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Conversational Artificial Intelligence and Natural Language Processing in Customer Service: A Bibliometric Review

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Abstract

The integration of conversational artificial intelligence (AI) and natural language processing (NLP) is currently transforming customer service in various domains, including commerce, education, and the public sector. This article examines recent studies that utilize these technologies in the context of customer support, with a particular focus on micro, small, and medium-sized enterprises (MSMEs). The articles were obtained from the following sources: Scopus, Web of Science, ScienceDirect, and Springer Nature. Using the PRISMA framework, 263 initial records were reviewed and narrowed down to 139 relevant studies. A bibliometric analysis was conducted using VOSviewer and Mendeley to ascertain the relationships between keywords, thematic groups, and citation patterns. The results show that the United States, India, and the United Kingdom are the most active contributors, exhibiting a robust presence in commerce, Industry 4.0, and technology tools. Common keywords include “AI,” “chatbot,” “customer service,” and “large language models.” This

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review identifies predominant research trends, emerging subjects, and the paucity of studies in areas such as public health and government policy. These findings have the potential to inform future research and stimulate practical initiatives in Latin America and other regions.

Keywords: Chatbots, Conversational artificial intelligence, Natural Language Processing (NLP), Customer service automation, Micro, Small and Medium Enterprises (MSMEs), Bibliometric analysis, Industry 4.0

1. INTRODUCTION

In recent years, automation has taken on a growing role in customer service and has become part of the digital transformation of many businesses. New tools such as Conversational Artificial Intelligence (CAI) and Natural Language Processing (NLP) now make it easier to improve efficiency and the overall user experience across areas such as e-commerce, health care, and public services[1, 2].

Large language models, including GPT-3.5 and GPT-4, have further accelerated this change by giving chatbots the capacity to understand context and to produce coherent, relevant responses [3, 4].

Conversational AI, one of the branches of artificial intelligence, seeks to make interaction between humans and computers sound natural. The recent progress in NLP has been key to this goal, helping systems to recognize intent, sense emotions, and reply in ways that resemble human communication [5, 6]. According to [7], NLP has evolved from simple semantic rules to advanced models trained with billions of parameters, that can understand contexts, cultural nuances, and idiomatic expressions.

Current conversational AI systems generally fall into three groups: rule-based, supervised learning, and generative models such as large language models (LLMs)[8, 9]. These systems adapt to many industries and support areas like customer service, sales, technical assistance, mental health, and education. For instance, ChatGPT has been studied in Industry 4.0, higher education, and corporate ticket management." [10, 11].

However, the implementation of these technologies is not without limitations. Some of the main challenges identified in recent studies include the lack of personalization, misinterpretation errors, dependency on training context, and the high cost of integrating with real-time databases. [12, 13]. As shown in [10] chatbots improve efficiency and customer satisfaction, their adoption depends on factors such as ease of use, accuracy, and perceived usefulness. Similarly, [14] shows that, although reductions in response times have been achieved, there are still limitations in terms of scalability and coverage of unstructured queries.

The growing use of these technologies has driven a sharp rise in scientific output. Across databases such as Scopus, Web of Science, ScienceDirect, and Springer, publications on customer service automation have increased since 2020, with 2023 and 2024 as the most productive years. This trend reflects growing academic interest, especially for applications in micro, small, and medium-sized enterprises (MSMEs) in emerging regions like Latin America.[14]. This reflects a strong trend in

academic interest in this field, motivated by its applicability in micro, small, and medium-sized enterprises (MSMEs), especially in emerging regions such as Latin America.

Given this scenario, a bibliometric analysis is needed to identify the main research lines, relevant authors, leading countries, and emerging topics. This study provides a foundation for future academic and technological work, linking current trends in chatbots, Conversational AI, and NLP with theories of AI adoption and digital transformation, particularly for MSMEs in Peru.

2. METHODOLOGY

This study adopted a descriptive bibliometric approach to examine the exploration of Conversational Artificial Intelligence (CAI) and Natural Language Processing (NLP) in customer service automation. The analysis focused on applications for small and medium-sized enterprises (SMEs), in which these technologies could enhance efficiency and the user experience. A bibliometric approach was chosen as it offers a systematic and objective method of identifying research trends, emerging areas and significant scientific contributions published between 2020 and 2024.

