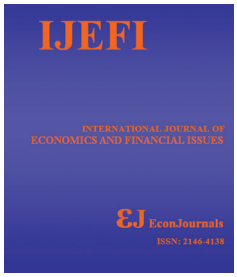

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From Automation to Personalization: A Bibliometric Analysis of Chatbot Adoption in Banking

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ABSTRACT

This bibliometric analysis explores the evolving landscape of chatbot adoption in the banking sector using data sourced from the Scopus database. The study employed advanced bibliometric tools such as Biblioshiny, VOSviewer, and CiteSpace to map the intellectual structure, research trends, and influential contributors in the field. Analysis of scientific output over the years reveals a sharp increase in publications post-2020, indicating rising scholarly interest in banking chatbots. Influential researchers and high-impact journals such as Tolga Cekic and the Lecture Notes in Networks and Systems were identified as key knowledge sources. The global distribution of research showed strong contributions from technologically advanced economies, with notable international collaborations visualized through timezone-based network maps. Co-citation analysis of authors and journals highlighted the foundational and interdisciplinary nature of chatbot research. Bibliographic coupling and keyword co-occurrence patterns underscored the thematic depth of current studies. Thematic mapping revealed well-developed motor themes like NLP and ChatGPT, while basic themes such as AI and customer satisfaction remained underexplored in terms of maturity. Trend topic analysis demonstrated a shift from technological adoption toward user experience and satisfaction in recent years. Overall, the findings illuminate existing research gaps and offer practical implications for future studies aiming to optimize chatbot implementation in banking services.

Keywords: Chatbot, Banking, Bibliometric Analysis, Biblioshiny, VOSviewer, Citespace
JEL Classifications: G2, G21, G24, O3

1. INTRODUCTION

The rapid evolution of digital technologies has significantly transformed the global banking industry (Shkodina et al., 2019; Tashtamirov, 2023). Among the most disruptive innovations are chatbots—AI-powered conversational agents that simulate human-like interactions to perform routine banking services (Chu and Zhan, 2024; Eren, 2021; Mukusheva, 2021). From answering customer queries to helping users complete transactions, chatbots have become a vital component of digital banking strategies, contributing to increased efficiency, personalization, and cost reduction (Alt et al., 2021; Suhel et al., 2020; Vinoth and Chinnasamy, 2024). With their 24/7 availability and consistent service quality, chatbots are reshaping customer service paradigms and driving the move towards intelligent banking solutions (Orifovich, 2025; Sarbabidya and Saha, 2020).

Banks and financial institutions are increasingly adopting chatbot solutions to stay competitive in a digitally driven marketplace (Satheesh et al., 2020; Wu, 2024). These conversational agents not only handle customer service requests but also assist with loan applications, balance inquiries, fraud alerts, and investment recommendations (Asthana, 2022; Petersson et al., 2023). Technologies like Natural Language Processing (NLP), Machine

Learning (ML), and Robotic Process Automation (RPA) have further enhanced chatbot capabilities, allowing for more contextual and sophisticated conversations (Karim et al., 2024; Prabhu and Chanda, 2023). Moreover, chatbots help banks gain actionable insights by analyzing user interactions, thereby informing product development and service enhancements (Shaikh et al., 2023).

While chatbots hold great potential for the banking sector, their implementation does present several challenges (Shaikh et al., 2023). Data privacy, cybersecurity risks, regulatory compliance, and user trust are critical concerns in the field (Biswas, 2020; Lai et al., 2018). Additionally, not all customers feel equally comfortable interacting with AI-driven systems, particularly in regions with lower digital literacy (Ibolya and Alt, 2021). These challenges have led to increased research on user experience, the development of ethical frameworks, and the exploration of hybrid models in which human agents and chatbots work together to provide seamless support (Petersson et al., 2023; Shrimali, 2024). Consequently, there has been a significant increase in both academic and professional interest in the area of banking chatbots (Singh et al., 2025; Wu, 2024).

Given this context, the field has witnessed a surge in scholarly publications exploring various aspects of chatbot deployment in banking (Wu, 2024). Research themes span technological innovations, customer acceptance models, performance evaluations, regulatory concerns, and more (Lai et al., 2018). However, while narrative reviews exist, a systematic bibliometric mapping of this emerging literature is lacking. A bibliometric analysis can provide a quantitative overview of global research trends, leading contributors, collaborations, and intellectual structures within the field (Agac et al., 2023; Agbo et al., 2021).

In the wake of digital transformation, financial institutions are under increasing pressure to innovate and enhance customer experience (Gupta et al., 2023). Chatbots have emerged as a promising digital interface, enabling banks to meet the demands of tech-savvy customers while optimizing operational costs (Gunawan et al., 2024; Karim et al., 2024). As research around this innovation grows, there is a need for a structured understanding of the scholarly landscape to identify influential authors, institutions, and emerging topics (Ibolya and Alt, 2021). Bibliometric analysis offers a strategic method to chart the developmental trajectory of chatbot research in banking, highlighting research gaps and future opportunities.

This bibliometric analysis focuses specifically on scholarly publications regarding the use of chatbots in the banking sector (Barrot, 2023; Cobo et al., 2015). The study primarily utilizes data from the Scopus database to ensure access to high-quality, peer-reviewed literature (Mongeon and Paul-Hus, 2016). It is restricted to documents published between 2017 and 2025, capturing a decade marked by rapid growth in chatbot usage. The analysis includes journal articles, conference papers, and review articles, offering a comprehensive perspective on academic discourse (Dulla et al., 2021; Ellegaard and Wallin, 2015a). The aim of this study is to visualize patterns in publication, author networks, institutional collaborations, and the evolution of themes within this field (Donthu et al., 2021).

