



Artificial Intelligence (AI) and Robotic Technologies Implementation in Libraries: An Integrative Literature Review

Kütüphanelerde Yapay Zeka (YZ) ve Robotik Teknolojilerinin Uygulanması: Bütünleştirici Bir Literatür İncelemesi

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Abstract

Artificial intelligence and AI-supported robots, emerging from the rapid development of software technologies and automation, have surrounded libraries with their transformative effects, as in many other areas. With an integrative approach, this study investigates how and to what extent the meaning, importance, use, advantages, and disadvantages of artificial intelligence and robotics technologies in libraries are covered in national and international literature, as well as predictions for the future in this context. Thus, it reveals the theoretical and practical status of the subject at a global level and questions the points on which national and international research agree and differ. The findings of the study indicate a strong consensus on particular perspectives. The positive perspectives indicate that AI and robots offer many opportunities for enhancing the effectiveness, efficiency, and user satisfaction of libraries, as well as the potential for libraries to successfully adopt and implement these technologies.

On the other hand, both national and international studies express various concerns and problems regarding AI and robots. These issues are similar to those of cost, infrastructure, privacy, ethics, training, resistance to innovation, and fear of losing staff jobs. Recommendations for strategies, which are determined within a responsible and ethical framework with appropriate training and guidelines, while considering their collaborations, are those on which consensus is reached. The study will comprehensively investigate the current status, advantages, and potential barriers to using artificial intelligence (AI) and robotic technologies in libraries in Turkey and abroad by analyzing national and international literature. The study aims to introduce the primary applications and processes where robots are used in library environments, such as the automation of routine tasks, improvement of user services, collection management, and educational activities. Another aim is to understand library professionals' perceptions, awareness levels, and educational needs regarding these technologies. The ultimate goal of the study is to provide a detailed perspective on artificial intelligence and robotic technologies, by highlight their benefits and challenges, and to develop recommendations for the effective integration of these technologies into libraries and their future development. The study uses an integrative review method to examine many studies (articles, books, theses, reports, etc.) to obtain a comprehensive overview of known but still unexplored topics. This method considers research that includes empirical data and non-empirical ideas or theories, unlike some reviews, which focus only on specific studies. It is a valuable method, because it combines different information types to understand a topic comprehensively.

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Öz

Yazılım teknolojileri ve otomasyonun hızla gelişmesinin ürünü olan ve geniş bir fırsat yelpazesine sahip olan yapay zekâ ve YZ destekli robotlar, birçok alanda olduğu gibi kütüphaneleri de dönüştürücü etkileriyle kuşatmıştır. Bu çalışma, bütünleştirici bir yaklaşımla, yapay zekâ ve robot teknolojilerinin kütüphanelerdeki anlamı, önemi, kullanımı, avantajları ve dezavantajlarının ulusal ve uluslararası literatürde ne kadar ve nasıl yer

aldığını ve bu bağlamda geleceğe yönelik öngörülerini araştırmaktadır. Böylece konunun küresel düzeyde kuramsal ve pratik durumunu ortaya koymakta, yerli ve yabancı araştırmaların uzlaştığı ve ayrıldığı noktaları sorgulamaktadır. Çalışmanın bulguları ortak görüş yoğunluğunu ortaya koymuştur. Bunlar, yapay zekâ ve robotların kütüphanelerin etkinliği, verimliliği ve kullanıcı memnuniyeti için birçok fırsat sunduğuna ilişkin olumlu bakış açıları ile kütüphanelerin bu teknolojileri benimseme ve uygulama potansiyel gücüne olan inançtır.

Öte yandan, hem yabancı hem de yerli literatür çalışmaları yapay zekâ ve robotlarla ilgili çeşitli endişe ve sorunları da dile getirmektedir. Bunlar; maliyet, altyapı, mahremiyet, etik, eğitim, yeniliğe direnç ve personelin işini kaybetme korkusu gibi benzerlik gösteren kaygılardır. Kütüphanelerin sorumlu ve etik bir çerçevede, uygun eğitim, yönergelerle ve işbirliklerini göz önünde bulundurarak belirleyecekleri stratejiler, fikir birliğine varılan öneriler arasındadır. Çalışmanın amacı, yerli ve yabancı literatürün analizi ile yapay zeka (YZ) ve robotik teknolojilerinin yurt içinde ve yurt dışında kütüphanelerdeki kullanımına ilişkin mevcut durumu, sunduğu avantajları ve potansiyel engelleri kapsamlı bir şekilde araştırmaktır. Çalışma, rutin görevlerin otomasyonu, kullanıcı hizmetlerinin iyileştirilmesi, koleksiyon yönetimi ve eğitim etkinlikleri gibi robotların kütüphane ortamlarında kullanıldığı birincil uygulamaları ve süreçleri tanıtmayı amaçlamaktadır. Buna ek olarak, bir diğer amaç, söz konusu teknolojilere ilişkin kütüphane profesyonellerinin algılarını, farkındalık düzeylerini ve eğitim ihtiyaçlarını anlamaya çalışmaktır. Nihai hedef, yapay zeka ve robotik teknolojilerine ilişkin ayrıntılı bir perspektif sağlamak, faydalarını ve zorluklarını vurgulamak ve bu teknolojilerin kütüphanelerde etkili entegrasyonu ve gelecekteki gelişimi için öneriler geliştirmektir. Çalışma, bilinen ancak hala keşfedilmesi gereken konuların büyük resmini elde etmek için birçok farklı çalışmayı (makale, kitap, tez, rapor vb.) incelemeyi sağlayan bütünlleştirici bir inceleme yöntemini kullanmaktadır. Bu yöntem, sadece belirli çalışma türlerine odaklanan bazı incelemelerin aksine, hem veri (ampirik) hem de fikir veya kuramlar (ampirik olmayan) içeren araştırmaları dikkate alır. Farklı bilgi türlerini birleştirerek bir konu üzerine net ve kapsamlı bir genel anlayış sağladığı için yararlı bir yöntemdir.

1. Introduction

The use of robots is one of the reflections of the rapid development and diversification of today's technologies in libraries. Libraries use various robots for their operations and services, such as information management, retrieval, routine technical operations, reference services, and user experience improvement. These technologies are still developing. They have advantages, and some factors can be prohibitive. Robots can automate many processes, such as the acquisition, cataloging, classification, shelving and inventory tracking of books and similar materials.

Similar to other disruptive technologies, artificial intelligence and robotics have transformed various industries, including libraries. Libraries use robots in internal operations such as automated information storage and retrieval, and public services (Tella & Ajani, 2022, p. 16; Tella, 2020). Robots can also move heavy boxes of books and other materials from one place to another in the library (Indraji, Naikar & Dominic, 2024, p. 3007; Martinez-Martin, Recatala & Pobal, 2019, p. 4). This function is an important advantage, especially for large, multi-story, and complex structures. Offloading such work to robots allows staff to use their time more efficiently. Robots interacting with users can also be used for different services, such as providing information, providing guidance in various contexts (Kaur, 2020, s. 293), and answering frequently asked questions (Guliciuc et al., 2017, p. 7; Harisanty et al., 2020, p. 4). Libraries can use robots in more complex and specialized operations, too. For example, by analyzing user information search behaviors and preferences, robots can develop the user profile and contribute to the collection development policy. Talking robots, also deployed in various library parts, can assist and guide users (Vysakh & Rajendra Babu, 2019, p. 61).

On the other hand, although there are still some issues with the use of robots in libraries and a lack of advanced intelligent services, they can reduce the workload of library staff by performing repetitive tasks quickly and accurately. User satisfaction will likely increase with the capacity to provide 24/7 service, that exceeds human capacity (Li, 2022, p. 57). Robots also contribute to libraries being more open to innovation and cutting-edge technologies, which will appeal to a younger audience (Indraji, Naikar & Dominic, 2024, p. 3007).

