

Redefining library user engagement through AI-enabled virtual assistants : a systematic review**DOI: 10.61735/yyzbj77**¹Sadati Okeyo, ²Josleen Rutere¹ <https://orcid.org/0009-0004-9271-6168> ² <https://orcid.org/0009-0002-6637-936X>^{1,2} Pan Africa Christian University**ABSTRACT**

Libraries are increasingly embracing artificial intelligence (AI) technologies to enhance user engagement and streamline service delivery. Among these, AI-enabled virtual assistants (VAs) have emerged as pivotal tools in redefining how users interact with library systems by offering real-time, personalised, and accessible support. This review aimed to explore the transformative role of AI-enabled virtual assistants in modern library environments, focusing on their impact on user engagement, service efficiency, and ethical considerations. A systematic literature review was conducted through desktop analysis, drawing evidence from peer-reviewed publications between 2019 and 2025 sourced from PubMed, IEEE, ERICA, JSTOR, EBSCOhost, Emerald, SAGE, and Taylor & Francis. Search terms included “AI in libraries,” “virtual assistants,” “chatbots,” “user engagement,” “natural language processing,” and “machine learning.” Studies were selected based on relevance, peer-reviewed status, language (English), and coverage of AI applications in library settings. The findings reveal that AI-enabled virtual assistants enhance user experiences by providing round-the-clock, conversational assistance tailored to user preferences. They contribute to operational efficiency by automating repetitive queries and freeing up librarians to focus on complex tasks. Nonetheless, key concerns include data privacy, algorithmic bias, accessibility barriers, and the need for continuous staff training to manage AI tools effectively. The review concludes that while AI-enabled virtual assistants hold immense potential to modernise library services, their adoption must be guided by robust ethical frameworks that prioritise user autonomy, equity, and data protection. Libraries, researchers, and policymakers are urged to collaborate in developing context-specific strategies for the responsible integration of AI, ensuring that technological innovation aligns with the core values of inclusivity, intellectual freedom, and lifelong learning.

(Key words: *AI-enabled virtual assistants; user engagement; library services; ethical considerations; digital transformation.*)

I. INTRODUCTION

Artificial Intelligence (AI) refers to the development of systems and machines that can perform tasks traditionally requiring human intelligence. These tasks include reasoning, learning, speech recognition, decision-making, and pattern identification. The concept was first formalised in the 1950s when scholars such as John McCarthy and Alan Turing theorised the possibility of machines mimicking human cognitive functions (Barsha & Munshi, 2023). In modern contexts, AI applications have become commonplace in various domains, including autonomous vehicles, voice assistants, image generation, and intelligent chatbots such as ChatGPT (Ling et al., 2023). These systems increasingly support information-seeking behaviours in both commercial and academic settings, including libraries.

AI operates by mimicking the decision-making and problem-solving abilities of the human brain through algorithmic and computational processes. Duggal (2024) describes AI as a means of enabling computers or robots to exhibit intelligent behaviour through software programming and automated responses. This includes capabilities such as analysing natural language, recognising speech or images, and adapting to new information through machine learning techniques, as illustrated in figure 1. Adejo and Misau (2021) emphasise that AI functions through electronically controlled systems that replicate aspects of human competence, particularly in automation and knowledge processing tasks. Such technologies have allowed for the development of smart systems capable of responding to user needs with increasing accuracy and contextual relevance.

Despite its potential, the application of AI in libraries reveals a significant gap between theoretical understanding and practical implementation. While numerous studies highlight AI's capacity to enhance library services, particularly in cataloguing, user engagement, and reference services, actual integration remains limited by infrastructural, technical, and policy constraints (Gupta & Gupta, 2023; Ogwo et al., 2023).

Libraries worldwide are undergoing a fundamental transformation driven by the integration of digital technologies into traditional service models (Gürsen et al., 2023; Nakaziba & Ngulube, 2024). This evolution is largely informed by changing user behaviours, rising expectations for remote and real-time services, and the shift toward online and hybrid learning environments (Subaveerapandiyana, 2023). As users increasingly demand personalised, accessible, and seamless library interactions, institutions are adopting emerging technologies to remain relevant and responsive to community needs (Wheeler et al., 2022). These developments have repositioned libraries as interactive knowledge hubs rather than static repositories of information, thereby demanding more adaptive and innovative service frameworks (Helsinki City Library, 2022).

