AI-Powered Revolution: Automating Information Management in Libraries

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ABSTRACT

Artificial Intelligence (AI) is revolutionizing library operations by streamlining cataloguing, enhancing search functionalities, and optimizing resource allocation. This paper explores the impact of AI on library operations, focusing on information management. AI streamlines cataloguing, enhances search functionalities, and optimizes resource allocation. It also plays a role in user experiences, enabling data-driven decision-making and addressing information overload challenges. The proposed system automates librarian and user tasks, simplifies book searches, locates paths within the library, and streamlines interactions. The paper highlights the importance of understanding AI technologies for progress in intelligent systems and the potential for AI to revolutionize libraries by creating a more efficient, accessible, and responsive information ecosystem.

Keywords: *Artificial Intelligence, Automation, Libraries, Information Management*

1. INTRODUCTION

Artificial intelligence (AI) encompasses a broad spectrum of research domains including but

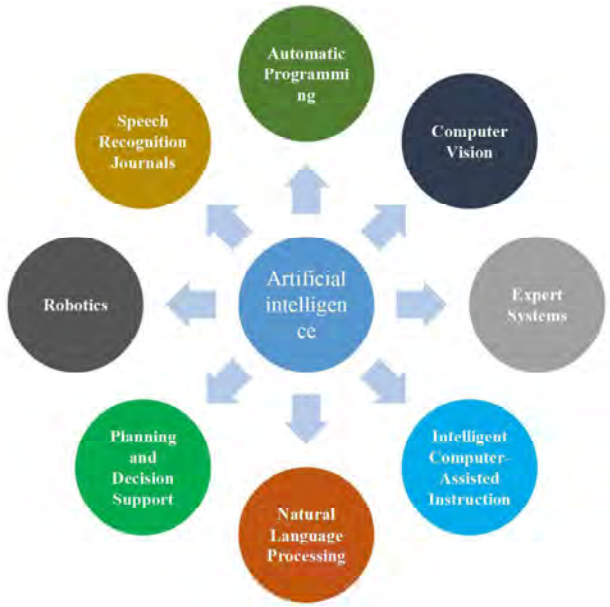

Figure 1: Research Domain of AI

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not limited to: (a) Automatic Programming, (b) Computer Vision, (c) Expert Systems, (d) Intelligent Computer-Assisted Instruction, (e) Natural Language Processing, (f) Planning and Decision Support, (g) Robotics and (h) Speech Recognition. (see fig. 1). Intelligent library systems leverage AI technologies to deliver knowledge-based services to both library patrons and staff.

Libraries have issues in maintaining huge volumes of material while providing customers with seamless access in the internet age. To satisfy these demands, libraries are being automated using cutting-edge technology. Artificial intelligence (AI) is one of many revolutionary forces that have the potential to improve library operations and user experiences. The use of AI in library automation encompasses a variety of services. It improves cataloguing and provides AI-driven recommendation systems, hence increasing user engagement, similar to collection management. AI adoption poses hurdles, ranging from technological complications to ethical implications. The Use of Artificial Intelligence in Library Automation. examines AI uses, user viewpoints, and ethical concerns. It seeks to provide insights into how AI might improve library services while also addressing possible problems. Libraries may employ AI to make more informed choices, increasing their ability to successfully serve people in the digital era. AI integration in library automation promises to elevate libraries as knowledge centers, providing users with frictionless access to information.

As science and technology continue to rapidly advance, artificial intelligence (AI) is increasingly integrated into various aspects of our daily lives, catalysing societal development. Broadly speaking, AI encompasses intricate computational processes, logical reasoning, knowledge acquisition, intelligent retrieval, information recognition, and voice recognition. These advancements are fuelled by rapid progress in Internet, computer, and Internet of Things technologies (Yan, 2019; Xu, 2020).

A competent librarian, by engaging with a user, may give a significantly more specialized service, perhaps eating up time saved by AI. - IFLA Library Policy and Advocacy Blog.

