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USAGE OF VOICE ASSISTANT: A BIBLIOMETRIC LITERATURE REVIEW AND RESEARCH AGENDA

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ABSTRACT

Voice assistant (VA) is one of the most popular artificial intelligence (AI) applications among users. This study aims to provide a comprehensive overview of major stakeholders, namely by affiliation, country, journal, author and article. It is hoped that in using the present study's proposed conceptual structure, a future research agenda will be provided concerning the use of VA as a field of study in its own right. Following the preferred reporting framework for systematic reviews and the PRISMA meta-analyses guideline, 505 articles in the Scopus database were selected, and a bibliometric analysis was conducted using Biblioshiny. Various methods and tools, such as keyword analysis, thematic evolution, and thematic mapping, were employed to analyse the data. This study presents findings on the most influential stakeholders, along with the results of the keyword analysis, thematic evolution, and thematic mapping. Furthermore, by synthesising the bibliometric analysis results, five key research themes, namely technical attribute, trust and privacy, experience, as well as adoption and application context, have been identified. and future research agenda within the field were put forward. This research is an example of an early bibliometric analysis focusing on the topic of VA usage. It is hoped that the findings will contribute to a better understanding of the use of VA and thus, offer valuable insights for practitioners in the VA industry.

Keywords: Voice assistant, PRISMA meta-analyses, bibliometric literature review, thematic mapping.

INTRODUCTION

With the swift expansion of artificial intelligence (AI) technologies, voice assistant (VA) has become an integral part of consumers' daily lives (Coker & Thakur, 2024). VA is a kind of smart device driven by voice recognition technology, designed to offer consumers with personal assistance in managing daily tasks (Fernandes & Oliveira, 2021). It is available as a mobile application, for example, Apple's Siri or embedded into different devices such as smart speakers like Amazon's Alexa, vehicles, wearables, etc. (Mou & Meng, 2024). Once consumers issue a voice command, VA can start a real-time conversation and assist in completing consumers' tasks like answering enquiries, managing appointments and controlling smart home devices (Shao et al., 2024). The great convenience offered by VA has led to its huge market potential. The global VA market size is projected to grow from $7.26 billion in 2025 to $23.3 billion by 2029 (Research and Markets, 2025).

Consumers' vast application of VA has prompted scholars to carry out extensive studies on the topic (Zhang et al., 2025a), indicating the importance of gaining a deep and comprehensive understanding about consumers' behaviour toward VA (Chahal & Mahajan, 2024a). Given the rapid expansion of research across various fields (Lim et al., 2022), it is important to review the current understanding of VA usage and outline future direction in the research field. A bibliometric literature review is a valuable approach as it can effectively decipher the research progress within large bodies of literature and identify the knowledge gaps in the future research agenda of a given field (Donthu et al., 2021a; Rosli & Omar Zaki, 2023). However, to the best of our knowledge, little bibliometric research has specifically been done on the topic of VA usage.

Table 1 lists the current literature review studies related to VA. It can be seen that most previous literature reviews are systematic literature reviews (SLR). They mainly focused on topics such as implementation of proactive behaviour by VA (Bérubé et al., 2024), the privacy issues associated with smart speakers (Maccario & Naldi, 2023), and the application of VA for individuals with disabilities (Esquivel et al., 2024), as well as older adults (Marziali et al., 2024). In addition, previous scholars tended to include VA in broader literature reviews, such as AI applications (Pentina et al., 2023), smart home devices (Buil-Gil et al., 2023) or conversational agents (Ling et al., 2021; Mariani et al., 2023). In these reviews, VA was however, featured as a key component of their research focus. In the only SLR focusing on consumer behaviour toward VA, Chahal and Mahajan (2024a) restricted the research scope with the keywords of "adoption", "attitude", "experience" etc., resulting in the inclusion of only 64 articles. This limited selection may not offer a comprehensive understanding of the topic. Besides that, in the limited bibliometric review related to VA, Lim et al. (2022) combined the SLR method and bibliometric analysis technique to study the topic about conversational agent and commerce. However, the study primarily examined the application of VA in commerce, without addressing their role in the daily life of the consumers.

Table 1

Existing Literature Review Related to VA Usage

Source	Review type	Number of reviewed articles	Review focus
Chahal and Mahajan (2024a)	SLR	64	Consumer behaviour toward VA
Bérubé et al. (2024)	SLR	21	Proactive behaviour of VA.
Esquivel et al. (2024)	Rapid review	48 articles and 281 social media posts	The usage of VA among the disability community
Marziali et al. (2024)	SLR and a bibliometric analysis	16	The usage of VA to reduce loneliness and social isolation of older adults
Manzo et al. (2024)	SLR	15	The application of conversational agent in sustainable fashion
Maccario and Naldi (2023)	SLR	89	Privacy in smart speakers
Buil-Gil et al. (2023)	SLR	63	The digital harms of smart home devices
Bălan (2023)	SLR	41	Chatbots and VA in high-quality business research
Pentina et al. (2023)	SLR	37	Consumer-machine relationship with AI applications
Mariani et al. (2023)	SLR	564	The emerging intellectual structure of marketing research related to conversational agent
Lim et al. (2022)	SLR and bibliometric analysis	722	Conversational agents in conversational commerce
Ling et al. (2021)	SLR	18	The factors influencing users' adoption and usage of conversational agent

From the above foregoing discussion, it is clear that a bibliometric literature review focusing on the usage of VA is scarce. To fill this gap, the present study, in its investigation of the usage of VA has conducted a bibliometric analysis to examine the most influential stakeholders by affiliation, country, journal, author and article. In addition, it is aimed at exploring the conceptual structure in the research on VA usage, and identifying the future research agenda in the usage of VA. By doing so, this study offers a fresh perspective and deeper understanding about the usage of VAs, providing valuable insights for both researchers and practitioners in the VA industry.

