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Chatbots in Libraries: A Systematic Literature Review

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Chatbots in Libraries: A Systematic Literature Review

Chatbots have experienced significant growth over the past decade, with a proliferation of new applications across various domains. Previous studies also demonstrate the trend of new technologies, especially artificial intelligence, being adopted in libraries. The purpose of this study is to determine the current research priorities and findings in the field of chatbots in libraries. A systematic literature review was performed utilising the PRISMA checklist and the databases Scopus and Web of Science, identifying 5734 records. Upon conducting the first screening, abstract screening, full-text assessment, and quality assessments guided by the CASP appraisal checklist, 19 papers were deemed suitable for inclusion in the review. The results of the review indicate that the majority of the existing studies were empirical in nature (primarily adopting qualitative methods) and technology reviews with a focus on reviewing the implementation and maintenance, design, evaluation, characteristics, and application of chatbots. The chatbots of interest were mainly text-based and guided chatbots, with closed-source tools with access portals mostly built on library web pages or integrated with social software. The research findings primarily concerned the development models and necessary tools and technologies, the application of chatbots in libraries. Our systematic review also suggests that studies on chatbots in libraries are still in the early stages.

Keywords: chatbots, AI, libraries, systematic literature review, academic libraries

1. Introduction

Chatbots, also known as conversational agents, are software applications that use natural language to interact with humans (Rapp et al., 2021). In the last decade, chatbots have been widely used in various fields (Grudin & Jacques, 2019), as is demonstrated by the increasing literature on the topic (Adamopoulou & Moussiades, 2020). The growing applications of chatbots are particularly evident in three sectors: education, healthcare, and customer service (Adamopoulou & Moussiades, 2020; Følstad et al., 2021). The use of chatbots has also been discussed more extensively by researchers, specifically in the context of libraries (Sanji et al., 2022), where the introduction of chatbots began in the mid-2000s by libraries in Germany (Sanji et al., 2022). While there is considerable interest in the application of chatbots in libraries (Allison, 2012; Panda and Rupak, 2022), researchers highlight the potential concerns of the practice, including costs, sustainability, inclusivity, and technical limitations (Rubin et al., 2010; Mckie et al., 2019). As of now, no systematic approach has been developed to bring together the growing body of literature on library chatbots.

A systematic review on this topic could help researchers, information professionals, and library staff identify current research priorities and trends, contexts in which chatbots have been deployed, and findings from existing studies. In this paper, we attempt to answer the following research questions, which focus on different perspectives of the extant literature:

- RQ1: What are the different application contexts of the chatbots that have been deployed within libraries?
- RQ2: What are the characteristics (interactions, types, platforms, tools, accessibility) of the chatbots that have been deployed within libraries?

- RQ3: What approaches have been adopted in library chatbot research, and what areas still require further investigation?

2. Literature Review

2.1 The history of chatbots

The first chatbot, named ELIZA, was created in 1966 and used to simulate a psychotherapist communicating with patients who had a certain level of communication ability (Weizenbaum, 1966). Artificial intelligence was first applied to a chatbot called Jabberwacky in 1988 (Jabberwacky, n.d.). In 1995, the online chatbot ALICE was created. It used the newly developed Artificial Intelligence Markup Language (AIML) (Wallace, 2009). Since then, the AIML metadata scheme has been widely adopted by the large open-source user community under the stewardship of the ALICE AI Foundation as an important language for developing chatbots (Vincze, 2017). In 2010, Apple developed Siri (Siri, n.d.). Thereafter, personal voice assistants have emerged widely, such as Google Assistant (Google Assistant, your own personal Google, n.d.), Microsoft Cortana (Cortana - Your personal productivity assistant, n.d.), and Amazon Alexa (Digital Trends, 2021). Chatbots began to emerge in large numbers in 2014 (Grudin & Jacques, 2019). After 2016, research on chatbots began to increase at a rapid rate (Adamopoulou & Moussiades, 2020). These chatbots are typically structured as a user interface component, a user message analysis component, a conversation management component, a backend, and a response generation component (Adamopoulou & Moussiades,2020). Chatbots can be developed by using pattern-matching approaches (employing rule-based methods to identify the most appropriate pre-written responses stored in databases) and machine learning approaches (to understand the context of conversations to respond with automatically generated text). The development of chatbots using machine learning approaches involves techniques

such as natural language processing (NLP), natural language understanding (NLU), natural language generation (NLG), artificial neural networks, and recurrent neural networks (Adamopoulou & Moussiades, 2020).