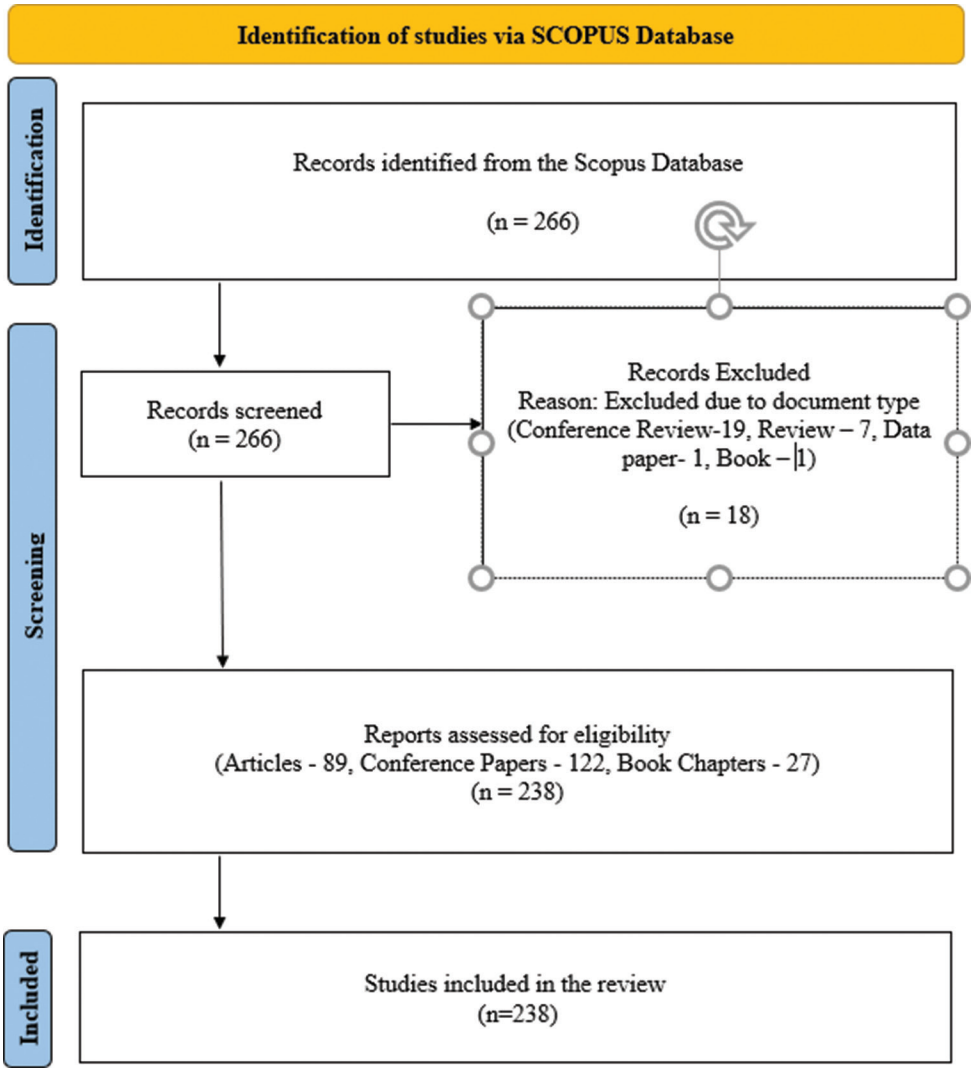
Bibliometric analysis is an analytical research technique quantifying scholarly publications to identify trends, patterns, and structures of knowledge (Alsharif et al., 2020; Ellegaard and Wallin, 2015b; Passas, 2024; Tabash et al., 2025). Using bibliometric methods on chatbot research within finance, this paper strives to comprehend trends in research evolution, globally rank influential contributors, and find thematic clusters (Chamorro-Atalaya et al., 2023). It seeks to respond to key questions relating to which nations drive chatbot research, which journals carry most relevant results, and how research focus has changed with time. Results obtained from this study can guide scholars, practitioners, and policymakers on how to develop future research and development.

Three commonly acknowledged software applications—Biblioshiny, VOSviewer, and CiteSpace—are utilized for this bibliometric study (John et al., 2024; Mathew et al., 2024). Biblioshiny, a web-based framework for the Bibliometrix R package, is an easy and interactive system to perform descriptive and network analyses (Fahamsyah et al., 2023; Komperda, 2017; Souza de Cursi, 2023). It enables the creation of informative measures like yearly scientific production, citations, trends for keywords, and author impact factors (Thangavel and Chandra, 2023; Waghmare, 2021). Biblioshiny is especially beneficial for users without extensive coding skills, and it makes bibliometric analysis easier and customizably accessible (Cherian et al., 2024; Huang et al., 2021).

VOSviewer and CiteSpace are complementary to Biblioshiny by adding strong scientific mapping and visualization capabilities (Ding and Yang, 2022; Li et al., 2022). VOSviewer is specifically tailored for the creation and investigation of bibliometric networks such as co-authorship, co-citation, and keyword co-occurrence maps (Abbas et al., 2021; Alam et al., 2025; Gupta and Chakravarty, 2021). VOSviewer offers rich visual maps of networks that expose structure and relationships in the literature (Ayodele et al., 2025; Kumar et al., 2024). CiteSpace, however, is aimed at discovering emerging trends and turning points of research development (Yang et al., 2017; Xie and Li, 2020). CiteSpace facilitates timeline visualization, burst discovery, and cluster analysis of cited references, and can identify turning points and influential studies within chatbot-related banking literature (Zang et al., 2022; Zhang, 2023).

The main aim of this study is to perform an extensive bibliometric overview for mapping research trends on chatbots within the banking industry. This entails reviewing trends of publications over time and determining the leading authors, institutions, and nations publishing within the area. The study also aims to identify leading cited publications and core journals serving key outlets for publishing research on banking chatbots. In addition, it aims to map collaboration networks and intellectual structure of the field based on co-citation and bibliographic coupling. Through examining thematic developments and determining emerging trends of research, the study aims to provide strategic recommendations and insights guiding future research and practical developments within the domain of chatbot applications within banking.

Figure 1: The PRISMA flow diagram is used to identify, screen, and include papers in the bibliometric analysis



2. MATERIALS AND METHODS

The bibliometric dataset for this study was extracted from the Scopus database, widely acknowledged for its extensive coverage of peer-reviewed scientific publications (Gavel and Iselid, 2008). A targeted search strategy was formulated using the query (TITLE-ABS-KEY (chatbot) AND TITLE-ABS-KEY (banking) OR TITLE-ABS-KEY (bank)) to retrieve literature specifically focused on the use of chatbots in the banking domain. This initial search yielded 266 records, including journal articles, conference papers, and book chapters. To ensure the relevance and consistency of the dataset, non-analytical formats such as reviews, conference reviews, data papers, and books were excluded through a systematic screening process. Following this refinement, a total of 238 documents—comprising 89 journal articles, 122 conference papers, and 27 book chapters—were retained for analysis, in line the PRISMA framework as illustrated in Figure 1 (Wang et al., 2014).

The cleaned dataset was exported in both CSV and RIS formats to enable detailed analysis using Biblioshiny (Bibliometrix R package), VOSviewer, and CiteSpace (version 6.2. R3 Advanced). Each software tool served a specific purpose in the bibliometric workflow: Biblioshiny facilitated descriptive and trend analyses related to publication volume, author productivity, and source impact; VOSviewer enabled the creation of bibliographic coupling networks and visual representation of keyword co-occurrence patterns; and CiteSpace was used to detect citation bursts and trace thematic shifts over time. Together, these tools allowed for a comprehensive, multi-dimensional examination of the research landscape, highlighting influential contributors, collaborative networks, and emerging trends in chatbot-related studies within the banking sector.

3. FINDINGS

3.1. Key Information Regarding the Investigation

The main information of the investigation highlights a rapidly expanding body of research on chatbots in the banking sector between 2017 and 2025, as evidenced by an impressive annual growth rate of 43.52%. A total of 238 documents sourced from 185 journals, books, and other scholarly outlets were analyzed, with an average document age of 2.42 years, indicating the recency and relevance of the research. Each document received an average of 19.74 citations, and collectively the dataset contained

8,336 references, reflecting significant scholarly engagement. In terms of content, 1,120 Keywords Plus and 712 author-supplied keywords were identified, showcasing thematic diversity. Authorship data revealed contributions from 1,157 authors, with only 14 single-authored documents, suggesting a strong trend toward collaborative research. On average, there were 5.14 co-authors per paper, and 17.23% of the documents involved international co-authorship, pointing to the global interest in the topic. The publication types included 89 journal articles, 27 book chapters, and 122 conference papers, indicating a balanced distribution across formal and emerging research forums.