LITERATURE REVIEW

The rise of AI in the digital age has profoundly transformed the way consumers interact with technology. A prime example of this shift is the widespread application of VA (Al-Kfairy et al., 2024). Often used interchangeably with terms like "virtual assistant", "digital voice assistant", "conversational agent", etc. (Zhao et al., 2024), VA refers to the physical or virtual autonomous technological entities that recognise and process consumers' voice commands, utilising natural language to communicate and perform a wide range of tasks powered by AI (Fernandes & Oliveira, 2021). Initially, VA was introduced as a mobile application, like Apple Siri. The high portability of VA enabled it to transcend mobile phones and expand to various consumer devices, such as smart speakers, televisions, vehicles, wearables, and more (Kowalczuk & Musial, 2024). Furthermore, scholars anticipate a broad range of future applications for VA, extending beyond the smart home and smart driving industries to include areas such as smart medical services and diverse public services (Mou & Meng, 2024).

The widespread application of VA stems from the smooth experience it provides, allowing consumers to complete various tasks with simple voice commands (Chahal & Mahajan, 2024a). To be specific, VA is designed to constantly monitor for a specific wake word, such as "Hi, Siri" in the case of iPhone. When the wake word is detected, VA is activated and capable of engaging in real-time interactions with consumers and performing various functions. These functions range from retrieving and providing requested information, delivering traffic updates, placing online orders, managing smart home devices, and much more (Shao et al., 2024). Moreover, unlike earlier versions of voice-controlled technologies, VA has the ability to learn from previous interactions. This allows it to continuously refine its responses and provide a more personalised consumer experience (Vimalkumar et al., 2021). In addition, academic forecasts suggest that the integration of generative AI technologies, such as ChatGPT with VA, is expected to revolutionise smart consumer services in the future (Dwivedi et al., 2023).These advancements have solidified VA as an essential part in consumers' lives (Zhang et al., 2025b).

The significant impact of VA on consumers has driven scholars to investigate this topic (Zhang et al., 2025a). In view of the growing body of literature on the topic, it is necessary to make a summary of the existing research. However, as discussed in Section 1, although there have been a few literature reviews in the field of VA, they lack a focused perspective on the usage of VA, as well as a detailed assessment of bibliometric data, such as the field's most influential stakeholders and its conceptual structure. By analysing bibliometric data, the present study fills this gap by uncovering the current performance and conceptual structure of the field, identifying critical research themes, and proposing a comprehensive agenda for future research.

METHODOLOGY

Referring to previous research (Khalek et al., 2024; Samanta & Aithal, 2024), the current bibliometric analysis was carried out in the following three stages: article selection based on preferred reporting items for systematic reviews and meta-analyses (PRISMA) guideline, bibliometric analysis with Biblioshiny, and the report of findings.

Article Selection Based on PRISMA

To enhance the reliability and credibility of the review process, the PRISMA guideline is commonly applied in bibliometric analyses (Bagdi et al., 2023). It is designed to justify the clear rationale for conducting the review, along with a detailed presentation of the employed methods and the results (Khaw et al., 2024). Four stages are included in PRISMA, and they are follows: identification, screening, eligibility, and inclusion (Moher et al., 2009). In the identification stage, Scopus was selected as the database because it is one of the largest database of scholarly articles, providing better coverage compared to other databases, such as the Web of Science (WOS) (Paul et al., 2021). The selection of Scopus was also in line with many previous high-quality bibliometric studies (Basu et al., 2023; Deryl et al., 2025). To help focus the study's scope on the topic of usage of VA, the search term was confirmed through a combination of "VA" and "consumer" related keywords, as shown in Figure 1. The keywords were searched in terms of the title, abstract and keywords. The retrieval was done on 8, January 2025. After inputting the query string in Scopus, 10292 articles were retrieved at this stage.

The retrieved articles were screened using multiple criteria in the screening stage. To maintain the quality of the dataset, this review included only peer-reviewed journal articles, as they have been rigorously evaluated by experts, ensuring their reliability and adherence to academic standards (Stehmann, 2020). This study has focused on articles across all areas of the social sciences, including arts and humanities (ARTS), business, management and accounting (BUSI), decision sciences (DECI), economics, econometrics and finance (ECON), psychology (PSYC), and social science (SOCI), so as to ensure the relevance of the data pertaining to the research topic. Additionally, for bibliometric analysis, the selected articles had to be written in English and the search period remained open until the end of 2024 to maximise the collection of relevant research papers. Following the screening according to the above criteria, a total of 1,195 articles remained.

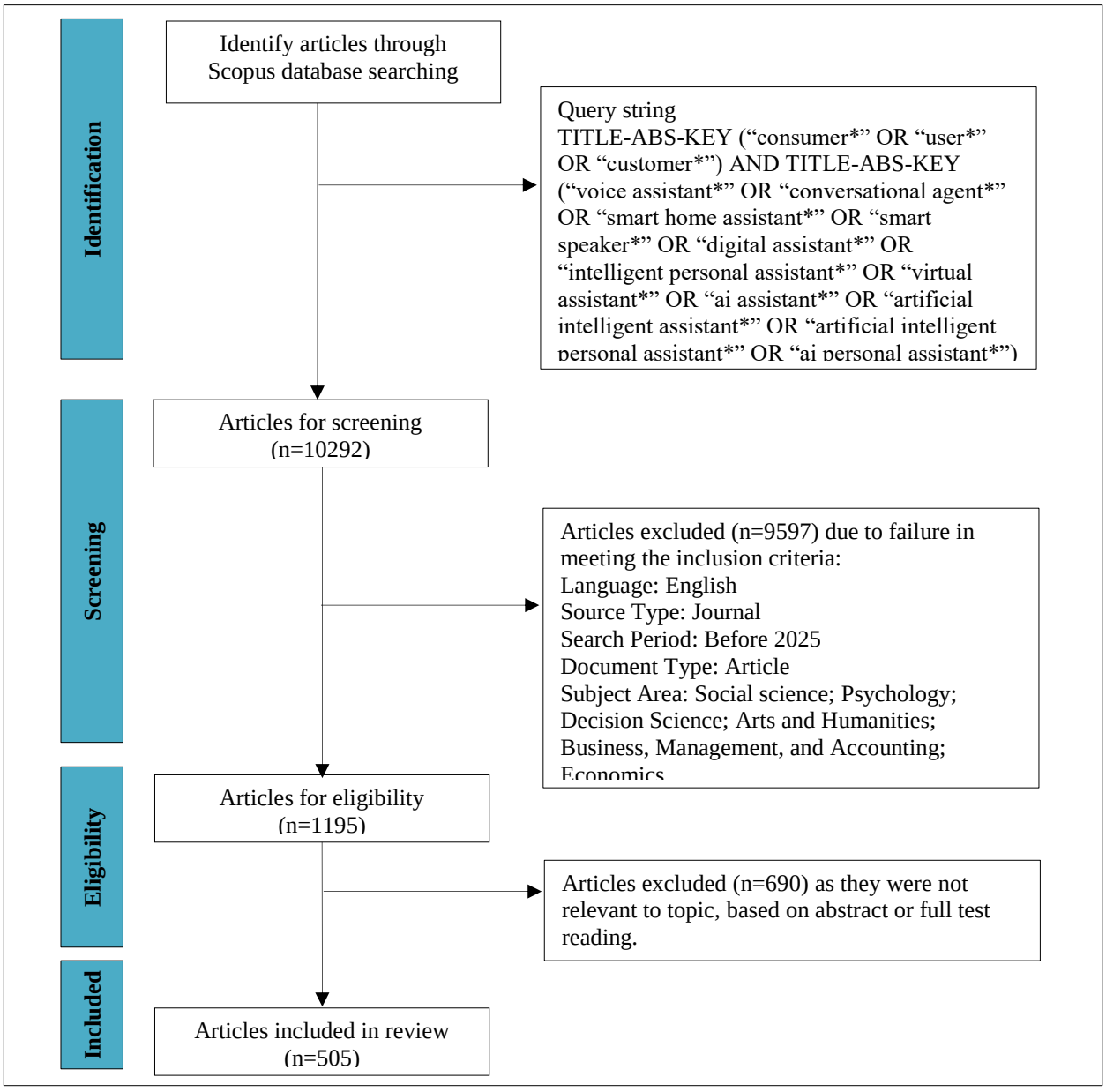
In order to guarantee the eligibility of the selected articles, the authors further checked the abstracts of the remaining articles. The full text of articles was further accessed if there was still doubt about the relevance of studies after reading the abstract. Another 690 articles were excluded and 505 articles were included in the final data analysis. The actual procedure of article selection is as shown in Figure 1.

