://xxgk.shu.edu.cn/ziliao/145.pdf	October 2021	2021–2025	10 January 2023	21
Xiamen University	https://gk.xmu.edu.cn/info/1025/2168.htm	October 2021	2021–2025	9 January 2023	4
University of Science and Technology Beijing	https://odp.ustb.edu.cn/docs/2019-04/20190417162027485659.pdf	–	2017-2020	9 January 2023	1
Beihang University (former BUAA)	http://xxgk.buaa.edu.cn/syljs.htm	May 2022	2021–2025	9 January 2023	12

Note: "-" means not found or not available.

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