3.2. Scientific Output Over the Years

Figure 2 illustrates the annual scientific production on chatbots in the banking sector, highlighting a clear upward trend in publication volume over the years. Starting with a minimal output of just 2 articles in the initial year, the number of publications steadily increased, with notable jumps observed in subsequent years, particularly after the mid-point of the timeline. From 16 and 23 articles in the early productive years, the output rose significantly to 52 articles, then peaked at 60 in the following year, indicating a heightened scholarly interest and rapid growth in this research domain. Although there is a slight dip to 36 articles in the most recent year, the overall trajectory demonstrates a substantial and sustained rise in research activity, reflecting the increasing relevance and integration of chatbot technologies in the banking industry.

3.3. Top Influential Researchers

Table 1 presents the top influential researchers contributing to the field, based on the number of publications. Leading the list are Cekic, Tolga; Deniz, Onur; and Dündar, Enes Burak, each with four published articles, indicating a consistent and active engagement in this research domain. Following closely are Chang, Yung-Ju; Kilic, O. Fatih; Law, Effie Lai-Chong; and Manav, Yusufcan, each contributing three publications, highlighting their notable scholarly involvement. Researchers such as Abdelhamid, Sherif; Abdulla, Hussam; and Agarwal, Samarth have also made valuable contributions with two publications each. The presence of multiple authors with recurring publications signifies a developing core group of researchers who are shaping the direction and discourse of chatbot-related studies in the banking sector.

3.4. Prominent Scientific Journals

Table 2 lists the most prominent scientific journals and conference proceedings that have significantly contributed to the dissemination of research on chatbots in the banking sector. "Lecture Notes in Networks and Systems" leads with 10 published articles, followed by the "ACM International Conference Proceeding Series" with 8 articles and "Lecture Notes in Computer Science," which includes its subseries in Artificial Intelligence and Bioinformatics, with 7 articles. Other notable sources include "AIP Conference Proceedings" (6 articles) and "Advances in Intelligent Systems and Computing" (3 articles), highlighting the interdisciplinary nature of the field. Journals such as the "International Journal of Bank Marketing," "International Journal of Human-Computer Interaction," and "Journal of Financial Services Marketing" also appear with 3 publications each, indicating a growing academic interest in the practical and user-centered aspects of chatbots. The inclusion of "Applied Sciences (Switzerland)" and "CEUR Workshop Proceedings" demonstrates the relevance of both applied research and early-stage exploratory studies in this emerging domain.

Figure 2: Annual scientific production from 2017 to 2025

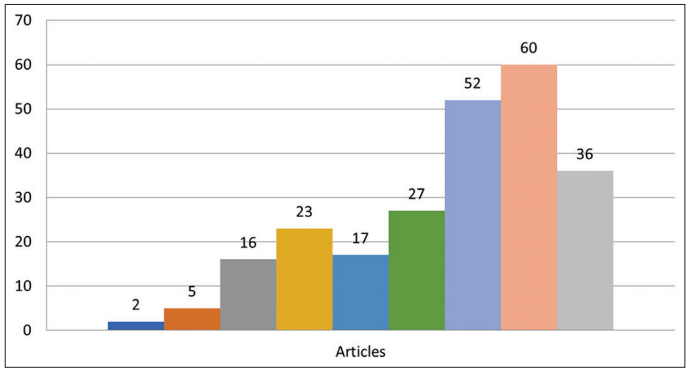


Table 1: Most relevant authors

Authors	Articles
Cekic, Tolga	4
Deniz, Onur	4
Dündar, Enes Burak	4
Chang, Yung-Ju	3
Kilic, O. Fatih	3
Law, Effie Lai-Chong	3
Manav, Yusufcan	3
Abdelhamid, Sherif	2
Abdulla, Hussam	2
Agarwal, Samarth	2

Table 2: Prominent scientific journals

Sources	Articles
Lecture Notes in Networks and Systems	10
ACM International Conference Proceeding Series	8
Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes In Bioinformatics)	7
AIP Conference Proceedings	6
Advances in Intelligent Systems and Computing	3
Applied Sciences (Switzerland)	3
International Journal of Bank Marketing	3
International Journal of Human-Computer Interaction	3
Journal of Financial Services Marketing	3
CEUR Workshop Proceedings	2

3.5. Global Research Contributions by Nation

Table 3 highlights the leading countries contributing to scientific research. India stands out as the most prolific contributor with 90 documents, demonstrating its strong academic engagement and growing technological focus in financial innovations. The United States follows with 26 publications, reflecting its established research infrastructure and interest in AI-driven banking solutions. The United Kingdom ranks third with 17 documents, showing consistent contributions from Europe. Other active nations include Taiwan (11), Indonesia (10), and the United Arab Emirates (10), suggesting expanding research efforts in Asia and the Middle East. Additionally, countries like Turkey (9), Brazil (7), Saud Arabia (7),

and Vietnam (7) are also making notable contributions, indicating a broad global interest in exploring chatbot applications for banking across diverse economic and technological landscapes.

3.6. Timezone Network Visualization of Countries' Collaborations

Figure 3 presents a timeline network visualization of international collaborations in research, structured into three major clusters based on shared citation patterns. The largest cluster, Cluster #0 (USMLE STEP), includes 13 countries with a silhouette value of 0.713, indicating moderate thematic coherence. This cluster shows significant scholarly output from India (89 citations), followed by the United Kingdom (15) and Turkey (9), making India the most influential contributor in this group. Major studies in this cluster address chatbot applications in banking and technology acceptance, including highly cited works by Mogaji (2021) and Ahmed (2022). These studies span topics such as user interaction, system evaluation, and adoption intent—primarily grounded in the financial services context and emerging markets.

Cluster #1 (ACCOUNTING ASSESSMENT), with 11 members and a high silhouette value of 0.893, represents a highly cohesive group of countries focused on chatbot use in educational and evaluative contexts, particularly in accounting. Taiwan (11 citations) and the United Arab Emirates (10) emerge as the leading contributors in this cluster, alongside Canada and Norway. The research themes revolve around AI chatbot accuracy, user trust, and educational assessments, with standout publications from Wood et al., (2023) and Ndukwe et al., (2019). Cluster #2, also labeled USMLE STEP, includes 9 countries with strong citation influence from the United States (26 citations), underscoring its central role. This cluster links medical education, chatbot resistance, and user interaction design, including landmark papers like Gilson et al., (2023) which explores ChatGPT's performance in medical exams. The visualization highlights not only the interdisciplinary nature of chatbot research but also the geographically diverse centers of influence and collaboration shaping its development.

Table 3: Countries scientific productions

Country/Territory	Documents
India	90
United States	26
United Kingdom	17
Taiwan	11
Indonesia	10
United Arab Emirates	10
Turkey	9
Brazil	7
Saudi Arabia	7
Viet Nam	7

3.7. Network Visualization of Co-citation of Cited Authors

Figure 4 presents a comprehensive co-citation analysis of cited authors, revealing 10 thematic clusters. The largest, Cluster #0: Underlying Sustainable Development, consists of 61 members and centers on themes like trust, usability, and continuance intention in chatbot services. Highly cited authors in this group include Venkatesh V (25) and Fornell C (18), whose models like TAM and customer satisfaction theory guide much of the research. The citing articles in this cluster, such as those by Nguyen et al., (2021) and Upadhyay and Kamble (2024), emphasize sustainable chatbot implementation in financial services, indicating a strong overlap between behavioral adoption theory and long-term usage frameworks.