Bibliometric Analysis with Biblioshiny

After confirming the final reviewed articles, this study utilised Biblioshiny, a Bibliometrix package in R, to conduct the bibliometric analysis. Biblioshiny is an efficient tool for bibliometric analysis due to its statistical reliability, adaptability and intuitive interface (Aria & Cuccurullo, 2017). It has the potential to conduct a thorough descriptive analysis by exploring multiple bibliographic elements, which proved essential in solving the relevant research questions (Khaw et al., 2024). Specifically, a performance analysis about the most influential stakeholder via affiliation, country, journal, author, and article was conducted to solve RQ1. Next, the conceptual structure (RQ2) was analysed through the analysis of keywords (frequency and co-occurrence), thematic evolution, and thematic mapping. In the final analysis, all the results presented in Figure 1 offered fundamental themes for a future research agenda (RQ3).

Figure 1

Flow Diagram of the Article Selection Process

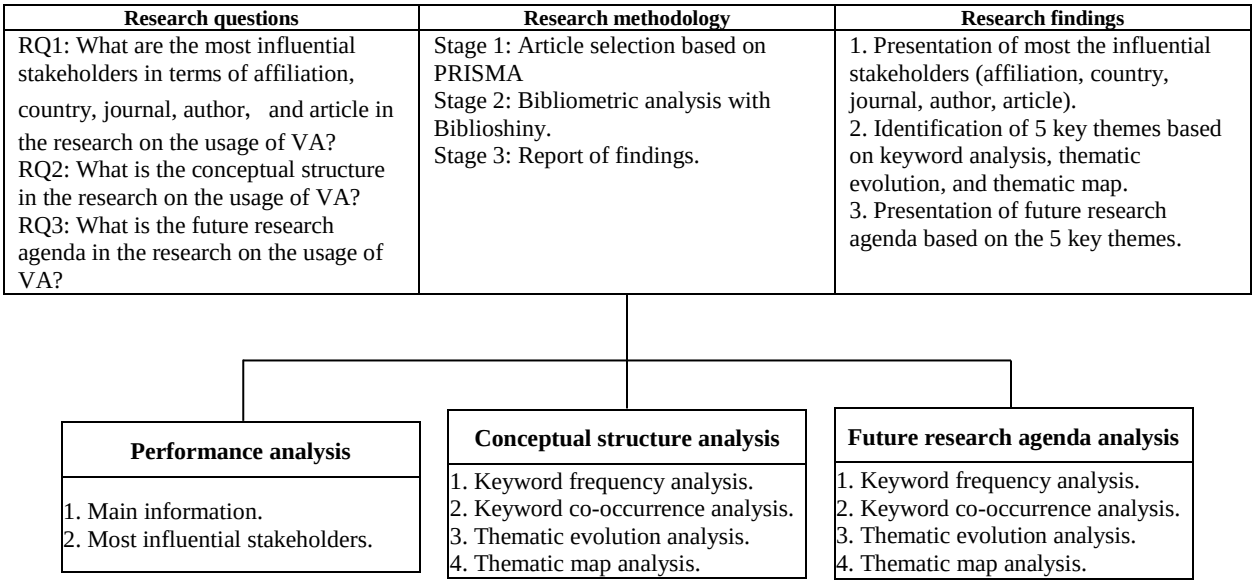


Report of Findings

Using the output from Biblioshiny, this study presents the results of the bibliometric analysis through a blend of figures, tables, and text. Subsequently, drawing on the integration of the above results and the authors’ literature review, the study outlines a future research agenda for the field of study. Figure 2 illustrates the overall research design of this review.

Figure 2

Research Design



FINDINGS

This section presents the findings on the basic information of the reviewed articles and key stakeholders, followed by an analysis of the conceptual structure from the perspective of the keyword analysis (frequency and co-occurrence), thematic evolution, and thematic mapping.

Performance Analysis

Main information

Table 2 lists the main information about the reviewed articles. This study reviewed 505 relevant articles published across 218 publications over the period from 2015 to 2024. The number of publications is growing at a rate of 73.16% annually, highlighting a rapidly expanding research interest in VA. This growth suggests the need for a focused, systematic review, as has been presented in this study. The reviewed articles own an average of 26.92 citations per document, which reflects the average intellectual impact for each article (Fernandez et al., 2024). A total of 1,367 authors were involved in the study, with the majority contributing to collaborative, multi-authored works. On average, there were 3.22 co-authors per document, and 24.16% of the co-authorships included international participation. In contrast, only 46 authors were associated with single-authored studies, highlighting the highly collaborative nature of the research.

