Optimization Of Digital Library Services Using Artificial Intelligence (AI): Approach To Green Library

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Abstract

Applying artificial intelligence (AI) in digital libraries can enhance operational efficiency and facilitate the implementation of green library concepts. This study aims to explore the potential of AI technology to optimize digital library services and support environmentally friendly principles. The data were gathered through a literature review and an observational study of the implementation of AI in various libraries. The qualitative descriptive approach was used to investigate how AI affects the automation of processes like cataloging and information retrieval and implementing chatbots for user interaction. The study's findings demonstrate that AI, encompassing natural language processing (NLP) search systems and chatbots, enhances the speed and accuracy of services while reducing reliance on printed materials and energy consumption. Furthermore, AI reduces carbon footprints by minimizing the physical storage space and energy consumption required for operations. The findings of this study indicate that the integration of AI in digital libraries not only enhances the efficiency of services but also supports environmental sustainability, making them more environmentally friendly and effective.

Keywords: Digital Libraries, Green Library, Artificial Intelligence (AI)

A. Introduction

A book is not just a collection of words printed on paper. Behind every page lies an infinite world, ideas that drive us, and immeasurable knowledge. Books become a gateway into the human mind, allowing them to meet historical figures, explore imaginary worlds, ponder the meaning of life, or transcend the boundaries of space and time. Every book has a value that cannot be equated with the material value contained within it. Reading books adds knowledge, provides new perspectives, and shapes our thinking.

Shafa Shafina Putri Andita said that by reading books, one can enhance their knowledge and understanding of the world. It is straightforward to express how important this habit is.(Shafina et al., n.d.). Reading is crucial to apply in daily life. Discovering new things can provide additional knowledge and fresh experiences.

Life has been greatly influenced by the advancement of information and computer technology. Organizations leverage technology to help achieve their goals. Libraries utilize technology to facilitate and enhance the effectiveness of information management and dissemination. Library services include circulation, reference, research results, journals, papers, and periodicals, mixed media, web computer stations, security, and procurement facilitated by technology.(Araf Aliwijaya et al., 2023)

A highly relevant theme in the development of information technology and environmental awareness today is how to optimize digital library services through the use

of artificial intelligence. (AI). Libraries are not just places for storing data but also centers of innovation that utilize technology to enhance the accessibility and efficiency of their services. The development of information technology has had a significant impact on life, including the operation of library automation systems. As an organization that serves as a center of information, the Library utilizes technology to ensure efficient and easy management and distribution of information. In addition, libraries today face the challenge of adopting the Green Library concept, which focuses on environmental sustainability and energy efficiency. The Green Library concept emphasizes efforts to reduce the use of natural resources through digitization and carbon footprint reduction, which aligns with the implementation of AI technology in digital libraries (Kesuma et al., 2024).

Green Library aims to integrate environmentally friendly practices into all library operations. This includes reducing paper usage, energy efficiency, and carbon footprint reduction. (Wahdah, 2020). Digital technology, including AI systems, plays an important role in supporting this goal. By leveraging AI for automation and digitization, libraries can reduce the need for physical resources such as paper and ink and decrease energy consumption associated with manual processes.

Artificial intelligence offers various applications that can optimize the user experience in digital libraries. For example, AI can be used to develop more efficient and relevant information search systems quickly. Additionally, the application of AI in catalog management and classification of library materials allows libraries to manage increasingly larger collections more effectively, making it easier for users to search for and access the information they need.

According to Choudhury in Afrizal Zein, artificial intelligence (AI), demonstrated by machines exhibiting human-like intelligence, is increasingly being applied in services and has now become a primary source of innovation (Afrizal Zein, 2021). Artificial intelligence, or AI, has changed many things, including libraries. AI has transformed the way libraries manage information, provide services to users, and manage collections. In libraries, AI can help index, search, and find content as well as enhance the user experience by personalizing their services.

The use of AI in libraries can help reduce the carbon footprint by decreasing the need to print documents and minimizing the physical travel required in information management. For example, AI systems like chatbots can reduce the need for face-to-face interactions and minimize the use of paper for guides or brochures (Prasojo et al., 2024), Thus, the digitization of collections allows for broader access without the need for physical storage that requires space and resources.