2. OBJECTIVES

i) To undertake a thorough examination of library automation, including identifying flaws in conventional library systems and successfully managing data and services in the digital world.
ii) To explore and assess the use of artificial intelligence in library automation, collection management, cataloguing, user services, and data analytics, make appropriate suggestions, and comprehend their potential, effect, and efficiency.
iii) To understand the benefits and drawbacks of incorporating AI into library operations, with an emphasis on operational efficiency, user-centric experiences, cost-benefit analysis, and long-term viability.
iv) To learn about the experiences of librarians, library personnel, and users in using AI in libraries via a mix of surveys and interviews.
v) To find and assess successful case studies and best practices from libraries that have deployed and effectively used AI-driven automation technology.
vi) To investigate the ethical and privacy aspects of AI in libraries, as well as to produce comprehensive guidelines and recommendations for AI deployment that address possible concerns such as data privacy, algorithmic prejudice, and the role of human librarians.

Contribute significantly to the current body of knowledge on harnessing cutting-edge technology, especially AI, to improve library services and reinforce information institutions, so enabling their efficient functioning in the modern technological environment.

3. CHALLENGES

Libraries have traditionally acted as repository of comprehensive knowledge, catering to persons seeking information, research materials, and amusement. However, as the world becomes more computerized and networked, conventional library systems need assistance in organizing and giving seamless access to the large amount of accessible information. To address these challenges, libraries have started to use automation and information technology, with Artificial Intelligence (AI) emerging as a disruptive solution. The main problem is understanding the function of artificial intelligence in library automation and its influence on improving library services. Despite AI's potential advantages, incorporating AI technologies into library operations presents various complications and uncertainties:

3.1. AI in Library Automation: Challenges and Implications

i) **Integration Challenges:** AI systems in library automation require seamless integration with existing infrastructure and operations. Questions arise about compatibility with older systems and resources needed for effective application.
ii) **User Experience:** AI-driven automation can improve user experiences but privacy preservation and understanding user preferences raise ethical concerns.
iii) **Expertise and Training:** Successful AI integration requires staff competency in AI technology, requiring adequate training and upskilling opportunities.
iv) **Cost and Sustainability:** Smaller and underfunded libraries may face cost limits when implementing AI technology. Evaluating AI deployments' cost-effectiveness and long-term viability is crucial.
v) **Ethical Considerations:** Use of AI in libraries raises ethical concerns about data privacy, algorithmic prejudice, and the influence on human librarians' duties and job security.
vi) **Ethical Considerations and Data Privacy**: Libraries must develop explicit rules and procedures for data collection, storage, and processing to ensure compliance with privacy requirements and ethical standards.
vii) **Algorithmic Prejudice and Fairness:** Libraries must address algorithmic bias and fairness problems, including bias detection and mitigation measures, evaluating AI systems for justice and equality, and encouraging diversity and inclusion in dataset curation and algorithm design.
viii) **User Trust and Acceptance**: Libraries must interact with stakeholders to gather input, resolve issues, and reach an agreement on AI deployment tactics.

4. AI IMPLEMENTATION IN LIBRARIES

Implementing AI in libraries involves overcoming technical challenges, ensuring legal compliance, addressing scalability and interoperability, providing user training, fostering collaboration, and conducting evaluation studies. See figure 2, for an overview.