Table 2

Main Information about Reviewed Articles

Description	Results
MAIN INFORMATION ABOUT DATA	
Timespan	2015:2024
Sources (Journals, Books, etc)	218
Documents	505
Annual Growth Rate %	73.16
Document Average Age	2.83
Average citations per document	26.92
References	31064
DOCUMENT CONTENTS	
Keywords Plus	1585
Author's Keywords	1509
AUTHORS	
Authors	1367
Authors of single-authored documents	46
AUTHORS COLLABORATION	
Single-authored documents	51
Co-Authors per document	3.22
International co-authorships %	24.16
DOCUMENT TYPE	
Article	505

Notes. Results from Biblioshiny analysis.

Most Influential Stakeholders

The study identified the most influential stakeholders from the perspective of affiliation, country, journal, author and article. As shown in Table 3, the University of Florida, Pratt Institute, and Yonsei University are the top 3 affiliations with the most articles. The USA is the country with the highest number of articles and total citations. China is second with the highest number of articles, while the UK has the second highest total citations.

In terms of the most influential journals and authors, various indicators can be applied to evaluate the productivity of a journal or author, such as the number of articles, total citations and the h-index, g-index, and m-index (h/g/m-index), as shown in Table 3. Among these indicators, the Hirsch index (h-index) represents the highest number of a researcher's articles, either authored alone or collaboratively, that have each been cited at least h times. It is considered more effective than other bibliometric indicators, which are based on total output. Many scholars have applied it as a reliable and precise indicator for evaluating a researcher's scientific performance (Hunt et al., 2010). Thus, the most influential journals and authors in Table 3 are ranked based on the h-index. It can be seen that the *Journal of Retailing and Consumer Services* stands out with the highest h-index of 15 based on 18 articles. Following this, *Computers in Human Behaviour* and *Proceedings of the ACM on Human-Computer Interaction* rank second and third, with h-index values of 14 and 12, respectively. Regarding the most influential authors, Lopatovska I, Loureiro SMC, Patrizi M, and Vernuccio M, all share the highest h-index of 5. Among them, Lopatovska I holds the highest total citations of 253. Furthermore, while Dwivedi YK and Lee S have a slightly lower h-index of 4, their total citation counts are notably high at 475 and 317, respectively.

For the most influential articles, the impact of an article is often measured by the number of citations it garners from highly cited works (Zaki et al., 2023). The article titled *"Alexa, Siri, Cortana, and More: An Introduction to Voice Assistants"* by Hoy (2018) stands out with the highest total citation count of 651, averaging 81.38 citations per year. The article *"Alexa, are you listening? Privacy perceptions, concerns and privacy-seeking behaviours with smart speakers"* written by Lau et al. (2018) holds the second position, achieving a total of 463 citations. It is closely followed by McLean and Osei-Frimpong's (2019) study, *"Hey Alexa … examine the variables influencing the use of artificial intelligent in-home voice assistants"*, which has accrued 459 citations in total. All these influential articles have become foundational references in studies examining consumer interactions with VA.

Table 3

Most Influential Stakeholders

Affiliation	NP	TC	
University of Florida	28		
Pratt Institute	17		
Yonsei University	16		
Beihang University	15		
Korea University	15		
University of Zaragoza	15		
Julius-Maximilians-University	14		
University of Nottingham	12		
Monash University	11		
Sapienza University of Rome	11		
Country			
USA	81	3141	
United Kingdom	31	1931	
China	53	1312	
Korea	32	1103	
Germany	34	535	
India	30	477	
Portugal	6	381	
Spain	17	341	
Australia	12	308	
Italy	19	208	
Journal	**NP**	**TC**	**h/g/m**
Journal of Retailing and Consumer Services	18	810	15/18/3
Computers in Human Behavior	19	1761	14/19/2
Proceedings of the ACM on Human-Computer Interaction	29	1123	12/29/1.5
International Journal of Human-Computer Interaction	30	539	11/23/1.571
Psychology and Marketing	14	958	10/14/1.429
Journal of Business Research	13	900	8/13/1.6
Frontiers in Psychology	12	186	7/12/1.167
Technological Forecasting and Social Change	7	266	6/7/1.5
International Journal of Information Management	6	459	5/6/1
Electronic Markets	5	161	4/5/0.571
Author	**NP**	**TC**	**h/g/m**
Lopatovska I	5	253	5/5/0.625
Loureiro SMC	7	74	5/7/1
Patrizi M	6	75	5/6/0.833
Vernuccio M	6	75	5/6/0.833

(continued)

Affiliation	NP	TC	
Dwivedi YK	4	475	4/4/0.8
Lee S	5	317	4/5/0.444
Pastore A	4	65	4/4/0.667
Burnett G	4	106	3/4/0.333
Casaló LV	4	80	3/4/0.6
Cho E	3	118	3/3/0.429
Document		**TC**	**TC per Year**
Alexa, Siri, Cortana, and More: An Introduction to Voice Assistants		651	81.38
Alexa, are you listening? Privacy perceptions, concerns and privacy-seeking behaviours with smart speakers		463	57.88
Hey Alexa … examine the variables influencing the use of artificial intelligent in-home voice assistants		459	65.57
Understanding consumers' acceptance of automated technologies in service encounters: Drivers of digital voice assistants adoption		348	69.6
Should AI-Based, conversational digital assistants employ social- or task-oriented interaction style? A task-competency and reciprocity perspective for older adults		264	37.71
Enhancing user experience with conversational agent for movie recommendation: Effects of self-disclosure and reciprocity		263	29.22
Alexa, she's not human but… Unveiling the drivers of consumers' trust in voice-based artificial intelligence		251	50.2
'Okay google, what about my privacy?': User's privacy perceptions and acceptance of voice based digital assistants		240	48
Understanding adoption of intelligent personal assistants: A parasocial relationship perspective		218	27.25
Okay, Google!: An empirical study on voice assistants on consumer engagement and loyalty		202	28.86

Notes. NP= number of papers, TC= total citations, Results from Biblioshiny analysis.

