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SURVEY

Tracking ChatGPT Research: Insights From the Literature and the Web

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ABSTRACT This article presents a scientometric and literature analysis of current research on ChatGPT, a conversational AI technology developed by OpenAI. Using various databases, 103 relevant articles were retrieved and analyzed through scientometric, quantitative, and application-based approaches. A Google trend analysis and comparison with other generative AI and chatbot technologies were also carried out. The study provides insights into the distribution of ChatGPT publications across different countries and regions, the network of co-occurring keywords, authorship analysis, article typology, and publishing entities. The findings offer a comprehensive overview of the current state of ChatGPT research, highlighting key directions for future research. The study finds that ChatGPT has gained significant attention and interest in online platforms, particularly in technology, education, and healthcare, and highlights potential ethical and legal concerns related to its use. Its applications extend to several literary and text generation areas. We do note that the sample of extracted publications is lower than anticipated due to the niche area of investigation. The article is relevant to researchers, practitioners, and policymakers interested in the field of AI-powered language models, especially ChatGPT.

INDEX TERMS ChatGPT, artificial intelligence, natural language processing, NLM.

I. INTRODUCTION

The advent of ChatGPT has sparked widespread discussion regarding its use as a language processing model and its popularity keeps escalating. As per statistics provided by Statista, ChatGPT acquired one million users within a mere five days of its launch in November 2022 [1]. According to estimations from Reuters, ChatGPT possesses the fastest-growing user base and achieved a milestone of 100 million users two months after its launch [2]. An analysis from the data firm Similarweb indicates that ChatGPT had approximately 590 million visits in January 2023 [3]. The universal prevalence of ChatGPT has driven numerous organizations, institutions, and scientific researchers to explore its potential significance and applications.

In recent years, the field of natural language processing (NLP) has experienced rapid advancements with the development of extensive pre-trained models. Founded by prominent figures such as Elon Musk and Sam Altman, the leading AI research lab, OpenAI [4] witnessed the design and development of the Generated Pre-trained Transformer (GPT), a deep learning model that utilizes neural networks to generate natural language texts [5]. The original model of GPT was released in 2018, and the updated version was born the following year. In 2020, the tech world welcomed the third generation, which was GPT-3. Serving as a variant of GPT-3, ChatGPT is an AI-powered language model that is capable of processing multiple conversational tasks [6]. These models are trained on massive amounts of textual data to execute language-related tasks with high accuracy [7]. AI-powered chatbots are expected to perform text-based tasks efficiently. For example, as a pre-trained transformer-based encoder model, BERT can accomplish various NLP tasks [8]. Compared with BERT, ChatGPT can handle multiple conversational tasks such as answering questions, language translation, summarizing texts, and many other functions [9]. But what distinguishes ChatGPT from other models is its ability to continually interact with a human naturally and

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provide responses to the user as well as a counter reply with interesting statements and assertions [10].

From the study of chatbot development, ChatGPT has proven to be a powerful tool for conversational tasks, and its applications have extended into areas such as information technology, healthcare, entertainment, education, and so on. Researchers and educators identify that ChatGPT can play a crucial role in educational sectors, including language translation teaching [11], academic writing tutoring [12], and education in specialized fields such as law [13] and finance [14].

In the field of healthcare, ChatGPT has been utilized in various scenarios, including stem cell research [15], clinical trials on writing medical papers about thrombosis and hemostasis [16], translating medical conversations and facilitating patient-doctor interactions [17], and improving medical students' skills [18]. Furthermore, ChatGPT provides significant inspirations in the field of information technology in terms of enhancement of AI conversational models [10], future advances in artificial intelligence [19], cyber security studies based on artificial intelligence [20], and the ethical analysis of AI development [21].

Thus, the advent, growth, and boom of ChatGPT have underscored the necessity of conducting a comprehensive review of the research literature to examine the focus and impact of ChatGPT and specifically decipher the type of publications, their usages, authorship, domains of application and other relevant aspects.

This paper presents an initial scientometric-based and thematic-based review of the current research literature on ChatGPT, a common technique employed to understand the evolution of a research area [22]. Similar research has been conducted in the latest technological developments such as blockchain technology [23], Internet of Things (IoT) [24], Fog Computing [25], Deep learning/Big data [26], Human-robot interaction [27], [28] or social phenomenon such as COVID-19 [29] or terrorism [30] or racism. These reviews utilize a variety of techniques to visualize and present research findings and metadata associated with the publications. In addition, a comprehensive application-based analysis of a range of ChatGPT studies was undertaken alongside a Google trends comparison with other AI-generative technologies. The main conclusions, as well as any possible areas for additional research and discussion are presented to conclude the proposed work.

Our scientometric review on ChatGPT aimed at investigating the following research objectives:

1. What are the prominent research applications of ChatGPT extracted via keywords and presented themes?
2. Who are the primary authors and institutions who have contributed to the research on ChatGPT?
3. What are the notable dissemination venues and outlets for publications on ChatGPT?
4. What categories of research publications have been generated on ChatGPT, and how do these categories impact the methodologies adopted and the findings obtained by researchers?
5. What is the range of domain areas and applications of the technology for which a qualitative review of the literature was undertaken?

The motivation for this research stems from the increasing significance of ChatGPT in the academic landscape and the broader research community. Our study makes a substantial contribution by demonstrating that ChatGPT holds notable influence, particularly within the realms of technology, education, and healthcare. This observation provides insight into the prevalence of non-academic discourse on ChatGPT disseminated through various outlets, such as blogs, technical publications, and news sources. Moreover, our study further advances understanding by substantiating the expansive potential of ChatGPT across a diverse array of disciplines, encompassing key domains such as education, academic spheres within higher education, and the domain of scientific writing. Within these spheres, ChatGPT possesses the capacity to precipitate significant paradigm shifts by challenging established methodologies and instigating critical ethical and legal deliberations, notably concerning issues such as plagiarism and its implications for entrenched critical thinking frameworks.

II. METHODS

The proposed work methodology and workflow are divided into three major stages (see Figure 1): i.e., Literature Retrieval, Scientometrics and Literature Analysis, and Google Trends Comparative Analysis.

A. LITERATURE RETRIEVAL

In our study, we extracted a pool of relevant research articles that focused on the scientific application and/or development of ChatGPT and analyzed them across a range of parameters. In the initial phase of the searching stage, a comprehensive literature search was conducted to identify manuscripts from various repositories, including Scopus, ScienceDirect, Semantic Scholar, PubMed, OpenAlex, Web of Science (WoS), Crossref, and search engines. Moreover, the scientometric mapping of the keywords and analysis based on countries, institutions, main authors, citations, affiliated organizations, keywords, and top sources was performed. The search was conducted on January 31, 2023. It is worth noting that our focus in this study was specifically on evaluating the quality and effectiveness of ChatGPT-generated content in the English language. As English speakers, we possess the necessary linguistic and contextual understanding to accurately assess the quality of the generated content in this language. To maintain the integrity and rigor of our evaluation, we chose to concentrate on English text generation to ensure an in-depth analysis. Evaluating text generated in languages that we are not proficient in could introduce biases or inaccuracies in our assessment, ultimately compromising the credibility and validity of our study.