Despite all the advantages, several factors can hinder the use of robots in libraries. These are the costs of providing and maintaining the technology (Shahzad, Khan, and Iqbal, 2024; Hsiung & Wei, 2013, p. 171). Cost is a significant problem, especially for libraries with budgetary constraints. In addition, the necessary infrastructure for the functionalization of robots must be in place. Other important

factors are staff and user perceptions of robots, the need for training, and security and privacy concerns (Vlachos, Hansen, & Holck, 2020; Hsiung & Wei, 2013).

This study aims to examine the advantages of utilizing artificial intelligence and robots in libraries and the factors that may hinder their implementation. To this end, the study analyzes and interprets related national and international literature. The study also identifies the primary processes and applications in which robots are employed in libraries. According to the results, libraries mostly use robots for simple, routine, and repetitive tasks. It is likely too early to use robots for more complex and specialized operations and services; and these technologies need to be further developed. In addition, the factors mentioned above prevent the activation of robots in libraries. Technological developments and research in this field are estimated to allow libraries to use robots more widely and comprehensively in the future. However, libraries should overcome the obstacles mentioned above first.

The general hypothesis of this study is that “The application of AI and robotic technologies in libraries increases efficiency and user satisfaction, but their widespread adoption presents barriers such as high costs, inadequate infrastructure, low awareness, and resistance to innovation, which can be reduced or eliminated through strategic training, ethical frameworks, and collaborative efforts.”

The research questions of the study are as follows:

- What is the current status of research on using artificial intelligence and robotic technologies in libraries nationally (Turkey) and internationally?
- What are the main applications and processes using artificial intelligence and robots in library environments?
- What are the advantages of implementing artificial intelligence and robotic technologies in libraries?
- What are the main challenges, barriers, and concerns regarding adopting and implementing artificial intelligence and robotics in libraries?
- What strategies and recommendations can effectively overcome these challenges and promote the responsible, ethical, and effective integration of AI and robots into library services?
- What are library professionals' perceptions, awareness levels, and training needs regarding AI and robotic technologies?

2. Methodology and Data Collection

This study employs the integrative literature review method, which aims to evaluate and synthesize data from various sources to answer research questions, generate new theories, and present a comprehensive view of existing knowledge on a topic of interest. A literature review can be an academic publication in its own right or an analysis of research about on a particular topic without contributing original research. Literature reviews help researchers stay current on a field and help them choose a research topic to fill gaps in knowledge about it. Common types are systematic, semi-systematic, and integrative reviews (University of North Dakota, 2024). In its narrow sense, a systematic literature review is a form of research that applies a systematic methodology to synthesize existing and previously published data. It is also a research method used to examine scientific literature using systematic and rigorous methods. Each section of such studies informs what came before it, contributing to a logical and linear process. In a broader sense, the systematic literature review is a review that aims to comprehensively identify, evaluate, and synthesize all relevant research on a given topic. It is also used to identify relevant studies related to a specific research question and to evaluate and synthesize existing collections of completed and documented studies. It is an open, comprehensive, method and research process based on a transparent and reproducible methodology (Polat, 2021, p. 258). A semi-systematic literature review (SSLR) is a synthesis of multidimensional topics. This method allows researchers to design themes, theoretical approaches, and commonalities, limited by the scope of their review objectives (Prasetyani, Destiningsih & Rosalia, 2022, p. 215). The quasi-systematic approach, designed for differently conceptualized and diverse studies, examined by

researchers in various disciplines, precludes a full systematic review process (Alsami, 2022, p. 157). An integrative review, which is less systematic and can be used to develop a theoretical model or reconceptualize an issue, often requires more creative data collection. This approach is valuable because it aims to combine perspectives and insights from different fields or research traditions (Snyder, 2019, p. 336). Integrative inquiry is one of the most comprehensive methodological approaches. It incorporates empirical and non-empirical studies to understand the phenomenon it analyzes comprehensively. It combines data from the theoretical and empirical literature. It has a wide range of objectives, including identifying phenomena, problems, and concepts, reviewing theories and evidence, and analyzing methodological problems in a particular topic (Souza, Silva & Carvalho, 2010, p. 103). A researcher with an integrative research approach should first clearly define the purpose of the research. Then, they should emphasize the scope of the topic they will examine and related concepts. When reviewing the history of research on the topic, the researcher should make the research question more specific, if the research has been the subject of many previous studies. In such cases, if the topic is new and there are few studies in this context, it may be necessary to broaden the research question. This approach is essential to obtain more information (Russell, 2005, pp. 8-9).

The reasons for adopting an integrative approach in this study can be listed as follows: the investigation of artificial intelligence and robotic technologies in libraries, and the content showing that the topic has been the focus of national (Turkish) and foreign studies in the field in recent years. Therefore, it is a relatively new and under-researched topic. Compared to other methods, the integrative approach is more comprehensive and flexible, allowing for the simultaneous examination of theoretical and empirical studies. With its comprehensive coverage of theoretical and empirical studies on the subject, this study aims to leave no stone unturned, providing a thorough analysis. One of the various aims of the methodology is to identify the phenomena, concepts, and problems related to the research topic. This study first clarifies the research purpose in line with the aforementioned steps of the integrative research process. The study aims to investigate the scope and issues of national and international literature on the use of artificial intelligence and robotic technologies in libraries and to question whether these technologies have been adopted. The scope of the study defines the concepts of artificial intelligence and robotics. Then, it provides information about the content of the sources from national (Turkish) and foreign studies, and the primary issues and problems they address. At the beginning of the literature review, the text provides brief historical background information to solidify the foundation of the research. This study aims to comprehensively evaluate and synthesize data from various sources, and create a new general perspective. In addition, this approach is appropriate for identifying existing knowledge and research gaps in the literature and determining concepts and fundamental problems. In the first stage, the purpose and scope of the research were clearly defined. The literature review was planned to cover the scope of national and international studies on using artificial intelligence (AI) and robotic technologies in libraries. In this context, the focus of the research was on the role of technologies in the literature, the areas in which they are used, their advantages, and the obstacles encountered.

In the data collection phase, keywords such as “artificial intelligence,” “robotics,” “robots,” “library,” “library services,” “automation,” “AI in libraries,” “robotic applications,” “library robots,” and their Turkish equivalents were used. In addition, sub-keywords such as “digitalization,” “information technologies,” and “future predictions” were preferred as supporting words in the research. With these keywords, suitable studies were identified from various data sources, the details of which will be detailed later in the study. Data sources and access platforms can be outlined as follows:

- International academic databases and platforms offering a diverse range of data sources: IEEE Xplore, Springer (Lecture Notes, Nature, etc.), Elsevier (ScienceDirect), ProQuest, ACM Digital Library, SAGE, ResearchGate, Semantic Scholar
- National, and local platforms: Dergipark, Bilgi Dünyası, Turkish Librarianship, YÖK Thesis Center.
- Open access and archives: Institutional repositories, university archives, Google Scholar, university library portals
- Organization and institution report: Council of Higher Education (YÖK, Yükseköğretim Kurulu), Australian Library and Information Association report.

These various platforms and data sources were used to keep the scope of the research broad and to collect data from different disciplines and publication types (articles, books, theses, reports, etc.). The data collection process was carried out in the following steps:

- A comprehensive search was conducted on each platform using keywords.
- The search aimed to cover the entire literature without any date limit, including the most recent and oldest studies.
- A preliminary selection was made based on the titles, abstracts, and keywords of the obtained studies. The appropriate studies were subjected to detailed analysis and classification by allowing full-text access.
- Most studies, especially articles and reports, are original and current while including classical and basic theoretical approaches.

In summary, this research method involves a comprehensive and systematic scanning of various platforms and sources in the context of the subject through related keywords, selecting the appropriate ones, and examining them in depth. Thus, it aims to present the current situation in the literature in a detailed manner.