2.1 Selection of Scientific Databases and Sources

Four major scientific databases were selected on the basis of their high impact and interdisciplinary coverage: Scopus, Web of Science (WoS), ScienceDirect, and Springer Nature. The selection of these sources was made on the basis that they index a wide range of relevant publications in artificial intelligence, computer science, and business management. The number of articles retrieved from each database is shown in FIGURE 1.

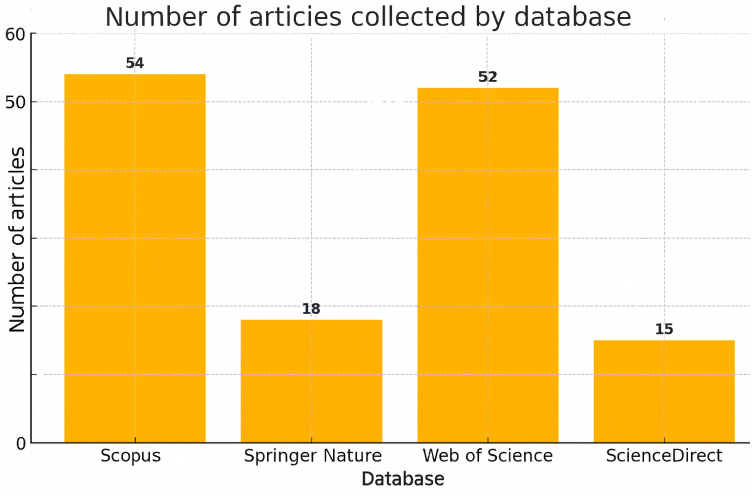

Figure 1: Number of articles collected by each database.

In order to ensure a structured and transparent selection process, the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) model was applied. As shown in FIGURE 2,

the flow of identification, screening, eligibility, and inclusion of studies throughout the review is presented. (FIGURE 2).