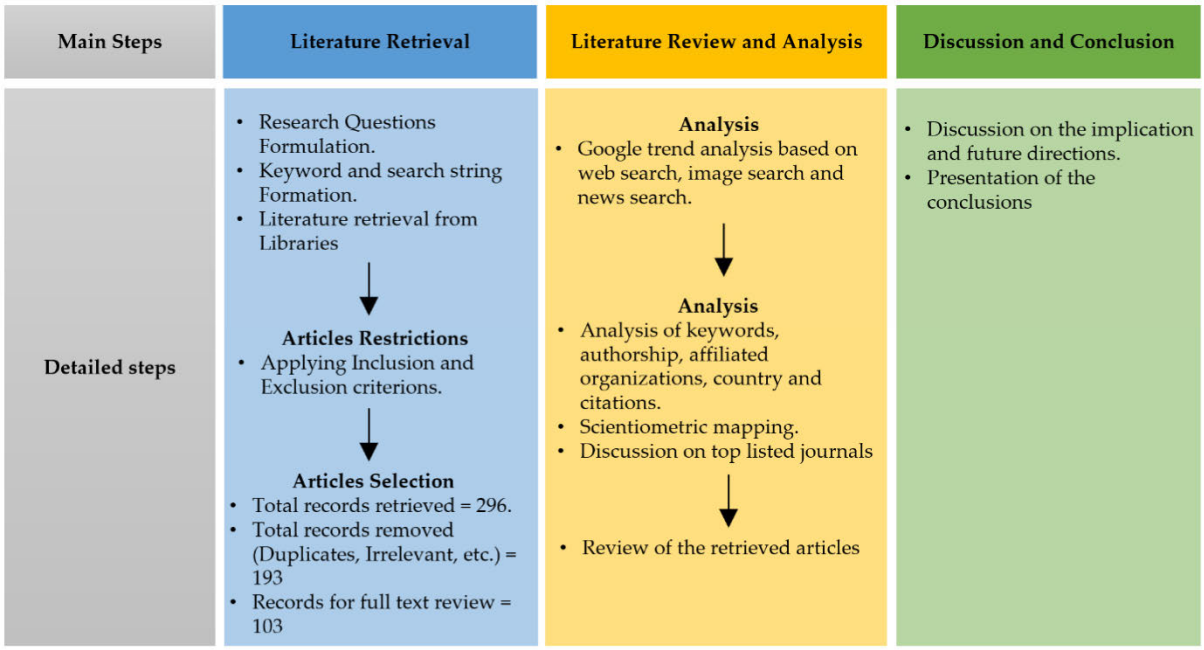

FIGURE 1. Proposed work methodology.

As shown in Table 1, the appropriate material was located using the search term ''ChatGPT'' within the search engines. Selecting ''ChatGPT'' as a search string ensures a focused exploration of literature directly related to ChatGPT. This approach enhances precision in capturing relevant documents specific to the language model. The decision to use 'chatgpt' as a keyword is a trade-off between specificity and potential oversight, providing a balance between maintaining focus and recognizing the diverse ways in which ChatGPT may be referred to in the literature. A total of 296 publications from various repositories were identified, all of which utilized the search string keywords within the title, abstract, and keywords. Google Scholar was not utilized in this study due to it comprising a significant amount of irrelevant literature from a wide range of sources, including reports, non-peer-reviewed publications, and various blogs. As indicated in Table 2, several constraints were used to maintain pertinent publications linked to the current study; namely, only journals and conferences were allowed (Criterion 1) and only papers written in English were permitted (Criterion 2).

Further, articles that did not practically use ''ChatGPT'' technology were excluded. A total of 157 duplicates found in the search engines were removed, giving a total of 139 articles In the end, the title, abstract, and full-text screening was also performed, and 103 relevant articles were ultimately selected for further analysis. A PRISMA flow chart summarizes the process described above (see Figure 2).

The ultimate compilation of chosen articles was subsequently subjected to coding for the subsequent parameters.

1. One-word description of research area as noted from classification categories given in the paper and author keywords; the values included Technological (focusing on the algorithm and backend technology and computation and accuracy-based studies), Education, Medical, Business, Research, Social Sciences, Media, Medicine,

TABLE 1. The search string, refinements, and results of various repositories.

Search Engine	String and Refinement	Results	Added to Screen
crossref	"ChatGPT"	72	10
open Alex		99	29
PubMed		17	1
ScienceDirect		15	12
Scopus		9	9
WoS		1	0
Semantic Scholar		83	78
Sum of papers = 296			
Duplicates = 157			
Remaining = 139			
After Abstract Screening = 121			
After full paper Screening = 103			
Total = 103			

TABLE 2. Inclusion and exclusion criteria followed to extract relevant studies.

Criterion	Inclusion	Exclusion
C1: Language	English	Other languages
C2: Article Type	Journals and conferences	Books, review, news etc.

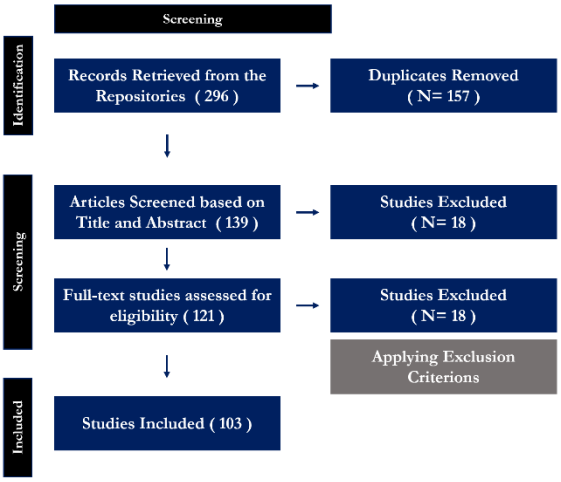

FIGURE 2. Prisma flow chart.

Engineering, Gaming, Human rights, Linguistics, Literature and Problem Solving.
2. List of authors
3. List of institutions, affiliations and countries attached to each paper.
4. The Venue or publication name
5. The type of article is determined by the publication type given by journal or venue.
6. Text-based or qualitative summaries of the methodology employed, and findings obtained.

III. RESULTS

We report on our findings in three stages. Firstly, we document the scientometric trends, followed by a qualitative reporting and overview of ChatGPT applications and lastly a comparison of ChatGPT with other generative-AI technologies using primarily Google Trends analysis.

A. SCIENTOMETRIC ANALYSIS

Utilizing metadata extracted from the research publications, a spectrum of scientometric analyses was conducted.

1) DISTRIBUTION ANALYSIS

To gain a comprehensive understanding of the global landscape surrounding ChatGPT research, we conducted an analysis of the distribution of publications across different regions and countries. Figure 3 illustrates the regions and countries that have demonstrated the highest productivity in publishing articles related to ChatGPT. The graph was generated based on the first author's affiliation as recorded in our sample. Extrapolating and extracting the first author's affiliation as a measure of the manuscript's attributes is a common practice observed in other scientometric studies [31].