In the literature review, academic and research repositories (ResearchGate, Google Scholar, institutional repositories, university archives), publisher platforms and digital libraries (IEEE Xplore, Springer, Elsevier), official government and organization reports (Council of Higher Education), open access platforms and conference proceedings (e.g. IEEE, ACM, conference websites), and Turkish academic platforms and journals (Dergipark, Information World Journal, The Journal of Turkish Librarianship, etc.) were examined through the related keywords mentioned above. The study, which also emphasizes the historical background when necessary, was conducted without any date limitations in the searches, ensuring a comprehensive review of the field. A total of 67 sources were referenced in the study.

To provide a more detailed account of the platforms used, all local journals related to the field were scanned, and the studies obtained were examined. These include the Journal of Turkish Librarianship (Kavak, 2024; Küçük & Soydal, 2003; Yıldız & Yıldırım, 2018), the Journal of Information World (Çuhadar et al., 2024; Öztürk & Özel, 2021; Sağlam & Çetintaş, 2022), the Journal of Information Management (Kavak, 2023), and Library, Archive, and Museum Research Journal (LAMRe) (Sivri, 2023). Apart from this, journals included in the TR Index (Polat, 2021) and other journals (Polat, 2024; Yılmaz, 1991) were also consulted. After consulting the books related to the field (Demir, 2024; Küçükcan & Yıldırım, 2023; Torunlar, 2023), the theses in the Council of Higher Education Thesis Center were also consulted (Murat, 2024; Özdem, 2013; Öztürk, 2020; Sarıçoban, 2024; Selçuk, 2019).

Other digital research platforms searched were ResearchGate (Anand et al., 2024; Harisanty et al., 2020; Indraj, Naikar, & Dominic, 2024; Kaur, 2020; Perez et al., 2018; Prasetyani, Destiningsih, & Rosalia, 2022; Russell, 2005; Sambo & Oyovwe-Tinuoye, 2023; Souza et al., 2010; Vysakh & Rajendra Babu, 2019) and Google Scholar (Anumula et al., 2024; Sachi & Kumar, 2020; Sheetal et al., 2024). In addition, some of the resources used are Emerald Insight (Alsami, 2022; Massis, 2018; Tella & Ajani, 2022; Tella, 2020; Tonta, 1990), Springer Nature (Ben-Ari & Mondada, 2017; Cheung et al., 2024; Vlachos et al., 2020), SAGE (Ingrand & Ghallab, 2012; Sastry, 2023; Shahzad, Khan, & Iqbal, 2024), IEEE Xplore (Alim, Tamami & Alasiry, 2022; Huy et al., 2022; Li, 2022; Suthakorn et al., 2002), Elsevier (Digital Commons) (Liu, 2011; Mess, 1991), Proquest (Subih, Nueangnong, & Pokkasut, 2019), Scopus (Snyder, 2019) and databases. In addition, publications by the International Federation of Library Associations and Institutions (IFLA), an important organization in our field, were also searched (Chakarova & Trabert, 2019; Guliciuc et al., 2017; Kim, 2019; Martinez-Martin, Recatala, & Pobil, 2019). IGI Global, an international academic publishing organization (Hsiung & Wei, 2013; Jayavadivel et al., 2024), and ACM Digital Library, a research discovery platform of the Association for Computing Machinery (ACM) were also searched. ACM Digital Library provides access to a wide range of publications including journals, conference proceedings, technical journals, newsletters, and books (Kang, Hwang, & Kwak, 2024). This variety of publications ensures a comprehensive search. Other sources scanned include the open-access MDPI (Multidisciplinary Digital Publishing Institute) (Martinez-Martin et al., 2021; Ramanan & Manoj Senthil, 2018) and

Semantic Scholar (Owen, 2024), a free, AI-powered research and discovery tool developed by the Allen Institute for Artificial Intelligence to navigate scientific literature. Additionally, official reports published by the Australian Library and Information Association (Nguyen, 2019) and the Council of Higher Education (YÖK, 2014) were included.

3. Artificial Intelligence and Robotics: Concepts and Classifications

Artificial intelligence today involves conceptualizing an intelligent machine regarding its operational and social consequences (Perez et al., 2018). It is a concept that relates to the simulation of human intelligence processes by machines, especially computer systems. These processes include learning (acquiring knowledge and rules for using it), reasoning (using rules to reach approximate or definite conclusions), and self-correction. Robotics, on the other hand, involves the design, construction, operation, and use of robots, which are automated machines that can perform tasks autonomously or semi-autonomously. Advanced systems that combine AI and robotics perform complex tasks in various sectors (Owen, 2024; Subih, Nueangnong & Pokkasut, 2019, p. 403).

Robotics is an interdisciplinary field combining mechanical and electrical engineering, control theory, and computer science, with recent expansions into materials physics, bioengineering, and cognitive science. The intersection of AI and robotics covers planning, tracking, goal reasoning, perception, interaction with humans, and robots, and learning models. It also focuses on integrating these functionalities into adaptive and resilient architectures (Ingrand & Ghallab, 2012, p. 63).

It is challenging to define robots by category as each has unique features and varies in size, shape, color, and components (Vysakh & Rajendra Babu, 2019, p. 60). Kim (2019, p. 1) points out that although the term 'robot' evokes the image of a humanoid machine, it can take many forms, from a drone to an autonomous vehicle to a therapeutic baby seal-bot. Robots can be grouped either as fixed and mobile robots according to their working environment. Fixed robots, such as industrial manipulators, work in controlled environments and perform tasks such as soldering or painting. Mobile robots, such as vacuum cleaners and autonomous cars, can navigate unpredictable environments. Mobile robots can be further categorized into water, land, and air types, each requiring different designs for movement; and are used in various applications, including industrial tasks, home assistance, and medical procedures (Ben-Ari & Mondada, 2017, p. 1).

The use of mobile robots in libraries is primarily aimed at increasing efficiency and automating tasks such as returning books to shelves (Alim, Tamami & Alasiry, 2022, p. 355; Huy et al., 2022, p. 350). Mobile robots can recognize books using RFID, find the shortest path with the A-Star algorithm, and then carry books quickly and accurately. Thus, they reduce the work of librarians and speed up processes in library operations (Alim, Tamami & Alasiry, 2022, p. 355). With advanced pathfinding algorithms and sensors, robots can navigate efficiently, avoid obstacles, and follow optimal routes, improving accuracy in library operations and saving time (Huy et al., 2022, p. 350). Robots for libraries are generally useful tools that can undertake repetitive tasks such as inventory management and finding books, making library work more efficient. Robots can save time and increase the speed and accuracy of operations, allowing librarians to focus more on user services. Overall, it is important to view robots as an opportunity to improve library operations rather than to replace human librarians (Chakarova & Trabert, 2019). Various robot categories are listed in the table below according to their application areas:

Table 1

Robot Categories

Sequence number	Types	Descriptions
1	Aero Space	Robots that include all types of flying robots and those that can operate in space (such as NASA's Robonaut).
2	Consumer	Robots that help with small tasks and chores (Eg, Robot Dog Aibo, Roomba Vacuum).
3	Disaster Response	Robots are used for multiple purposes during any disaster or calamity, (such as Packbots used during the earthquake in Japan).

4	Drones	Unmanned aerial vehicles that vary in size, shape, and weight find application in almost every field and work with onboard sensors and GPS (for example, DRDO Netra and DRDO Rustom).
5	Education	Robots that are used to support educational tasks and activities at home and school (Example: EMYS teacher robot).
6	Entertainment	These robots are made for the purpose of entertaining people, such as theme park robots like Disney's Navi Shaman and bots with musical talents that act as a partner.
7	Humanoid	These are robots that look like humans (example: Pepper robot at the Roanoke County Public Library).
8	Industrial	These robots are used in factories to perform repetitive tasks, for example, Amazon warehouse robots.
9	Medical	Healthcare robots that are used to support medical operations (Example: Da Vinci surgical robot).