Cluster #1: MICMAC Approach, comprised of 59 members with a silhouette value of 0.738, deals with assessing barriers for adopting chatbots, especially in developing markets. Strong influencers here are Trivedi J (27) and Hair JF (25), indicating a methodological orientation involving ISM-MICMAC and SEM approaches.

Figure 3: Timeline Network visualization of countries' collaborations

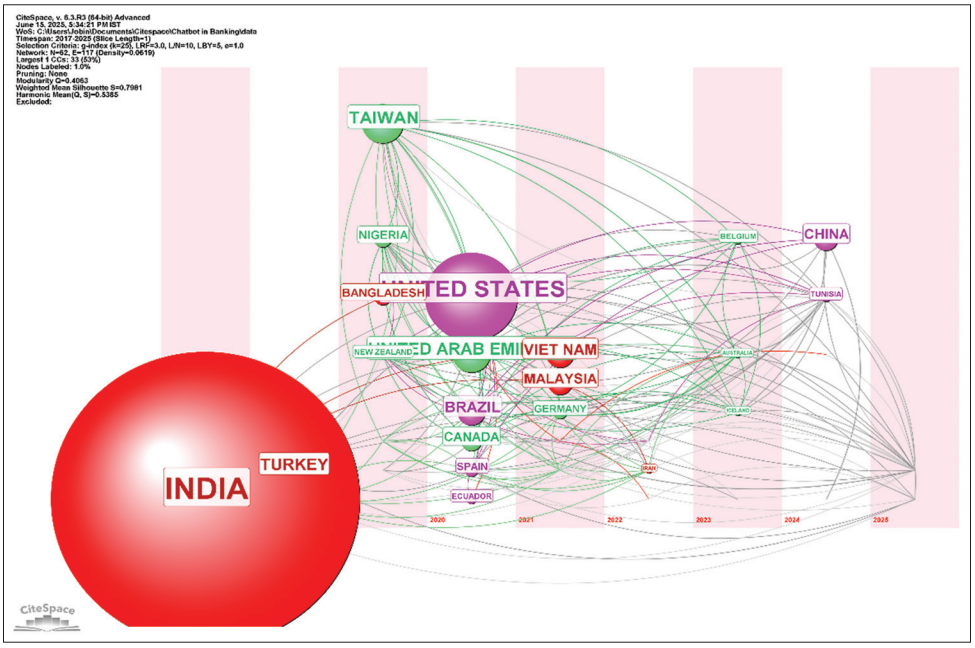
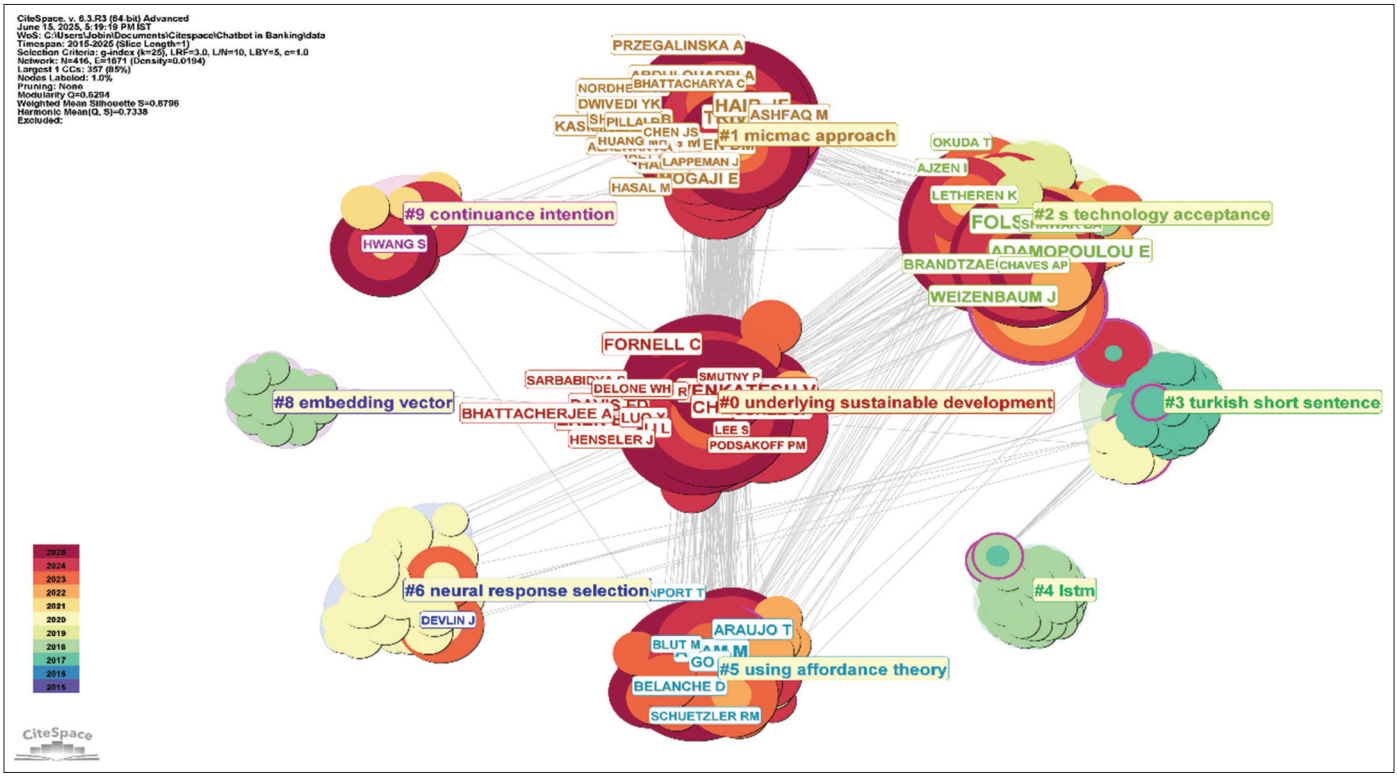


Figure 4: Network visualization of co-citation of cited authors



Here, perceived risk, service quality, and attitude among users are addressed, which can be seen from seminal works such as Mehrolia et al., (2023) and Bansal et al., (2024). The cluster indicates an increased research focus on utilizing structural modeling and decision science instruments for investigating complexities behind chatbot adoption.

Cluster #2: Technology Acceptance with 57 members and silhouette value of 0.87 focuses on user attitudes and design attributes of chatbot trust and usability. Principal cited authors are Folstad A (30) and Adomopoulou E (20), characterized by a movement towards conversational design, anthropomorphism, and human-AI interaction. Citing Law (2022) and Mogaji (2021) examine how human-likeness of various features in bots translates into consumer trust, acceptance, and satisfaction. This cluster indicates how convergence of psychology, human-computer interaction, and consumer behavior determines chatbot efficacy.