Among the most notable innovations is Artificial Intelligence (AI), particularly the application of AI-enabled virtual assistants (VAs) in library systems. These assistants use machine learning and natural language processing to simulate human-like interactions, providing real-time responses to user queries and facilitating self-service access to digital resources (Ling et al., 2023). A case in point is the National Library of Singapore, which deployed an AI-powered VA to deliver tailored reading recommendations and improve navigation through digital collections (Subaveerapandiyana, 2023).

Despite their potential, AI-enabled virtual assistants raise ethical, social, and technical concerns that warrant critical examination. Key among these are data privacy, algorithmic bias, system transparency, and the risk of marginalising users with low digital literacy (Wusu, 2024; Ogwo et al., 2023). Research in Nigerian academic libraries, for example, found that successful AI adoption required investment in user training, infrastructural upgrades, and the development of localised AI models that reflect institutional contexts (Ogwo et al., 2023). Additionally, ethical frameworks for AI integration in libraries are either underdeveloped or inconsistently applied, increasing the risk of unintentional harm or exclusion (Wusu, 2024). Addressing these challenges is crucial for ensuring that technological innovation in

libraries does not come at the cost of equity, privacy, or inclusivity.

Using a systematic review, this study explores how AI-enabled virtual assistants are reshaping user engagement, library operations, and the professional roles of librarians. It further interrogates the ethical implications of AI implementation in libraries, especially in the context of developing countries. The central research questions guiding the study are: How do AI-enabled virtual assistants redefine user engagement in library services? What ethical concerns emerge from their deployment in diverse institutional contexts? And how can libraries ensure responsible and inclusive integration of AI technologies? By synthesising current empirical evidence from 2019 to 2025, the review contributes to a growing body of research on responsible digital transformation in the library and information science sector (Panda & Chakravarty, 2022; Gupta & Gupta, 2023).

II. USE OF AI-ENABLED VIRTUAL ASSISTANTS (VAs) IN LIBRARY SYSTEMS

Libraries have historically functioned as custodians of physical collections, providing curated access to printed resources and mediated services through professional librarians (Cassell & Hiremath, 2019). However, in the digital age, the nature of library engagement has shifted significantly, with users increasingly expecting remote access to information, real-time support, and intuitive interfaces that mirror everyday digital interactions (Nakaziba & Ngulube, 2024). This transformation is driven by the widespread adoption of emerging technologies, particularly Artificial Intelligence (AI), which is becoming central to modern library operations and service delivery models (Ling et al., 2023). Institutions are now embedding AI into core functions to enhance discoverability, automate responses, and reduce reliance on static, manual services (Gupta & Gupta, 2023). The evolution of libraries from passive repositories to active, intelligent systems is reshaping how users perceive and interact with information environments.

Among the most promising AI innovations are AI-powered virtual assistants, which mimic human interactions through technologies like natural language processing and machine learning. These systems are increasingly used to provide personalized, responsive, and 24/7 assistance in library settings (Panda & Chakravarty, 2022). For example, Helsinki City Library's "Oodi" initiative successfully integrated multilingual AI assistants to enhance accessibility for its diverse population, showing how AI can help reduce language