**(Robot categories according to their application areas (Vysakh & Rajendra Babu, 2019, p. 60)).*

Robots are used everywhere: in factories, homes, hospitals, and space. Much investment is being made in R&D to develop robots that interact directly with humans. Schools also use robots as a pedagogical tool to increase students' motivation to study STEM and teach STEM in a concrete environment (Sachi & Kumar, 2020, p. 231).

The national and international literature on using robots in libraries is analyzed and interpreted separately in the following part, including a brief historical background.

4. International Literature Review Analysis on the Use of Robots in Libraries

The presentation of the international studies' content evaluated in chronological order on the subject and the analysis made as a result of this presentation are as follows:

Jayavadivel et al. (2024, p. 276) note that the 1980s and 1990s witnessed the emergence of expert systems in libraries worldwide. These AI applications aim to mimic the decision-making skills of human professionals in specific domains. Professional systems were applied to tasks such as reference assistance and collection development, providing patrons with more customized and informed assistance. As mentioned by Vysakh and Rajendra Babu (2019, p. 60), artificial intelligence applications have been on the agenda of libraries since the 1990s. Artificial intelligence can be utilized for many library applications, from technical services to user services. According to Liu (2011, pp. 1, 29), since the 1990s, research in the literature has focused on digital library services. These services include agent-based digital library projects, multi-agent architecture for digital libraries, intelligent agents for distributed heterogeneous information retrieval, and agent support for information search processes in digital libraries, rather than traditional library services. Various architectures, frameworks, and models that use agent technology in library services have been proposed, but only some have been implemented in practical settings. The application of agent technology is still in the research and experimental stage. Agent technology has great potential in many areas of the library context but also presents challenges for libraries. These challenges include involving IT staff in development, educating users on the benefits of intelligent agents, and providing library professionals with the knowledge and skills needed to design and implement this technology. According to Jayavadivel et al. (2024, p. 277), in the late 1990s and early 2000s, natural language processing (NLP) was integrated into library structures. NLP allowed libraries to improve consumer interactions by enabling for more natural and intuitive search queries. Chatbots and digital assistants have also emerged, providing interactive and conversational interfaces to users.

Mess (1991, p. 43) stated that artificial intelligence offers a wide range of options for libraries: "automatic cataloging/classification using character recognition, automatic translation of foreign language materials, automatic indexing/retrieving of audiovisuals, interactive bibliographic instruction using various media, intelligent gateways to online resources, user-configured information environments, portable computer reader services for the handicapped, intelligent document delivery," and so on. Mess pointed out that these services were then in development in academic and industrial circles. However, Hsiung and Wei (2013, p. 157) pointed out that the economic downturn led to

reduced budgets and staff cuts at the University of California, Santa Cruz Library, even as digital formats and technology have been rapidly advancing. To address these challenges, the library's Technical Services (TS) department transformed by maximizing technology and using batch processing tools. This study outlines the strategies for aligning human resources with these tools to achieve library goals, discusses obstacles faced, and offers guidance for implementing ongoing technological changes.

A study by Suthakorn et al. (2002) is noteworthy because it finds a solution to the space problem in libraries through digitalization. Suthakorn et al. describe a robotics project called "Comprehensive Access to Printed Materials" (CAPM), which was developed to increase access to printed materials in libraries. The project uses autonomous mobile robotic systems to move printed materials from shelves to scanning stations to solve the problem of limited space while providing increased digital services. Users can trigger this process through a web interface to perform real-time scanning of printed materials. The paper focuses on the robot design, control systems, and results obtained. The authors state that the project was successful after testing, and that similar gains can be achieved in developing digital libraries.

According to Hsiung and Wei (2013, p. 171), human barriers have been factors that slow down or prevent the use of technology in technical services. Some employees have resisted change or have been reluctant to allow interference in their areas of responsibility. Loss of expertise, fear of exposing weaknesses, and the implication that past work was inadequate have made staff uncomfortable. Economic downturns are also a significant problem that increases the fear of job loss. Automation requires reshaping work processes, while fear of technology and reluctance to learn new skills have made it difficult for some employees to adapt to change. Fear of failure and lack of incentives to change can create reluctance to adopt new methods.

Guliciuc et al. (2017, p. 7) stated that expert systems used in libraries would increase the productivity of librarians and facilitate dialogue between staff and users. Library functions of expert systems include reference service, cataloging, classification, indexing, and acquisition. Another reflection of artificial intelligence in libraries is virtual assistants. The author gives an example of Cybersphinx, a Virtual Assistant Librarian. Cybersphinx is a fully customizable chatbot that automates librarians' routine and low-level queries. This bot can answer questions such as library hours, location, and special events. While it cannot perform the functions of a research librarian, it does answer frequently asked questions. A virtual assistant librarian has a great deal of customizable flexibility.

Phillips's (2017, p. 2) master's thesis investigates attitudes toward developments in robotics and artificial intelligence in libraries and their impact. The thesis includes literature findings, a survey in which 165 responses were received from 188 people, and the findings of a focus group interview with five people. Although a significant number of the survey participants (75.2%) did not work when the survey was conducted, they had diverse knowledge and experience. The survey also included responses from the USA, New Zealand, Australia, Hungary, the Republic of Congo, Jordan, Cambodia, Jamaica, Guyana, Japan, and Spain. The participants worked in different libraries, such as schools, public libraries, universities, law libraries, and businesses. The study's findings showed that individuals welcomed automation when it helped them eliminate routine, mundane tasks. There were concerns about job losses and concerns that robots and artificial intelligence would not provide the 'human touch' and empathy. Participants also think that many complex query operations performed by library staff cannot yet be automated and require human intervention.

In addition to all the problems listed so far, Massis has pointed to a widespread concern. Massis (2018, p. 456) noted that a new technology's radical and disruptive nature can be perceived as a threat to many institutions, including libraries. However, AI can also offer many positive improvements to library services. Many of these technologies are still being studied, evaluated, and piloted.

Ramanan and Manoj Senthil (2018) provide information about a project on using robots in Library Management Systems. The autonomous robot finds the books and eliminates the librarian's need to search them manually. The robot organizes the bookshelves using sensors and motors, works with the information in the database, and delivers the books to the user. It receives book data from the PC via Zigbee and carries the books using the IR sensor. This system facilitates the organization of the books

and reduces the workload of the library staff. Ramanan and Manoj Senthil (2018, p. 712) stated that the results presented in this project were the beginning of their efforts to build a robot to pick up books and deliver them to the user.

In a report, Nguyen (2019, pp. 1, 19-21) surveyed 10 librarians in public libraries in Queensland, South Australia, and Victoria on their views on using humanoid robots in libraries. The librarians had experience with humanoid robots in their libraries. The researcher also observed five incidents in public libraries where audiences interacted with humanoid robots. According to the research findings, humanoid robots posed new challenges. Despite their advantageous functions, which include alleviating the burden of routine work, communicating with people, providing entertainment, and facilitating socializing, there is a need for more expertise within libraries and among librarians. Librarians did not have sufficient expertise in this regard. In addition, librarians had to deal with new robots alongside their full-time jobs, which led to frustration due to the additional work responsibilities. While humanoid robots help librarians in some tasks, the robots require the librarians to take on multiple roles. In addition to their role as a librarian, they need to be to some extent a robotics expert, an information technology technician, and a teacher. In short, too much is being asked of librarians. The author recommended that public libraries collaborate with other stakeholders, such as local governments and universities, as well as roboticists and robotics centers, in planning the strategic use of humanoid robots and other technologies. These collaborations should also include training in robotics and new technologies. In addition, public libraries and municipal councils should strengthen their relationships with robot vendors to benefit from direct support.