It can be observed that the region of America (40.8%) exhibits the highest productivity in terms of publications related to ChatGPT, with all the publications in this region originating from the United States. Europe is the second most productive region, accounting for 31.1% of the total publications, with the United Kingdom, Germany, and Ireland being the top three countries in terms of publications. Asia takes the third place with 10.7% of attribution with the top representatives being China and North Korea.

2) KEYWORD ANALYSIS

This study utilized a keyword co-occurrence network (see Figure 4) to represent the relationship between different keywords visually. Initially, a list of 138 keywords was generated from the literature retrieval. Nevertheless, upon testing, it was observed that only 22 keywords satisfied the criteria when applying a rule of a minimum of two keyword occurrences, and further refining the threshold to at least three keyword occurrences resulted in only 16 keywords meeting the criteria.

After careful consideration, it was decided to use the network containing all 138 keywords for the analysis. The keyword co-occurrence graph was deeply analyzed to uncover meaningful insights. Clusters of keywords around the topics of education and ethics appeared as areas of interest. Most other clusters were related to algorithmic development. To improve the clarity of the analysis, similar keywords were combined. This merging of similar keywords made the analysis more meaningful and easier to understand. For instance, 'Artificial Intelligence' and 'AI', 'Natural Language Processing' and 'NLP', and 'chatbots' and 'chatbots' were merged. The top 10 keywords were identified based on their frequency of occurrence in the dataset and their relevance to the research questions. These keywords were 'ChatGPT', 'artificial intelligence', 'natural language processing', 'get', 'machine learning', 'ethics', 'deep learning', 'transformers', 'gpt3', and 'generative artificial intelligence'.VOSviewer [32], a tool for bibliometric network analysis, was used to construct and visualize the keyword co-occurrence network (see Figure 4). This type of graph typically represents how often terms appear together within a given context, such as academic papers, search queries, or online discussions. The proximity and linkage between terms like ''artificial intelligence,'' ''natural language processing,'' ''machine learning,'' and ''generative artificial intelligence'' highlight their strong association with ChatGPT, indicating that these areas are likely fundamental to its development and application. Surrounding terms cover a diverse range of disciplines and considerations, from ''education'' to ''ethics'' and ''computational chemistry,'' illustrating the extensive reach and potential implications of ChatGPT's technology. The various line thicknesses and colors could signify the strength and nature of these associations, providing insights into which areas are most frequently discussed or considered in relation to ChatGPT. This graph serves as a visual summary of the complex relationships between ChatGPT and numerous fields, reflecting its multifaceted impact and the broad interest it generates across different.

3) 1ST AUTHORS' AFFILIATIONS ANALYSIS

An analysis based on the first authors' affiliations was conducted to determine the universities with the highest number

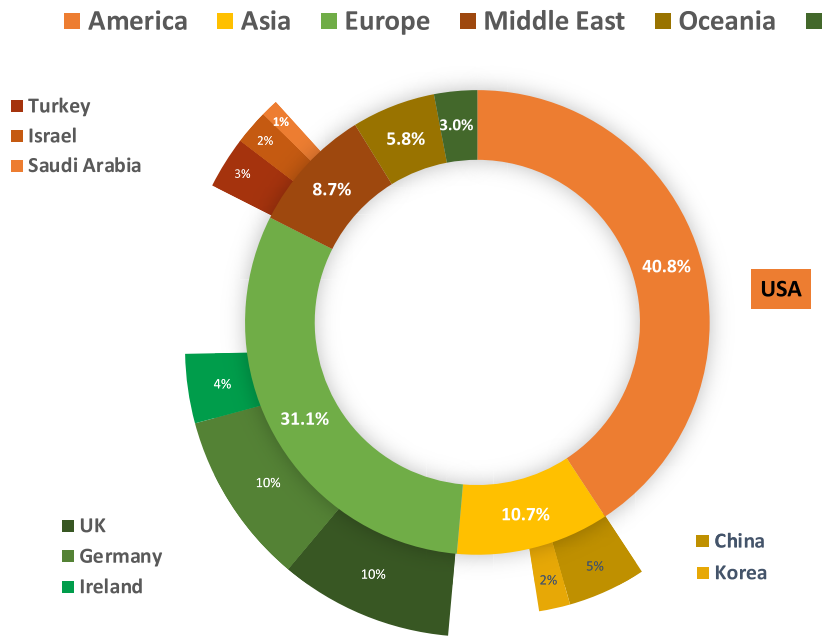

FIGURE 3. Distribution productivity across regions and countries.

of publications related to ChatGPT (see Figure 5). The results indicate that the top two universities, namely Johns Hopkins University and Massachusetts Institute of Technology, are both located in the United States and have each produced three publications. The remaining seven universities have each produced two publications, with three of them being situated in the United States and two in Germany.

4) AUTHORS LIST ANALYSIS

The analysis of authors' lists serves as a critical component of our study, offering nuanced insights into prolific contributors within the ChatGPT domain. A comprehensive analysis based on the complete list of authors reveals that 194 authors (including 3 non-identifiable authors) have contributed to the total 103 articles. The top 12 authors with the highest volume of publications are displayed in Figure 6. It is worth noting that the AI language model "ChatGPT" is recognized as a co-author and is included in the authorship list (a total of 3 times).

5) PUBLISHER ANALYSIS

Approximately half of the 103 publications included in our database are preprint versions, which were not excluded due to their status as peer-reviewed manuscripts awaiting formal publication (see Figure 7). Subsequent popular publication types were articles, editorials, opinion papers, research papers, and fiction. The top publishers identified in our analysis were the SSRN Electronic Journal with 12 publications and Nature with 6 publications.

B. APPLICATION BASED ANALYSIS

We now report a qualitative review of ChatGPT applications as evidenced in the extracted literature. The research

TABLE 3. Table of related works.

Application Field	Related Works
Technology	[21], [33]–[37], [50]
Education	[6], [7], [13], [14], [38]–[49]
Healthcare	[18], [51]–[53], [55]–[57]

domains were systematically organized into distinct categories predicated on their pragmatic applications. These categorizations encompassed prominent sectors including Technology, Education, Healthcare, Research, Business, and Social Sciences. The description of these categories was informed by meticulous consideration of author-supplied keywords and/or classifications attributed to the papers under examination by the publications. Based on the information presented in Figure 8, it can be observed that the research on ChatGPT predominantly falls under three major areas, namely Technology (32.93%), Education (31.71%), and Healthcare (20.73%). However, to gain deeper insights, we intend to further investigate the specific fields in which ChatGPT is being utilized, as per our sample of publications (see Table 3).