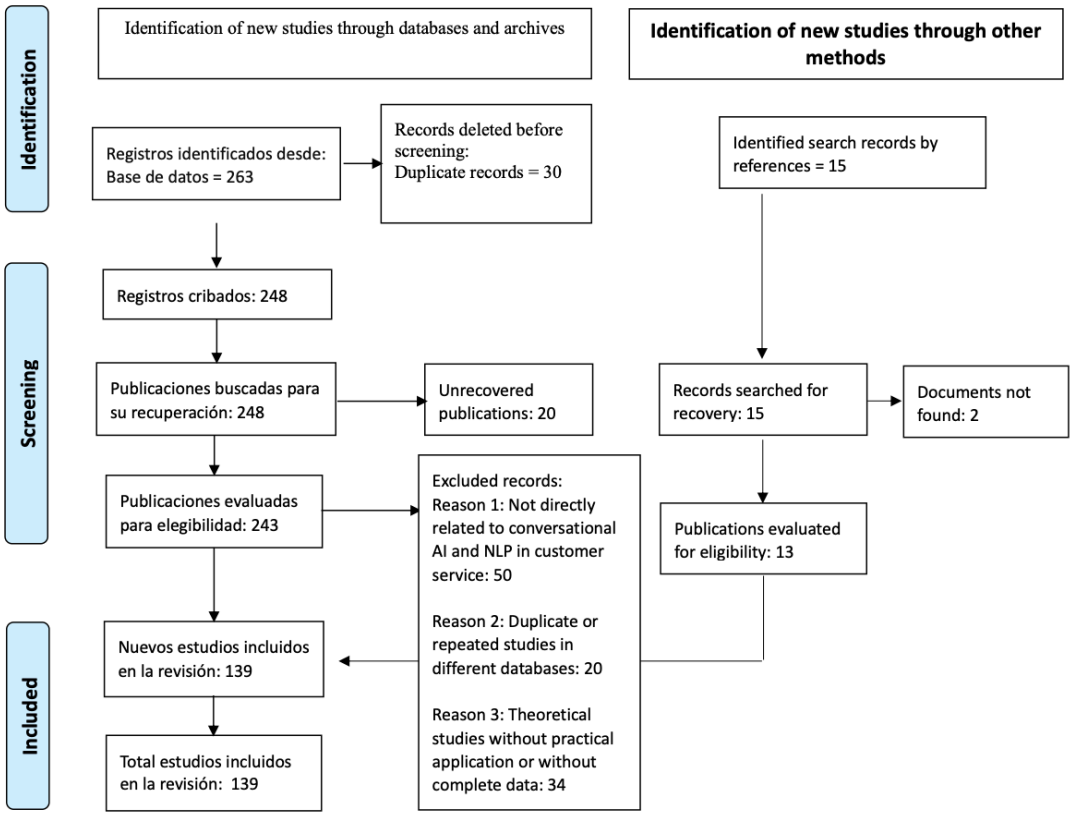

Figure 2: Prisma model

The PRISMA diagram illustrates that 263 records were initially retrieved from the databases, with a further 15 records obtained from other sources. Following the removal of duplicates, the application of exclusion criteria, and a thorough review of the full texts, a total of 139 articles were retained for the bibliometric analysis.

2.2 Search Strategy Design

The search process followed a progressive refinement strategy to narrow down the most relevant publications. A search string was developed in English using Boolean operators to increase precision. The query included the following combination of terms:

(Conversational AI AND Natural Language Processing AND Customer Service AND SMEs)

Afterward, several filters were applied consistently across all databases:

- Time range: 2020 to 2025

- Language: English
- Document type: Research articles, conferences, and reviews
- Subject areas: Computer Science, Engineering, Artificial Intelligence
- Publication models: Including Open Access and indexed publications

This design ensured a focused and replicable retrieval process, allowing the inclusion of only peer-reviewed and thematically relevant studies.

Table 1: Review of the terms used

Term	**Keywords**
Chatbots and Conversational Agents	chatbot, conversational, "conversational ai"
Natural Language Processing (NLP)	"natural language processing", language
Artificial Intelligence	ai, "artificial intelligence", "machine learning"
Customer Service	"customer service", customer
Small and Medium Enterprises (SMEs)	SMEs, "small and medium enterprises"

2.3 Inclusion and Exclusion Criteria

Studies were included if they met the following criteria:

- Direct thematic relevance (use of CAI and NLP for customer service)
- Business applications, particularly in the context of SMEs or similar
- Availability of complete metadata (author, year, title, abstract, source, DOI)

The exclusion criteria applied to the studies included duplicates, those not directly related to the research focus, non-peer-reviewed chapters, and purely theoretical works lacking a practical connection to customer service. The application of these criteria ensured that the finalised dataset comprised exclusively high-quality and thematically consistent research.

2.4 Collection, Coding, and Refinement of Articles

The preliminary search produced a set of studies that, following refinement and filtration, yielded 139 classified scientific articles. The articles were then organised into a structured matrix to support systematic classification by key bibliographic parameters, such as year, publication type, journal, country, and language. The configuration of this matrix is shown in FIGURE 2.

2.5 Keyword Extraction and Thematic Processing

Keywords and abstracts were extracted from all the included articles, as shown in TABLE 1, and analysed using co-occurrence mapping in VOSviewer. This process generated cluster maps of terms and themes that revealed the main research areas and their interconnections. The analysis revealed frequently explored topics, including customer experience, chatbot architecture, deep learning and GPT-3. Identifying these clusters helped to outline the thematic structure of the field and the evolution of research trends.

2.6 Tools and Software Used

Three main tools supported the bibliometric analysis.

- Microsoft Excel was employed for initial data cleaning, organization by variables, and the creation of frequency tables.
- VOSviewerwas used to perform keyword co-occurrence mapping, analyze co-authorship networks, and detect emerging research topics.
- Mendeley assisted in managing citations, examining the temporal evolution of publications, and assessing the impact of authors, countries, and sources.

2.7 Bibliometric Indicators Considered

Several bibliometric indicators were analyzed to describe the structure and dynamics of research in this field. The indicators included:

- Annual scientific productivity
- Most active publication sources
- Most influential authors and institutions
- Geographical distribution of publications
- Emerging topics according to keywords
- Predominant areas of application (education, health, commerce, SMEs)

This methodology guarantees the traceability, replicability and robustness of the analysis by enabling clear tracking of the most relevant research trends surrounding the automation of customer service through conversational AI and natural language processing (NLP).