Conceptual Structure

The conceptual structure was analysed based on keyword analysis (frequency and co-occurrence), thematic evolution, and thematic mapping, with the aim of presenting the key themes and their evolution in the field.

Keyword Analysis: Frequency

Author's keywords hold significant value in an article, as they are intentionally chosen by authors to reflect the main themes of their study (Donthu et al., 2021b). Examining these keywords and their co-occurrence can be vital for revealing the conceptual structure and research trend in a particular field (Marino-Romero et al., 2024). Keyword analysis was done based on the frequency of occurrence and the co-occurrence of the author's keywords.

Table 4 presents the 20 most frequently occurring keywords. It is obvious that various names for VA, such as smart speaker, virtual assistant, conversational agent etc. appear frequently, which may complicate identifying the key research themes in the field. To address this issue, all occurrences of the keyword "voice assistant" and its synonyms were excluded when creating the word cloud, thematic evaluation and thematic map. Additionally, given that VA is an AI-based technology, the keyword "artificial intelligence" appears

with high frequency but may not reflect a specific research theme or direction in the field. Thus, this study excluded the keyword "artificial intelligence" in its analysis, so as to get a clearer visualization of other keywords and themes in the word cloud and thematic analysis.

Table 4

Most Frequent Keywords

Words	Occurrences
voice assistant	147
artificial intelligence	129
smart speaker	73
virtual assistant	45
conversational agent	40
anthropomorphism	30
trust	29
intelligent personal assistant	28
alexa	23
digital assistant	19
privacy	19
chatbot	18
human computer interaction	17
privacy concern	14
internet of things	11
technology acceptance	11
technology adoption	11
voice shopping	11
older adults	10
social presence	10

Notes. Results from Biblioshiny analysis.

Figure 3 displays the word cloud, which illustrates the relative importance of keywords based on their frequency of occurrence. Keywords that appear more frequently are displayed in larger and bolder text within the word cloud. The word cloud reveals that "anthropomorphism" is the most frequently occurring keyword, emphasising its significance in shaping consumers' interactions with VA. The popular keyword in consumer behaviour research, "trust", appears as the second most common keyword in the current review. Additionally, "privacy" emerges as the third most frequent keyword with 19 occurrences, while another similar keyword "privacy concern" appears 14 times. The high frequency of these privacy-related keywords underscores the pervasive nature of privacy issues during consumers' usage of VA. Besides, the keywords "human computer interaction", "internet of things", "technology acceptance", "technology adoption", and "voice shopping" also appear more than 10 times, indicating their prominence in the research field. These frequent keywords collectively integrate technological, ethical and psychological dimensions, offering a preliminary answer to RQ2 by uncovering the fundamental conceptual framework that underpins consumers' usage of VA.

Figure 3

Word Cloud

Notes. Results from Biblioshiny analysis.

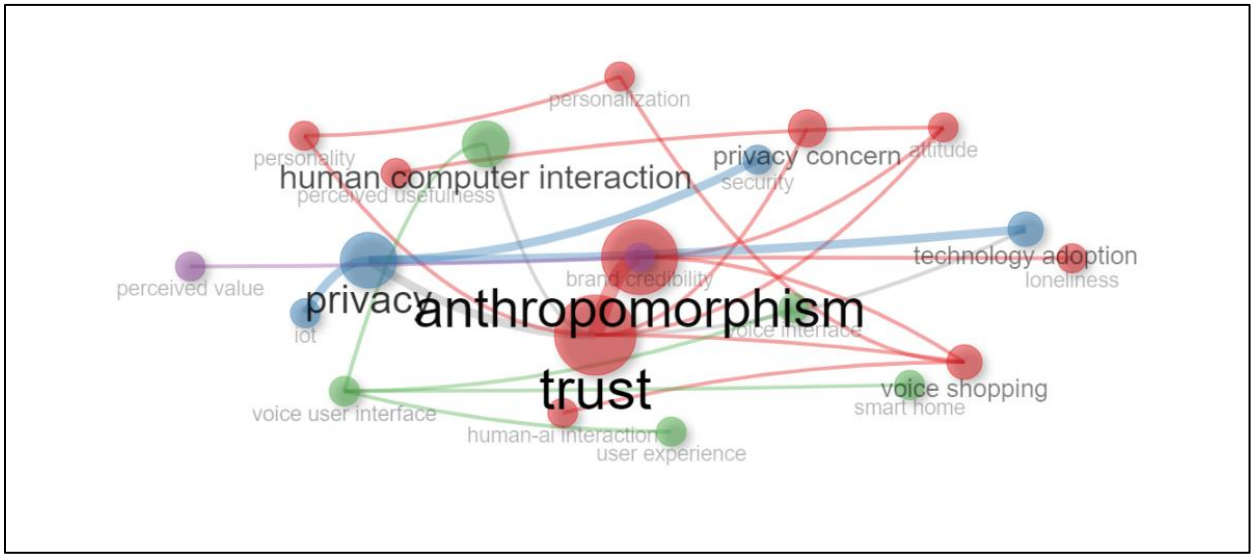
Keyword Analysis: Co-occurrence

Keyword co-occurrence analysis is grounded in the idea that the repeated appearance of two keywords across multiple articles signifies a conceptual connection between them (Donthu et al., 2021b). Consequently, a keyword co-occurrence network provides valuable information in helping to identify key and emerging themes within the field or research frontier, as well as facilitating the analysis of theme evolution over time (Tanwar et al., 2024).

Figure 4 displays the co-occurrence network based on the present authors' keywords in reviewed articles. Figure 4 clearly shows clusters organised into nodes of different colours, each representing a narrow focus area in the field. Specifically, Cluster 1 (red) consists of 10 keywords, which includes some of the most frequently occurring keywords like "anthropomorphism", "trust", "privacy concern" etc. These keywords cover consumers' focus during their usage of VA. Both Cluster 2 (blue) and Cluster 3 (green) have four keywords, with the most frequent keywords being "privacy" and "human computer interaction" respectively. The keywords "perceived value" and "brand credibility" are categorised in Cluster 4 (purple). These clustering results further address RQ2 by elucidating the interrelationships among major research constructs, thereby demonstrating how diverse constructs jointly define the conceptual landscape of consumers' usage of VA.