1) TECHNOLOGY

The Natural Language Processing capabilities of ChatGPT have drawn significant attention to technology-based applications. Several studies have been conducted to examine ChatGPT's potential and accuracy. An experiment [33] demonstrated ChatGPT's ability to paraphrase, explain, and

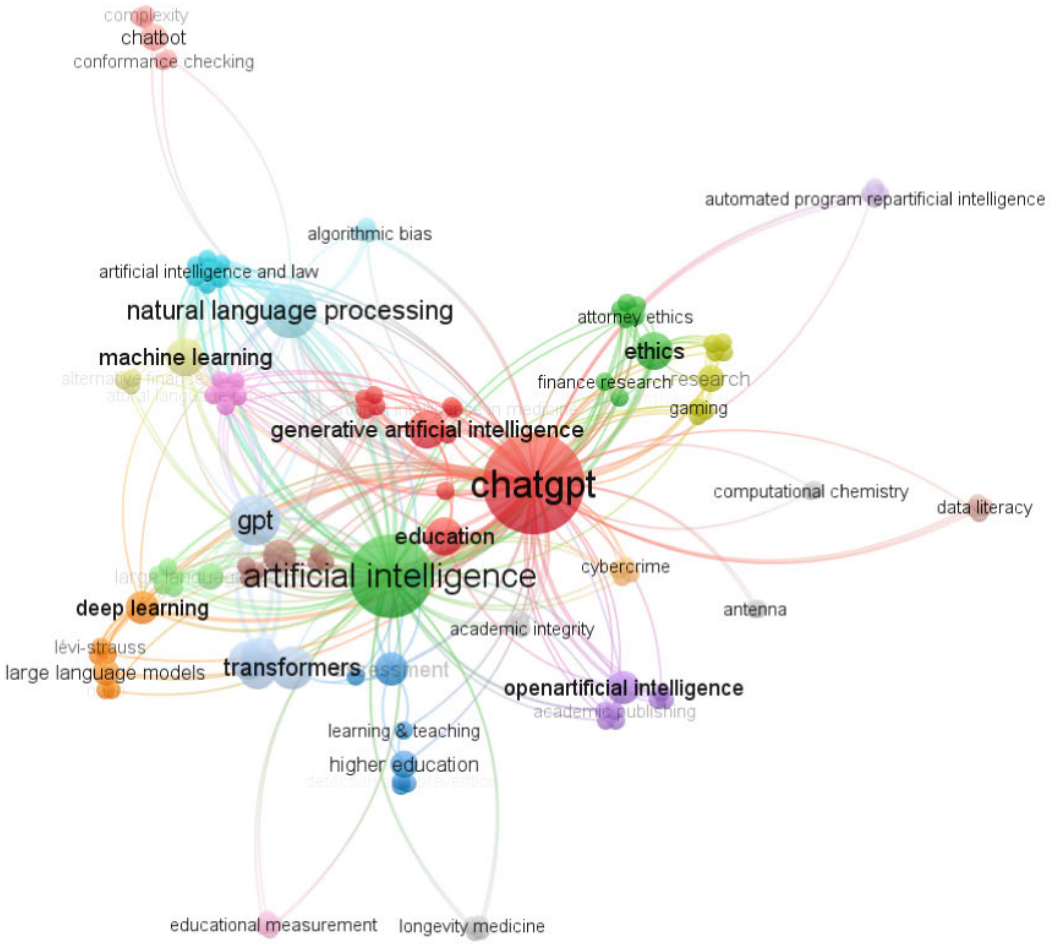

FIGURE 4. Keyword co-occurrence network.

TABLE 4. The search string, refinements, and results of 5 AI language models.

Model	Search Engine	Search String	Refine Date	Result-google	Result-Scopus	Result-WoS
ChatGPT	Google Scholar Scopus WoS	ChatGPT	12/2022- present	53	28	7
ChatSonic		ChatSonic	12/2022- present	0	0	0
Perplexity AI		Perplexity AI	08/2022- 11/2022	0	0	0
Amazon Alexa		Amazon Alexa	11/2014- 01/2015	35	2	0
Cortana		Cortana	04/2014-07/2014	26	15	0

Inclusion Criteria: Articles published within 3 months after each model's advent or first release.
*The dataset was acquired on the 28th of February, with the term "present" denoting this timeframe.

connect concepts, but it fell short when genuinely joining ideas. The authors also found that ChatGPT can provide false information with complete confidence, which can have serious consequences. An evaluation of ChatGPT for stance detection was conducted in another study [34]. Results showed that ChatGPT could achieve state-of-the-art (SOTA) or similar performance for widely used datasets. A comprehensive diagnosis of AI Ethics encoded by ChatGPT was also conducted [21]. According to the results, ChatGPT may perform slightly better than current SOTA language models, but it also poses ethical risks. In their study, the authors found that ChatGPT is sensitive to prompts that can lead to unethical behavior.

Jiao [35] conducted a preliminary evaluation of ChatGPT for machine translation and found that ChatGPT performs competitively with commercial translation products such

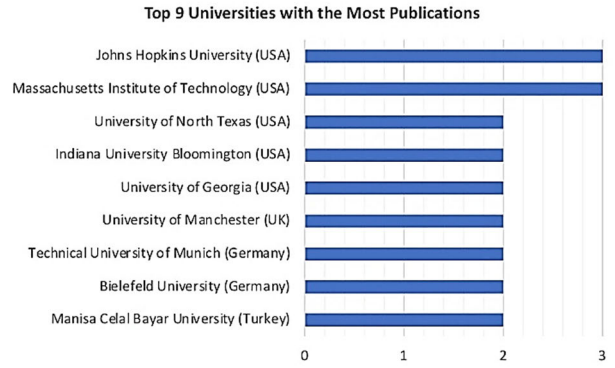

FIGURE 5. Top 9 productive universities.

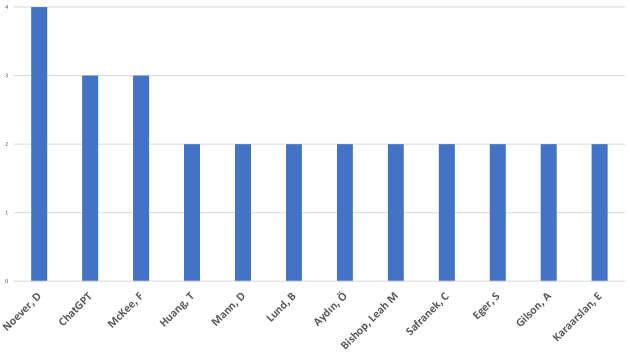

FIGURE 6. Top authors with the most publications.

as Google Translate in high-resource European languages. However, it lags significantly behind on low-resource or distinct languages. Security-wise, ChatGPT has proven effective at detecting and deflecting malicious activity [36]. Moreover, ChatGPT has a unique feature that spawns coding approaches that conceal executable coding steps using images. As a result of this feature, ChatGPT can support a more advanced understanding of complex coding questions [36]. Finally, it is worth noting that ChatGPT has been tested without fine-tuning and still performs on the level of the best-fine-tuned system [37]. This result showcases the impressive capabilities of ChatGPT even without significant customization.

2) EDUCATION

Through our analysis, it is evident that ChatGPT has shown potential value for various educational applications. According to Dowling and Lucey, ChatGPT can generate impressive, and believable research papers for well-ranked journals by adding data and results analysis [14]. Besides, ChatGPT's language translation capabilities, text summarizing, and QAs make it a powerful tool that can help users with a range of tasks [6] and also provide new opportunities to develop skills in students [38]. Cotton [39] proves that ChatGPT has potential benefits for higher education, such as increasing student engagement and accessibility. For example, students who received personalized and adaptive feedback from AI-based learning platforms showed higher engagement and better performance, particularly those with low prior knowledge and at risk of dropping out ChatGPT also benefits educators. It was stated that machine-generated questions are similar to human-generated questions and can be used in final exams [40].