Table 2: Number of studies by country

No.	Country	f	%
1	USA	31	6.73
2	India	28	6.28
3	UK	14	6.73
4	People's R. China	14	4.48
5	Italy	10	7.17
6	Germany	8	7.17
7	Spain	8	6.28
8	Australia	8	38.12
9	South Korea	7	4.48
10	Canada	7	4.93
11	Others	4	7.62
	Total	**139**	**100**

3. RESULTS AND DISCUSSION

3.1 Evolution of Research on Intelligent Automation of Customer Service

The results reveal sustained growth in scientific output related to the automation of customer service using conversational AI and PLN, particularly since 2020. This evolution has been greatly influenced by the development and public availability of generative language models such as GPT-3, GPT-3.5 and GPT-4, as well as the adoption of new transformer-based tools. The peak in publications is concentrated in 2023 and 2024, coinciding with the boom in conversational platforms in business, education and healthcare.

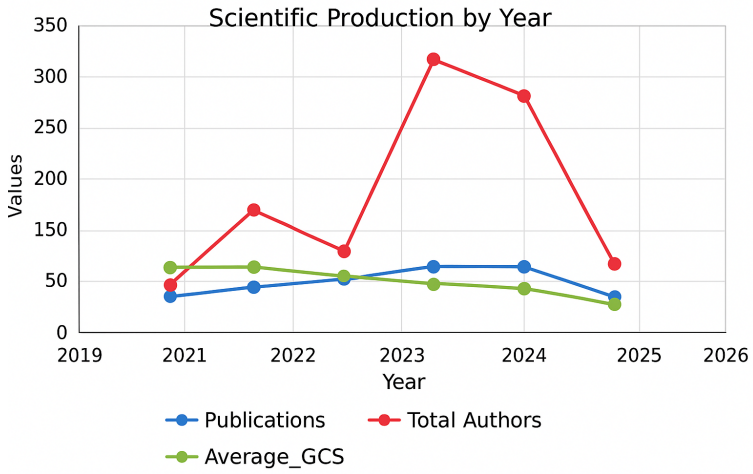

Figure 3: Number of publications related to articles and global citations

This increase in the number of publications as shown in the FIGURE 3, reflects not only greater academic interest, but also greater business demand for automated solutions that improve operational efficiency and customer experience. Similarly, approaches have shifted from being exclusively technical to integrating functional perspectives such as usability, user experience and adaptability to real contexts.

3.2 Most Frequent Words in Article Titles

The title analysis revealed the terms that appeared most frequently in the literature, including 'AI', 'chatbot', 'conversational', 'customer', 'intelligence', 'automation' and 'service' as shown in the FIGURE 4. These terms demonstrate the prevalence of conversational technologies in customer-oriented contexts and the increasing significance of natural language models. The inclusion of words such as 'generative', 'learning', 'digital', and 'business' reflects a research orientation that combines technological innovation with organisational applications, particularly within business environments.

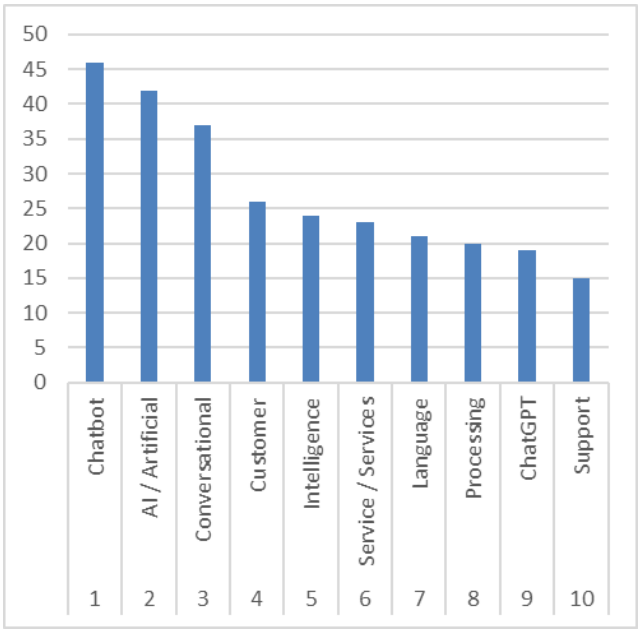

Figure 4: Most frequently used keywords

3.3 Emerging Topics and Thematic Clusters

Through the analysis of keyword co-occurrence using the VOSviewer tool, four thematic clusters were identified, shown in FIGURE 5, These groups represent the predominant approaches found in the literature on Conversational AI and NLP applied to customer service and operational efficiency in companies.

