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Sentiment Analysis in Social Media: A Comprehensive Bibliometric Analysis

Análisis de sentimiento en las redes sociales: un análisis bibliométrico completo

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Sentiment Analysis; Social Media; Bibliometric Analysis; Digital Communication; Interdisciplinary Research

Palabras clave

Análisis de sentimiento; Redes sociales; Análisis bibliométrico; Comunicación digital; Investigación interdisciplinar

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Abstract

This research aims to present a bibliometric review of sentiment analysis in social media, highlighting its evolution, key contributors, and emerging themes. The study utilizes the Clarivate Web of Science database, employing a strategic search methodology to ensure accurate results. With the assistance of RStudio and the "bibliometrix" package, the research employs a rigorous approach to analyse 764 articles, emphasizing themes, citation patterns, and collaborative dynamics. Research output from 2011 to 2023 revealed significant growth in the sentiment analysis domain, with an annual growth rate of nearly 40%. The collaborative nature of this domain is evident, with international collaborations constituting 27%. Geographically, the USA, China, and India dominate, though there is significant input from multiple countries worldwide. This bibliometric review is a comprehensive exploration of sentiment analysis in social media, presenting insights into the field's progression, interdisciplinary nature, and potential future trajectories. It underscores the importance of international collaborations and quality-driven research, suggesting avenues for future exploration in the dynamic landscape of digital communication.

Resumen

Esta investigación tiene como objetivo presentar una revisión bibliométrica del análisis de sentimientos en las redes sociales, destacando su evolución, contribuyentes clave y temas emergentes. El estudio utiliza la base de datos Clarivate Web of Science y emplea una metodología de búsqueda estratégica para garantizar resultados precisos. Con la ayuda de RStudio y el paquete "bibliometrix", la investigación emplea un enfoque riguroso para analizar 764 artículos, enfatizando temas, patrones de citación y dinámicas colaborativas. Los resultados de la investigación de 2011 a 2023 revelaron un crecimiento significativo en el ámbito del análisis de sentimiento, con una tasa de crecimiento anual de casi el 40%. La naturaleza colaborativa de este ámbito es evidente: las colaboraciones internacionales constituyen el 27%. Geográficamente, dominan Estados Unidos, China e India, aunque hay aportaciones significativas de varios países de todo el mundo. El estudio enfatiza el atractivo universal del análisis de sentimientos y se muestra prometedor para aplicaciones y metodologías innovadoras. Esta revisión bibliométrica es una exploración integral del análisis de sentimientos en las redes sociales, presentando ideas sobre la progresión del campo, la naturaleza interdisciplinaria y las posibles trayectorias futuras. Subraya la importancia de las colaboraciones internacionales y la investigación impulsada por la calidad, sugiriendo vías para la exploración futura en el panorama dinámico de la comunicación digital.

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1. Introduction

The age of digital information has ushered in an exponential growth of online interactions, underscoring the need to systematically decipher the embedded sentiments within the vast landscapes of social media. Sentiment analysis, standing at the crossroads of computational linguistics, artificial intelligence, and data science, endeavours to distil these textual narratives into discernible affective categories. Considering its escalating relevance, there is an inherent need to conduct a rigorous bibliometric analysis to shed light on the progression of sentiment analysis within the framework of social media.

Sentiment analysis, also known as opinion mining, delineates the categorization of textual information into sentiment-polarized groups. Its adaptation to the social media domain, characterized by its real-time, succinct, and spontaneous nature, has paved the way for multifarious applications. Whether it's enterprises assessing customer sentiments or policy makers gleaning public sentiments for decision-making, the ramifications are vast and consequential.

The increasing academic interest in sentiment analysis applied to social media calls for a thorough and systematic evaluation of its academic trajectory. A bibliometric review stands out as the method of choice, delineating the progression, demystifying collaborative patterns, pinpointing influential works, and laying the groundwork for future research directions. This approach is particularly resonant within the purview of communication studies, offering insights into how sentiment analysis interfaces with prevalent digital communication paradigms and the ensuing implications for future investigations.