Figure 4

Co-occurrence Network



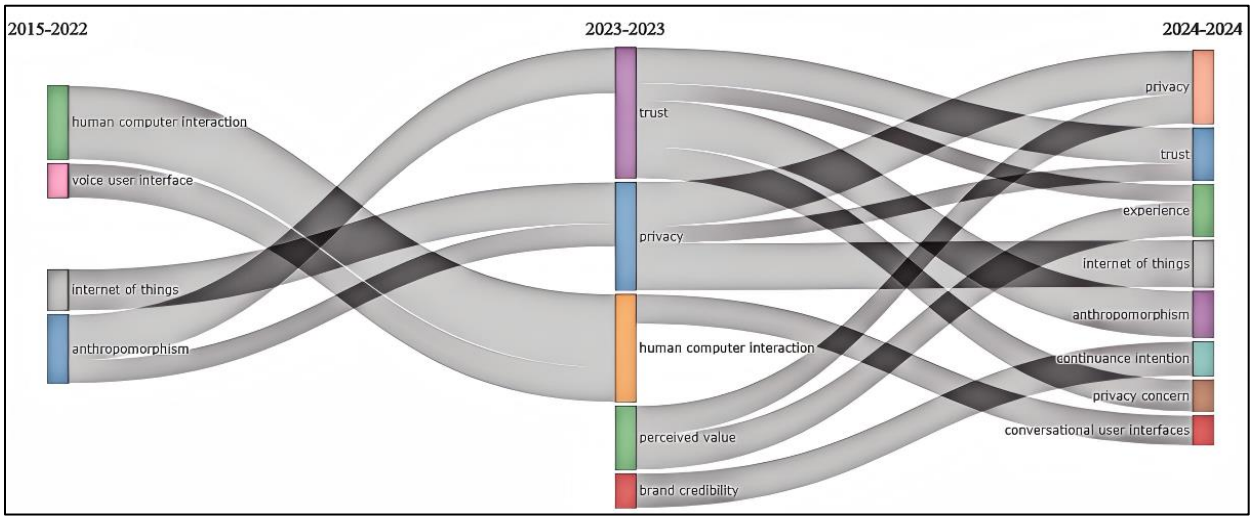
Notes. Results from Biblioshiny analysis.

Thematic Evolution

To gain deeper insights into the theme progression within the research theme, a thematic evolution figure was created with Biblioshiny (see Figure 5). The thematic evolution figure directly addresses RQ2 by displaying distinct thematic sections divided by time periods and groups of keywords represented by coloured blocks. Prior to 2022, the research primarily revolved around technological and interaction-oriented themes including "human-computer interaction," "voice interface," "internet of things," and "anthropomorphism," reflecting scholars' emphasis on the functional design and user interaction mechanisms of VA, such as how the anthropomorphism of Amazon Alexa facilitates consumers' parasocial interactions with the product (Aw et al., 2022). In 2023, the thematic focus began to shift from purely technological aspects toward socio-psychological considerations. The evolution of "internet of things" and "anthropomorphism" into themes such as "trust" and "privacy," along with the convergence of "voice user interface" and "human-computer interaction," signifies a growing academic concern with the human-machine relationship and ethical issues regarding VA. During this period, trust (Hsu & Lee, 2023) and privacy (Molinillo et al., 2023) have been consistently examined for their influence on consumers' intention of continued usage of VA. In 2024, the themes expanded to a broader range of topics. While "trust" and "privacy" continued to appear, their usage decreased significantly. These two themes evolved and spread across other themes, such as "experience", "anthropomorphism", "privacy concern" and "internet of things". Besides, "perceived value" evolved to "privacy" and "experience", while "brand credibility" evolved to "continuance intention" in 2024. These changes indicate that research in 2024 began to move beyond the traditional focus on trust and privacy toward a more diversified exploration of consumers' experiential perceptions, value creation and continued engagement with VA.

Figure 5

Thematic Evolution



Notes. Results from Biblioshiny analysis.

Thematic Map

A thematic map is useful in better understanding the existing research landscape and evaluating potential future research agendas in the reviewed field (Bagdi et al., 2023). It is usually divided into four quadrants based on the following two key metrics: centrality and density. Density represents the intensity of connections within a cluster, indicating how well-developed a theme is, while centrality reflects the strength of connections between clusters, indicating the significance of a theme in a particular area (Khaw et al., 2024).

Figure 6 presents the thematic map of this review. The upper-left quadrant represents niche themes, covering highly developed but isolated topics. The keywords in this quadrant are typically associated with specialised areas of interest. Thus, keywords such as "privacy concern" and "attitude" in this quadrant are expected to garner more attention.