Red cluster: learning models and cognitive processing This group includes terms such as machine learning, sentiment analysis, neural networks, learning algorithms, adversarial machine learning and human-like behaviour. This cluster represents the algorithmic and cognitive foundations that underpin the development of intelligent systems, particularly with regard to understanding human language and simulating conversational behaviour. The green cluster covers business and functional applications, including customer service, customer satisfaction, chatbots, students, knowledge-based systems, sales, customer support and conversational agents. This cluster highlights the focus on the practical implementation of conversational systems in real contexts, such as customer service, education and sales, with an emphasis on improving the user experience and process efficiency. Blue cluster: conversational interfaces and large models This cluster includes terms such as ChatGPT, generative AI and language models, as well as user interfaces and computational linguistics. It brings together research focused on the evolution of generative models and user-system interaction through advanced interfaces. It demonstrates progress towards using pre-trained models such as GPT in commercial environments. Yellow cluster: Technological infrastructure and NLP This group comprises keywords such as natural language processing, artificial intelligence, learning systems and language processing. It reflects the technological core of conversational systems. This cluster is cross-cutting and connects with all the others, as natural language processing technologies are the common technical basis for the various approaches.

3.4 The Most Prolific Authors in the Field.

A co-authorship analysis was performed using VOSviewer to identify a network of researchers with an active research output who are closely connected through their work on systems based on conversational AI and natural language processing, as shown in FIGURE 6. This network exhibits a well-defined structure of established collaboration, centred around authors who have repeatedly collaborated on joint publications. Papadopoulos T. stands out in this group, appearing as one of the most central and connected nodes within the co-authorship map. This indicates his coordinating role in the network. Other significant contributors include Alexopoulos C., Charalabidis Y. and Karacapilidis N., who have addressed topics such as the design of conversational architectures, the integration of emerging technologies in public administration and the use of chatbots in corporate environments. Most of these authors are affiliated with European institutions, particularly in southern Europe, such as Greece, suggesting a high concentration of regional scientific production supported by joint projects and international research networks. This collaboration reflects the multidisciplinary nature of the field, where areas such as software engineering, human–computer interaction, and organisational management converge.

3.5 Thematic Analysis of the Most Frequently Cited Articles.

The bibliometric analysis identified the 50 articles with the highest number of citations in the studied document database. To provide an organised overview of the main areas of research focusing on the use of artificial intelligence and related technologies, these articles were classified according to their main theme.

The TABLE 3, It provides a detailed classification showing the number of articles in each category and the percentage each category represents of the total. It also provides related references. This