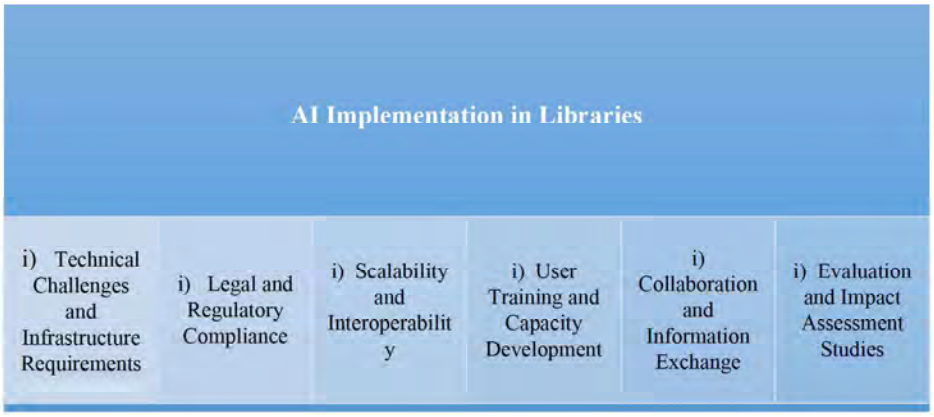

Figure 2: Overview of Key Considerations in AI Implementation in Libraries

i) Technical Challenges and Infrastructure Requirements

- High-performance computer resources, scalable storage systems, and reliable network access are essential for AI technology implementation.
- Libraries must upgrade their IT infrastructure, identify gaps, and modernize systems to support AI deployment.
- Cloud-based solutions and Software-as-a-Service (SaaS) platforms offer scalable and cost-effective access to AI tools and services.
- Collaboration with external partners can provide specialized experience and resources to overcome technical barriers.

ii) Legal and Regulatory Compliance

- Libraries must comply with intellectual property rules, copyright restrictions, and data protection legislation.
- Legal counsel and privacy specialists can help navigate these legal and regulatory hurdles while adhering to responsible data management and governance.

iii) Scalability and Interoperability

- Libraries must address scalability and interoperability needs to ensure smooth integration and compatibility with current systems.
- Open standards and interoperability frameworks can improve data sharing and interoperability across systems and platforms.
- Scalable and modular architectural designs provide flexible deployment choices.

iv) User Training and Capacity Development

- Libraries should engage in user training and capacity development efforts to provide knowledge and skills for proper AI interaction.
- User-centered design concepts and usability testing procedures ensure AI-powered systems are intuitive, accessible, and user-friendly.

v) Collaboration and Information Exchange

- Libraries should collaborate with academic institutions, research organizations, and industry partners to create AI solutions.
- Participation in professional societies, conferences, and seminars allows libraries to network and stay updated on AI research and applications.

vi) Evaluation and Impact Assessment Studies

- Comprehensive evaluation and impact assessment studies are necessary to determine the efficacy, efficiency, and influence of AI-powered systems on library operations.

Addressing these problems and uncertainties is critical for realizing AI's full promise in library automation. Thus, the purpose of this study is to investigate, analyse, and give insights into the role of artificial intelligence in library automation, as well as its consequences for library services. This research will provide vital information to help libraries make educated choices on AI integration, boosting their capacity to serve people successfully in the digital age.

5. APPLICATION OF AI IN LIBRARIES

i) **Cataloguing and Metadata Enhancement:** Artificial intelligence can help in cataloguing and organizing library materials by automatically tagging, categorizing, and improving metadata. Users may now search for and retrieve information more efficiently.

ii) **Recommendation Systems:** AI-powered recommendation engines may propose appropriate books, articles, or resources based on user preferences, borrowing history, and behaviour, so improving user experience and engagement.

iii) **Natural Language Processing (NLP) for inquiries:** NLP methods help libraries comprehend and react to natural language inquiries. Users may utilize AI-powered chatbots or virtual assistants to navigate the library, access materials, and get tailored suggestions.

iv) **Predictive Analytics for Collection Development:** AI algorithms may use consumption patterns, trends, and demand to forecast future resource requirements. This allows libraries to optimize their collections by collecting resources that are expected to be in high demand.

v) **Improved Accessibility Services:** AI technology may improve accessibility by transforming texts into different forms (audio, braille, etc.) and supporting people with impairments in efficiently accessing and browsing library resources.

vi) **Preservation & Conservation:** AI can help digitize and preserve delicate or uncommon items using technologies such as picture recognition and restoration, providing long-term access to precious resources.

vii) **Workflow Optimization:** Artificial intelligence-powered solutions can automate mundane processes like inventory management, scheduling, and resource allocation, freeing up human resources for more complicated and specialized services.

viii) **Content Curation and screening:** AI may help with content curation by screening out irrelevant or low-quality materials, ensuring that the library collection maintains high levels of information quality.

ix) **Cybersecurity and Data Protection:** AI technologies may help libraries improve their cybersecurity procedures by recognizing and mitigating possible attacks while also protecting sensitive user data and library resources.
x) **Learning and Training Support:** AI-powered educational solutions may help patrons and staff by providing individualized learning routes, tutorials, and training materials based on their specific requirements and learning styles.

These examples highlight the many ways AI may transform information management in libraries, eventually improving user experiences and maximizing library services.