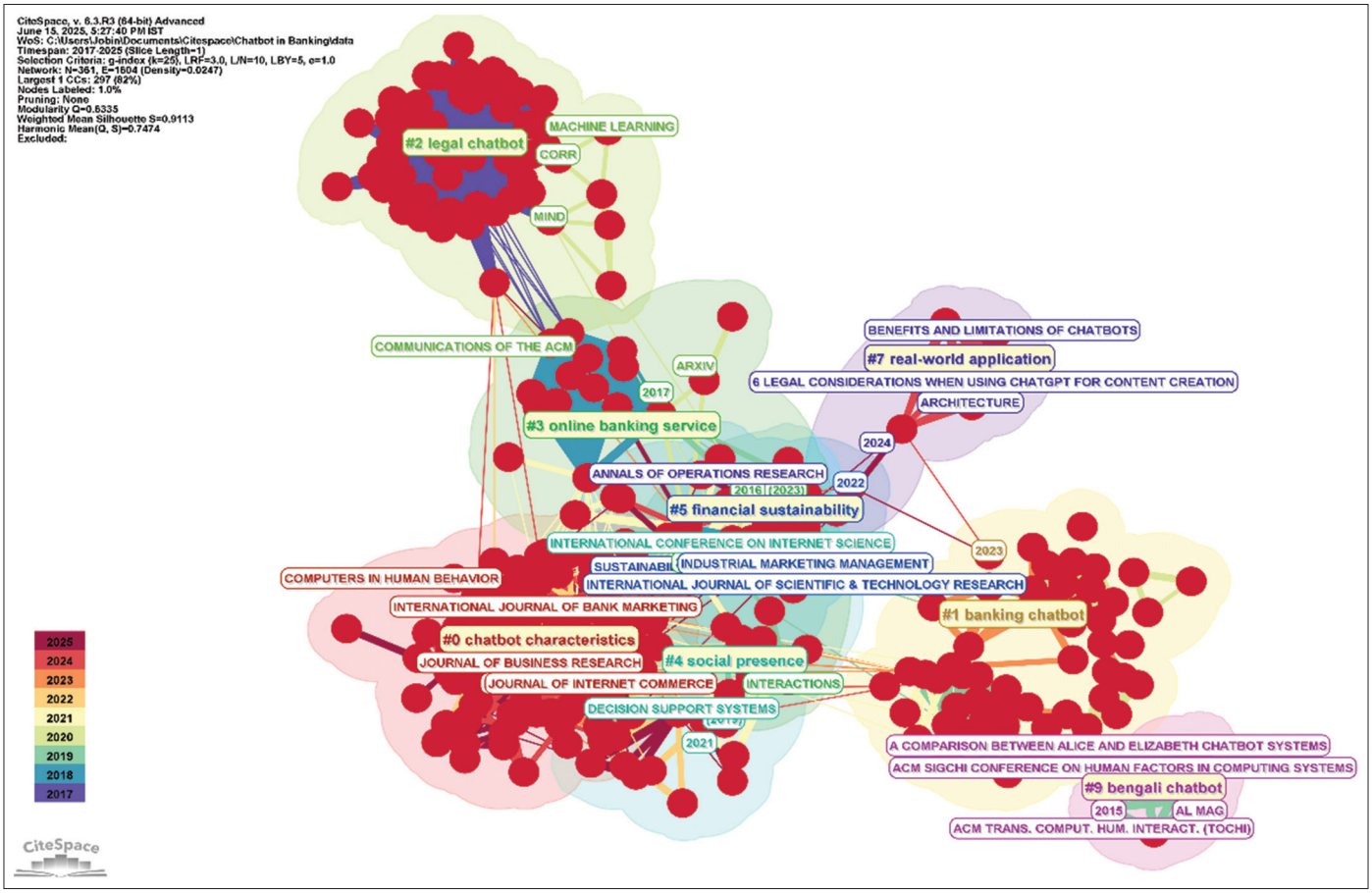
Other notable clusters include Cluster #3 (Turkish Short Sentence) and Cluster #4 (LSTM), which orient themselves towards linguistic modeling and deep learning. Mikolov T and Sutskever I are key authors mentioned here, proposing a technology focus on NLP, embeddings, and conversational systems based on AI. Cluster #5 (Affordance Theory) bridges marketing and cognitive psychology, referring to authors such as Adam M (20) and Araujo T (13) to learn how chatbot capabilities get converted to user effects such as loyalty. Smaller yet impressive clusters such as Cluster #6 (Neural Response Selection), Cluster #8 (Embedding Vector), Cluster #9 (Continuance Intention), and Cluster #12 (Adoption) also contribute to the multidimensionality of the field—with topics ranging from legal applications and education to marketing automation and regional adoption models. Taken together, the figure reflects a strong and multidisciplinary research terrain, combining theory, technology, and human behavior.

3.8. Network Visualization of Co-citation of Cited Journals

Figure 5 illustrates the network visualization of co-cited journals, structured into nine thematic clusters. The largest, Cluster #0: Chatbot Characteristics, contains 93 members and focuses on factors influencing user interaction, trust, and satisfaction with banking chatbots. Journals such as the International Journal of Bank Marketing (40 citations), Computers in Human Behavior (32), and Journal of Business Research (32) dominate this cluster, indicating a strong focus on user-centered design, marketing psychology, and consumer behavior. Citing articles like those by Upadhyay and Kamble (2024) and Nguyen and Le (2025) emphasize the behavioral and motivational aspects of chatbot usage, reflecting this cluster's grounding in service design and adoption theory.

Cluster #1: Banking Chatbot with 62 members and a high silhouette value of 0.958, centers around chatbot functionality, language preferences, and customer retention strategies. Key citing works, such as Li et al. (2023) and Lee and Li (2023), focus on affordance theory and loyalty formation through AI interfaces in banking. While this cluster shares thematic overlap with Cluster #0, its emphasis leans more on system features and cross-cultural adoption. In contrast, Cluster #2: Legal Chatbot (55 members) focuses on ethics, privacy, and the regulation of chatbot usage. Leading cited journals here include Communications of the ACM (12) and arXiv (9), with articles like Queudot et al. (2020) and Henderson et al. (2019) underscoring legal implications and neural

Figure 5: Timezone Network visualization of co-citation of cited journals



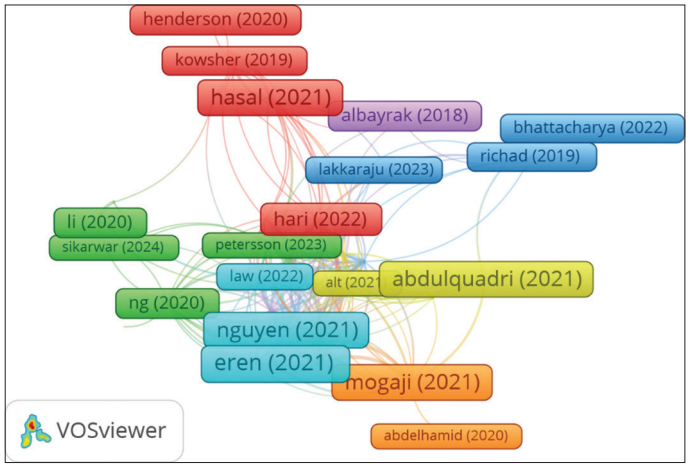
response selection systems—highlighting interdisciplinary interest at the intersection of law, computing, and social impact.