However, researchers and educators express their worries and concerns regarding implementing ChatGPT in teaching and education. For example, Zhai stated that using ChatGPT in education should involve real-world problem-solving tasks while ensuring that the assessments focus on creativity and critical thinking which cannot be replaced by an AI language model [41]. Kasneci and other experts believe that utilizing large language models like ChatGPT for education may lead to risks regarding ChatGPT knowledge limitations, potential biases, privacy, security, environmental, regulatory, and ethical requirements [7]. Professors and researchers in law also see the potential benefits and risks of ChatGPT in legal research and writing [42]. Choi et al. [43] requested ChatGPT to write and attempt Law exams and they found that ChatGPT's performance on final exams was average with better performance on essay components than multiple-choice, although its essay performance was highly uneven. However, ChatGPT is tested to be able to ''think like a lawyer'' because it can ask difficult questions [13]. Ventayen and his team [44] believe that ChatGPT's ability to generate plagiarism-free articles potentially threatens academic integrity. The fidelity of short-form essays as an assessment method in Physics courses is threatened by AI chatbots like ChatGPT [45]. Lund also proposed that scholars should use ChatGPT responsibly and ethically since it could disrupt academia and librarianship [46] and the risks should be made clear to the students [47]. Although many experts see the benefits and potential risks of ChatGPT, some believe that academia must adapt to the limitations of ChatGPT, as the technology is here to stay and may become as widely used as a research or search engine [48]. What's more, Zhai [49] concluded that ChatGPT has the potential for automatic assessment, grading, learning guidance, and recommendation of materials for science learning, but it cannot replace teachers.

3) HEALTH

Natural language processing (NLP) models have gained increasing attention in the healthcare industry in recent years due to their potential to improve care delivery and enhance patient outcomes. There has also been research and evaluation of ChatGPT's performance in healthcare applications. For example, queries related to Shoulder Impingement Syndrome (SIS) were entered [50], and responses to medical information and treatment options were received and analyzed. A study comparing the knowledge and interpretation ability of ChatGPT and medical students found that ChatGPT's performance was lower than that of medical students [51]. However, other studies have shown that ChatGPT outperforms other NLP models in answering medical questions, as demonstrated by its performance on the United States

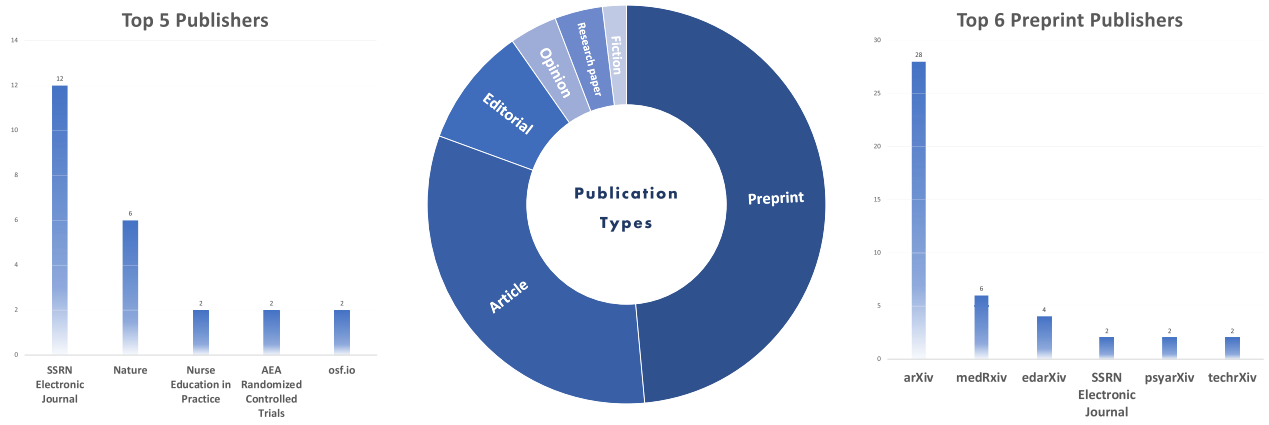

FIGURE 7. Publication types and top publishers.

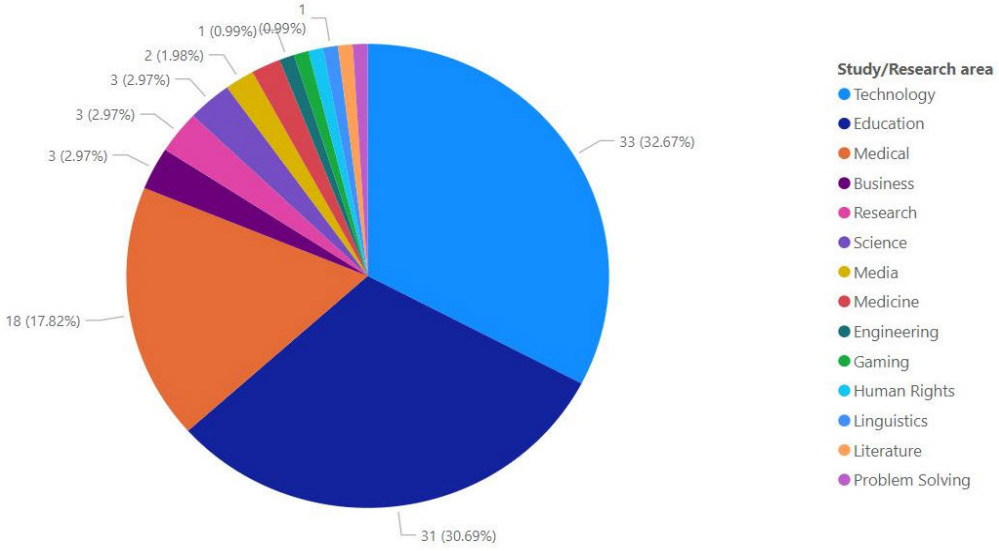

FIGURE 8. Distribution of research area.

Medical Licensing Exam (USMLE) [52], [53]. Furthermore, a study by Antaki [54] indicated that ChatGPT's performance varied across sub-topics in the medical field, with the best results in general medicine and the worst performance in neuro-ophthalmology. These findings suggest that ChatGPT may require more pretraining to improve its performance in specific topics and domain areas.

In addition, ChatGPT has been evaluated for its usefulness in providing quick guidance to students on pharmacology topics [18]. A comparative analysis of ChatGPT, InstructGPT, and GPT-3 showed that ChatGPT outperformed InstructGPT across all data sets, while GPT-3's performance was similar to random chance in the evaluation [53]. The superior performance of ChatGPT over InstructGPT suggests that ChatGPT is better equipped for processing and analyzing language-based data sets. In the context of daily patient healthcare, ChatGPT's responses to patient questions were found to be only weakly distinguishable from responses given by healthcare providers [55]. This finding suggests that laypeople may be willing to rely on ChatGPT to answer lower-risk health questions.