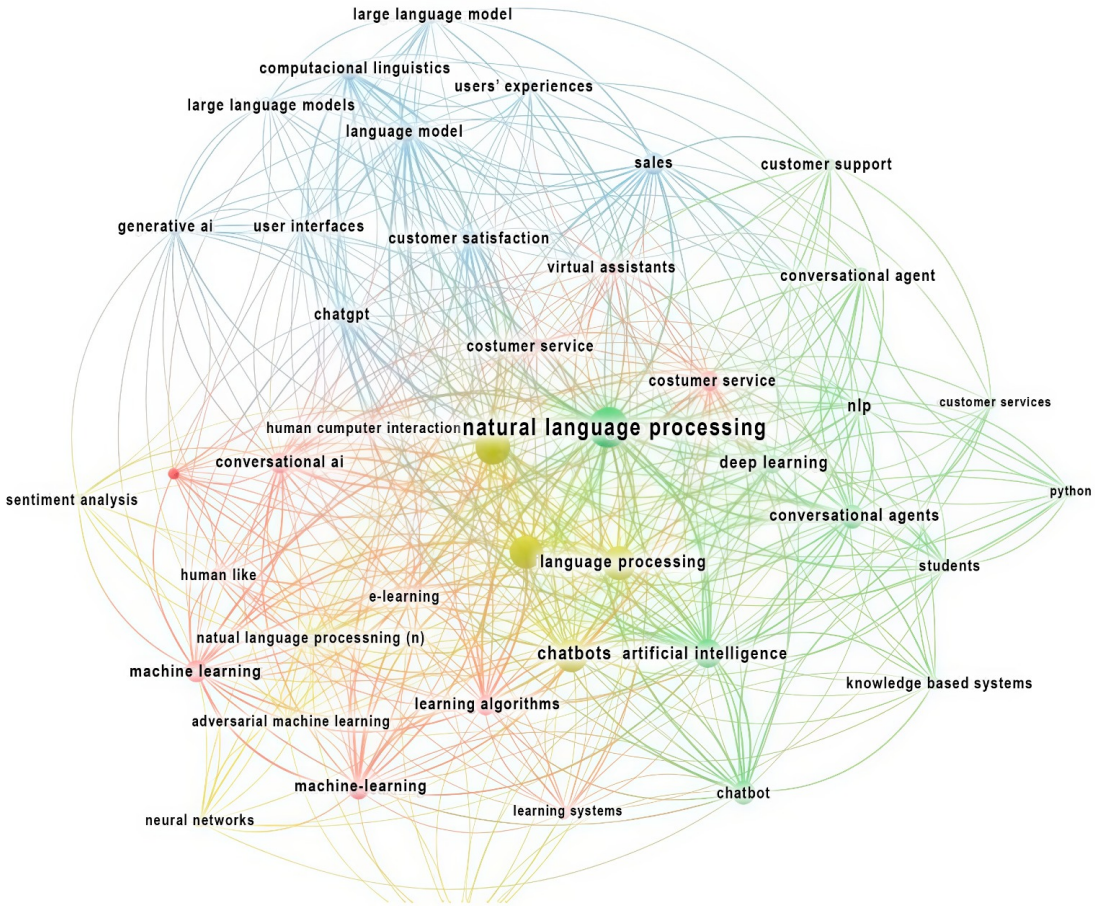

Figure 5: Topics and clusters in VOSviewer:

organisation makes it possible to identify the sectors with the greatest scientific output and those most impacted by recent technological developments such as generative artificial intelligence, chatbots and decision support systems. Notably, the Technology/General Tools and Commerce/Retail areas represent a significant proportion of the analysed publications (28% and 24%, respectively), highlighting the substantial interest these fields generate in academia and business. Next in terms of frequency are Industry 4.0 and Finance/Legal/ESG, reflecting technology's cross-cutting impact on key economic and administrative sectors. Including this table provides a clear visualisation of the thematic focus of leading publications and serves as a basis for discussing research opportunities that have not yet been sufficiently explored. For example, areas such as health and government/public policy were less represented in the set.

3.6 Implications of the Study

This bibliometric study provides a numerical overview of the development of artificial intelligence research by theme and region in key sectors. The results highlight two key points: some fields,