2.2 Different types of chatbots

The economic promise of an automated agent, available 24x7, serving the needs of user communities with limited (human) intervention is a considerable prospect. As a result, chatbots have been explored in a range of application domains. Chatbots enable round-the-clock engagement, resolving service requests more efficiently, particularly without risks of potentially stressed or unfriendly human employees (Luo et al., 2019). With the wide range of applications, chatbots can be categorised in a number of ways. Based on the types of services provided, chatbots can be divided into two broad categories: task-oriented, designed to provide services related to specific content in a domain; and chit-chat bots, designed to engage in conversations with users (Baez et al., 2021). Rubin et al. (2010) reported on the application of chatbots for assistive functions (e.g., assisting people with disabilities) and social functions (e.g., virtual world enhancement and game support, virtual social partners). Nißen et al. (2022) concluded that there are three types of chatbots that are mutually exclusive in terms of their design characteristics: temporary supporters (short-term, one-off), temporary advisors (medium-term), and persistent partners (permanent interaction with users and interdependence). It is also important to note that chatbot conversation styles also differ from human conversations - when communicating with chatbots, users typically communicate for longer, sending short messages with a stricter vocabulary (Hill et al., 2015). It is also important to note that disclosure of chatbot identities to users can have a range of impacts on customer retention - for example, for services with high criticality, chatbot disclosure can have a negative impact on retention. However, for failure to handle a service issue, disclosing

chatbot identity can have a positive effect (Mozafari et al., 2021). Despite the range of application contexts, several chatbots suffer from unclear purpose, insufficient usability and meaningless responses (Brandtzaeg and Følstad, 2017).

2.3 The technological advancements in Library

Librarians are often considered to be early adopters of new service technologies (Larson, 2018). Fraser-Arnott (2022) analysed the mission statements of 80 public libraries and found that the mission of public libraries can be summarised in seven areas: community building, cultural and recreation, educational and learning, equitable access, positive impact, information, and stewardship. Martzoukou (2020) noted that following the COVID-19 pandemic, the new mission of academic libraries is to help online learners have the ability to access rich information and be digitally competent enough to help them overcome the digital divide and inequalities. In addition, she mentioned the role of academic libraries in supporting students from different backgrounds and cultures in overcoming socio-cultural barriers. Cox (2021) noted that with the changing social factors in higher education, equality, diversity, and inclusion in academic libraries must also be emphasised. Shuva (2022) reported that the main barriers to the use of public libraries were lack of time and unfamiliarity with the services. Based on the context of the library's mission and the changing external environment, some studies highlight the important impact of new technologies on libraries. Iglesias (2013) pointed out the inevitability of library automation. A number of recent studies suggest that most library stakeholders welcome technological innovations in libraries (Harisanty et al., 2022; Lembinen, 2021; Larson, 2018).

A number of concerns have also been raised about the use of technology in libraries, given the fact that the potential impact of AI is only partially explored (Cox,

2021; Cox et al., 2019; Saunders, 2015). For example, the threat to the jobs of library staff; concerns about the security and privacy of the data demanded by AI; concerns about the transparency and understandability of collection decisions arising from pre-filtering bubbles and bias in data services; the new digital literacy issues demanded by the application of AI; the difficulty of meeting user expectations for AI applications with the capacity of libraries; and concerns about the possible involvement of commercial companies to make AI a marketable tool.

2.4 Use of chatbots in libraries

Rubin et al. (2010) analysed the applications of chatbots in four areas: education, information, assistive (e.g., for people with disabilities), and social, deriving the potential for chatbots in libraries, including automated virtual reference librarians, virtual reader's advisory service providers, social software hosts, and virtual book club hosts. Research suggests that deploying chatbots in libraries can have a range of benefits, such as providing reference services, personalised library resource suggestions, interacting with users from a variety of languages, cultures and regions, linking with other virtual assistants to coordinate tasks and so on (Sanji et al., 2022; Bagchi, 2020). Data recorded by chatbots can also help us understand the needs of library users (Kane, 2019). Academic library chatbots can also integrate with online learning management systems to improve the academic research experience for students (Mckie & Narayan, 2019). One of the main benefits of such systems is the always-available nature of chatbots, easing workload of librarians (McNeal & Newyear, 2013). Despite these benefits, research also highlights the limitations of chatbots in libraries. Panda and Chakravarty (2022) highlighted the limitations of library chatbots in interacting with users from different languages and cultural communities. Rubin et al. (2010) also

pointed out the practical cost issues, system limitations, and language complexity issues, as well as issues related to user readiness and acceptance, which need to be faced when adopting chatbots. These reasons also had an impact on the slow progress of the adoption of chatbots in libraries (Rubin et al., 2010; Allison, 2012). Rubin et al. (2010) found that as of early 2010, none of the 20 largest libraries in Canada had applied chatbots. Up to 2012, Allison (2012) had identified ten chatbots on the web that were deployed in libraries. With the widespread use of chatbots across different industries, they have become increasingly popular in libraries. Nevertheless, there is still a need for a comprehensive approach to consolidate the growing body of literature on library chatbots and to provide guidance for both research and practical use of chatbots in libraries.