Additionally, according to Kresnanto in Restiana and Retno Sayekti, along with the advancement of AI, there is an increasing number of international studies discussing the use and impact of AI on libraries (Restiana et al., 2023). The system known as artificial intelligence (AI) can think and act like humans and is expected to solve problems independently. Librarians can now serve patrons well while still managing data with AI.

The green library approach emphasizes the importance of sustainability in library operations. By integrating AI, libraries can reduce paper and other resource usage, as well as improve energy efficiency through intelligent management systems. This aligns to create a more environmentally friendly and sustainable environment.

In the context of libraries, AI not only helps with operational efficiency but also enriches the services provided to patrons and is an effort to implement environmentally friendly libraries. Although AI brings many benefits, it is important to remember that the role of librarians as information managers remains irreplaceable. Librarians can use AI as a tool to enhance service quality, such as by providing more accurate reading recommendations, quickly answering patrons' questions, and optimizing library collection

management. Therefore, AI and librarians can work synergistically to provide excellent service to patrons, transforming the library into not just an information storage location, but also a center of innovation and knowledge (Kesuma et al., 2024).

Thus, the optimization of digital library services through artificial intelligence and the green library approach not only enhances service quality but also contributes to environmental sustainability, creating adaptive and innovative libraries in the future.

B. Literature Review

Previous studies on the application of Artificial Intelligence (AI) in digital libraries and the implementation of Green Library principles provide important context for this research. Several relevant studies include:

The Use of AI in Library Services

Afrizal Zein explains how artificial intelligence (AI) automates various library services, enhancing operational efficiency and information management. This research shows that AI can optimize cataloging and information retrieval in libraries, contributing to operational efficiency and reducing dependence on printed materials. (Afrizal Zein, 2021).

Integration of AI in the OPAC System

Azzahra and Ramadhani conducted a study on developing a web-based Online Public Access Catalog (OPAC) application that utilizes AI technology. This study demonstrates how AI can enhance the speed and accuracy of information retrieval in libraries, as well as support better information access for users (Azzahra et al., 2020).

Implementation of Chatbots in Library Services

Prasojo et al. analyze the use of Telegram-based chatbots for information and academic services in higher education institutions. This research reveals how chatbots can enhance service efficiency by providing automated responses and reducing the need for face-to-face interactions, which saves library users time and effort (Prasojo et al., 2024).

The Concept of Green Library and Carbon Footprint Reduction

Restiana and Sayekti investigate the trend of AI research in libraries focusing on sustainability and carbon footprint reduction. They found that the use of AI in libraries can support the principles of a green library by reducing reliance on printed materials and minimizing energy consumption (Restiana et al., 2023).

C. Method

In this study, the author applies a qualitative descriptive method. In this case, the research can be conducted through direct or indirect observation. (Literature interviews or online). This approach is in line with Sugiyono's views on qualitative research. In his work, Sugiyono explains that qualitative research is a method based on post-positivist philosophy, used to understand the situation of a natural object. In quantitative research, theory is incorporated into the data and it is decided whether the theory is accepted or not. On the other hand, in qualitative research, researchers start the study with data and use the theory they have developed as a basis to explain the problem and ultimately draw conclusions about the theory. In qualitative research, data is obtained from various sources. Data collection methods vary and are used repeatedly until the data is available. The main data was collected by the researcher (Sugiyono, 2023).

D. Results And Discussion

1. Efficiency of Information Retrieval with AI

In the current digital era, information retrieval has undergone significant transformation thanks to technological advancements, particularly artificial intelligence (AI). AI not only facilitates access to information but also enhances the accuracy and relevance of search results. Information retrieval is the process of searching for the necessary data or knowledge from various sources. With the increasing volume of information available online, traditional methods of information retrieval often prove to be ineffective. This is where AI plays a crucial role, with its ability to analyse data and understand context.

AI technology enables more efficient management of library collections. AI can assist in the cataloguing process, collection monitoring, and usage data analysis. This minimizes the need for manual management in improving the energy efficiency required for library operations. The use of AI in cloud-based systems also reduces the need for physical servers and IT infrastructure that require energy and resources. AI uses technologies such as natural language processing (NLP) and machine learning to enhance the search experience. With NLP, the system can understand and analyse human language, allowing users to search for information more naturally and intuitively (Blog Teknologi Dan Informasi. ", 2023)

Digital libraries are one of the fields where AI shows its potential significantly. With the increasing amount of information sources, digital libraries need to use AI technology to enhance search efficiency. An automated search system that uses AI can search for and display relevant information sources based on the keywords entered by the user. This saves time and effort in finding the needed information (Hamdi Husein, 2024).