The remaining clusters showcase more specialized or emerging subfields. Cluster #3: Online Banking Service (28 members) features work focused on customer satisfaction and e-banking utility, citing Web Intelligence and IJCESEN, while Cluster #4: Social Presence explores psychological dimensions of interaction, referencing journals like Decision Support Systems. Cluster #5: Financial Sustainability includes journals like Sustainability (33 citations), emphasizing long-term technological adoption. Smaller but distinct clusters such as Cluster #7: Real-World Application, Cluster #9: Bengali Chatbot, and Cluster #11: Smart Banking reflect emerging geographical, linguistic, and technical applications of chatbots, with cited sources like Lecture Notes in Networks and Systems and Journal of Financial Services Marketing. Overall, the figure reveals a rich, multidisciplinary landscape grounded in marketing, information systems, behavioral psychology, and emerging regulatory frameworks.

3.9. Network Visualization of Bibliographic Coupling of Documents

Figure 6 illustrates the bibliographic coupling of documents, based on a minimum citation threshold of 10. Out of 238 total documents, 69 met this criterion, and 52 were interconnected within a bibliographic network composed of 8 distinct clusters. Each cluster represents a group of documents that share common references, signifying thematic alignment or intellectual proximity.

Figure 6: Network visualization of citation of documents



For example, Cluster 1 (Red) consists of authors such as Hasal et al. (2021), Kowsher et al. (2019), and Henderson et al. (2019), implying a solid conceptual framework and technological considerations for chatbot adoption. Cluster 2 (Green) consists of authors such as Li et al. (2020), Sikarwar et al. (2024), and (Ng et al. (2020), presumably discussing user interaction, digital banking systems, or adoption behavior.

Cluster 3 (Blue) and Cluster 4 (Yellow), including authors like Bhattacharya & Sinha (2022) and Abdulquadri et al. (2021) respectively, reflect theme areas like AI architecture within

banking and chatbot functionality or trust models. Such other notable clusters are Cluster 6 (Cyan) with densely interconnected authors like Nguyen et al. (2021) and Eren (2021), perhaps on customer satisfaction or geography-specific uses of chatbots. Cluster 7 (Orange) includes Mogaji et al. (2021) and Abdelhamid and Katz (2020), suggesting marketing or psychological aspects of chatbot deployment. The map reveals how scholarly work in this domain is organized into coherent thematic blocks, with a few bridging authors like Hari et al. (2022) and Law et al. (2022) playing integrative roles across clusters, indicating an evolving and collaborative research landscape.

3.10. Network Visualization of Co-occurrence of Author Keywords

Figure 7 presents a co-occurrence network of author keywords, illustrating the conceptual structure of chatbot-related banking research. Out of 712 keywords, 28 met the minimum occurrence threshold of 5, and these were mapped into four distinct clusters based on their frequency and interconnections. This network, visualized using VOSviewer, captures how frequently certain keywords appear together in the same documents, highlighting thematic relationships and core areas of scholarly interest.

Cluster 1 (Red) is the largest and centers on "artificial intelligence," "chatbots," and "customer satisfaction," connected with terms like "customer service," "banking industry," "banks," "financial services," and "fintech." This suggests a strong emphasis on practical applications of AI-driven chatbots in enhancing customer relations and operational efficiency within financial institutions. Cluster 2 (Green) is built around technical innovations and includes "natural language processing," "machine learning," "chatgpt," "conversational agent," "large language models," and "medical education," indicating an academic focus on intelligent conversational systems and their broader interdisciplinary implications.

Cluster 3 (Blue) is dominated by the central keyword "chatbot," along with "banking," "trust," "technology acceptance," and "artificial intelligence (AI)," pointing to user-centered research around acceptance models and trust in automated banking systems. This cluster bridges technical design and human interaction, making it integral to understanding user adoption. Cluster 4 (Yellow) includes terms such as "virtual assistant," "AI," and "banking sector," which appear slightly peripheral but conceptually linked, possibly indicating foundational or emerging themes related to automation and service personalization. Overall, the network reveals that "chatbot" (99 occurrences) and "artificial intelligence" (58) are the most dominant keywords, underscoring their central role in the discourse. The map reflects both the technological underpinnings (e.g., NLP, ML, LLMs) and application-level concerns (e.g., customer experience, trust, banking services), indicating a well-rounded and evolving research field with significant interdisciplinary engagement.

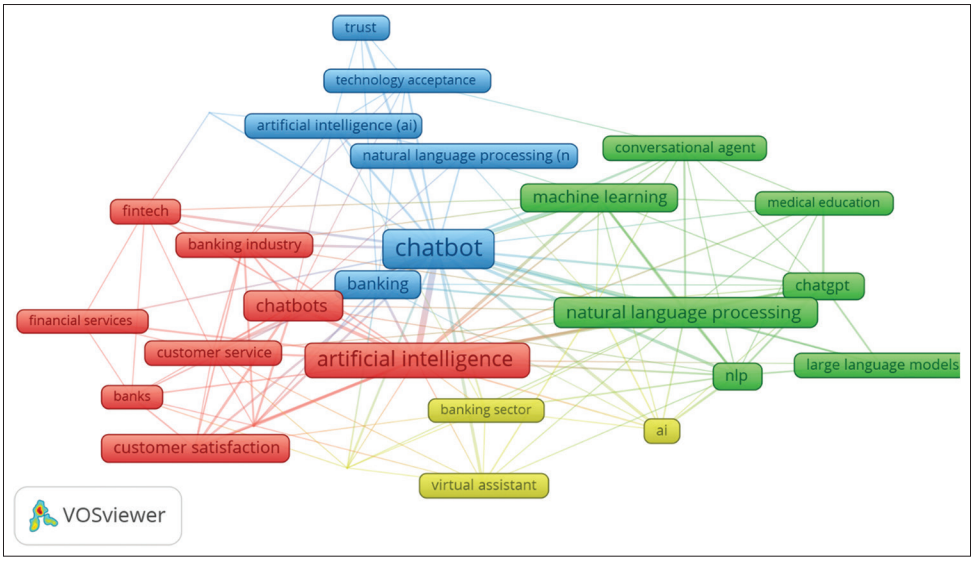
3.11. Thematic Evolution

Figure 8 illustrates the thematic evolution of research from 2017 to 2025, highlighting how scholarly focus has shifted and expanded over time. During the 2017-2021 period, early research themes were centered around foundational technologies and applications such as chatbot, AI, natural language processing (NLP), deep learning, conversational agents, digital transformation, and banking, reflecting an exploratory phase in integrating AI-driven tools into financial services.

In the 2022-2023 phase, the themes became more refined and focused, with "chatbot" remaining central, while financial services, banking, and artificial intelligence solidified as core areas of application and investigation. The appearance of both singular ("chatbot") and plural ("chatbots") forms in this period may suggest diversified implementations and broader academic discourse around user experiences, platforms, and tools.

By 2024, the field experienced a thematic branching. While chatbot continues as a core term, newer themes such as ChatGPT, customer experience, and medical education emerge, indicating an interdisciplinary expansion and the influence of advanced conversational models. Finally, in 2025, the focus shifts towards more cutting-edge and specific domains like artificial intelligence,

Figure 7: Co-occurrence of author keywords



large language models, natural language processing, and continued interest in chatbots and customer experience. This progression underscores the growing sophistication and sectoral penetration of chatbot technologies, from basic automation in banking to broader AI-driven transformations impacting various domains.