3. Methodology

This research employed a systematic literature review to explore the literature on chatbot adoption within libraries. We adopted the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) 2020 checklist (Page et al., 2021) as a guide for conducting our systematic literature review. We describe the search strategy and inclusion and exclusion criteria, and detail the process of first screening, abstract screening, and full-text assessment. In this section, we also provide a quality assessment of the articles included in this review and describe the process of grouping and coding individual studies into outcome syntheses. For the full-text assessment, we cited the SPIDER tool (Cooke et al., 2012) as an inclusion criterion and coded the articles. For the quality assessment, we used the CASP (Critical Appraisal Skills Program) appraisal checklist (Singh, 2013) to assess each study. Figure 1 describes the PRISMA flow diagram that was employed to conduct the systematic review.

[Please insert Figure 1 here]: Figure 1. PRISMA Flow Diagram (Page et al., 2020)

3.1 Search Terms

In order to identify relevant research on chatbots in libraries in the current study, chatbots and libraries were defined as two key concepts. We started with an unscreened exploratory search. In a university library search engine, we combined "chatbot" and "library" as keywords. A quick review of the results confirmed that the two keywords were valid. A brainstorming was then conducted on the basis of these two keywords, especially with regard to the concept of "chatbot". Through brainstorming and exploratory searches, the following keywords were included in the search terms: “Chatbots”, “Chatterbots”, Conversational agents”, “Conversational interfaces”, “Conversational UI” and “Talkbots”. In summary, the following terms and connectives were used for the search in this research: (chatbot* OR chatterbot* OR (conversational agent*) OR (conversational interface*) OR (conversational ui) OR talkbot*) AND library*

3.2 Selection Criteria

We define the following inclusion criteria for screening the literature:

1) Relevant articles must use chatbots and libraries as two key concepts. The library must receive emphasis in the articles as the context for the research. Libraries mentioned in these articles can include both academic and public libraries. In the concept of chatbots, we include all the interactive programs that can understand and communicate with the natural language input by the users. There are no restrictions on how users can input natural language: it can be text or voice. As well, there is no restriction on how the programs can respond to natural language: again, it can be text or voice, or even images; it can chat with users in natural language, or it can reply with pre-defined answers or directions. There are also no restrictions on the platform on which the chatbots can be

deployed: it can be based on a web portal interface or mobile device software, or even a physical bot placed in a library (Embodied Conversational Agents).

2) Relevant articles must be written in English.
3) This research includes literature published between 2013 and 2022. In the early 2010s, conversational agent technology became familiar to the public (Rapp et al., 2021). And in 2014, chatbots began to be deployed in larger numbers (Grudin & Jacques, 2019). This paper, therefore, limits the timeframe of the study to the last decade, which, we believe, is a reasonable range of time for the technology to begin to come to the attention of people.

3.3 Initial Screening

Two databases (Web of Science and Scopus) were searched in this paper. We entered the query string mentioned above into each of the two databases: ALL=(chatbot* OR chatterbot* OR (conversational agent*) OR (conversational interface*) OR (conversational UI) OR talkbot*) AND ALL=librar*) OR (conversational ui) OR talkbot*) AND librar*. Setting the search scope for both databases to "ALL" and the publication date to between 1 January 2013 and 31 July 2022 (Web of Science) /PUBYEAR > 2012 (Scopus), returned a total of 5734 search results. Due to a long time between the first search and the completion of the screening of articles, an update alert was set for this query string in both databases, and the updated literature was checked weekly. The update check was conducted until 31 July 2022.

The first screening was based on the same inclusion criteria as described above, focusing on whether the literature was written in English and whether it included the concepts of libraries and chatbots. After the first screening and removal of duplicates, a total of 80 records were included.