Moreover, the response generated by ChatGPT for the translational medicine review [17] was comparable to that of an early career graduate medical student who conducted a Google search lasting 60 to 90 minutes. However, ChatGPT gave unreliable results when asked to review the role of AI algorithms in drug discovery, indicating that human intervention is necessary to produce reliable scientific texts [56], [57].

C. GOOGLE TREND ANALYSIS

We would like to further explore and examine the popularity and uptake of ChatGPT via a Google Trends analysis. Our study encompassed an investigation into the dynamics of search trends and the global interests surrounding the specified keyword, "ChatGPT." This search string was

deliberately aligned with our overarching search string utilized during the data exploration across all selected databases for this study. The primary aim of this investigation was to understand discernible patterns, fluctuations, and variations within online search activities, aiming to explain the scope of global engagement with the precise term ''ChatGPT''. Figure 9 shows the results obtained from a Google Trends analysis within the period of July 2022 to February 2023 illustrating search behaviors related to the keyword ''ChatGPT'' across three main search modalities: web search, image search, and news search [58]. There was a substantial increase observed in the search volume for all three sources (web search, image search, and news search) from December 2022 and search volumes have kept rising in the past 2 months. Figure 10 presents the geographical distribution of interest in the term ''ChatGPT'' over the past 12 months until February 2023, as obtained from Google Trend data [58]. Users in China (including Hong Kong and Taiwan) were observed to have the greatest level of interest. Following these are countries like Singapore, Nepal, Bangladesh, and Lebanon.

D. COMPARISON WITH OTHER GENERATIVE AI AND CHATBOT TECHNOLOGIES BASED ON GOOGLE TREND ANALYSIS

The worldwide web search volume for five predominant AI chatbots or language models is presented in Figure 11 as per Google Trends (namely, ChatGPT, ChatSonic, Perplexity, Amazon Alexa, and Cortana). These AI technologies were selected based on the comprehensive review of market adoption/presence, user size, and expert recommendations. It is worth noting that the range of the data is confined to the initial three months following the advent or first release of each model or technology. The first three months following the release of ChatGPT in December 2022 witnessed a significant and continuous surge in search volume [58].

IV. MAXIMIZING CHATGPT FOR RESEARCH SUCCESS

In addition to presenting our research findings, this section serves as a practical guide for researchers eager to maximize the utility of ChatGPT. To effectively leverage the capabilities of the language model, several key strategies are highlighted. Firstly, researchers must formulate questions with clarity and conciseness, enhancing the likelihood of obtaining relevant responses and improving overall interaction with ChatGPT. The importance of experimenting with diverse input formats is underscored, allowing researchers to gain insights into and optimize the model's responses to different types of queries. Another critical step involves fine-tuning parameters such as temperature and maximum tokens. Researchers are encouraged to tailor these parameters to control the randomness and length of generated responses, ensuring outputs align with their specific requirements and preferences. These steps will facilitate a smoother and more effective integration of ChatGPT into the research process, ensuring that its benefits are fully realized by future investigators.

Understanding the ChatGPT landscape is crucial, with multiple versions introducing iterative improvements. A notable distinction emerges between versions 3.5 and 4, each refining the model's capabilities. Version 4, for example, enhances language understanding, improves context retention, and introduces a more nuanced response mechanism. Researchers must weigh these differences, acknowledging that version 4 is adept at handling complex queries and extended interactions, while version 3.5 may offer advantages in specific use cases. This nuanced awareness empowers researchers to make informed decisions about which ChatGPT version aligns best with their specific research needs.

V. DISCUSSION

Our analysis has revealed several key findings in relation to the propagation of ChatGPT research since its inception in late 2022. ChatGPT has garnered widespread and persistent attention and interest on online platforms, and this is indicated in the Google Trends analysis. However, we do suggest that the sample size of ChatGPT-focused papers is lower in comparison to other disruptive and advanced technologies of the past but much higher than other competing chatbots (as evidenced by our comparative analysis). Via prior analysis of arxiv repositories [63], we can note that the rate of self-archival of papers focusing on ChatGPT is at least 10 times lower than what would be expected of an AI-based technology. This may be attributed to the specific nature of the technology, which is the niche area of natural language processing (NLP). Prior research informs us that NLP does not feature amongst the top 10 frontier areas (''hot research topics'') in Computer Science [64] and may hence contribute to the overall low sample of papers noted in our comparative analysis of chatbot technologies.

Moreover, our literature overview highlights that the applications of ChatGPT are plentiful extending to many social domains, where ChatGPT can be readily and immediately applied as an end-user application. This may result in many of the writings on ChatGPT being published in non-scientific mediums such as blogs, technical reports, or new articles. The question hence emerges regarding the evolution of ChatGPT as a tool, and whether it is a research or commercial utility. The underlaying and background technology (which is shown to work) is most certainly the former however the usage and deployment of the tool appear to be the latter. We may find more discussion on the latter; hence fewer research articles are located.

Further, we observed in addition to the lower sample size of publications, in connection the aggregated list of contributing authors is lower as are any ensuing collaborations. Perhaps not enough time has lapsed for collaborations to emerge or mature that focus on ChatGPT. ChatGPT originates from within a US-based company, so the initial waves of impact have been felt in the US first, with the US dominating nearly half of the affiliations. Due to the nature of the rapidly evolving technology of ChatGPT, scientists are relying on

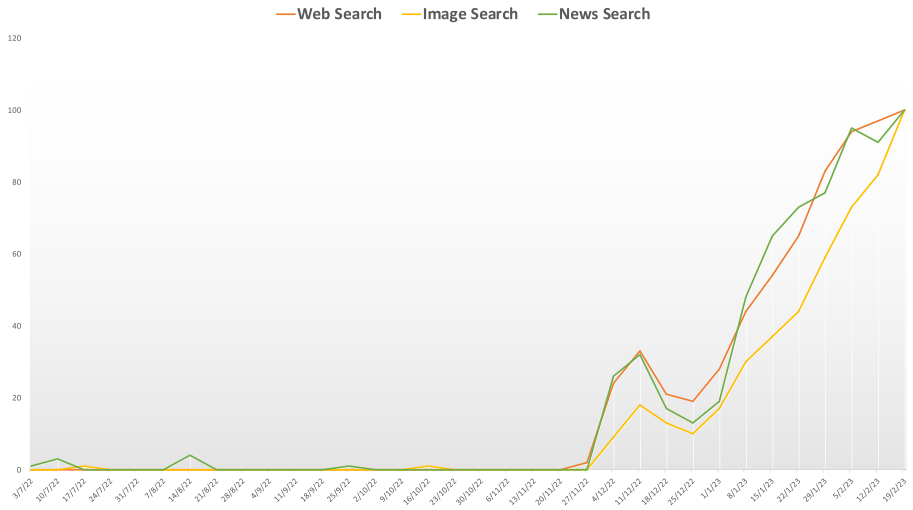

FIGURE 9. Google trend main analysis (JULY 2022 TO FEB 2023).