AI can also personalize search results based on user profiles and search history. In this way, the system can provide results that are more relevant and tailored to individual needs (Hamdi Husein, 2024). The OPAC system is an important tool in libraries that allows users to search the library's collection online. By using AI technology, the OPAC system can improve the accuracy of search results. AI can analyze previous search patterns and provide better recommendations to users (Perpustakaan Universitas Muhamadiyah Yogyakarta, 2024).

People who need information from the library can use the Online Public Access Catalog (OPAC), a search tool. OPAC not only functions as an online catalog but also serves as a component of information technology that enables access to information retrieval systems (Azzahra et al., 2020). The library has many branches of computer science that can be used. One of them is artificial intelligence.

To maximize the benefits of AI in information retrieval while minimizing its risks, it is important to maintain a balance between the use of technology and traditional search skills. This can be achieved by:

a. Developing manual search skills: Encouraging individuals to continuously hone traditional information search skills, such as using indexes, abstracts, and references.

b. Implementing strong privacy and security policies: Ensuring that there are clear policies to protect user data and prevent the misuse of obtained information.

c. Encouraging critical thinking: Educating users to critically evaluate information, question sources, and understand the limitations of AI in information retrieval.

d. Supporting research and development: Encouraging further research on the responsible and ethical use of AI for information retrieval, as well as the development of appropriate tools and policies.

With a balanced and responsible approach, AI can become a valuable tool for enhancing the efficiency and effectiveness of information retrieval, while still preserving traditional search skills and minimizing associated risks.

In addition, AI also enables real-time monitoring of collections. By using sensors and IoT (Internet of Things) technology, libraries can track the usage of their collections, including the most frequently borrowed books and the borrowing times. This data is very valuable for better decision-making in collection management. For example, if the data shows that a certain book is rarely borrowed, the library can consider replacing or donating the book, or even holding a promotional program to increase interest.

AI-supported usage data analysis also opens new opportunities for libraries to understand user needs and preferences. By analysing borrowing patterns and user behaviour, libraries can adjust their collections and services to be more relevant. For example, if the analysis shows an increase in interest in a certain genre, the library can expand its collection in that area. In addition, AI can help predict future trends, allowing libraries to prepare for changes in user needs.

The field of artificial intelligence related to understanding human language is called natural language processing. Natural Language Processing (NLP) is a field of artificial intelligence that investigates how humans process it when speaking to each other (Araf Aliwijaya et al., 2023). AI algorithms allow users to search for information more quickly and accurately. Technologies such as machine learning and Natural Language Processing (NLP) help in understanding user requests and providing relevant results.

Natural language processing, also known as Natural Language Processing (NLP), is a subfield of artificial intelligence that deals with understanding human language. Translation from one human language to another is one such example. Most of the time, natural language processing is done through translation programs that store a large vocabulary, analyze the word to be translated, and then match it with the correct grammar to produce the translation of the word or sentence (Octaviani et al., 2020).

If related to libraries, the use of artificial intelligence, particularly in the form of software like Google Translate, has significant implications for service and operational efficiency. NLP technology integrated into translation software not only facilitates text translation but can also be used for searching and cataloging library collections. For example, the system can recognize and insert metadata in multiple languages, making it easier for users to find relevant resources in their preferred language.

In reality, there are still many library users who do not understand how to use OPAC. AI technology can provide innovation in this reality, such as creating an OPAC assistant. This can be utilized as a guide in using the Online Public Access Catalog (OPAC), allowing users to easily conduct independent searches without asking librarians and only interacting with the OPAC assistant (Octaviani et al., 2020)

In the context of libraries, information technology and artificial intelligence (AI) have become integral in enhancing efficiency and user experience. The use of word processing programs, spreadsheets, and OPAC demonstrates the early application of information technology, while AI technologies such as Natural Language Processing (NLP) provide the ability to understand and respond to user requests more quickly and accurately. For example, AI translation systems like Google Translate not only facilitate cross-language text translation but can also be applied to the search and cataloging of library collections, allowing users to efficiently find resources in their preferred language. AI innovations like OPAC assistants can also help guide library patrons in conducting self-searches, enhancing information accessibility without reliance on librarians.