In their study, Vysakh and Rajendra Babu (2019, p. 59) examined how robots could effectively adopt artificial intelligence (AI) in libraries. Many libraries, including the NY Public Library, Temasek Polytechnic Library, UMKC Library, and the University of Chicago Library, have tried this technology and found it efficient. They used robots for book arrangement, sorting, material handling, and inventory operations. Vysakh and Rajendra Babu (2019, pp. 59, 62–63) pointed out that library activities involve much manual work that can be done effectively with the help of robots, either partially or entirely. They also added that the use of AI technologies in Indian libraries was underutilized. They recommended its use as soon as possible for timely and cost-effective service to users.

Another study by Vlachos, Hansen, and Holck (2020, p. 312) identified cultural and technological barriers to the acceptance of robots in libraries, using literature reviews. They conducted the research in Scopus, Web of Science, IEEEExplore, and LISTA databases, complemented by Google searches. The authors identified English-language studies published between 2016 and 2018 that described the use of robots in libraries. Within this framework, they included 18 records in the analysis after screening the title, abstract, and full text of 1037 references according to eligibility criteria. As a result of the research, they summarized the main functions of library robots into three categories: navigation, book finding and placement, serving as information desks, and being used in education. They explained the barriers to robotic acceptance as follows: concern and fear among librarians that robots will replace them, lack of resources (time, money, space) to sustain robot use and the cost of institutional restructuring, sustainability of enthusiasm in this context and users' need for human contact. According to Vlachos, Hansen, and Holck (2020, p. 320), the application of robotics in libraries can be developed in line with internal needs and user demands. Robots can provide autonomous navigation, book retrieval, information desk service, and educational support. However, personnel concerns, inadequate functionality, and lack of resources hinder robot adoption. It is also vital to consider robots in the context of the need for human contact, especially for the elderly and young children.

According to Kaur (2020, s.293), artificial intelligence applications have attracted great interest in libraries and have diversified their services and functions. In particular, robots equipped with human-like cognitive abilities are transforming various library operations, such as the placement of books, lending, and return facilities. Libraries are now taking on a new form shaped by the combination of humans and technology. Robots can perform several main applications in libraries, including automatic sorting of books, placing each returned book in its proper place, quickly meeting user information requests quickly, and innovative shelving operations, facilitating labor-intensive tasks.

The research conducted by Harisanty et al. (2020, pp. 1, 5-6) aimed to develop an innovative robot prototype that libraries can use, to help librarians improve the quality of information services. The robot is purposed to contribute to academic libraries by providing support information and reference services. Artificial intelligence studies are rarely conducted in the library, especially in Indonesia. The research introduces a system that loads frequently asked questions by users into a chatbot. Users can browse topics to select a query or type a keyword directly into the chatbot. The Library Smartbot prototype is in the early stages of developing artificial intelligence for library information services. The mechanism of this system for processing data is still limited in its capacity. It needs to be developed to improve the performance of a more intelligent robot. The work is ongoing. Another dimension is to train library staff in the use of robotic technologies. The management should enhance internet services and ensure that budget allocations are used effectively for library needs.

Martinez-Martin et al. (2021, pp. 1-2) introduce the UJI librarian robot, which is defined as a mobile manipulator that can autonomously find a book in a library and grasp it from its shelf. The robot works with an image-based book recognition technique that combines computer vision to detect labels on book spines and then optical character recognition (OCR) to convert the book code on the labels into text. This system can use the data for library inventory: automatically detecting displaced books and finding a specific book within the library. The robot has been tested in an actual library, and promising results have been obtained. Martinez-Martin et al. (2021) discuss the system's problems and limitations, and its relationship to similar applications such as automated warehouse inventory. The problems and limitations are as follows:

- Complexity of operations: Methods for reading titles on book spines are complex and time-consuming.
- Insufficient detection: The robot may make mistakes because it has difficulty recognizing bookshelves.
- Visibility assumptions: Some methods assume that only one bookshelf is visible, which is not always accurate in actual libraries.
- Physical constraints: Certain conditions are needed for successful book recognition, such as the thickness of the book spine, the distance from the camera to the bookshelf, and the camera orientation.
- Limited success rate, even advanced methods, such as multi-stage frameworks, still face difficulties and do not provide high success rates in correctly recognizing books.

Considering the system's limitations, Martinez-Martin et al. (2021, p. 13) recommend that librarians manually check books with incorrect labels, such as damaged or skinny books. It has been estimated that the system has a success rate of 65%, which will initially reduce costs by 42% in terms of the time of the same operations when performed manually.

Sastry (2023) proposed a design for a library robot that uses the Internet of Things (IoT) to simplify the book organization process in a library. The robot has a [insert number]-degree of freedom arm, IR and ultrasonic sensors, a linear actuator, and a movable base. It can identify a book by its RFID tag, pick it up, and place it on a table. The author wants to make it easier for students and librarians to access the books they need by reducing the labor and time required for book organization in libraries. The robot aims to automate the book collection process, allowing library staff to focus on other tasks. The author believes that IoT technology can create a more efficient and reliable system for managing books in a library.

The findings of a study conducted by Sambo and Oyovwe-Tinuoye (2023, pp. 26, 32) in 2021 using a social survey technique consisting of 452 certified librarians showed that librarians' awareness of the use of robotic technologies in library services was at an average level. Librarians know that innovative tools will increase global recognition and improve library services. However, they face challenges with robotic technologies, such as potential job loss concerns and insufficient funding. Other challenges and concerns for librarians include unstable electricity, lack of service providers, poor IT infrastructure, lack of business expertise, mechanical problems, high maintenance risk, and lack of robotic equipment. The authors recommend that library management explain to librarians that implementing robotic technologies will not lead to layoffs. In addition, these technologies must be

integrated into educational curricula at all levels for national development and a promising future for students. Another dimension is to train library staff in the use of robotic technologies. The management should expand internet service providers and ensure that budget allocations are used effectively for library needs.

Also, a study by Shahzad, Khan, and Iqbal (2024) aims to identify the factors affecting the adoption of robotic technologies in academic libraries, examine the impact of robots on academic library services, and reveal the challenges faced by these applications. The authors examined 16 pioneering studies through a systematic literature review and found that innovation, artificial intelligence advancements, library security, and personalized services positively influenced adoption. They also found that robots provide significant benefits by assuming various roles in libraries, but challenges such as loss of critical thinking, technical issues, and financial barriers hinder their implementation.

Kang, Hwang, and Kwak (2024, pp. 352–354) describe introducing the CollaBot system to provide greater library access. This system provides customized services to users through the collaboration of robots. The study addresses user acceptance of robot types, robot characterization, and prioritization of services provided by the robot. The study included 30 participants, 13 men and 17 women in their twenties and thirties, all of whom were university graduates and had previously worked in library services. The authors discovered that participants preferred product-type robots over anthropomorphic robots across three stages of user evaluation. They also (Kang, Hwang & Kwak, 2024, p. 359) preferred robots that assisted other robots, even when these robots were incompetent, as opposed to robots that only excelled at assigned tasks. Finally, service prioritization varied based on specific limitations or deficiencies encountered by individual users. The study found that participants preferred product-type robots over anthropomorphic robots. Interestingly, while previous research suggests that anthropomorphic robots are viewed as more socially engaging, the study findings showed that product-type robots were perceived as more socially skilled when users observed them without interacting. Additionally, participants rated robots that helped others, even if they occasionally made mistakes, as more intelligent, suggesting that task nature influences acceptability and perceptions of robots.

A pilot study by Cheung et al. (2024, pp. 1–2) in the UK public libraries showed that summer robotics activities increased children's interest in robotics and related careers. The study also highlighted the potential role of libraries in promoting technological literacy. One function of using robots in libraries is to support STEM education. One of the most common approaches in this context is integrating robots into library services and various activities such as summer camps, competitions, and formal classes. One example is Pepper, a social humanoid robot that assists with teaching and storytelling in the children's section of the Mohammed Bin Rashid Library in Dubai. Robotics education offers many advantages, such as promoting active learning pedagogy, critical thinking, and questioning, improving the learning experience, enabling students to acquire new knowledge, developing their creativity, and increasing their interest and engagement in STEM fields.