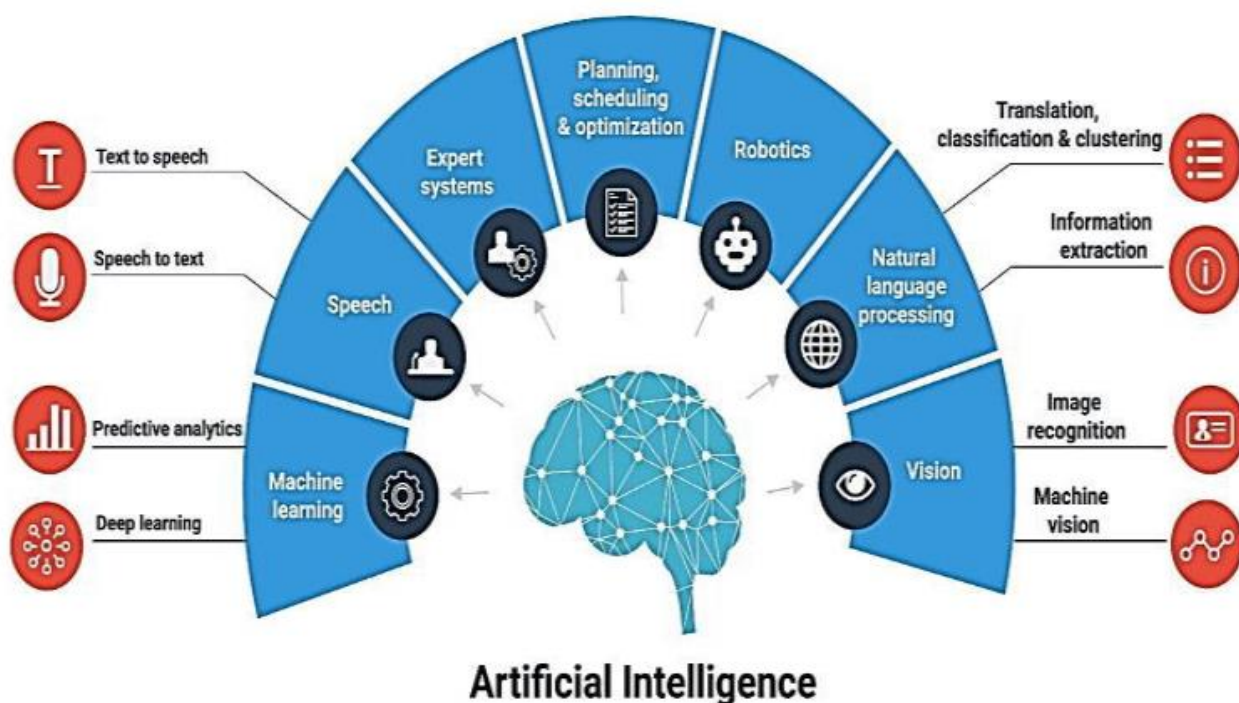
and literacy barriers in public services (Helsinki City Library, 2022). Similarly, the University of Pretoria's adoption of the "LibChat" virtual assistant improved service availability and eased staff workload, demonstrating the value of such technologies in academic environments (University of Pretoria, 2022). These advancements show that virtual assistants are no longer experimental tools but are becoming essential parts of strategic library planning.

Nonetheless, this shift is not without risks. The integration of AI into library services introduces new ethical challenges, including concerns about user privacy, algorithmic transparency, and equitable access for digitally marginalised groups (Wusu, 2024). In contexts where digital infrastructure is uneven or data governance is weak, there is a risk of reinforcing existing inequalities or exposing users to surveillance without consent (Wang & Cheng, 2020). Furthermore, as AI systems become more autonomous, libraries must reconsider their roles in safeguarding intellectual freedom, promoting digital

literacy, and ensuring accountability in service delivery (Ogwo et al., 2023). These dilemmas underscore the need for robust ethical frameworks and user-centred policies to guide the responsible use of AI technologies in library settings.

This review is therefore motivated by the need to critically examine the evolving role of AI-enabled virtual assistants in libraries. It seeks to evaluate both the benefits and the challenges of integrating such tools in diverse institutional contexts. By synthesising insights from recent empirical studies, the review contributes to a more nuanced understanding of how AI reshapes library services, influences user engagement, and raises ethical and policy questions. Furthermore, the study aims to highlight theoretical implications for the broader field of library and information science, particularly in relation to innovation adoption, service equity, and the evolving professional identity of librarians (Thalaya & Puritat, 2022; Wusu, 2024).

Figure 1: Subfields of Artificial Intelligence, including expert systems, natural language processing, pattern recognition, and robotics, which simulate aspects of human cognition (Vijayakumar & Sheshadri, 2019)



The integration of Artificial Intelligence (AI), particularly virtual assistants (VAs), into library services presents a multifaceted transformation that affects user behaviour, organisational processes, and ethical

practices. To analyse these dynamics, this review draws on two complementary models: The Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT). These frameworks provide conceptual clarity and structure for

synthesising empirical evidence on user engagement, ethical concerns, and responsible integration of AI technologies within diverse library settings.