3.12. Thematic Map

Figure 9 provides an elaborate thematic map of clusters of keywords based on two axes—centrality, i.e., how relevant it is to the field, and density, i.e., development or maturity of theme. This strategic map indicates how different themes of research are positioned according to their relative importance and stage of development. The quadrants—Motor Themes, Basic Themes, Niche Themes, and Emerging or Declining Themes—emphasize intellectual structure and evolution of the field.

In the upper right quadrant of Motor Themes, we see some of the most powerful and established topics including NLP, ChatGPT, large language models, medical education, generative AI, and banking and finance. They are not only core to the discipline and also highly internally coherent, suggesting that these are highly developed and driving future research. Their location here implies interdisciplinary evolution, particularly with topics like personalization and medical education coming into play, potentially broadening applications for chatbots outside normal banking.

The Basic Themes (lower right) are key concepts like chatbot, chatbots, artificial intelligence, machine learning, banking, customer satisfaction, and deep learning. These are very central and constitute the foundation layer of studies regarding this field of study but are relatively less advanced in terms of theme development. Their strategic placement indicates that although these are commonly cited and essential to the literature, there is considerable scope for greater theoretical and empirical precision, especially regarding applications and impact analyses.

In contrast, the Niche Themes (upper left) like anthropomorphism, ECM (Expectation Confirmation Model), user study, and mobile banking are well-developed but less central. These areas are of specialized interest and may gain prominence as chatbot interfaces evolve to become more human-like and adaptive. Finally, the Emerging or Declining Themes (lower left) such as cognitive computing and social competency show low development and low relevance, suggesting they may either be nascent topics awaiting deeper exploration or previously studied areas that are losing academic interest. Collectively, this visualization provides

Figure 8: Thematic evolution of research in chatbots in the banking sector

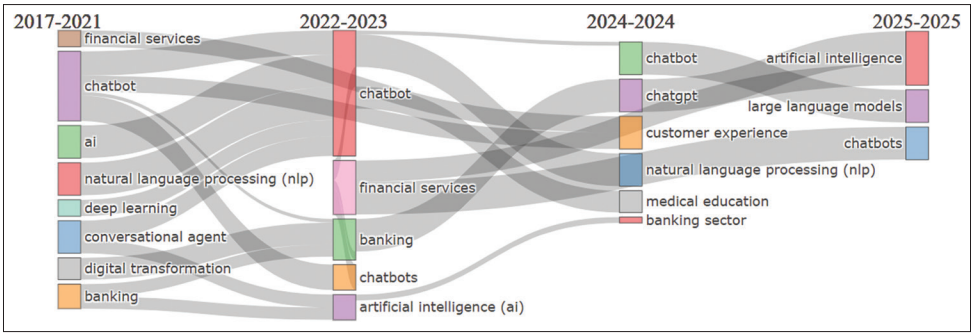


Figure 9: Thematic visualization of keywords

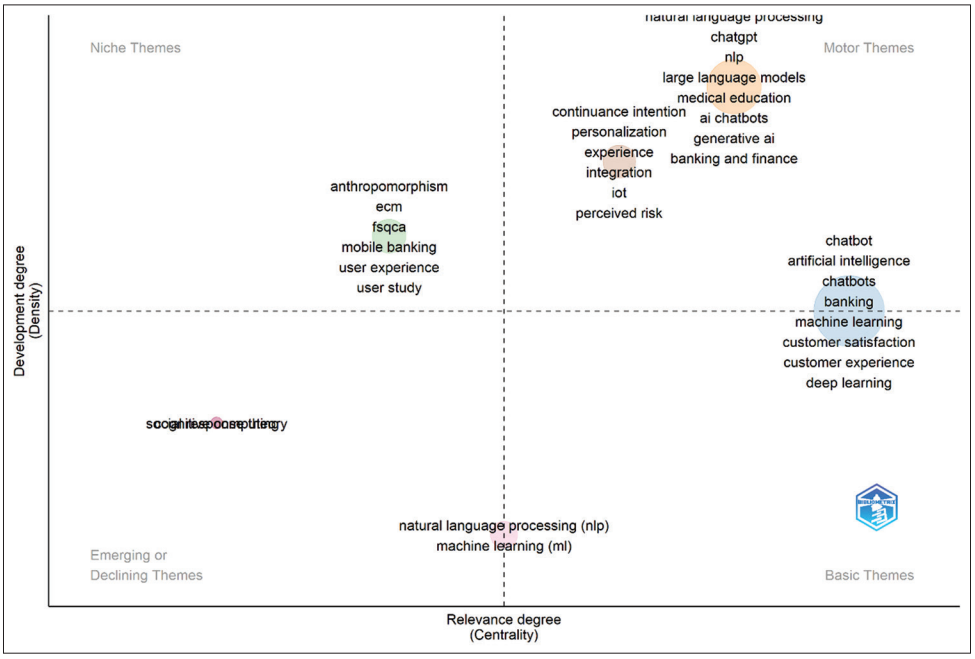
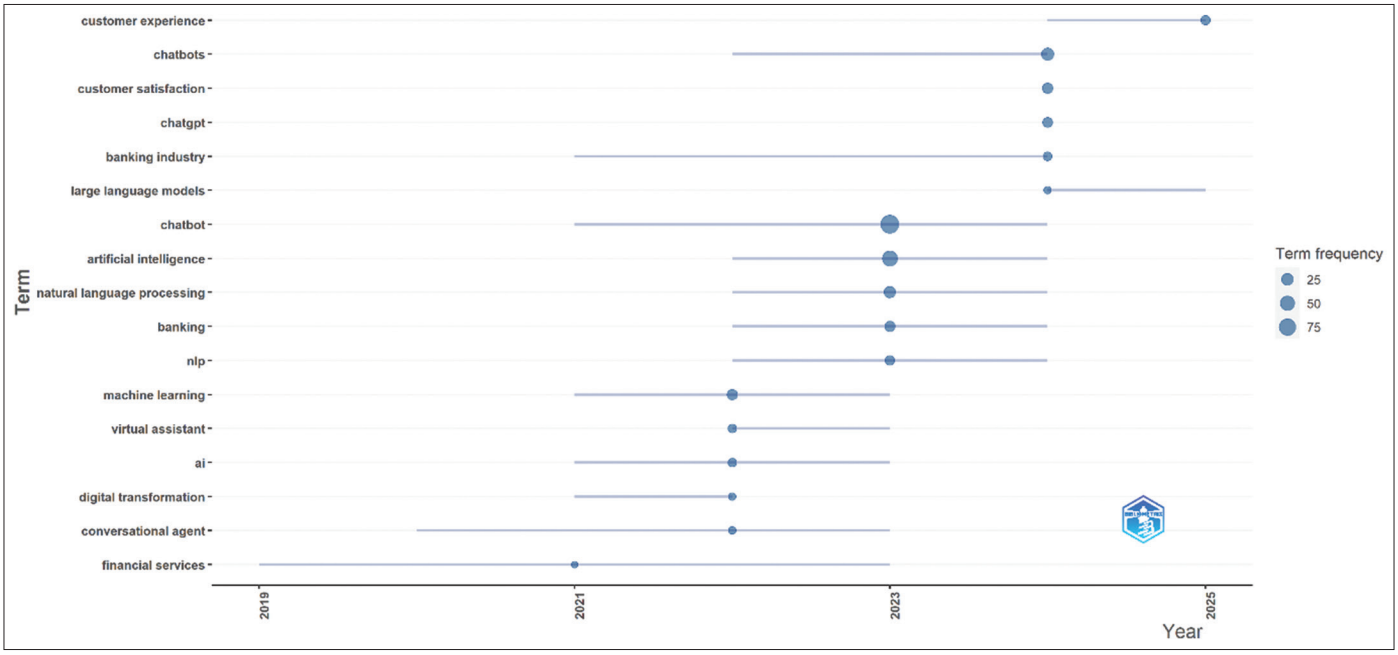


Figure 10: The evolution of trend topics in chatbot-related banking research



a roadmap for identifying mature topics, emerging directions, and underexplored gaps in the research landscape.