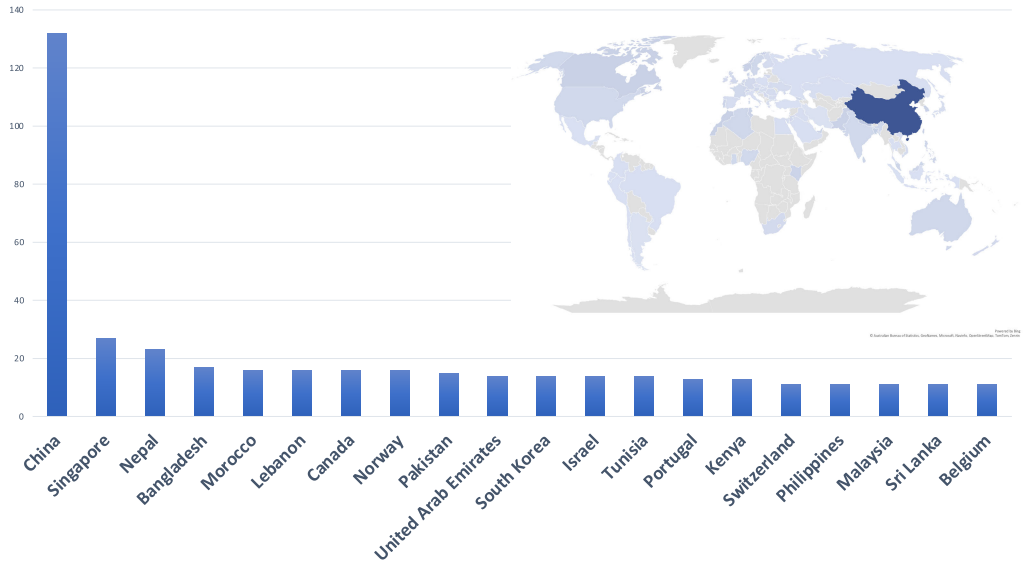

FIGURE 10. Top 20 countries using CHATGPT (JULY 2022 TO FEB 2023).

quick self-archival, which is a common tendency in Computer Science and Artificial Intelligence [63], [65]. Self-archived repositories such as arXiv were the standout dissemination platforms in our sample of ChatGPT publications. We have already alluded to the readily applicable commercial nature of ChatGPT as an end product so many more research articles focused on applications of ChatGPT than on algorithmic discussion on natural language processing. Several methodologies and research techniques were employed in the articles. A conclusion section is not required. Although a conclusion may review the main points of the paper, it does not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions.

VI. ETHICAL AND LEGAL CONCERNS

Throughout our comprehensive review, we observed critical perspectives directed at ChatGPT. To capture pertinent literature, we conducted searches across Scopus, Web of Science, and Google Scholar databases, utilizing the search terms ''ethical legal malicious, chatbot''. Initially, a total of 32 articles were identified. Subsequent to meticulous evaluation of titles, abstracts, and full texts, 10 articles emerged as relevant and were consequently incorporated into our review paper.

It is of significance to highlight that a notable revelation has been observed concerning the perspectives held by researchers and scholars toward the advanced AI-powered tool. This observation becomes particularly pertinent following the introduction of ChatGPT 3.0. A consequential

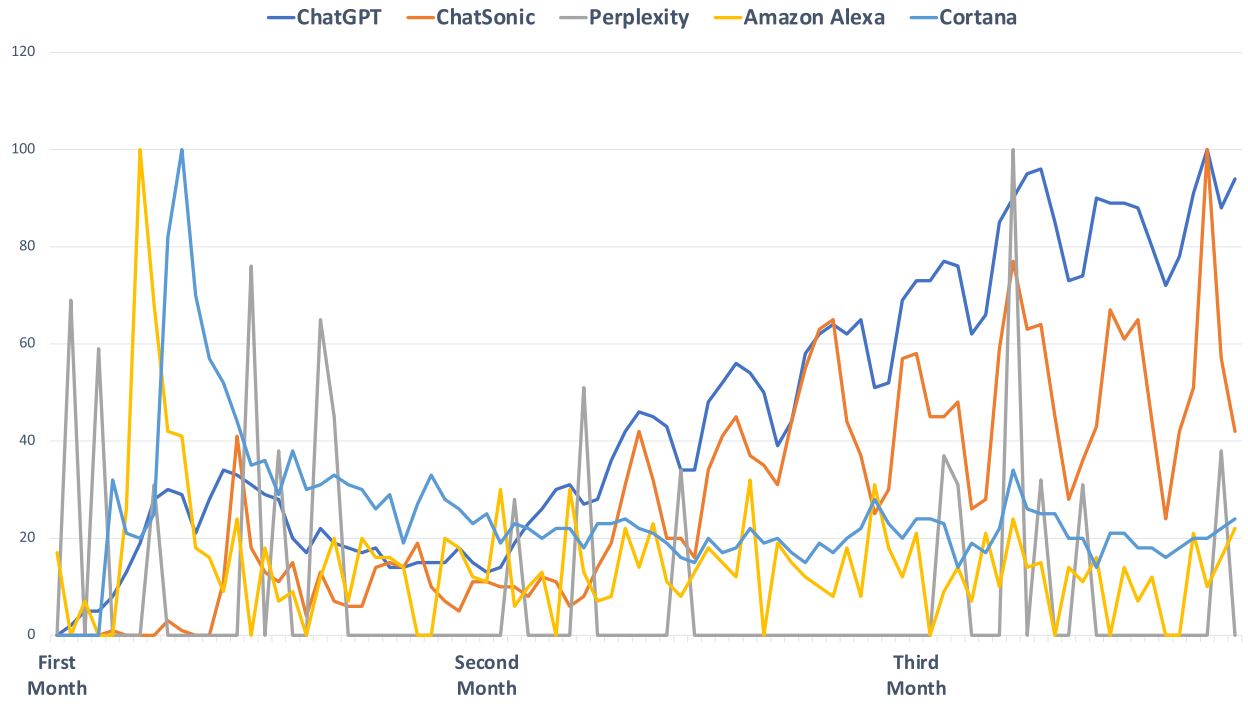

FIGURE 11. Worldwide web search volume.