It is very important to balance the use of AI technology with traditional search skills because excessive reliance on AI can reduce individuals' ability to search for information manually (Bank Mega, 2023). Although AI offers many advantages in information retrieval, some several challenges and risks need to be considered. The use of AI in information retrieval can pose privacy and data security risks. It is important to have

clear policies to protect user data and ensure that the information obtained is not misused (Hamdi Husein, 2024).

The use of AI in library management can enhance operational efficiency and contribute to environmental sustainability. By reducing dependence on manual management, libraries can decrease energy consumption for daily operations. Additionally, cloud-based systems supported by AI reduce the need for physical servers, which often require cooling and maintenance, thereby reducing the carbon footprint.

Cloud-based systems also allow libraries to access resources more flexibly, without having to invest in expensive physical infrastructure. By shifting most operations to the cloud, libraries can optimize resource usage and reduce operational costs. This is not only economically beneficial but also supports broader sustainability goals.

2. The Use of AI-Based Chatbots or Virtual Assistants

The advancement of Artificial Intelligence (AI) technology has resulted in significant changes in various aspects of life, including in the field of libraries. One of the increasingly popular applications of AI is the use of chatbots or virtual assistants in libraries. AI-based chatbots enable libraries to provide more efficient, interactive, and responsive services for patrons.

According to S. Sannikova in Bagus Prasojo et al., a chatbot is defined as computer software that uses artificial intelligence to mimic human conversation (Prasojo et al., 2024). Although chatbots usually interact with humans nowadays, new applications can also communicate with each other. The WhatsApp and Telegram chat applications are the most popular among users. Although it may seem trivial, this usage will save the user's time and energy.

However, communicating through chat services like WhatsApp and Telegram with such an outdated system might be very inconvenient for obtaining the information you need. Consumers in the modern world need precise and quick results. As a result, you need a program or system that can automatically answer library users' questions accurately, such as the Telegram Chatbot.
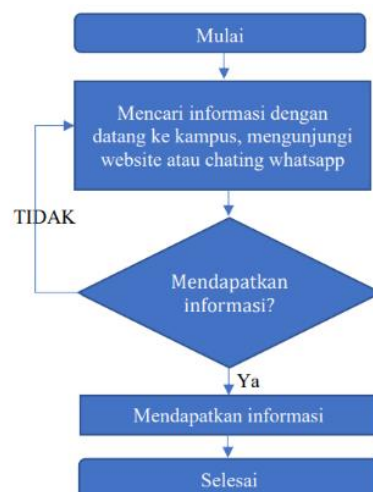

Figure 1. Library User Scheme Without Using a Chatbot

Among Telegram chatbots, the company offers a free tool called Botfather. Telegram has many advantages as a chatbot platform, including its wide availability, compatibility with various social media platforms, and its API that makes creating chatbot applications easier. Python and the Python IDLE environment are used on the server where the bot is run. This chatbot has many aspects that support the IF-THEN logic. (Prasojo et al., 2024)
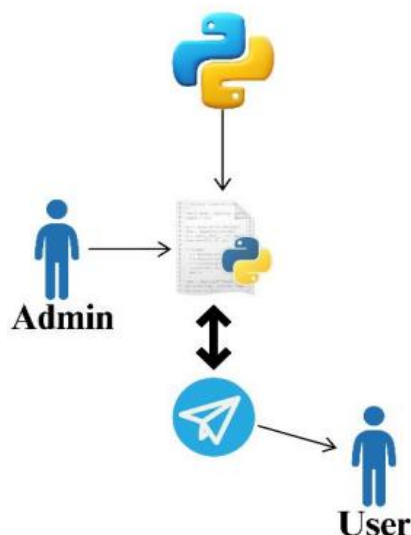
Figure 2. User Scheme When Using a Chatbo

Chatbots are very helpful for library users in terms of saving time. Chat applications like WhatsApp and Telegram, which are widely used today, can save library users time and effort with the implementation of chatbots. However, communicating through conventional chat services may still be considered cumbersome by some users. Therefore, the implementation of a chatbot on Telegram supported by free tools like Botfather becomes the ideal solution. The advantages of Telegram as a chatbot platform include wide availability, compatibility with many social media, and an API that facilitates development. Chatbots run on servers using Python can provide quick and accurate responses, meeting the needs of increasingly tech-savvy consumers who desire efficient results.