3.13. Trend Topics

Figure 10 illustrates the evolution of trend topics from 2019 to 2025, emphasizing the frequency and emergence of key terms over time. The horizontal lines show when each term began appearing in the literature, while the size of the bubbles indicates the frequency of usage, with larger bubbles representing more prominent research interest. Initially, terms like "financial services," "digital transformation," "conversational agent," and "AI" appeared around 2019-2020, reflecting the foundational technological and industry context for chatbot applications. Over time, these broad concepts gave way to more specific, high-frequency themes such as "chatbot," "artificial intelligence," "natural language processing," "banking," and "machine learning," especially during the 2021-2023 period. These terms represent the core technologies and sectors where chatbots are most actively studied.

From 2022 onward, the emergence of terms like "ChatGPT" and "large language models" signals a shift toward more advanced and specialized technologies, particularly in response to the development of generative AI tools. Simultaneously, the banking industry itself has become a more targeted focus of research, highlighting the practical implementation of chatbots within this domain. By 2024-2025, the research focus further shifts toward user experience and satisfaction, as seen in the rise of terms like "customer satisfaction," "customer experience," and the pluralized "chatbots." These suggest a growing academic interest in evaluating the human side of chatbot interactions—how users perceive, engage with, and are affected by AI-powered banking tools. Overall, the trend data reflects a progression from technological foundation to real-world application and user-centered evaluation in chatbot research.

4. DISCUSSION

The bibliometric analysis of chatbots in banking reveals a rapidly expanding and vibrant research landscape marked by a 43.52% annual growth rate in publications. The dataset, consisting of 238 documents and over 1,100 authors, demonstrates a strong collaborative ethos and increasing global academic engagement. India, the United States, and the United Kingdom emerged as leading contributors, while core researchers such as Cekic, Deniz, and Dundar were notable for their publication frequency. Prominent publication outlets include Lecture Notes in Networks and Systems, ACM International Conference Proceedings, and International Journal of Bank Marketing, reflecting both technical and applied interests in chatbot adoption.

Network analyses uncovered rich intellectual structures through co-citation and bibliographic coupling. Research clusters focused on topics such as technology acceptance, customer trust, service personalization, and performance assessment. Influential authors like Venkatesh, Folstad, and Trivedi have shaped foundational theories and user behavior models in this domain. Journals like Computers in Human Behavior, MIS Quarterly, and Sustainability serve as key platforms for interdisciplinary discourse, bridging information systems, business strategy, and sustainable innovation. The mapping of these connections highlights the presence of mature theoretical frameworks alongside growing empirical exploration.

Thematic mapping and keyword co-occurrence patterns indicate strong emphasis on artificial intelligence, natural language processing, customer satisfaction, and trust in banking applications. Conceptual clusters show a division between foundational technologies (e.g., NLP, ML, LLMs) and user-centred themes (e.g., trust, acceptance, customer experience). Newer keywords such as "ChatGPT" and "large language models" reflect a shift in scholarly attention toward generative AI, showcasing how the

field is responding to recent technological advancements. Research outputs increasingly explore human-AI dynamics, privacy, and the effectiveness of chatbot interactions in banking scenarios.

Temporal analyses of thematic evolution and trend topics reveal a movement from generalized AI and digital transformation discussions toward domain-specific, customer-focused applications. Over the years, the literature has grown from investigating the feasibility of chatbot systems to evaluating their design, adoption, and impact on user behavior. Key areas like virtual assistants, anthropomorphism, and cognitive computing have emerged as potential research frontiers, while topics like mobile banking and user study remain less central yet relevant. Collectively, these findings illustrate a mature yet evolving research domain that integrates technological innovation with behavioral and managerial insights, offering pathways for impactful future studies in banking and beyond.

5. RESEARCH GAPS AND PRACTICAL IMPLICATIONS

The thematic map highlights both well-established and underdeveloped areas in the research landscape of chatbot adoption in banking. A notable research gap exists in the Basic Themes quadrant—despite the central importance of topics like artificial intelligence, machine learning, deep learning, and customer satisfaction, these remain relatively underdeveloped. This suggests a need for more empirical work that examines how these technologies translate into tangible user benefits and operational efficiencies in real banking environments. Furthermore, the Niche Themes such as anthropomorphism and ECM, though mature, are not yet central to the field, indicating missed opportunities for integrating psychological and behavioral theories to better understand user-chatbot interaction dynamics, trust-building, and long-term engagement. Emerging or declining themes like cognitive computing and social competency are also underexplored, and could provide rich insights into the ethical, cognitive, and social dimensions of chatbot use, particularly with increasing reliance on conversational AI in sensitive financial contexts.

The trend topic analysis points toward a practical implication: research is evolving from technological exploration to human-centric evaluation, yet there is a lag in systematically studying long-term user experience, privacy concerns, and personalization in chatbot services. While new technologies like ChatGPT and large language models are gaining rapid academic interest, there is insufficient research linking these tools to measurable improvements in banking service quality, security, and inclusiveness. Additionally, despite the rise in interest around customer satisfaction and experience in recent years, there is a lack of longitudinal studies that track changes in user behavior or institutional performance post-chatbot implementation. These gaps present opportunities for researchers and practitioners to develop holistic frameworks that incorporate advanced technologies with nuanced user needs and regulatory concerns, ensuring that chatbot deployment is not just efficient but also ethical, inclusive, and trust-driven.

6. CONCLUSION

This bibliometric study on chatbot adoption in banking demonstrates a growing and increasingly dynamic research area shaped by advancements in artificial intelligence and the digital transformation of financial services. Results confirm mounting scholarly interest from various nations, with significant advances within domains such as natural language processing for chatbots, customer satisfaction with chatbots, and learning and applications of machine learning to chatbots. Established core technology and applications within customer service domains continue to thrive, yet nascent themes such as user trust, social and ethical considerations, and emotional interactions are relatively less investigated. We need to prioritize studies based on evidence regarding the effects of chatbot interfaces on trust and satisfaction among users. Increased research on regional and cross-cultural variations in adoption could provide useful insights for broader and improved implementations. Development of fully integrated generative models of AI with banking applications may unlock novel opportunities for personalization and contextualized services. Collaboration among technologists, financial professionals, and social scientists will become crucial for tackling technical and user-centric impediments to future chatbot development.

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