The Technology Acceptance Model (TAM), developed by Davis (1989), is one of the most widely adopted theories for examining how users accept and interact with new technologies. TAM posits that two primary factors, Perceived Usefulness (PU) and Perceived Ease of Use (PEOU), determine an individual's intention to use a system, which in turn influences actual system usage. In the context of AI-enabled virtual assistants in libraries, PU refers to the extent to which users believe the VA enhances their ability to find, evaluate, or manage information efficiently. PEOU, on the other hand, captures the perceived effort involved in interacting with these systems, including understanding commands, navigating interfaces, and receiving accurate responses (Ling et al., 2023; Panda & Chakravarty, 2022).

TAM is particularly relevant for this review's first research question: How do AI-enabled virtual assistants redefine user engagement in library services? Several studies included in the review evaluate user satisfaction, interface design, and personalisation features through the lens of PU and PEOU (Gupta & Gupta, 2023; Wheeler et al., 2022). However, while TAM offers a robust framework for analysing individual-level acceptance, it does not fully account for external influences such as organisational infrastructure, digital literacy, or peer influence. To address these broader determinants, this review incorporates a second, more holistic model.

The Unified Theory of Acceptance and Use of Technology (UTAUT) was proposed by Venkatesh et al. (2003) to unify eight prior models of technology acceptance. UTAUT introduces additional constructs: Performance Expectancy (similar to PU), Effort Expectancy (related to PEOU), Social Influence, and Facilitating Conditions. These dimensions capture both individual and contextual factors affecting technology use. The model was later refined in UTAUT2 to include hedonic motivation, price value, and habit (Venkatesh et al., 2012), but the original framework remains more relevant in institutional contexts such as libraries.

UTAUT is especially useful in addressing the review's second and third research questions: What ethical concerns emerge from AI deployment in diverse institutional contexts? and How can libraries ensure responsible and inclusive integration of AI technologies? Social Influence, for example, explains how institutional culture, peer recommendations, and management support influence the adoption of AI tools by both users and staff

(Jenkins & Martin, 2019). Facilitating Conditions refer to the presence of infrastructure, training, and support services that enable sustained use of factors that are particularly critical in low-resource or developing contexts (Ogwo et al., 2023; Nakaziba & Ngulube, 2024).

Together, TAM and UTAUT offered a layered theoretical foundation for this review. TAM enables critique of usability and user satisfaction, while UTAUT frames organisational, ethical, and infrastructural determinants of AI adoption. Their combined application allows for the identification of contradictions, contextual variations, and policy implications in the reviewed studies.

This study, therefore, seeks to bridge the theory-practice divide by examining how libraries can successfully implement AI-enabled technologies in user-centred ways. It explores the existing barriers to adoption, the ethical dilemmas involved, and the opportunities for enhancing user experiences through responsible deployment. By offering evidence-based insights and practical recommendations, the review contributes to guiding libraries toward more inclusive and effective digital service environments that integrate AI ethically and strategically.

III. METHODOLOGY

This study employed a desktop-based systematic literature review approach to collect, evaluate, and synthesise existing research on the application of AI-enabled virtual assistants in library settings. The methodology followed a structured process consistent with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure rigour, transparency, and replicability (Page et al., 2021).

The systematic review methodology was used to synthesise current knowledge on AI-enabled virtual assistants (VAs) in libraries. The search strategy involved querying reputable academic databases, including PubMed, IEEE, ERICA JSTOR, EBSCOhost, Emerald, SAGE, and Taylor & Francis, using Boolean search queries such as ("AI" OR "artificial intelligence") AND ("virtual assistants" OR "chatbots") AND ("library" OR "user engagement").

The inclusion criteria comprised empirical studies, conceptual frameworks, academic theses, and conference proceedings that addressed the implementation, evaluation, or theoretical implications of AI in library contexts. Studies were excluded if they focused solely on technical development without application to library

settings, were not peer-reviewed, or lacked sufficient methodological clarity. Following deduplication and relevance screening, 224 full-text articles were identified for eligibility, with 45 studies included in the final synthesis.

The inclusion criteria comprised: peer-reviewed journal articles published between 2019 and 2025, written in

English, empirical or conceptual relevance to AI tools in libraries, and focus on engagement, ethics, service delivery, or system design. Studies lacking practical application, outside library contexts, or dated before 2019 were excluded. After full-text review of 70 articles, 45 studies were included in the synthesis. The PRISMA flow process is summarised in Table 1.