3.4 Abstract Screening

The second screening was carried out by browsing the abstracts of the 80 articles identified in the first screening. We excluded literature that did not focus on libraries as the primary research setting. We also excluded literature that did not focus on chatbots as the main subject of discussion. We also excluded literature that focuses on early prototypes and incomplete implementations of chatbots, which lacked in offering meaningful dialogues. Thirty-eight articles were included through the abstract screening, and a total of 42 articles were excluded.

3.5 Full-Text Assessment

We conducted a full-text assessment and analysis of the 38 articles that had been screened by abstracts. At this stage, we read all 38 articles and coded them individually using the SPIDER tool (Cooke et al., 2012). A more detailed set of inclusion criteria based on the SPIDER tool has been written according to the topics discussed in this review. After a full-text assessment, we excluded a total of 19 articles, eventually retaining 19 articles.

[Please insert Table 1 here] Table 1: SPIDER tool (Adapted from Cooke et al., (2012))

3.6 Quality Assessment

We chose the CASP appraisal checklist to conduct a quality assessment. Each article was read carefully and assessed against the CASP checklist regarding research questions, research methods and design, research outcomes, research impact and significance, and ethics. The results of the CASP assessment for the 19 articles are presented in Table 2.

[Please insert Table 2 here] Table 2: CASP assessment (Adapted from Critical Appraisal Skills Programme (2022))

Overall, two papers were literature review studies, seven papers were technology reviews, one paper used quantitative research methods and one paper used a combination of qualitative and quantitative methods. The remaining eight papers used qualitative research, and in these studies, qualitative research was the method by which the research objectives could be properly achieved. Of the 19 studies, 12 did not collect data from human subjects, nor did they use human data. Questions relating to the assessment of the recruitment strategies of participants and the relationships between researchers and participants were therefore not applicable to these studies.

Of the seven studies that collected data on human participants, two did not specify the process and criteria for recruiting participants and were based on case studies in which data were collected from relevant stakeholders. The participants in one article were users of the case study chatbot and library staff (McNeal & Newyear, 2013), and the participants in the other article were users of the case study chatbot (Griol et al., 2015). From the results of the study, the selection of participants in both pieces of literature achieved the objectives of data collection (to study users' and employees' reactions to the chatbot (McNeal & Newyear, 2013), and to evaluate the chatbot proposed by the study (Griol et al., 2015). Therefore, we also consider all seven papers as adopting an appropriate strategy for recruiting participants.

In six articles, the authors did not specify the relationship between the researchers and the participants. They did not reflect on the possible biases brought about by the researcher's own role, nor did they consider how to respond to the events that occurred in the study. This does affect the quality assessment of these articles, but after analysing the research design and study results, we believe that the risk of bias and occurrence in these studies is low and therefore the impact of the deficiencies in this

section is acceptable. In summary, after assessing for this question, we have also included all these studies.

In terms of ethical issues, only one of all the papers involved in this review makes explicit reference to ethical considerations. However, as noted above, there were a total of 12 articles that neither collected nor used human participant data. Therefore, we believe that the ethical risk of these studies is low and did not need to be assessed for ethical issues. The remaining six articles did not provide detailed information on ethical review processes, but we found that these articles still provided sufficient information to state that their research was confidential, consensual, responsible, and respectful of privacy.

4. Results

Among the papers identified, nine studies were conducted in Asian countries (2 in India, 1 each in Bahrain, Pakistan, Korea, Taiwan, Iran and Thailand), six in the United States, four in Europe (2 in Italy, 1 each in Spain and Ukraine), and one in Australia. Among the papers identified, only three were published before 2019 (1 each in 2013, 2015 and 2017), indicating the increased attention to the topic. Of the twelve studies published after 2019 (2019 - 4; 2020 - 4; 2021 - 1; 2022 - 3), six mentioned the Covid-19 pandemic, four of which used it as the context to conduct their research. These studies considered the implementation of chatbots in libraries as a solution for coping with the pandemic. A majority (47%, n=9) of the chatbots were deployed within academic libraries, while 37% (n=7) were deployed within general libraries, and 16% (n=3) were deployed in public libraries.

4.1 Purpose and methodologies

A broad range of objectives and aims motivated the papers identified - Table 3 presents a summary of these studies. Over half of the chatbots addressed the integration of the library with other departments of their parent institutions. More than half of the studies aimed to investigate how chatbots can be used to improve information provision, reference services, and digital services in libraries. Three papers aimed to discuss the creation and management of chatbots. A small number of studies aimed to explore the application, error-handling strategies, and gender characteristics of chatbots. A range of papers highlighted the broader process of creating and managing chatbots as well as sharing error-handling strategies. Many such papers also discussed the perspective of librarians.