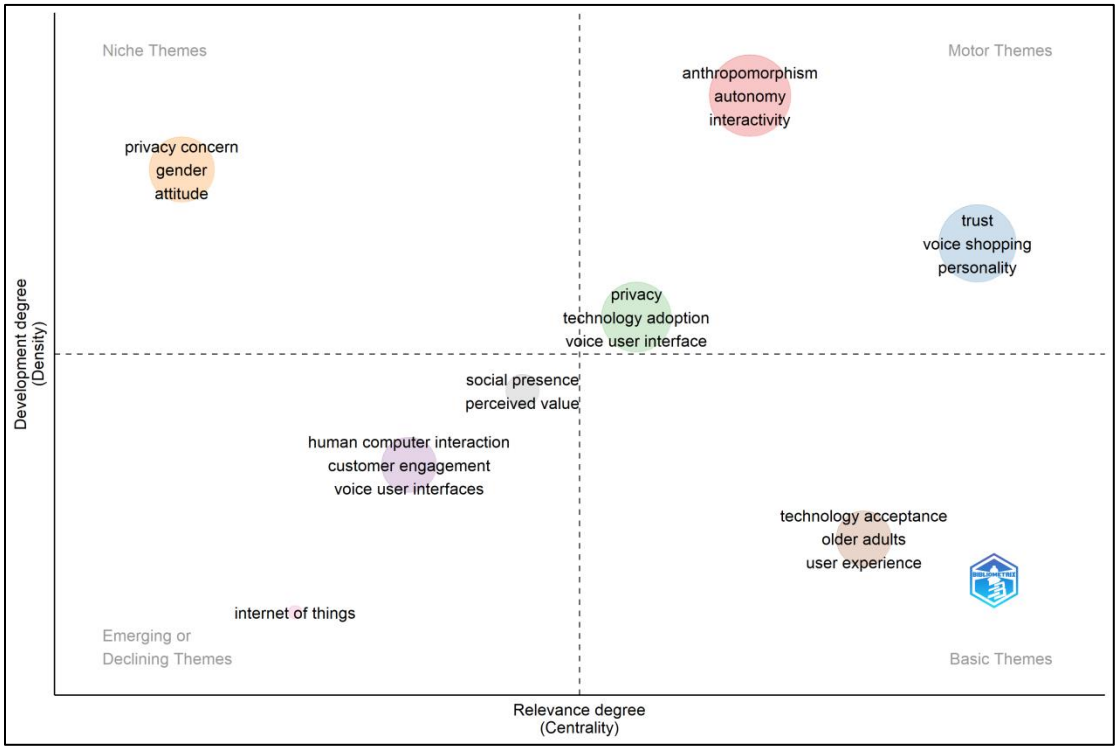
The motor theme in the upper right quadrant is distinguished by its substantial importance and well-developed nature. These themes often attract significant attention from scholars due to their high relevance and potential impact on the discipline (Khaw et al., 2024). Keywords of "anthropomorphism", "autonomy", "trust", "voice shopping", "privacy", "technology adoption" etc., fall into this quadrant.

The bottom-left quadrant, labelled as the emerging or declining theme, represents themes with low centrality and density. These themes are not fully developed and may either be in the early stages of gaining research momentum or experiencing a decline. Consequently, it can be concluded that the keywords in this quadrant, such as "social presence", "human computer interaction", and "internet of things", are either nascent and showing potential for growth or losing prominence within the research landscape.

The basic theme is located at the bottom-right of the map. They represent fundamental and transversal themes that are vital to a research field but have not yet been fully explored. Thus, this quadrant offers considerable opportunities for future researchers to further develop these themes by pursuing new research avenues (Tanwar et al., 2024). Future scholars can give more focus to topics such as "privacy", "technology acceptance", "older adults" and "user experience". Overall, the thematic map analysis answers RQ2 by deepening the understanding of the conceptual structure underpinning existing research while also providing valuable implications for future research directions in the field of consumers' usage of VA.

Figure 6

Thematic Map



Notes. Results from Biblioshiny analysis.

DISCUSSION AND IMPLICATIONS

This section presents the responses generated through the bibliometric analysis for all the three research questions. The discussion is structured based on the pre-formulated research questions.

In this research, a performance analysis was employed to provide an extensive investigation of the most influential stakeholders from the perspective of affiliation, country, author, journal and article, on the topic of consumers' usage of VA. In the reviewed articles, the University of Florida is the most influential affiliation with 28 related articles, while the USA is the country with the highest number of articles (81) and total citations (3141). From the perspective of h-index, the *Journal of Retailing and Consumer Services* has the highest h-index of 15. Lopatovska I, Loureiro SMC, Patrizi M, and Vernuccio M share the position of being the most influential authors with the highest h-index of 5. For the most influential article, the article *"Alexa, Siri, Cortana, and More: An Introduction to Voice Assistants"* ranks first with 651 total citations.

The question about the conceptual structure in the field was solved through the analysis of keyword, thematic evolution and thematic mapping. Generally speaking, "anthropomorphism", "trust", "privacy", "human computer interaction", "technology adoption", and "voice shopping" were frequent occurrence keywords in the co-occurrence network, thematic evolution and thematic map, indicating their significance in research on consumers' usage of VA. Based on the results mentioned above, the authors of the current study conducted a thematic content analysis and synthesised the following five key themes in the field: technical attribute, trust and privacy, adoption, experience and "application context". These five themes have garnered considerable attention from previous researchers and can also provide valuable insights for guiding future research.

To answer the third research question, this study conducted a further literature review of 505 articles based on the five themes generated from the bibliometric analysis. The future research agendas are summarised below.

Technical Attribute

This review identified three frequent occurrence keywords about the technical attributes of VA, namely "anthropomorphism", "autonomy", and "interactivity". Specifically, "anthropomorphism" was the highest usage keyword in the word cloud, as well as the motor theme with well-established research in the thematic map. However, existing research mainly investigates the positive side of anthropomorphism, while some scholars have pointed out that the high level of anthropomorphism may also evoke consumers' concern about the potential negative psychological impact. Future research could include the negative influence caused by anthropomorphism in the research model and explore the boundaries of the effectiveness of anthropomorphic features (Zhou et al., 2023).

In addition, another two attribute keywords, "autonomy" and "interactivity" were also positioned within the motor themes, indicating their well-development and significance. Autonomy and interactivity have been taken as two important intelligent attributes of VA, but their influence on human behaviour has received limited attention (Kang & Shao, 2023). Since the rapid development of AI, the autonomy and interactivity of VA have been improved greatly, compared with traditional information technology. Further investigation about how two intelligent attributes influence consumers perception and usage experience is still needed.

Trust and Privacy

"Trust" and "privacy" stand out as prominent keywords frequently appearing in keyword and theme analysis, highlighting their significance in VA research. By offering parasocial interaction through its humanlike traits, VA is able to obtain consumers' trust (Hsieh & Lee, 2021; Hsu & Lee, 2023), while consumers' privacy perception plays a negative role on trust (Hsu & Lee, 2023). Thus, "trust" and "privacy" are two keywords which often appear simultaneously and are regarded as critical determinants of consumers' usage of VA (Chahal & Mahajan, 2024a). Although these two terms were very common in the research on consumer behaviours, their influence on consumers' usage behaviour of VA is uncertain. For example, Hsu and Lee (2023) demonstrated the positive impact of trust on consumers' continued usage of VA, whereas Pitardi and Marriott (2021) did not observe such an effect. Besides, the influence of privacy on consumers' usage intention remains unclear as well. Many scholars, for example, Molinillo et al. (2023), and Choi & Choi (2023) found that privacy did not have a direct effect on consumers continued usage intention, which contradicted their initial expectations. These inconsistent and unexpected results emphasize the necessity for further study on the topic of trust and privacy. In addition, given that VA has been widely applied in various context, investigating consumers' perception in different contexts, for example, in the home and public place, would be an interesting topic.