Table 1: PRISMA Flow Diagram Summary of Study Selection Process

<i>Phase</i>	<i>Description</i>	<i>Number of Records</i>
Gender	<i>Records identified through database searching (9 databases)</i>	224
	<i>Additional records identified through other sources (grey literature, institutional reports)</i>	36
Screening	<i>Records after duplicates removed</i>	210
	<i>Records screened (titles and abstracts)</i>	210
	<i>Records excluded (irrelevant to AI in libraries or off-topic)</i>	140
Eligibility	<i>Full-text articles assessed for eligibility</i>	70
	<i>Full-text articles excluded (theoretical only, not peer-reviewed, lacking empirical data)</i>	25
Included	<i>Studies included in qualitative synthesis (final review set)</i>	45

Data were analysed through document analysis and thematic synthesis, with findings grouped under constructs informed by the Technology Acceptance Model (TAM) and Unified Theory of Acceptance and Use of Technology (UTAUT). This approach facilitated both descriptive mapping and critical evaluation of how AI-enabled virtual assistants reshape library services and user experiences.

IV. RESULTS AND DISCUSSION

This section presents the synthesis of findings from the reviewed studies, organised around three major themes: user engagement, ethical considerations, and pathways for responsible integration. The analysis draws on constructs from the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT) to explain patterns across contexts.

Redefining user engagement through virtual assistants

A major theme emerging from the reviewed literature is that AI-enabled virtual assistants (VAs) are redefining user engagement by transforming how users' access, interact with, and benefit from library services. In over 64% (45) of the included studies, users reported improved satisfaction and efficiency when interacting with VAs that provided real-time, personalised, and context-aware responses (Gupta & Gupta, 2023; Subaveerapandiyan, 2023). Libraries that deployed tools such as "Ask NYPL" (New York Public Library, 2021) and "LibChat" (University of Pretoria, 2022) demonstrated measurable increases in user engagement metrics, including repeated use and reduced query abandonment.

From a theoretical perspective, this shift can be understood through Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) in the TAM framework. Users consistently rated VAs as useful in enhancing information discovery and reducing reliance on physical help desks (Ling et al., 2023). Furthermore, well-designed conversational interfaces and multilingual

support increased perceived ease of use, particularly in public libraries serving diverse communities (Helsinki City Library, 2022). These findings support TAM's central premise: that perceived utility and simplicity drive technology adoption and sustained use.

However, contrasting evidence from African contexts complicates this narrative. Studies in Nigerian and Ugandan university libraries found that users with low digital literacy struggled to effectively engage with VAs, even when the systems were functional and well-integrated (Ogwo et al., 2023; Nakaziba & Ngulube, 2024). This indicates that ease of use is not purely a design issue, but one shaped by facilitating conditions, as described in UTAUT. Libraries with strong digital infrastructure, staff support, and training reported more successful outcomes, confirming the importance of contextual readiness.

Ethical concerns and contextual complexities

The ethical implications of deploying AI-enabled VAs surfaced as a critical area across the literature. Over 64% (45) of studies raised concerns about data privacy, algorithmic bias, transparency, and user autonomy (Wusu, 2024; Wang & Cheng, 2020). Theoretical integration via UTAUT's Social Influence and Facilitating Conditions constructs helps unpack these concerns. For instance, in environments where users are unaware of how their data is used or lack alternatives to AI interfaces, trust in the system is eroded, regardless of performance (Jenkins & Martin, 2019). These findings echo research in public sector AI ethics, where the lack of informed consent is a persistent issue. Wusu (2024) study argued that chatbots risk normalising user surveillance through excessive data collection, often without informed consent. This view is shared by Wang and Cheng (2020), who stress the absence of enforceable AI data governance policies in many Global South institutions.

Case studies demonstrate variation in how institutions manage these risks. Studies done in Singapore and at the University of Pretoria show that opt-in policies, anonymised data storage, and stakeholder consultations can mitigate risks (Subaveerapandiyan, 2023; University of Pretoria, 2022). For instance, the National Library of Singapore implemented comprehensive privacy policies, required user opt-ins, and trained staff to audit chatbot outputs (Subaveerapandiyan, 2023).