In a study, Anumula et al. (2024, pp. 587, 589-590) examined the relationship of leading research libraries in the US and Canada with AI. The study found that academic libraries lag in engaging with AI despite its growing importance. According to the authors, only some academic libraries, such as those at Stanford, MIT, the University of Oklahoma, and the University of Rhode Island, are actively exploring AI. However, almost no initiatives have focused on educating library users about AI. There has been no attempt to update existing library standards, such as the Framework for Information Literacy in Higher Education, to address AI-related concerns, including bias and ethics. As a result, the authors conclude that libraries need to embrace AI and take the initiative in this area.

Anand et al. (2024) describe the functions of robots, which they call friendly machines, in libraries. Library assistant robots use RFID technology to help users find books efficiently, saving time and increasing accuracy. They can also retrieve and return books from shelves, reducing pressure on librarians and streamlining operations. By integrating robotics, libraries increase accessibility and service quality, helping individuals with disabilities or mobility issues navigate resources independently.

Indraji, Naikar and Dominic (2024, pp. 3002, 3008) focus on using artificial intelligence and robotic technologies in cataloging, information retrieval, user support, and library maintenance. According to the information provided by the authors, robotic systems stand out due to their interactive and customized user support and improve the overall user experience. Robots support standard and routine tasks such as book retrieval and shelf organization. AI-supported systems manage cataloging processes and increase their efficiency by automating metadata generation and classification. AI algorithms provide users with faster and more accurate access to relevant information. As a result, AI and robotic technologies increase service quality and operational efficiency in libraries. Indraji, Naikar and Dominic (2024, p. 3008) also emphasize the possible obstacles to the widespread use of these technologies. In this context, the most intense concern is that there may be a decrease in data privacy and human interaction .

Sheetal et al., 2024, p. 13, 16 explain in detail the use of robotic systems focused on library management. These technologies aim to optimize the inefficiencies in manual processes such as book sorting, shelving, and inventory management. These systems aim to reduce labor requirements, increase accessibility, minimize errors, and improve the library user experience. The authors also emphasize the need for comprehensive training in this context. Apart from this, robotic systems can also significantly improve accessibility for disabled users.

Rakshith et al. (2024, pp. 167, 175-176) similarly emphasize the facilitating functions of robots in libraries, such as book picking, shelving, and improving user experience. The integrated approach, in which the library will develop software that includes cataloging, monitoring, and user management, aims to simplify library work and enable users to more quickly access the books they want. Rakshith and others specifically address the key benefits of library management robots. These include efficiency through automation of tasks, accuracy in the precise identification and organization of elements by advanced technology, and access to resources and services by users, including those with disabilities. They also include more consistent performance in repetitive tasks than humans, optimization of limited library space for extensive collections, interactive educational experiences, especially for young people, and flexibility to adapt to the unique needs of different libraries

Many authors agree on the benefits of AI and robotics for libraries. These include the prominence of expert systems and customization (Guliciuc et al., 2017; Jayavadivel et al., 2024) and the facilitation and acceleration of routine and repetitive tasks such as shelving, inventory tracking, and record-keeping (Kaur, 2020; Martinez-Martin et al., 2021; Sheetal et al., 2024; Vlachos, Hansen & Holck, 2020); thus saving librarians time and increasing their productivity.

Robots can perform many functions, from technical services such as automatic cataloging and classification (Guliciuc et al., 2017; Indraji, Naikar & Dominic, 2024; Mess, 1991), collection development (Harisanty et al., 2020), acquisition (Guliciuc et al., 2017), and indexing (Guliciuc et al., 2017; Mess, 1991). They can also provide user services including information access and reference services (Guliciuc et al., 2017; Harisanty et al., 2020; Indraji, Naikar & Dominic, 2024; Jayavadivel et al., 2024) as well as handling frequently asked questions (Guliciuc et al., 2017; Harisanty et al., 2020).

The need for training in the integration of robots into the library system and technology literacy is other vital issue that the authors emphasize (Cheung et al., 2024; Nguyen, 2019; Sambo & Oyovwe-Tinuoye, 2023; Vlachos, Hansen, & Holck, 2020). The authors also highlight many challenges and limitations in adopting AI and robots in library systems, mainly due to barriers such as economic anxiety, technological resistance, and fear of losing one's job (Hsiung & Wei, 2013; Sambo & Oyovwe-Tinuoye, 2023; Phillips, 2017; Vlachos, Hansen, & Holck, 2020). Security and privacy concerns are primary concerns for libraries (Indraji, Naikar & Dominic, 2024; Vlachos, Hansen, & Holck, 2020).

The foreign literature review shows a broad consensus on the benefits of AI and robotics in libraries. In addition to utilizing expert systems and customization, the automation of routine tasks enhances librarians' time management and productivity. Robots facilitate library operations by performing many services, such as cataloging, classification, and information access. In this context, the authors also emphasize that various social and structural barriers, such as economic and educational concerns and lack of technological literacy, must be overcome for libraries to benefit most from these technologies.

5. National Literature Review Analysis on the Use of Robots in Libraries

The history of computer use and technology integration into libraries in Turkey dates back to the early 1970s when university libraries began using computers primarily for 'batch' tasks such as serials' union catalogs, acquisition lists, and the like. Current computer use in university libraries is focused primarily on the following operations: serials and books union lists, circulation control, acquisitions, cataloging, and current awareness (Tonta, 1990, p. 73). The transition to automation systems in libraries and studies in this sense began in the 1980s (Özdem, 2013, p. 1; Yılmaz, 1991, p. 215) and with the widespread use of the internet, many automation systems were transferred to the web environment in order to reach more users (Özdem, 2013, p. 1). The transition to automation processes did not occur smoothly.

According to the information provided by Yılmaz (1991, p. 216), the problems encountered in these processes are the lack of standards, the lack of collaborations, and the lack of legal bases in the field of librarianship, the absence of a central organization with legal authority and sanction power regarding automation, the lack of trained personnel, and the language problem. These problems are reminiscent of those experienced in the transition processes to new technologies today. Therefore, one can say that innovations are always challenging.

Küçük and Soydal (2003, p. 144) stated that since digital library and archive applications have just begun in Turkey, it seems possible to disseminate standard-based applications. As can be understood from the authors' statement, digitalization and standardization efforts have been ongoing since the early 2000s.

The support of ANKOS (Consortium of Libraries of Anatolian Universities), a voluntary organization representing university libraries in Turkey; TUBITAK, an organization supporting scientific research; and the EKUAL project, which provides universities with access to electronic resources, is an important initiative that fosters collaboration for the development and digitization of library services and more effective access to important information resources and databases across the country (YÖK, 2014, pp. 1-2).

The report titled "University Libraries in Turkey Towards 2023: Current Situation, Problems, Standards, and Solution Proposals," prepared by the Council of Higher Education (YÖK, 2014), aimed to establish standards that would increase the quality of university libraries by bringing together senior university administrators, library managers, information and records management departments, and relevant NGOs (Non-Governmental Organizations) in a workshop. Another aim of the study was to pave the way for cooperation and projects at national and international levels.

As can be understood from the literature review provided below, the development of information and communication technologies and artificial intelligence in Turkish libraries and the context of librarianship research extends from the automation studies that started in the 1990s to the present day. Despite the difficulties encountered, efforts increasingly focused on maximizing the benefits of artificial intelligence technologies promise to drive continuous innovation.