Artificial intelligence (AI) has found extensive utility in library information services, encompassing various applications such as:

i) Employing optical character recognition (OCR) for automatic cataloguing and categorization, as noted by Picard & Pentland (1996).
ii) Utilizing natural language processing (NLP) for automatic translation of foreign language resources, as demonstrated by Ragab et al. (2022).
iii) Implementing Expert Systems for automatic indexing, as highlighted by Arif et al. (2019).
iv) Facilitating the retrieval of audiovisual content through optical character recognition and speech recognition, enabling swift access to music and photographs in library collections alongside printed materials, thereby enhancing information storage and management, as discussed by Wactlar et al. (1999).
v) Offering interactive bibliographic education through diverse mediums, as observed by Samuel & Williams (2020).
vi) Serving as intelligent gateways to internet sources, as articulated by Hobohm (2018).
vii) Creating user-structured information environments, as suggested by Okunlaya et al. (2022).
viii) Providing portable computer reader services tailored for individuals with disabilities, as highlighted by Hamad et al. (2023).
ix) Delivering Intelligent Document Delivery Services (DDS), as outlined by Park et al. (2021).

These applications demonstrate how intelligent library systems leverage artificial intelligence technology.

6. IMPACT OF AI IN LIBRARIES

i) **Information professionals:** They are the first to be impacted. It improves the accuracy and efficiency of information and retrieval, allowing users to access relevant resources. (Makri et al., 2022).
ii) **Library operations** are being combined with robotic procedures, automation, and smart technology to properly manage resources. (Harper et al., 2021).
iii) **User Services:** Artificial intelligence has transformed the way people access information, engage with library resources, and get help. Some important implications include improved search, 24/7 availability, user recommendations, resource access, data analysis, and so on. (Samuel & Williams, 2020).
iv) **Data and AI literacy:** Libraries develop to include the essential technologies. The personnel must understand how to utilize the AL. They aid users in obtaining and changing data, developing resources, providing technical support and assistance, ensuring ethical behaviour, and doing research. (Hobohm, 2018).
v) **Library Analytics:** The systematic analysis of data acquired from diverse sources allows them to make choices and enhance library services. There are five important components of applying age metrics: user behaviour analysis, collection creation, decision assistance, and library evaluation and improvement. (Hobohm, 2018).

7. AI IN LIBRARIES: TRANSFORM SERVICES AND OPERATIONAL EFFICIENCY

Implementing AI in libraries revolutionizes services by automating cataloguing and classification processes, enhancing user discovery and access, and improving operational efficiency. See figure 3, for a visual representation of how AI transforms library services.

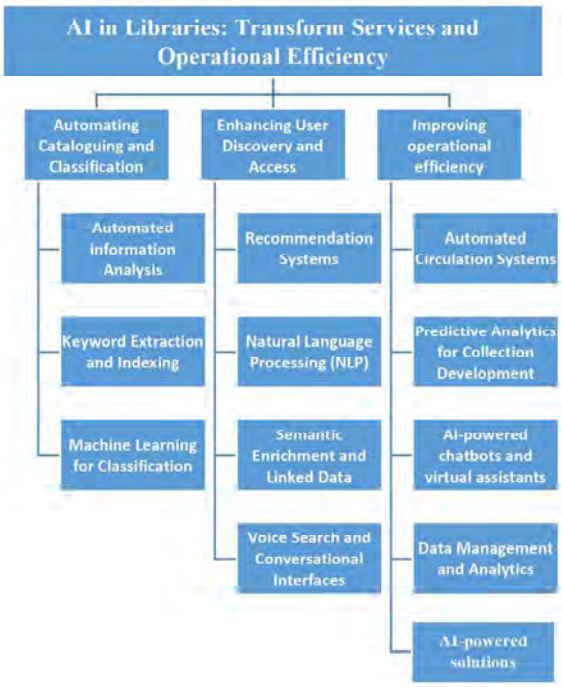

Figure 3: AI in Libraries: Transforming Services and Operational Efficiency.