The implementation of a Telegram-based chatbot is a strategic step, considering the popularity of this application among students. Telegram is known as a secure and user-friendly platform, allowing users to easily access library services through an application they are already familiar with. This integration also allows the library to reach a wider audience, as many students actively use Telegram for communication. By utilizing existing platforms, libraries can reduce the costs of developing and maintaining new systems. A catboat integrated with Telegram can be quickly adopted by users, which in turn can increase the usage of library services.

Benefits of using AI chatbots in libraries:

a. More Effective Virtual Reference Services

AI chatbots can help library users find relevant information quickly and accurately. They can answer general questions, provide book recommendations, and direct users to the appropriate resources (Universitas Diponegoro, 2023).

b. 24/7 Access and Interactive Experience

The AI chatbot is available 24 hours a day, 7 days a week, providing instant access to library information whenever needed. Interactions with the chatbot are also more interactive and enjoyable for library users (Dera Mutia Azizah, 2024).

c. Service Efficiency

AI chatbots can help lighten the workload of librarians by handling basic questions and routine tasks. This allows librarians to focus on more complex services and build more personal relationships with patrons (Araf Aliwijaya et al., 2023).

d. Personalization of Recommendations

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AI chatbots can provide personalized book and resource recommendations based on the preferences and history of the library users. This helps users find reading materials that match their interests. (Invosights, 2023).

Although there are many benefits offered, the implementation of chatbots in library services faces challenges. The main challenge is the need to develop and maintain an effective chatbot system. The chatbot must be continuously updated with the latest information and be able to handle various questions that users may ask.

Additionally, there is also the challenge of ensuring that the chatbot can understand the different variations of questions posed by users. Although NLP technology has advanced rapidly, there is still a possibility that chatbots cannot provide satisfactory answers to all questions. Therefore, it is important to have a backup system where users can contact a librarian if the chatbot cannot provide an adequate answer.

The use of AI chatbots in libraries will continue to grow with technological advancements. Some trends and future potential of AI chatbots in libraries. AI chatbots will be integrated with more advanced AI technologies such as natural language processing, machine learning, and computer vision. This will enhance their ability to understand and respond to patrons better (Araf Aliwijaya et al., 2023).

AI chatbots will be equipped with multimodal capabilities, allowing interaction through various channels such as voice, images, and video. Their interfaces will also become more intuitive and user-friendly. AI chatbots will increasingly be able to understand the preferences and individual needs of library users. They will provide recommendations and services that are truly tailored to each patron (Invosights, 2023).

AI chatbots will work more closely with librarians, assisting them with routine tasks and allowing librarians to focus on more complex and personalized services. In conclusion, the use of AI chatbots in libraries brings many benefits such as more effective virtual reference services, 24/7 access, service efficiency, and personalized recommendations. However, its implementation also faces challenges such as data security, technological limitations, user acceptance, and costs. AI chatbots can be integrated with various library services to enhance efficiency and user experience. In the future, AI chatbots will become more sophisticated, multimodal, and integrated with librarians, bringing libraries into a new era of smarter and more personalized services.

3. AI & Chat Bot Search is a Concept of Green Library

The Green Library concept focuses on sustainability and efficiency in library resource management. In the digital era, the implementation of technologies such as artificial intelligence (AI) and chatbots has become important to enhance library services. This technology not only helps in information management but also supports environmentally friendly practices by reducing the need for physical resources.

AI-based chatbots are used to provide faster and more efficient reference services. They can answer general questions, provide information about collections, and help users find relevant resources. For example, the chatbot at San Jose State University that helps answer questions related to circulation and reference services (Universitas Diponegoro, 2023).

NLP technology enables chatbots to better understand and process user questions. This increases the accuracy and relevance of the answers provided, thereby enhancing the user experience in searching for information. By adopting chatbots, libraries can reduce the use of paper and other physical resources. Chatbots can operate 24/7, providing better access to information without the need for additional staff, thereby reducing the library's carbon footprint (Universitas Diponegoro, 2023).

The application of Artificial Intelligence (AI) technology and chatbots in the context of libraries has become one of the main innovations in the implementation of the

green library concept. The green library concept emphasizes environmentally friendly practices to reduce ecological impact and improve operational efficiency. AI and chatbots contribute significantly in this regard by offering solutions that support the library's environmental sustainability goals.