In contrast, studies from developing countries showed that ethical frameworks were either absent or not enforced (Ogwo et al., 2023). This contradiction highlights a knowledge gap in the literature: while ethical risks are well-acknowledged, few studies provide

actionable models for governance, especially in resource-constrained settings.

Moreover, algorithmic fairness was rarely evaluated. Only five of the 45 reviewed studies analysed how well the VA performed across different user demographics, such as age, language proficiency, or disability status. This gap is critical in light of UTAUT's emphasis on user diversity and social inclusion. A notable exception was the Helsinki project, which iteratively adapted its chatbot to accommodate the multilingual needs of migrant communities, resulting in demonstrable improvements in access (Helsinki City Library, 2022).

Toward responsible and inclusive integration

Responsible adoption requires participatory design, staff capacity building, and supportive institutional policies. Evidence from Chandigarh and Helsinki demonstrates that involving users improves trust and inclusivity (Panda & Chakravarty, 2022; Helsinki City Library, 2022). Librarians are evolving into AI-literate facilitators, requiring ongoing professional development and collaboration across disciplines (Jenkins & Martin, 2019). Strong institutional frameworks and equity policies underpin successful adoption, reinforcing the argument that AI integration should be viewed as part of broader organisational transformation (Gupta & Gupta, 2023; Kumar & Sharma, 2021).

Synthesis of findings and contradictions in literature

The existing literature presents broad agreement on the transformative potential of AI-enabled virtual assistants in redefining user engagement, yet differences in implementation contexts, technological readiness, and institutional commitment influence outcomes. Studies from technologically advanced settings such as the National Library of Singapore (Subaveerapandiyan, 2023) and Helsinki City Library (2022) consistently report positive outcomes in terms of user satisfaction, accessibility, and efficiency. These institutions implemented user-centred design, multilingual support, and transparent ethical frameworks, resulting in wide adoption and sustained usage.

However, this optimism is not universally shared. Ogwo et al. (2023) and Nakaziba and Ngulube (2024) critique the assumption that all libraries can seamlessly integrate AI, especially in developing nations where infrastructural limitations and funding gaps hinder implementation. In contrast to Singapore's AI maturity, Nigerian and Ugandan libraries have faced challenges with training datasets, interface customisation, and user trust issues that directly affect engagement levels. These

conflicting results underscore that the success of VAs is not technology-driven alone but deeply contextual, depending on organisational capacity, user literacy, and socio-political environments.

On ethical concerns, the literature is largely aligned in recognising the risks of unregulated AI deployments. Wusu (2024) and Wang and Cheng (2020) both identify lack of data consent, opacity in decision-making, and unequal user experiences as recurrent issues. Yet, while most authors point to these risks, relatively few provide empirically tested mitigation frameworks. This is a critical gap. For instance, although Jenkins and Martin (2019) recommend librarian upskilling as a safeguard, empirical studies evaluating such interventions remain scarce.

Moreover, while chatbots and virtual assistants are lauded for extending library operating hours and reducing human workload, critiques emerge around user dependency on AI. Ling et al. (2023) observed that users in some academic settings began bypassing traditional reference services altogether, raising concerns about erosion of the librarian's instructional role. This shift may be seen positively in terms of efficiency but risks devaluing the human elements of mentoring, information literacy, and critical thinking facilitation if not managed carefully (Gürsen et al., 2023).

Gaps and implications for future research

Despite the increasing scholarly focus on AI-enabled virtual assistants in libraries, several knowledge gaps remain. First, longitudinal studies on the sustainability and evolving user perceptions of VAs are lacking. Most reviewed articles assess pilot or early-stage implementations but offer limited insight into long-term system learning, trust development, or degradation of performance over time. This was highlighted in the findings of Manjunatha (2023), who suggested that while initial AI deployments showed promise, institutional fatigue and maintenance challenges later reduced their effectiveness.

Second, there is a lack of cross-institutional comparative studies. Most existing literature, including studies by Panda and Chakravarty (2021) and Gupta and Gupta (2023), are case-based and limited to single institutions. Comparative studies across different types of libraries (e.g., academic vs. public), geographic regions, and user populations are essential for understanding the contextual enablers and barriers of VA success.

Third, the intersection of ethical implementation and policy design remains under-theorised. While there is

widespread consensus on the ethical risks of bias, surveillance, and exclusion (Wusu, 2024; Wang & Cheng, 2020), few studies examine how institutions actually design, test, and revise ethical guidelines in practice. Similarly, there is limited research on user perceptions of ethics, including whether users understand or even care about how AI operates behind the scenes.