7.1. Automating Cataloguing and Classification

The amount of information accessible to libraries has expanded tremendously in the digital era, making it difficult to efficiently organize and classify resources. AI-powered solutions show promise for automating cataloguing and categorization operations, optimizing workflows, and increasing library collection accessibility. (Wactlar et al., 1999)

i) **Automated information Analysis:** Artificial intelligence systems can automatically extract useful information from textual material such as book titles, abstracts, and topic headers. Natural Language Processing (NLP) approaches enable computers to grasp and interpret text's semantic meaning, allowing for more accurate metadata extraction. Libraries may speed up the cataloguing process and maintain uniform metadata quality throughout their holdings by automating the analysis. (Ragab et al., 2022)

ii) **Keyword Extraction and Indexing:** Machine learning models may be taught to recognize keywords and ideas inside text texts, allowing for automatic indexing and categorization. AI algorithms may improve discoverability and searchability by assigning relevant topic headers, keywords, and tags to books, articles, and other materials after assessing their content. Keyword extraction approaches, such as Term Frequency-Inverse Document Frequency (TF-IDF) analysis and word embeddings, allow computers to recognize important words and phrases related to the content's subject matter. (Arif et al., 2019)

iii) **Machine Learning for Classification:** Supervised machine learning algorithms may use labelled training data to categorize library materials into predetermined categories or topic areas. Librarians may train machine learning models using current cataloguing procedures and metadata standards, enabling computers to automatically classify new resources. Libraries may use machine learning for categorization to decrease human work, assure consistency in cataloguing methods, and improve collection management. (Picard & Pentland, 1996)

iv) **AI-powered solutions:** AI-powered solutions may help with quality assurance and mistake detection in library catalogues. Machine learning algorithms may detect inconsistencies, errors, and missing information in metadata entries and mark them for inspection by library personnel. Libraries may maintain high standards of data integrity and correctness in their catalogues by

automating quality assurance operations, which improves search result dependability and customer happiness. (Arif et al., 2019)

7.2. Enhancing User Discovery and Access

In the digital era, people demand easy access to information resources as well as customized suggestions based on their interests and preferences. AI technologies provide novel solutions for boosting user discovery and access in libraries, hence improving overall user experience and engagement. (Samuel & Williams, 2020)

i) **Recommendation Systems:** AI-powered recommendation systems leverage user behaviour, preferences, and previous interactions with library materials to provide tailored suggestions. Collaborative filtering algorithms employ user profiles and item similarities to recommend books, articles, and other items that fit the user's interests. Content-based filtering approaches employ metadata and content attributes to propose resources based on their relevance to the user's preferences. Libraries may improve user happiness, encourage serendipitous discovery, and boost engagement with their resources by providing tailored suggestions. (Makri et al., 2022)

ii) **Natural Language Processing (NLP):** approaches provide sophisticated search capabilities in library catalogues by enabling users to engage with the system via natural language queries. NLP systems analyse user queries, extract key phrases, and provide meaningful search results based on semantic similarity and contextual relevance. Understanding the meaning and purpose underlying user searches enables NLP-powered search engines to increase the accuracy and precision of search results, allowing users to get the information they need more effectively. (Ragab et al., 2022)

iii) **Semantic Enrichment and Linked Data:** AI technology may enhance library metadata with semantic annotations and linked data, improving interoperability and discoverability. Semantic enrichment algorithms examine textual material and metadata to discover entities, ideas, and connections, then supplement metadata records with contextual information. Libraries may use linked data principles to connect their catalogues to external knowledge graphs and ontologies, allowing for seamless integration with other data sources while also improving cross-referencing and navigation capabilities. Libraries may increase the visibility and accessibility of their collections by implementing semantic enrichment and linked data practices, allowing users to better locate relevant materials and explore interlinked subjects. (Okunlaya et al., 2022)

iv) **Voice Search and Conversational Interfaces:** Voice-enabled search and conversational interfaces use voice recognition and natural language understanding technology to provide hands-free interaction with library catalogues. Users may audibly express their search queries or preferences, and AI-powered voice assistants can comprehend and process them in real time. Voice search interfaces make it easier and more accessible for users to browse library resources, especially those with visual or movement disabilities. Libraries that offer voice search and conversational interfaces may improve accessibility, inclusiveness, and usefulness for all users, regardless of technical skill or physical limitations. (Park et al., 2021)