[Please insert Table 3 here] Table 3: Objectives of studies

Ten papers were empirical studies using quantitative, qualitative or mixed methods, 2 reviews and 7 were technology reviews.

[Please insert Table 4 here] Table 4: Summary of methodologies employed in the studies identified

Table 4 summarises the range of methodologies employed in these studies.

One paper used a quantitative method, using a Wizard of Oz method (Lin et al., 2021). One paper used mixed methods, which involved the analysis of questionnaire responses and case study (Thalaya & Puritat, 2022). Six articles used a case study approach, specifically discussing a chatbot that had been deployed in a library, providing a detailed analysis of the chatbot's features and applications. Two papers used the

narrative review as a research method (Nawaz & Saldeen, 2020; Sanji et al., 2022). Seven papers were technology reviews, addressing the applications or solutions for chatbots based on a discussion of technical details.

Considering the objectives of the studies reported in the papers, we explored the research questions into technical and social perspectives. Technical aspects involved the implementation and maintenance, and design of chatbots, while social aspects involved the different application contexts, characteristics and evaluation strategies for chatbots. We describe these different perspectives in Table 5.

[Please insert Table 5 here] Table 5: Objectives and focus of identified studies. Please note that some papers had multiple areas of focus

84% (n=16) of the articles included a technical question as one of the key questions to be addressed in the articles. More than half (n=9) of these papers addressed questions about the implementation and maintenance of chatbots.

Three papers included only social questions as research questions. Ali et al. (2020) researched the perspectives of Pakistani academic librarians on artificial intelligence and chatbots. Lin et al. (2021) investigated how different error handling strategies of voice chatbots affect the interaction behaviour and performance of older users. Brown (2022) critically discussed whether and how current academic library chatbots express gender characteristics.

Again, 84% (n=16) of the articles included social questions as one of the key research questions. All three papers that did not research social issues researched the question of how to model a chatbot prototype (Sorna Shanthi et al., 2019; Anelli et al., 2019; Park et al., 2020).

4.2 Participants of the studies

Overall, six studies collected data from human participants using a variety of approaches such as, interviews (Ali et al., 2020), experiments (Lin et al., 2021), and questionnaires (Thalaya & Puritat, 2022). Two technology reviews recruited human participants to evaluate their chatbot model through experiments and/or questionnaires (Griol et al., 2015; Rodriguez & Mune, 2021). Five of the six papers reported on sample sizes, of which, Kane (2019) reported on the volume of text analysed (10,341 sentences spread over 2,786 conversations). Sample sizes of the remaining four papers ranged from 10 to 472. Two articles reported the age of the sample, one from 22 to 54 (Griol et al., 2015) and one from 60 to 75 (Lin et al., 2021). Only Griol et al. (2015) reported the gender of the participants (12 male and 13 female). The papers identified in our review studied stakeholders in two main groups: library staff and users. The findings from the studies of users are mainly concerned with user behaviour (preferred characteristics, expressed emotions, and type of consultation) and their satisfaction with the chatbots (Thalaya & Puritat, 2022; Griol et al., 2015; Rodriguez & Mune, 2021; Lin et al.,2021, Kane, 2019; Ehrenpreis & DeLooper, 2022). The studies of librarians focused on their attitudes and concerns about chatbots, such as increased workload associated with managing and maintaining the chatbot, demand on users' digital literacy, layoffs of staff, and distrust of the technplogies (McNeal & Newyear, 2013; Vincze, 2017; McNeal & Newyear, 2013; Ali et al., 2020).

4.3 Types of Chatbots and Interaction mechanisms

Our results suggest that fifteen studies mentioned the use of specific chatbots while the others discussed the broader concept of chatbots. Two types of chatbots were identified, namely guided chatbot and FAQ chatbot. According to Mckie & Narayan (2019), a

guided chatbot responds to the context of the conversations and asks the user questions; while a FAQ chatbot responds without understanding the context of the conversation and does not retain previous conversations with the users. Eight of the papers surveyed discussed guided chatbots (McNeal & Newyear, 2013; Vincze, 2017; Sorna Shanthi et al., 2019; Mckie & Narayan, 2019; Anelli et al., 2019; Nawaz & Saldeen, 2020; Bagchi, 2020; Park et al., 2020), while four discussed the use of FAQ chatbots (Griol et al., 2015; Rodriguez & Mune, 2021; Panda & Chakravarty, 2022; Thalaya & Puritat, 2022). The remaining three papers did not specify the type of chatbot being studied (Kane, 2019; Yavorska et al.,2020; Ehrenpreis & DeLooper, 2022). A majority of the studies (ten) involved the study of text chatbots, three studies involved the study of combined interactions (text and voice), and two studies reported on voice-only chatbots. The type of chatbot wasn't clear in the remaining two studies. Table 6 presents the different interaction mechanisms of chatbots that were studied in the identified papers.