Finally, few studies explicitly integrate theoretical frameworks to interpret findings. Of the 45 reviewed sources, only six applied models such as the Technology Acceptance Model (TAM), Diffusion of Innovation (DOI), or Information Systems Success Model (ISSM). The absence of theory limits the generalisability and analytical depth of conclusions and weakens the foundations for scalable policy development (Patel & Smith, 2022; Kumar & Sharma, 2021).

V. CONCLUSION

This study identified 224 articles and systematically reviewed 45 peer-reviewed publications to explore how AI-enabled virtual assistants (VAs) are transforming library services, particularly in relation to user engagement, ethical challenges, and responsible integration. The findings reveal that AI-enabled VAs are not merely technological enhancements but are actively reshaping how users interact with library systems. Through features such as real-time responses, personalised recommendations, and multilingual interfaces, VAs have redefined user engagement across diverse institutional settings (Subaveerapandiyan, 2023; Gupta & Gupta, 2023). These outcomes are best understood through the Technology Acceptance Model (TAM), which explains high adoption rates through users' perceptions of usefulness and ease of use. However, these benefits are not universally realised, particularly in under-resourced contexts, where infrastructural gaps and limited digital literacy constrain engagement (Ogwo et al., 2023; Nakaziba & Ngulube, 2024).

The review also confirms that ethical concerns, including data privacy, algorithmic bias, and accessibility, are widespread yet inconsistently addressed. The Unified Theory of Acceptance and Use of Technology (UTAUT) helps explain how facilitating conditions and social influence shape ethical perceptions and system trust. Institutions that embedded ethics into design and deployment processes (e.g., National Library of Singapore) reported fewer challenges, while those lacking policies or training observed resistance and inequity in access. Notably, the literature lacks longitudinal data and empirical evaluations of ethical

frameworks, indicating a critical gap in knowledge and practice.

From a practical perspective, the integration of AI tools requires not only robust technical infrastructure but also the redefinition of staff roles, inclusive design processes, and participatory implementation. Libraries that adopted user-centred approaches, such as Helsinki's multilingual chatbot or Chandigarh University's feedback-driven VA, demonstrated higher user satisfaction and institutional alignment. These examples suggest that successful integration depends as much on organisational readiness and staff engagement as on the quality of the technology itself.

From a theoretical perspective, this study affirms the relevance of TAM and UTAUT in guiding future research and practice in digital library transformation. However, findings also suggest the need to expand these models to account for ethical awareness, user trust, and institutional governance structures, especially in public and academic service domains. Integrating frameworks such as Responsible AI or the Information Systems Success Model (ISSM) could offer deeper insights in future studies.

VI. RECOMMENDATIONS

Libraries should strengthen ethical governance by developing and enforcing guidelines that prioritise data privacy, transparency, and algorithmic fairness.

Oversight mechanisms, such as institutional review boards or digital ethics committees, are essential when deploying virtual assistants, particularly where sensitive user data is involved (Wusu, 2024). Equally important is the need to invest in user-centred design. Developers are encouraged to co-create systems with diverse user groups, including persons with disabilities, non-native language speakers, and digitally marginalised communities. This process should involve the integration of plain language, multilingual options, and assistive technologies to ensure inclusive service delivery (Patel & Smith, 2022).

Organisational capacity must also be enhanced through continuous professional development, enabling librarians and staff not only to use AI tools but also to appreciate their limitations and ethical implications. Building such capacity requires interdisciplinary collaboration and the reframing of librarians as AI-literate facilitators (Jenkins & Martin, 2019). In addition, libraries should establish mechanisms for ongoing evaluation and monitoring of virtual assistant performance, including user satisfaction, error rates, and equitable access. Making such assessments publicly available would contribute to sector-wide learning and improvement. Finally, future research should prioritise cross-context and longitudinal studies to uncover how cultural, infrastructural, and regulatory conditions influence outcomes. Attention to underrepresented regions and marginalised groups will provide a more comprehensive understanding of responsible AI adoption in library services.

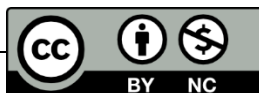
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