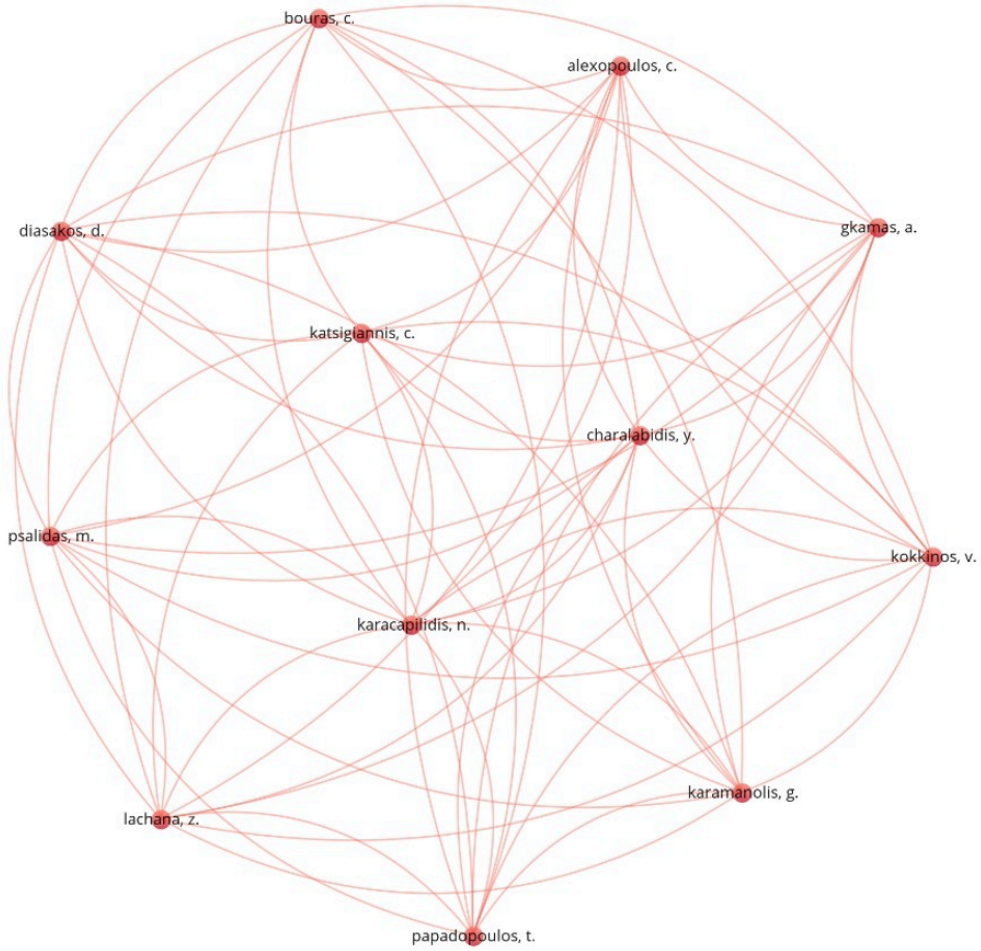

Figure 6: Co-authorship Analysis

such as the use of conversational agents in commerce and manufacturing, have a solid foundation of work, while others, such as public health and education, are still emerging.

From a practical point of view, I consider this classification to be a useful guide for researchers, policymakers, and developers seeking to understand the direction in which the field is moving. It shows where activity is strongest and where there is potential for growth. Additionally, reviewing co-authorships and institutional links enables us to identify the groups leading scientific output, which helps us to consider future international cooperation.

Table 3: Thematic classification of the 50 most cited articles

Thematic Area	Articles	% of total	References
Commerce / Retail	12	24.0	[15], [16], [17], [18], [19], [20], [21], [22], [23], [24], [25], [26]
Education	3	6.0	[27], [28], [29]
Finance / Legal / ESG	4	8.0	[1], [30], [31], [32]
Government / Public Policy	1	2.0	[33]
Industry 4.0	8	16.0	[34], [35], [36], [37], [38], [39], [40], [41]
Health	2	4.0	[42], [43]
Technology / General Tools	14	28.0	[44], [45], [46], [47], [48], [49], [50], [51], [52], [53], [54], [7], [55], [56]
Others	6	12.0	[57], [58], [59], [60], [61], [62]

3.7 Study Limitations

The study acknowledges several limitations. For example, the search was only conducted in four databases (Scopus, Web of Science, ScienceDirect and Springer), so papers from other repositories were probably not included. Another issue is that I only included articles with complete metadata, which may have introduced a bias into the final selection.

Even after cleaning and normalisation, small errors in author names, institutions or keywords could remain when processing the data. In addition, the analysis relied on VOSviewer and Excel. Different programmes might have produced different results, for example using semantic analysis or text mining techniques.

4. CONCLUSIONS AND FUTURE LINES OF RESEARCH

This article presents a systematic review based on 139 studies selected through a structured process of filtering and data cleaning. The review combines textual description, graphs, and statistics to show the current state of research on conversational agents and artificial intelligence across several sectors.

The results indicate that most publications are concentrated in Commerce, Industry 4.0, and Technology Tools, while fields such as Health and Public Policy receive less attention. The analysis also reveals the countries, as shown in TABLE 2, and institutions with the highest scientific production, showing that publications are often concentrated in certain academic contexts.

When comparing with other reviews, some points align while others differ, especially in the way topics are classified and in the trends that are emerging. Because conversational agents cut across many disciplines, future studies should expand into underexplored sectors and promote collaboration between different areas and institutions.

Future studies should extend to underexplored areas and foster interdisciplinary and institutional collaboration. The results can serve as a reference for mapping state-of-the-art advances and guiding future development of intelligent conversational systems. These insights contribute to understanding how AI adoption shapes digital transformation processes in diverse contexts.

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