The content of the national studies evaluated chronologically in the context of the subject, and the analyses made as a result of this introduction are as follows:

Yıldız and Yıldırım (2018, p. 29) emphasize that artificial intelligence improves technical and daily functions, as well as user interaction, in libraries by accelerating them. According to the information provided by the author, as the applicability of artificial intelligence and robotic technologies in areas such as cataloging, classification, documentation, and collection development evolves, their impact on Library and Information Science will also increase significantly.

In his research, Selçuk (2019, pp. 5-6) asked the library managers of 157 universities about the awareness and usage level of artificial intelligence applications in university libraries in Turkey. The results showed that the managers did not have enough information about these applications and primarily obtained this information from the Internet and social media. At the same time, all the participants thought that AI applications in Turkey were insufficiently developed. They thought this was due to the lack of literature, education, and technological literacy. study result is that almost all

managers limit the concept of AI to humanoid robots, which shows the absolute need for awareness and education in this context.

Similarly, a study conducted five years later (Sarıçoban, 2024, p. 88) questioned the awareness of university libraries and librarians in Turkey about artificial intelligence and similar new-generation technologies. The results of the study conducted with library managers from 20 universities across Turkey revealed that library staff do not have sufficient knowledge about artificial intelligence and that training is needed. Sarıçoban (2024, p. 40) emphasizes that integrating robotic applications with artificial intelligence in libraries will facilitate users' access to information, providing automated book transportation, cataloging, and reference services, thus accelerating library processes and creating systems that can produce solutions close to human intelligence.

Öztürk (2020, pp. 76-77) and Öztürk and Özel (2021, p. 362) state that the use of robots for high-volume and repetitive transactions saves labor, and the use of devices such as sensors, barcode readers, GPS, and robotic arms allows for the recording of resources and the rapid transfer of books. Öztürk (2020, p. 77) mentions that robots, which prevent users and librarians from wasting time between shelves, will enable the elderly, disabled, and disadvantaged users to use the library frequently and effectively.

Research conducted by Öztürk (2020, pp. 90-91) and Öztürk and Özel (2021, p. 381) revealed that university librarians' awareness and familiarity with artificial intelligence applications such as expert systems, intelligent agents, natural language processing, pattern recognition, and robotics is low and that they need training for these applications.

Based on the literature, a theoretical study prepared by Sağlam and Çetintaş (2022), addresses the Society 5.0 project, the effects of the digital transformation process, and information services in super-smart societies. The authors question the relationship between artificial intelligence and sustainable development, and the role, and functions of libraries in this context. They refer to the many advantages libraries offer through new technologies, from technical and routine transactions to customization and improvement of user services. According to Sağlam and Çetintaş (2022, p. 101), libraries should address their infrastructure deficiencies as quickly as possible to adapt to new technologies. The use of technology in service delivery will reduce the workload of library staff while saving users time, labor, and costs. The changing understanding of libraries in super-smart societies will expand the user base and increase their social impact.

A comprehensive literature-based study by Kavak (2023, pp. 280, 304) also focuses on the features that combine technology and community 5.0 targets in libraries, and mainly involve predictions. The author argues that technologies such as big data, artificial intelligence, IoT, and AR/VR can be successfully integrated into library services. According to Kavak, libraries should closely monitor technological developments and strengthen their personnel competencies to use these new technologies effectively. In addition, it should further improve personalized services to respond to user needs more quickly and effectively. The author, who has examined the historical evolution of libraries since Web 1.0, reflects the vision of the future library, with its current situation. The Library 5.0 approach, shaped by Society 5.0, will be equipped with chatbot services that can be customized based on artificial intelligence and tailored to the user. The Library 5.0 approach reflects a service model in which technology is used at the most advanced level; user needs are prioritized, focusing on social goals.

Similarly, Sivri (2023), who provides information about the potential power and future of artificial intelligence and robotic technologies in libraries, also explains the practical functions of these systems. In his literature-based study, Sivri (2023, pp. 180-181) gives examples of robot use worldwide, such as the Max Planck Institute, Cologne City Library, Singapore Technology Research Agency, and Oodi Library. Robots support librarians in routine processes such as book recognition, classification, and inventory counting. Sivri (2023, p. 182) states that artificial intelligence and new-generation technologies, which are closely related to lifelong learning, will shape the future of libraries. Therefore, librarians should be trained in these areas.

Some studies question the perception, knowledge, skills, and educational status related to artificial intelligence technologies among librarians working in public and university libraries in Turkey. In his

study, Kavak (2024, pp.227-228) states that chatbots and voice assistants have been integrated into library systems for approximately 10 years as practical applications in library work, to provide personalized services and help users with information search and access. In this context, the author evaluated the perception and status of public library employees. His study showed that employees viewed the technological support of artificial intelligence, such as saving labor and costs, positively. However, they were undecided about possible risks and dangers.

Polat (2024, pp. 628, 630) emphasizes the need for librarians who follow new technologies to cope with the possible destructive or side effects of artificial intelligence, despite its advantages, and have the competencies to incorporate artificial intelligence and robotic technologies into library services. While the author emphasizes the applications for information discovery in library services and the functions of chatbots, he also notes that resistance is likely to be encountered and that change management is important in overcoming this obstacle. The author's research on 117 public librarians in Izmir shows that their artificial intelligence education levels are low and that they need training.

The results of the study conducted by Çuhadar et al. (2024, pp. 412, 418-420) with the participation of 111 university library managers in Turkey revealed that university libraries use artificial intelligence applications superficially and at a limited level. In this context, they need training to develop their knowledge and skills. The authors point out that artificial intelligence applications such as virtual assistants and chatbots facilitate users' interactions with library systems and lighten the workload of library staff by providing quick answers to simple questions. Another important conclusion from the study is that artificial intelligence has gone beyond being a mere innovation for libraries and has become a basic need in the digital age.

In a literature-based study conducted by Ergün (2023), it is emphasized that artificial intelligence has a high potential for use in areas such as data analysis in libraries, automatic metadata creation, multilingual search support, book counting, reference services, and digitalization. The author emphasizes the advantages that artificial intelligence provides in library services, such as automation, accessibility, and improvement of search results, and discusses the difficulties encountered. These issues include technological inadequacies, individuals' adaptation processes, and unemployment concerns. As suggested solutions, emphasis is placed on the training of librarians and support programs. The author also emphasized the necessity of considering the ethical values of professional librarians in artificial intelligence systems. It was concluded that strategies should be developed to ensure the balance between the opportunities and difficulties that artificial intelligence offers to library services.

Çakmak and Eroğlu (2023, pp. 237–238) point out the multidimensional use of artificial intelligence, machine learning, and deep learning in libraries. These are acquisition, cataloging, and classification, metadata and collection management, lending, user services, consulting services, library management information access, and many other areas. The authors used bibliometric analysis and visualization techniques to measure the trend in the international literature on the subject. The study's results revealed how artificial intelligence, machine learning, and deep learning applications are structured in information centers. In this respect, the authors aimed to provide an insight for the applications that can be implemented in information centers in Turkey.

In his research, Torunlar (2023, p. 261) questions the place of the archiving profession, which can sometimes be dismissed as belonging to the past in the new technology-based world evolving into artificial intelligence. According to the author, if this perspective continues, it is impossible for all technological changes, including artificial intelligence, to enter our lives in a healthy manner. Torunlar (2023, p. 289) points out that for the appropriate, and meaningful use of digitalization and artificial intelligence applications, they should be associated with original information and content at the right point to match the appropriate conditions and requirements.

Demir's (2024, pp. 290-291) research, which examines the importance of innovative initiatives, including artificial intelligence technologies for libraries and information centers, also touches on the functions of library robots. These are automatic mobile robot systems using the A-Star Algorithm for shelf arrangement, RFID and mobile robot movement, book transportation, and similar functions that increase the efficiency of librarians and save time by reducing daily workload.