7.3. Improving Operational Efficiency

In addition to boosting user experiences, AI technologies have the ability to improve operational efficiency and streamline internal operations in libraries. AI-powered solutions may help libraries increase productivity, save costs, and better distribute resources by automating repetitive operations, optimizing resource allocation, and improving decision-making processes. (Harper et al., 2021)

i) **Automated Circulation Systems**: AI-powered circulation systems automate the handling of library items such as book loans, renewals, returns, and holds. Machine learning algorithms can use previous circulation data to forecast demand, improve inventory levels, and automate reordering operations for popular items. Automated circulation systems may also identify irregularities, such as overdue goods or lost volumes, and notify library personnel to take appropriate action. By automating typical circulation procedures, libraries may improve service efficiency, minimize administrative stress, and increase customer satisfaction. (Samuel & Williams, 2020)

ii) **Predictive Analytics for Collection Development:** Libraries may utilize predictive analytics approaches to estimate user demand, evaluate collection use trends, and make data-driven resource purchase and deselection choices. Machine learning algorithms may leverage circulation data, user preferences, and demographic information to discover trends, predict future demands, and improve collection development methods. Predictive analytics algorithms may also propose content for purchase based on their expected popularity, relevance, and effect. Libraries that employ predictive analytics for collection creation may optimize resource allocation, increase collection value, and assure alignment with user requirements and preferences. (Makri et al., 2022)

iii) **AI-powered chatbots and virtual assistants:** provide automated help and support to library patrons by answering questions, delivering information, and directing them through library services and resources. Natural Language Processing (NLP) technologies allow chatbots to interpret and reply to user questions in real time, offering tailored suggestions, search aid, and procedural instruction. Chatbots may also help with interactive communication, gathering customer input, and collecting statistics to enhance service quality and satisfaction. Libraries may increase service hours, improve customer support, and provide customized help on a large scale by introducing AI-powered chatbots and virtual assistants. (Samuel & Williams, 2020) (Panda & Chakravarty, 2022)

iv) **Data Management and Analytics:** AI technology may help libraries manage and analyse data more effectively, allowing for data-driven decision-making and performance improvement. Machine learning algorithms can evaluate enormous amounts of library data, such as circulation records, use statistics, and user comments, to extract insights, detect patterns, and provide meaningful suggestions. Data visualization tools and dashboards provide user-friendly interfaces for viewing and analysing library analytics, allowing stakeholders to monitor performance, track key performance indicators, and discover areas for improvement. Libraries may improve operational efficiency, optimise resource allocation, and adapt their services to changing customer demands and preferences by using data management and analytics. (Hobohm, 2018)

8. CASE STUDIES

i) **Singapore National Library Board (NLB):** The NLB used AI-powered Chatbots to improve the user experience and aid users in accessing materials, navigating the library catalogue, and offering real-time support with queries.

ii) **University of Oklahoma Libraries:** This institution used AI algorithms to improve cataloguing operations, metadata correctness, and information retrieval for its vast academic resources.

iii) **The New York Public Library (NYPL)** used machine learning algorithms to assess borrowing habits and user preferences, allowing users to get tailored suggestions for books, events, and services.

iv) **Bibliothèque nationale de France (BnF):** The BnF used artificial intelligence (AI) to digitize and handle large volumes of historical documents and manuscripts, using Optical Character Recognition (OCR) and Natural Language Processing (NLP).

v) **The Library of Congress** used AI systems to automate metadata tagging and classification, which streamlined the categorization and retrieval of various media kinds within its vast collection.

vi) **Calgary Public Library, Canada:** This library used AI-powered tools to manage inventory and improve resource allocation, allowing for more efficient borrowing and forecasting demand for certain resources.

vii) **Oodi Library** in Helsinki has used AI-driven space management tools that analyse foot traffic patterns to optimize layout and resource allocation for better user accessibility.

viii) **The British Library** has utilized AI-powered solutions for digitization, metadata enhancement, and preservation. Machine learning algorithms have improved digitization workflows, metadata quality, and material access. AI technologies have also automated preservation tasks, prioritizing items based on condition and historical significance.

ix) **Stanford Libraries** have utilized AI to enhance research support services and improve access to scholarly resources. AI-driven recommendation systems and natural language processing tools

provide personalized research assistance, analysing user preferences and queries for valuable scholarly content.

x) **The National Library of Medicine (NLM)** has utilized AI to improve biomedicine information retrieval and knowledge discovery. AI-powered search algorithms and text mining tools have enhanced accessibility of biomedical literature, facilitating new discoveries in healthcare and life sciences. This has led to advancements in medical research and patient care.