Benefits of Implementing AI and Chatbots

1. Information Accessibility: Users can access information anytime and anywhere, thereby increasing user engagement and satisfaction.

2. Reduction of Staff Workload: With the chatbot handling routine inquiries, library staff can focus on more complex and strategic tasks.

3. Improvement of User Interaction: The chatbot can provide a better interactive experience, encouraging users to be more active in seeking information.

Although there are many benefits offered, the implementation of the Green Library concept and AI technology also faces several challenges. Some of the challenges that may be encountered include:

1. Implementation Cost

The initial investment to build environmentally friendly infrastructure and implement AI technology can be very high. Many libraries, especially in areas with limited budgets, may struggle to meet these costs.

2. Limited Knowledge and Skills

Not all librarians possess the knowledge and skills required to implement AI technology and Green Library principles. Therefore, training and education for librarians are crucial to ensure successful implementation.

3. Resistance to Change

Changes in the way libraries operate and are managed often face resistance from staff and users. Building awareness and understanding of the benefits of Green Library and AI technology is crucial to overcoming this challenge.

AI, including chatbots, plays an important role in automating various administrative tasks in libraries. Chatbots can handle questions and information requests automatically, reducing the need for face-to-face interactions and the expenditure on printed materials such as brochures and user guides (Pongtambing Yulita Sirinti, 2023). By reducing dependence on physical documents, libraries can decrease paper and ink consumption, which is an important step in reducing the carbon footprint.

AI technology enables more efficient management of library collections. AI can assist in the cataloging process, collection monitoring, and usage data analysis. This minimizes the need for manual management and increases the energy efficiency required for library operations (Devianto et al., 2020). The use of AI in cloud-based systems also reduces the need for physical servers and IT infrastructure that require energy and resources.

By utilizing chatbots and AI systems, libraries can provide broader and easier access to information without the need for physical travel to the library location. This reduces carbon emissions related to transportation and travel, as well as the need for physical storage space for collections. (Prasojo et al., 2024). This system can also provide 24/7 service, allowing users to access information anytime without operational time restrictions.

AI can help optimize energy use in libraries by automatically adjusting lighting and air conditioning systems based on actual usage data and needs (Restiana et al., 2023). This system supports green library practices by reducing energy consumption and minimizing the environmental impact of library operations.

One of the other benefits of implementing AI in libraries is the enhancement of user experience. With AI-supported recommendation systems, libraries can provide more personalized suggestions to patrons based on their preferences and borrowing behavior. This not only increases user satisfaction but also encourages them to explore a wider collection.

Chatbots and virtual assistants powered by AI also make it easier for users to access information. Users can ask questions and get instant answers without having to wait for library staff. This is very useful in situations where users need quick assistance, such as when searching for information for research or school assignments.

The concept of a Green Library and carbon footprint reduction is becoming increasingly important in the context of climate change and sustainability. The application of AI technology in libraries can support the principles of a Green Library by reducing dependence on printed materials, increasing operational efficiency, and reducing the carbon footprint. Although there are challenges in its implementation, the long-term benefits of the Green Library and the use of AI in libraries are very significant. With collaboration between librarians, library managers, and users, libraries can become agents of change in sustainability and environmental preservation efforts

E. Conclusion

This research highlights the importance of artificial intelligence (AI) innovation in enhancing the efficiency of digital library services, as well as its application in the context of green libraries. Along with the development of information technology, libraries face new challenges and opportunities in their efforts to improve operational efficiency and environmental sustainability.

The use of AI in digital libraries has proven significant in optimizing information management processes and user interactions. Systems like the Online Public Access Catalog (OPAC) integrated with AI technology, including Natural Language Processing (NLP), help in faster and more accurate information retrieval and access. Chatbots and AI-based virtual assistants also contribute to saving time and effort, as well as enhancing user satisfaction by providing 24/7 services without relying on face-to-face interactions.

In the context of a green library, AI plays a crucial role in supporting environmentally friendly practices. By reducing reliance on printed materials and minimizing the need for physical storage space, AI helps libraries reduce their carbon footprint. In addition, AI technology also supports more efficient energy management through lighting and air conditioning automation systems.

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