The national literature reviewed on using artificial intelligence and robotics in libraries, shows a broad consensus among researchers on the potential benefits and advantages of these technologies. The literature also revealed significant gaps in knowledge and practice among library professionals in Turkey. Many authors (Ergün, 2023; Sariçoban, 2024; Öztürk, 2020; Öztürk & Özel, 2021; Yıldız & Yıldırım, 2018) agree that artificial intelligence improves technical functions in libraries such as cataloging, classification, documentation, and user interaction. They emphasize that integrating robotic technologies can increase operational efficiency, automate repetitive tasks, and facilitate access to information.

Many studies highlight a significant lack of awareness and knowledge among librarians about AI technologies. Sariçoban (2024), Selçuk (2019), and Öztürk (2020) state that many library staff do not feel ready to use AI and that there is an urgent need for training programs to provide the necessary skills. Çuhadar et al. (2024) and Polat (2024) also support that idea, emphasizing the implementation of training initiatives to reduce knowledge gaps.

Like other researchers, Çuhadar et al. (2024), Kavak (2024), and Öztürk (2020) state that chatbots and other AI applications can improve user interactions and provide efficient library operations. This consensus points out that these technologies complement library functions and are necessary to increase user involvement in the digital environment.

There is a shared recognition among authors, including Sağlam and Çetintaş (2022) and Kavak (2023), about the importance of integrating advanced technologies such as artificial intelligence and the Internet of Things into library services. According to the researchers, libraries are vital in serving as community centers in a digitally transformed society, ensuring sustainable development, and meeting user needs.

The theses prepared in recent years, obtained from the Council of Higher Education Thesis Center (Murat, 2024; Öztürk, 2020; Sariçoban, 2024; Selçuk, 2019), reveal a consensus on the benefits of artificial intelligence, while the common theme is the limited use of artificial intelligence in the context of libraries in Turkey and the need for training in this regard. Murat (2024, p. 5, 48) specifically addressed the context of cataloging in his master's thesis and touched on the problem of inadequate use of artificial intelligence technologies in cataloging services. Regarding library automation, the insufficient competence of library staff is an important problem, and library staff should be subject to training programs to have the necessary knowledge, skills, and experience to adapt to new technologies.

The message of these studies is that although librarians in Turkey have positive attitudes toward AI technologies, their knowledge and literacy levels are low, and their training needs must be met urgently. It is recommended that training programs be developed and resources be enriched to enhance the integration of libraries with AI.

6. Conclusion and Recommendations

Artificial intelligence and robotic technologies, which represent important opportunity for operational efficiency and labor savings in many institutions, also have a transformative effect on libraries. These technologies, which can be functionalized for routine, repetitive tasks that are time-consuming for librarians and more sophisticated, specialized tasks, have become the focus of attention for libraries. This study investigates how artificial intelligence and robot applications in libraries are reflected in literature. The study's results, which extensively and in detail analyze both national and international literature, emphasize the wide range of dimensions and applications of these technologies, from cataloging and classification to interactive user support. In light of the information obtained so far, we can summarize the use of robotic and artificial intelligence technologies in libraries under the following categories, but not limited to them:

- Labor and cost savings: Robots automate repetitive and time-consuming tasks, allowing staff to spend time on more specialized tasks. Although these technologies may be expensive at first, they provide savings in the long run by reducing labor costs. These devices do not include salary, social security, and similar rights required for human employees. The

maintenance costs of these technologies are usually much lower than the investment in human resources.

- Robots can reduce human errors, such as misplacing books on shelves and errors in inventory management.
- Efficiency in technical operations: Robots automate and speed up routine and repetitive operations, such as cataloging, indexing, sorting, shelving, and placement, inventory management, and many other tasks.
- Efficiency in user services: Technologies such as virtual assistants and chatbots can answer user questions, including frequently asked questions. Robots can also be used in consultation services and user communication, taking on socialization and inclusive roles. Autonomous robots can guide users within the library.
- Information access: These technologies provide platforms where users can access resources and the information they need quickly, accurately, and interactively.
- Data Management and Analysis: Provides management and analysis of relational data in many processes, from analysis of user profiles to budget management.
- Collection development: These systems contribute to developing acquisition policies as they effectively determine user preferences and trends.
- Education and Learning Support: Supports the provision of information and artificial intelligence literacy training, including algorithmic literacy, to library users.
- Entertainment Support: Educational functions can be loaded within various games and activities for children and adults.
- Customized services and experiences: AI recommends resources for users' preferences by querying their information search and borrowing history. It can also support learning programs specific to individual's knowledge and skill background. These functions represent the user-centered dimension of AI and robots.
- Service for disabled individuals: Robots can guide them to the sections and/or resources they need within the library. They can also answer questions from these users and provide them with information on topics of interest. Robots and systems integrated with robots can help individuals who are unable to reach the bookshelves.

Both national and international literature have revealed standard views on the advantages of using artificial intelligence and robotics in libraries, as well as some concerns and risks. The issues include the lack of knowledge and skills among employees to use these technologies; fear of disruption of the existing order and losing jobs; the cost of these technologies; concerns about data privacy not being protected; the risk of artificial intelligence being biased and prejudiced; and resistance to change. However, considering that these technologies are still developing, the adoption and implementation of various management strategies, including education, awareness, and responsible, ethical behavior in institutions, will be the antidote to the problems mentioned.

In this context, the recommendations can be summarized as follows, within the framework of related categories, but not limited to them:

- Budget Allocation: Budget constraints are often a common problem for libraries. With good planning regarding their goals and priorities, research grants and sponsorships for infrastructure and maintenance costs, and collaboration with educational institutions and technology providers, libraries can choose the technologies they will provide. In this context, consortial solutions involving other libraries and related organizations are also among the options that can be evaluated. The most important thing is for libraries to convince their affiliated management levels of the long-term cost savings and efficiencies provided by artificial intelligence.
- Ethics and Privacy Issues: Libraries should develop clear ethical policies and guidelines for using AI and robotics. These guidelines should include important information, such as how user data is managed and what measures and regulations are in place to protect it, so that staff and user concerns can be addressed.
- Security Issues: Prioritizing the security of AI and robotic systems to protect user data and prevent cyber threats is another important issue for libraries. Implementing strong

cybersecurity measures such as encryption, secure access controls, regular security audits, and protection against hacking or data breaches is essential. Ensuring the integrity and confidentiality of sensitive information will build trust between users and staff and help prevent malicious attacks that could disrupt library services or compromise personal data.

- **Training Programs for Staff:** Libraries should consider developing comprehensive training programs to increase staff members' technological literacy and skills in using AI and robotic systems. To do this, it is important first to alleviate staff's concerns about AI and robots and also emphasize their usefulness and gain their trust. It is essential to shape the institutional culture in a way that is open to innovation.
- **User Training Programs:** Libraries have deep-rooted knowledge of information literacy education for years. Incorporating artificial intelligence technologies will prepare the infrastructure and educate users in this direction. Interactive education programs for users on artificial intelligence and robotic technologies, as well as the incorporation of user feedback, will ensure user satisfaction and recognition of libraries.
- **Sustainable Management Approach:** Continuous research and supervision on the effects of artificial intelligence and robotics are important in the management policies of libraries. In this context, eliminating possible gaps and/or problems requires sustainable research and supervision. Such an approach will also foster the development of an innovation culture.
- **Collaborations:** Libraries do not have unlimited resources and power. Strong partnerships between libraries and government agencies, NGOs, other libraries, educational institutions, and technology providers can support the effective use of AI and robotics in libraries. These collaborations can create an effective ecosystem by sharing resources, technology, and educational planning processes.

The successful integration of artificial intelligence and robotics technologies into libraries will create a library that meets the requirements of the digital age. A library that meets the needs of such a dynamic and diverse user base will ensure the educational, cultural, social, and intellectual development of individuals and societies.

Compliance with Ethical Standards

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