Adoption

"Technology acceptance" and "technology adoption" are another two frequently occurring keywords in the analysis. "Technology adoption" falls in the motor theme, while "technology acceptance" is the basic theme in the thematic map. Another closely related keyword "continuance intention" also received more attention in 2024, as shown in thematic evolution. The research about "adoption" is a popular topic when a new technology appears, it can be further divided into two stages: initial adoption (initial acceptance) and post-adoption (continued usage). Since the emergence of VA, scholars have focused more on the initial adoption of VA, there is a notable gap in researching consumers' continued usage (Kowalczuk & Musial, 2024). Although initial adoption is a crucial step in the diffusion of new technologies, consumers' continued usage plays a more significant role in ensuring the long-term success of such technologies (Bhattacherjee, 2001;

Zhou et al., 2023). Given that VA has been available in the market for a considerable period of time, it is crucial for researchers to develop a comprehensive understanding of why, how, and under which conditions consumers are willing to keep using this device, so as to guarantee the long-term sustainability of the technology (Ko et al. 2024).

Experience

Since 2023, "experience" has gained popularity in theme evolution and emerged as a basic theme in the thematic map. Other frequent occurrence keywords, such as "engagement", "human-computer interaction", "social presence", etc., can also be categorised under this theme. The increased prevalence of these keywords in recent years may be attributed to the widespread adoption of VA by consumers, leading to a shift in research focus from initial acceptance to usage experience. Future scholars can delve deeper into how the unique attributes of VA, for example, autonomy, and interactivity influence consumers' diverse usage experience, for example, smart experience, authentic experience, hedonic experience, and flow experience, as well as how these experiences build consumers perception of commitment, attachment or trust etc., which may further contribute to their continued usage and brand loyalty. Additionally, since VA can be used to perform a variety of tasks, exploring consumers' different usage experience across various scenarios would be a new avenue for research. For instance, whether the way consumers interact with VA for entertainment differs significantly from how they use VA for productivity or information retrieval would be a valuable direction for future research (Chahal & Mahajan, 2024b).

Application Context

Finally, the keywords "voice shopping" and "older adult" represent two different application contexts, corresponding to the motor theme and basic theme in the thematic map, respectively. With the growing prevalence and adoption of VA devices, leading e-commerce platforms, such as Alibaba and Amazon have incorporated voice shopping capabilities into their systems (Calahorra-Candao & Martín-de Hoyos, 2024). By offering hands-free and convenient experiences, VA like Alexa and Tmall Genie have increasingly become a popular option for online shopping activities (Shafei & Tan, 2024). The Business Research Company (2025) reported that the global voice commerce market is expected to grow rapidly from $116.83 billion in 2024 to $150.34 billion in 2025, with a compound annual growth rate of 28.7%. Some scholars even predicted that VA will gradually replace personal computers and laptops as the primary tool for shopping (McLean & Osei-Frimpong, 2019). Despite the big potential of voice shopping, there is still a significant gap between early adopters and the early majority. Thus, guiding consumers to adopt the VA based voice shopping channel has become a crucial challenge that many retailers are actively investigating (Yang et al., 2024). Future research may focus on what features of VA, for example, its voice feature, and what type of products, for example, whether a hedonic or utilitarian product will influence consumers' VA purchase intention (Calahorra-Candao & Martín-de Hoyos, 2024). Besides, whether shopping through VAs facilitates consumer impulsive buying behaviour is an intriguing question that warrants further attention (Yang et al., 2024).

In addition, older adults have embraced VA due to its ability to provide a more intuitive and natural way of communication, offering convenience, emotional comfort, and relief from loneliness. VA also provides an alternative way to obtain health information, i.e., an alternative to their usual usage of traditional channels (Zhong et al., 2022). However, the current literature places greater emphasis on older adults' usage experiences, while the potential of VA to address social isolation and loneliness among this population seems to be underexplored (Marziali et al., 2024). Furthermore, given the complexity and individual variability of older adults' behavioural intentions, factors specific to their unique circumstances, such as cognitive abilities and emotional trust, should be taken into account when researching the application of VA for older adults (Xie et al., 2024). A summary about the future research agenda is listed in Table 5.

Table 5

Summary of Future Research Agenda

Theme	Future research agenda
Attribute	What is the potential negative influence of anthropomorphism on consumers?
	What is the effective boundary of the anthropomorphism feature in VA?
	How do autonomy and interactivity influence usage of VA?
Trust and privacy	How does trust influence continued usage of VA?
	How does privacy influence the continued usage of VA?
	How do consumers' privacy perceptions differ between home and public contexts?
Adoption	Why, how and under which conditions are consumers willing to continue to use VA?
Experience	How do the unique attributes of VA influence diverse usage experience?
	How do various consumers' experiences build their perception of commitment, attachment, or trust in VA?
	How do various consumers' experiences facilitate their continued usage and brand loyalty of VA?
	Do consumers have different usage experiences across various usage scenarios of VA?
Application context	What attributes of VA can encourage consumers to apply it for online shopping?
	What type of products (hedonic or utilitarian) do consumers prefer to buy on VA ?
	Does VA based voice shopping facilitate consumers' impulsive buying behaviour?
	What attributes of VA are there, and how do these attributes reduce older adults' loneliness and social isolation?
	How do older adults' cognitive abilities and emotional trust influence their application of VA?

CONCLUSION, IMPLICATIONS, LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

This study is an early attempt to conduct a bibliometric analysis on the usage of VA. By conducting a bibliometric analysis on 505 articles selected from the Scopus database, this study has identified the most influential stakeholders, proposed a conceptual structure, and suggested a future research agenda for the field. The findings of the present study have provided some critical information for researchers and practitioners in the VA industry. However, this study has its own limitations. One limitation is the sole selection of the Scopus database, which may lead to the neglect of some articles listed in other databases. Future research might improve on this work by integrating other indexes, such as WOS and Scimago Journal Rank. This will not only contribute to extending the coverage of related articles, but also provide some new insights based on the bibliometric indicators of other databases.

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