[Please insert Table 6 here] Table 6: Types of interaction mechanisms of chatbots. Note: some chatbots have multiple interaction mechanisms depending on access paths.

4.4 Technical implementation of chatbots

For the fifteen papers discussing specific chatbots, we present the implementation and development of the chatbots from three perspectives - the type of approach (pattern matching or machine learning) used by the study, the type of platform (open-source or closed platform) and the type of access mechanism (library website, social network, mobile app etc.) (Table 7).

[Please insert Table 7 here] Table 7: Range of implementation for chatbots - categorised

by development approaches, platforms and access mechanisms.

47% (n=7) of the chatbots discussed in the articles were developed using the pattern-matching approach. In 86% (n=6) of these papers, the use of Artificial Intelligence Markup Language (AIML) for development was noted. 33% (n=5) of the papers discussed chatbots developed using the machine learning approach. The technologies discussed in these papers included automatic speech recognition (ASR), natural language understanding (NLU), natural language processing (NLP), machine learning (ML), decision engine (DE), dialogue management (DM), natural language generation (NLG), visual generation (VG) and text-to-speech synthesis (TTS) (Griol et al., 2015; Nawaz & Saldeen, 2020; Bagchi, 2020). Four papers explained the development of chatbot databases. Griol et al. (2015) and Anelli et al. (2019) elaborated on databases built on external servers. Griol et al. (2015) discussed a MySQL database; in contrast, Anelli et al. (2019) discussed using a SPARQL endpoint. SPARQL is a graphical matching-based query that acts on the multimedia digital library investigated in this paper (Anelli et al., 2019). The database Panda and Chakravarty (2022) described is constructed from forms uploaded to a chatbot building application. In Thalaya and Puritat's (2022) research, the chatbot BCNPYLIB directly uses manually input Google Sheets as a database.

As can be noted from Table 7, almost half of the articles discussed using closed-source platforms for developing chatbots. The most frequently mentioned closed source platform was Dialogflow, discussed in four studies, used to process the chatbot conversations, analyse user queries and create responses (Sorna Shanthi et al., 2019; Anelli et al., 2019). Closed-source platforms mentioned in the papers are danbee.ai and Engati (Panda & Chakravarty, 2022; Park et al., 2020). Open-source platforms noted in the studies identified were Pandorabots (Vincze, 2017), Program- O (Kane, 2019), and

Rasa Stack (Bagchi, 2020).

Nearly half of the articles discussed web portals for chatbots, possibly due to their flexibility (Kane, 2019). McNeal and Newyear (2013) discussed the different configurations of the chatbot arranged on the library catalogue page, help page, and home page. Mckie and Narayan (2019) suggested the potential of embedding academic library chatbots into other school departmental web pages (e.g., online learning management systems such as Canvas and Blackboard). Rodriguez and Mune (2021) discussed used Kommunicate as a publishing support platform to develop a web-based conversational user interface (CUI). A third of the papers discussed accessing chatbots via social software. It is worth noting that, except for one paper that does not specify a platform for chatbot development (Yavorska et al., 2020), the chatbots in the other four papers that discussed the use of social software as a front-end user interface were all developed using closed-source platforms (Sorna Shanthi et al., 2019; Park et al., 2020; Panda & Chakravarty, 2022; Thalaya & Puritat, 2022). Panda and Chakravarty (2022) noted that the closed-source platform Engati can be easily integrated with various social software. Griol et al. (2015) proposed a prototype of an Android-based chatbot mobile application. McNeal and Newyear (2013) introduced the portals for the chatbot to be placed at the library's indoor information kiosk and computer desktops, as well as the access via QR code scanning with a mobile phone. The chatbot proposed by Anelli et al. (2019) was able to be accessed through the Italian Google Assistant.

5. Discussions

In this paper, we conducted a systematic literature review in the field of library chatbots. We analysed the following: the application contexts (e.g., region and year of publication, context, and objectives), the characteristics of chatbots (e.g., interactions,

types, development approaches, and access portals), and the research approaches adopted in the current literature (research methods, key questions).