Digital communication, with its ever-evolving contours, necessitates a dynamic integration of emerging methodologies. Sentiment analysis, with its capability to extract subjective nuances from textual data, stands as a testament to such methodological evolutions. Hence, charting its academic journey, methodologies, and implications is essential.

The robustness and authenticity of this bibliometric analysis rest firmly on the choice of a reliable database and a strategic search methodology. The decision to opt for the Clarivate Web of Science (WoS) exemplifies the endeavour for accuracy and comprehensiveness. This is further bolstered by a meticulous search strategy that strikes a balance between platform-specific nuances and the overarching domain of digital social interactions.

The temporal progression of research outputs in the realm of sentiment analysis on social media platforms offers important markers. Notable surges in research publications could be indicative of underlying catalysts, be it technological advancements or significant socio-political events. This systematic mapping becomes instrumental in unearthing key publications, methodological shifts, and evolutionary trajectories of the field.

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In parallel, the citation patterns furnish insights into the sustained influence and relevance of these academic contributions. While an uptick in research publications signifies burgeoning interest, the citation patterns unveil the wider academic community's reception and acknowledgment of these works.

Furthermore, a deep dive into the oeuvre of prolific authors illustrates the contributions that have shaped the domain. Conversely, a macroscopic lens on the geographical distribution of research, both in terms of volume and pioneering contributions, presents a panoramic view of the field's global evolution. The collaboration dynamics between countries and the ensuing synergy provide invaluable insights into the interdisciplinary and cross-national character of sentiment analysis research.

Central to this bibliometric analysis are several research questions How has sentiment analysis in social media evolved over time, both in terms of volume and thematic focus? Which scholars have consistently contributed to this domain, and what have been their essential contributions? How have collaborations across nations influenced the trajectory of the field, and what does this signify about the global landscape of sentiment analysis research? Lastly, what emergent themes and paradigms can be identified, and how might they shape the course of future research?

In conclusion, this bibliometric review, grounded in rigorous methodologies, aims not only to chronicle but also to interpret, assess, and predict the trajectory of sentiment analysis within the ever-evolving realm of social media.

2. Literature review

Sentiment analysis, particularly in the field of social media, has gathered significant attention across various domains due to its capacity to extract and decode vast textual data and, consequently, generate valuable insights into human perceptions and behaviours. These investigations have opened doors to diverse applications, ranging from politics and health to commerce and crisis management.

Sentiment analysis, also known as opinion mining, is a computational technique used to identify and extract subjective information from textual data, such as social media posts, reviews, and comments. The primary goal of sentiment analysis is to determine the sentiment expressed in the text, categorizing it as positive, negative, or neutral. This technique is widely applied across various domains, including marketing, political analysis, and customer service, to understand public opinion and inform decision-making processes (Baek & Yi, 2021; Fahmi, 2021; Peterson et al., 2021).

The methodologies employed in sentiment analysis can be broadly classified into three main approaches: lexicon-based, machine learning-based, and hybrid

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approaches. Lexicon-based methods rely on predefined dictionaries that contain words annotated with their sentiment polarity. These methods calculate the overall sentiment of a text by counting the occurrences of sentiment-laden words. Tools such as the NRC Emotion Lexicon and AFINN sentiment analysis methods are commonly used in this category. Although lexicon-based methods are straightforward and interpretable, they often struggle with context-specific sentiment and sarcasm detection (Deori et al., 2021; Chen & Kwak, 2021).

Machine learning-based approaches involve training algorithms on labeled datasets to recognize sentiment patterns in text. Supervised learning models, including logistic regression, support vector machines, and deep learning networks, are commonly used to classify sentiment based on features extracted from the text (Baek & Yi, 2021; Fahmi, 2021; Xu et al., 2021). Machine learning models can adapt to various contexts and capture complex patterns in the data, but they require large annotated datasets for training and can be computationally intensive. For instance, Fahmi (2021) used machine learning to analyze user comments on social media, identifying key features of economic rumors during the Russian-Ukrainian War.