These case studies highlight how AI technologies have been used to simplify information administration, improve user experiences, and optimize resource allocation in a variety of library environments.

9. NEXT-GEN LIBRARIES

The emergence of shelf reading robots and other AI-driven applications signifies a significant shift in the future landscape of libraries. Artificial intelligence, much like the transformative impact of the electric lightbulb, is poised to revolutionize various facets of human existence, including the domain of libraries. As a result, librarians may find themselves liberated from conventional tasks such as reading books for information gathering and decision-making. Instead, computers equipped with AI capabilities can efficiently perform a multitude of functions, including reference services, shelf organization, circulation activities, library data management, cataloguing, and categorization.

The potential of AI encompasses the creation of an ideal librarian capable of addressing users reference inquiries through speech recognition, natural language processing and neural networks. Such advancements promise swift, efficient, and effective processing of library materials, delivering state-of-the-art services to patrons regardless of their location. Embracing technological advancements, future libraries are anticipated to adapt and integrate new technologies rather than shying away from them. Initiatives like the Center for the Future of Libraries aim to identify trends pertinent to libraries and their communities, fostering innovation techniques to aid librarians and library professionals in shaping the future. Collaboration with experts and innovative thinkers is crucial for addressing emerging challenges. However, there remains a need to develop the skill sets of librarians, scholars, and other stakeholders to ensure the establishment of intelligent information systems that uphold core library values such as inclusivity, privacy, intellectual freedom and social justice. Additionally, fostering imagination, knowledge creation, and human learning remains a priority in this evolving landscape.

The Center for the Future of Libraries endeavours to discern trends that hold significance for both libraries and the communities they serve. Its mission includes advocating for the adoption of futuring and innovation methodologies among librarians and library professionals, empowering them to actively shape the future of their field. Additionally, the center seeks to establish collaborations with experts and innovative thinkers to assist libraries in addressing emerging challenges. - American Library Association (ALA).

Garcia-Febo (2019), the President of the American Library Association, has advocated for the incorporation of artificial intelligence into the professional agenda of libraries and national discussions aimed at evaluating and addressing associated challenges. Libraries are embracing AI in its early stages to enhance information literacy and foster critical thinking skills, including computer programming. Moreover, they are utilizing AI to assist users in formulating inquiries for these systems and learning to assess the outcomes. These significant advancements in library practices globally indicate a widespread adoption of AI that will shape the future of libraries. As Jacknis (2017) points out, the pivotal question is not a binary choice between "AI or libraries," but rather how libraries can effectively harness technology to deliver optimal services to their communities.

10. CONCLUSION

The integration of Artificial Intelligence (AI) into library systems offers a substantial potential for enhancing information management. It is evident that AI is capable of streamlining operations, customizing user experiences, and redefining library services. Effective integration, nevertheless, necessitates the consideration of personnel skills, budgetary constraints, and ethical considerations. Collaboration among stakeholders is of the utmost importance in order to optimize the benefits of AI while upholding ethical principles and fundamental library values. By effectively managing the competing demands of innovation and inclusivity, libraries can redefine their role as

crucial repositories of information and endure in the digital age. In conclusion, the integration of AI technology holds tremendous potential for transforming library operations, enhancing patron experiences, and advancing library information services. Automation propelled by artificial intelligence may be utilized by libraries to expedite cataloguing and categorization, enhance user discovery and access, boost operational efficiency, and provide individualized services and recommendations in accordance with patron preferences and needs. Cooperation, user training, and assessment initiatives, in addition to ethical, technical, legal, and social considerations, are necessary to ensure the responsible and effective application of AI technologies in libraries. Libraries can leverage artificial intelligence (AI) to identify emerging opportunities, address escalating challenges, and maintain their relevance and responsiveness in the digital era through proactive planning, strategic investment, and stakeholder engagement.

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