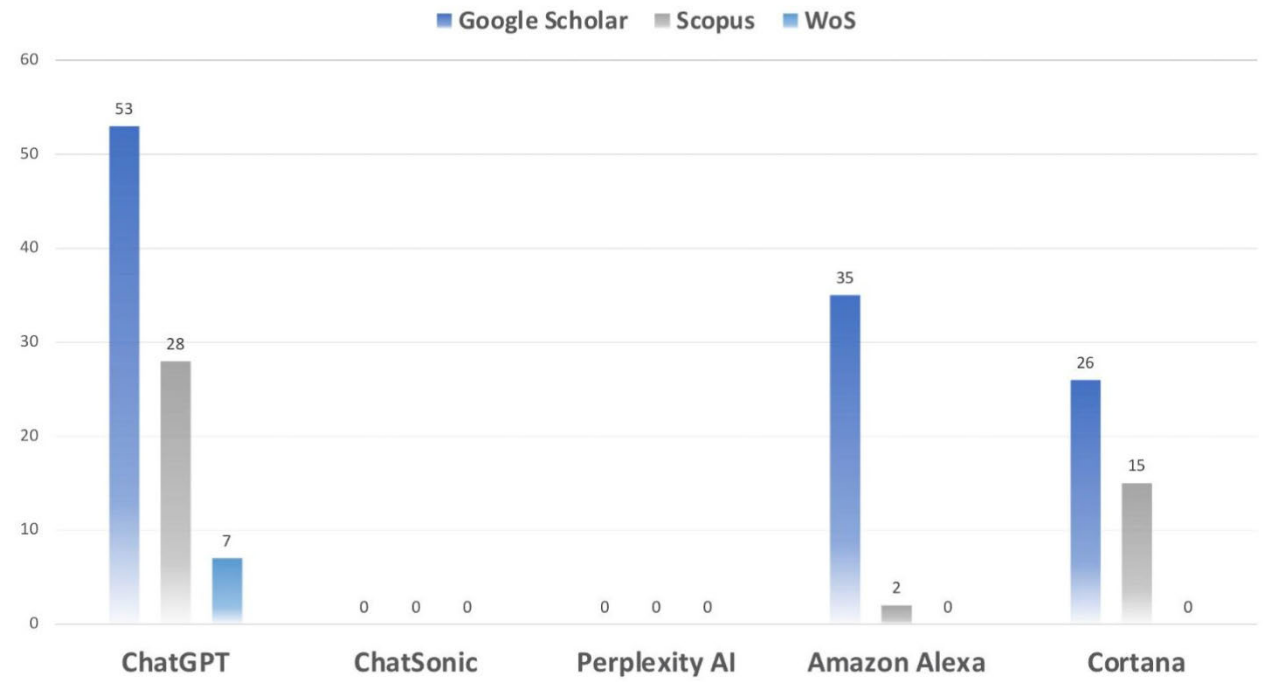

FIGURE 12. Publication results of 5 AI models.

discussion has emerged relating to the ethical anxieties associated with AI tools, as well as the recognition of human responsibilities in their utilization [68]. Large Language Models, such as ChatGPT, of this nature present advantages upon human daily activities, concurrently stimulating sociocultural effects on the contemporary generation. This encompasses alterations in critical thinking paradigms, creative faculties, and even patterns of social conduct and

lifestyles [69]. It is particularly intriguing to ascertain that a considerable portion of the ethical considerations pertaining to ChatGPT are concentrated within the domains of education and healthcare. Our analysis, as illustrated in Figure 8 of this review paper, indicates that education and healthcare emerge as prominent fields among the top three employing ChatGPT. Rahimi and Abadi pronounced concerns regarding the production of scholarly manuscripts subsequent to the introduction of ChatGPT. The unresolved debate regarding AI content generators as ''co-authors'' in academic works remains a substantial point of contention within the scholarly discourse [70]. Another discourse also involves reflections concerning the integration of ChatGPT within the educational context, which in turn presents challenges concerning the education fairness and quality of educational processes [71]. Within the realm of medical and healthcare sectors, the utilization of ChatGPT in doctor-patient interactions reveals both advantageous outcomes and prospective hazards [72]. As clarified in Sallam's paper [73], the employment of ChatGPT holds the potential for advancements in medical and scientific domains. However, this course of AI-powered medical progress also raises the threat of hidden risks, including the weakness of scientific fraud.

As advocated by certain scholars, the aspiration is for humans to not be excessively dominated by artificial intelligence. Conversely, the responsibility rests upon humans to thoroughly employ AI-powered tools as a means to extend the scope of human knowledge [74]. Consequently, individuals have begun to engage in action. The evolution of the European AI regulatory strategies, as discussed in Li's article [69], serves as an illustrative instance of human response subsequent to the recognition of ethical dilemmas. The framework of Human-centered Artificial Intelligence (HCAI) similarly functions as a response to the excessive engagement of AI applications, emphasizing the significance of human responsibility [75]. The increasing calls for the development of AI-content detection models and justification mechanisms signify a concerted effort to promote the ethical utilization of ChatGPT [76].

Aside from the above-noted ethical considerations, there have been cases of malicious reporting and misrepresentation utilizing ChatGPT. Examples include the creation of fake articles [77] and falsified academic references in order to provide false credibility to a piece of content [78], as well as occasions when ChatGPT has incorrectly cited or misreported Quranic passages [79].

Future research trends for ChatGPT include the creation of embodied chatbots for improved human interaction, diagnostic instruments for healthcare and problem-solving applications, enhanced industry-wide troubleshooting, revolutionary customer service experiences, interactive entertainment opportunities, and improved personalized education [69], [77]. The appropriate and effective integration of AI technology across diverse fields will depend on ethical concerns and cooperation between AI and human specialists.

VII. CONCLUSION

In conclusion, our review of ChatGPT research has revealed some interesting findings. Despite being a relatively new technology, the AI-powered language model, ChatGPT, has already earned significant attention and interest on online platforms, as indicated by the Google Trends analysis with a continually increasing trajectory of popularity. However, compared to other disruptive and advanced technologies of the past, the sample size of ChatGPT-focused papers is relatively low (103 extracted papers as per our sample). Authorship is concentrated in the USA and nearly half of our sample were pre-print. Moreover, the applications of ChatGPT are plentiful and extend to many social domains. Our findings from the application-based analysis part reveal the prominent research fields of ChatGPT lie in technology, education, and healthcare. This may explain why many writings on ChatGPT are published in non-scientific mediums such as blogs, technical magazines, or news articles.

Nevertheless, our literature overview highlights the potential of ChatGPT in various fields such as education, university academia, and scientific writing, where it has the potential to disrupt traditional methods and introduce novel ethical and legal concerns such as plagiarism and impacting conventional critical thinking abilities. Moreover, the Google trend analysis ChatGPT has garnered increasing popularity due to its outstanding text generation, question answering, and overall textual assistance. Its advanced sophistication enables it to generate language output that closely resembles human text, providing users with an exceptionally lifelike conversational experience.

In sum, our review provides a comprehensive overview of the current state of ChatGPT research and reveals several key findings, including the potential of ChatGPT to disrupt traditional methods in various fields, the need to address ethical and legal concerns arising from its use, and the relatively lower sample size of papers. Our low sample size naturally dictated the extent of the analysis and we anticipate that many more research articles would have surfaced after we concluded our search. Further, we have not established the impact of ChatGPT via other means such as traction on social media and the like which would provide a different insight to the prevalence and dissemination of ChatGPT. While insightful, this review has limitations. The effectiveness of strategies may vary across domains, and the evolving nature of language models could impact their applicability. Insights are based on information up to January 2023, and researchers should stay updated. Additionally, our study focuses on English-language articles, potentially excluding valuable information from other languages. Despite efforts to include keywords, some synonyms may have been overlooked. In the future, our review will critically assess the trajectory of large language models (LLMs), such as ChatGPT, to determine their potential long-term impact and adoption in the technology landscape. Our study will also investigate whether LLMs are likely to follow a similar path as previous innovations,

like Wearable Devices and Google Glass, which initially generated significant attention but encountered challenges in achieving mainstream adoption.

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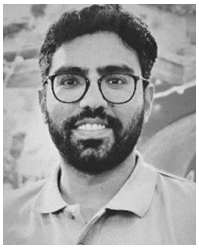

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