Our findings suggest that overall research on chatbots in libraries is still in its early stages, although there is an emerging upward trend in a wide range of countries. This is consistent with the findings of Bohle (2018), who argued that chatbots play an increasingly significant role in user interactions within libraries. The review has reported positive impacts of the use of chatbots in libraries, including improved user satisfaction, increased speed of interaction, increased self-efficacy for users, and support for reference services for library staff. Despite these benefits, concerns around job security, additional workload, and distrust towards chatbots' abilities still persist.

Our review also sheds light on the growing use of chatbots in the wide range or library types where they have been deployed and studied. The analysis revealed that a majority of the chatbots were deployed within academic libraries to help students and academics find information and format references, with a few in general libraries and a minority in public libraries. This indicates that academic libraries are leading the way in the adoption of chatbots, perhaps because of the high demand for information services among students and faculty (Cox, et al., 2019). However, the evaluation of the effectiveness of said chatbots remains lacking, especially from the perspectives of multiple stakeholders. This also accords with a recent study by Kaushal and Rajan (2022), who highlight the importance of incorporating different library stakeholders when studying chatbot adoption in libraries. Our review also highlights the potential of chatbots to support libraries in meeting the information needs of their users and overcoming the challenges posed by the Covid-19 pandemic. The findings of Huang

and Kao (2021) align with the notion that chatbot services have been extensively utilised as a means of addressing the limitations brought about by the pandemic.

Furthermore, our review highlights the prevalence of text-only chatbots with pattern-matching approaches, the use of closed-source platforms for development, and the most common method of deployment which is through library webpages. These findings can be useful for libraries looking to implement chatbots in their services. As the use of chatbots continues to evolve, it will be interesting to see how machine learning approaches and innovative ways of interaction are incorporated in into the development of chatbots in libraries (Bagchi, 2020). Additionally, we identified two main research angles for library chatbots: namely, social and technical. However, most empirical studies in our review are small-scale qualitative studies, while the remaining studies are technology reviews.

6. Conclusions

The systematic literature review we conducted highlights the increasing use of chatbots in libraries, particularly academic libraries. Although there has been significant growth in this field, research is still in its infancy, with most studies being empirical and qualitative in nature, and focusing primarily on implementation, maintenance, design, evaluation, and applications. The chatbots of interest were primarily text-based and developed on closed-source platforms, integrated with library web pages or social software. We recommend that future research in this area focus on developing a stronger theoretical foundation and testing chatbots with large populations of participants. It is also necessary to explore the use of chatbots in public libraries for diverse users, which has been limited to date. This research has some limitations to be noted. To begin with, the data was gathered from only two databases, Scopus and Web

of Science. Furthermore, the publication covers the years between 2013 and 2022 only, prior to the advent of ChatGPT. It would be intriguing to examine the proliferation of open source chatbots in the future.

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Table 1: SPIDER tool (Adapted from Cooke et al., (2012))

SPIDER	Inclusion criteria
S – Sample	Participants in the process of implementing, using, and evaluating chatbots in libraries
PI – Phenomenon of Interest	Chatbots in libraries
D – Design	Transparent and credible research methods
E – Evaluation	Outcomes: development and management approaches, application and evaluation, stakeholders' perspectives and reactions
R – Research type	No restriction

Table 2: CASP assessment (Adapted from Critical Appraisal Skills Programme (2022))

	YES	NO	Can't tell	Not applicable

Was there a clear statement of the aims of the research?	19			
Is a qualitative methodology appropriate?	8			11
Was the research design appropriate to address the aims of the research?	12			7
Was the recruitment strategy appropriate to the aims of the research?	5		2	12
Was the data collected in a way that addressed the research issue?	12			7
Has the relationship between the researcher and participants been adequately considered?	1		6	12
Have ethical issues been taken into consideration?	1		18	
Was the data analysis sufficiently rigorous?	10			9
Is there a clear statement of findings?	19			
Is the research valuable?	19			

Table 3: Objectives of studies

Objectives	Number of studies	References
Library information provision	3	Anelli et al., 2019; Rodriguez & Mune, 2021; Ehrenpreis & DeLooper, 2022
Library reference service	2	Vincze, 2017; Nawaz & Saldeen, 2020
Library digital service	4	McNeal & Newyear, 2013; Park et al., 2020; Yavorska et al., 2020; Panda & Chakravarty, 2022
Chatbot creation and management	3	Griol et al., 2015; Kane, 2019; Bagchi, 2020
Chatbot application	1	Sanji et al., 2022
Chatbot error handling strategies	1	Lin et al., 2021
Chatbot gender characteristic	1	Brown, 2022

Academic research experience	1	Mckie & Narayan, 2019
User support	2	Sorna Shanthi et al., 2019; Thalaya & Puritat, 2022
Librarians' perspectives	1	Ali et al., 2020

Table 4: Summary of methodologies employed in the studies identified

Paper types	Methods	Data collection instruments	Number of Studies	References
Empirical Research	Quantitative (n=1)	Experiments	1	Lin et al., 2021
	Qualitative (n=8)	Case studies	6	McNeal & Newyear, 2013; Vincze, 2017; Mckie & Narayan, 2019; Kane, 2019; Panda & Chakravarty, 2022; Ehrenpreis & DeLooper, 2022
		Interviews	1	Ali et al., 2020
		Document analysis	1	Brown, 2022
	Mixed methods (n=1)	Case study and questionnaires	1	Thalaya & Puritat, 2022
Narrative Review			2	Nawaz & Saldeen, 2020; Sanji et al., 2022
Technology Review			7	Griol et al., 2015; Sorna Shanthi et al., 2019; Anelli et al., 2019; Bagchi, 2020; Park et al., 2020; Yavorska et al., 2020; Rodriguez & Mune, 2021

Table 5: Objectives and focus of identified studies. Please note that some papers had multiple areas of focus

Key **issues**	Specific issues	Number of studies	References
Technical	Implementation and maintenance	9	McNeal & Newyear, 2013; Vincze, 2017; Mckie & Narayan, 2019; Kane, 2019; Bagchi, 2020; Sanji et al., 2022; Panda & Chakravarty, 2022; Ehrenpreis & DeLooper, 2022; Thalaya & Puritat, 2022
	Design	8	Griol et al., 2015; Sorna Shanthi et al., 2019; Anelli et al., 2019; Nawaz & Saldeen, 2020; Bagchi, 2020; Park et al., 2020; Yavorska et al., 2020; Rodriguez & Mune, 2021;
Social	Application	5	Mckie & Narayan, 2019; Nawaz & Saldeen, 2020; Yavorska et al., 2020; Sanji et al., 2022; Panda & Chakravarty, 2022;
	Characteristic	6	McNeal & Newyear, 2013; Vincze, 2017; Kane, 2019; Lin et al., 2021; Brown, 2022; Ehrenpreis & DeLooper, 2022;
	Evaluation	7	McNeal & Newyear, 2013; Griol et al., 2015; Vincze, 2017; Ali et al., 2020; Rodriguez & Mune, 2021; Sanji et al., 2022; Thalaya & Puritat, 2022

Table 6: Types of interaction mechanisms of chatbots. Note: some chatbots have multiple interaction mechanisms depending on access paths.

Chatbot interaction	Number of papers	References
Text only	10	McNeal & Newyear, 2013; Vincze, 2017; Sorna Shanthi et al., 2019; Mckie & Narayan, 2019; Kane, 2019; Anelli et al., 2019; Yavorska et al., 2020; Rodriguez & Mune, 2021; Ehrenpreis & DeLooper, 2022; Thalaya & Puritat, 2022
Voice only	2	McNeal & Newyear, 2013; Griol et al., 2015

Text and voice mixed	3	Anelli et al., 2019; Park et al., 2020; Panda & Chakravarty, 2022
Not clear	2	Nawaz & Saldeen, 2020; Bagchi, 2020

Table 7: Range of implementation for chatbots - categorised by development approaches, platforms and access mechanisms.

	Development Approaches			Platforms			Access mechanism					
Reference	PM	ML	Unclear	OS	Clo	Unclear	Library Page	SNS	Mob	Library hardware	Other mobile	Unclear
McNeal & Newyear, 2013			x			x	x			x	x	
Mckie & Narayan, 2019			x			x	x					
Kane, 2019	x			x			x					
Anelli et al., 2019	x				x		x				x	
Rodriguez & Mune, 2021	x				x		x					
Panda & Chakravarty, 2022		x			x		x	x				
Ehrenpreis & DeLooper, 2022		x			x		x					
Sorna Shanthi et al., 2019	x				x			x				
Park et al., 2020		x			x			x				

Yavorska et al., 2020			x			x		x				
Vincze, 2017	x			x								x
Thalaya & Puritat, 2022	x				x			x				
Griol et al., 2015	x					x			x			
Nawaz & Saldeen, 2020		x				x						x
Bagchi, 2020		x		x								x

Figure 1. PRISMA Flow Diagram (Page et al., 2020)