Hybrid approaches combine the strengths of both lexicon-based and machine learning methods. These approaches typically use lexicons to extract initial sentiment features, which are then refined using machine learning models. This combination can enhance the accuracy and robustness of sentiment analysis. For example, Baek and Yi (2021) applied a hybrid approach by using both unsupervised topic modeling and sentiment analysis to uncover prevalent themes and sentiments in cryptocurrency marketing tweets.

The application of these methodologies spans various domains, providing valuable insights into public sentiment. For example, Baek and Yi (2021) employed sentiment analysis to examine Twitter content related to cryptocurrency marketing, revealing prevalent topics and associated sentiments. Similarly, Peterson et al. (2021) conducted a mixed-methods study on mass shooters' social media usage, integrating systematic content analysis with sentiment analysis to identify behavioral patterns. Goldman et al. (2021) analyzed social media communication during the Kilauea Volcano eruption, highlighting the impact of empathic communication on public sentiment during crisis situations. Cranmer et al. (2021) examined sentiment in social media comments towards professional athletes, revealing insights into public reactions and engagement.

These methodologies have been successfully applied in diverse contexts, from marketing and crisis communication to political and social analysis, demonstrating their broad utility and impact (Baek & Yi, 2021; Goldman et al., 2021; Peterson et al., 2021).

In the political sphere, sentiment analysis holds substantial promise. Minango Negrete et al. (2023) examined sentiment dynamics during the Ecuadorian presi-

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dential election, emphasizing the predominantly positive and neutral perspectives on Twitter associated with the candidates. Similarly, Park et al. (2023) dove into the nuanced emotion-based strategies employed during the 2016 Russian election campaigns on Facebook and Twitter. These findings not only spotlight the significance of sentiment analysis in electoral processes but also emphasize its potential to reveal complex influence strategies targeting the electorate. Further, Yaqub et al. (2021) illustrated the role of sentiment in influencing the communication pattern of public sector organizations on social media platforms.

Health and crisis communication domains have also seen notable explorations. Saeed et al. illustrated the utility of sentiment analysis in assessing public opinion regarding COVID-19 vaccines, achieving significant accuracy. Additionally, Carvache-Franco et al. (2023) pinpointed the power of Twitter in shaping public perceptions during the COVID-19 tourism crisis. Such insights suggest that sentiment analysis can prove invaluable during global crises, helping governments and organizations tailor their communication strategies effectively. The studies by Demczuk et al. (2022) and Kaur et. all (2021a, 2021b) also emphasize the significant role of sentiment in crisis communication, particularly during the COVID-19 pandemic.

The commercial sector, comprising e-commerce and business communication, has leveraged sentiment analysis for strategic refinement. Yin et al.'s (2022) analysis of sentiments towards e-commerce platforms like Lazada and Shopee unveils predominantly positive perspectives, valuable for adjusting marketing strategies. On a similar note, Trivedi and Singh (2021) underscored the importance of monitoring sentiments about competitors, as demonstrated by their focus on online food delivery brands. Sabol & Horak's (2022) work on informal business communication introduced enhanced sentiment analysis tools, catering specifically to the unique communication styles predominant on social media.

The evolution of techniques in sentiment analysis remains an important area of exploration. While Mann et al. (2023) and Xie et al. (2023) both highlighted the capabilities of BERT-based models in recognizing sentiments, Jindal and Aron (2021) introduced a multi-modal framework, VITESA, combining visual and textual data, revealing an impressive accuracy in sentiment classification. Hartmann et al. (2023) delved into the trade-offs between accuracy and interpretability in sentiment analysis, spotlighting the superiority of transfer learning models.

Unique challenges also surface in sentiment analysis. Del Valle Martin & de la Fuente Valentin (2023) highlighted the dominance of English language research and the gaps in sentiment analysis for the Spanish language. Pradhan and Sharma (2023) addressed the complexities of sentiment analysis on code-mixed data, reflecting the intricacies of multi-lingual analysis.

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Several studies, like those by Mi & Zhan (2023), Fleet & Hine (2022), and Ngou Njikam Abdou & Fute Tagne (2021), transcend the conventional domains, shedding light on topics like climate change perceptions, technological advancements like facial recognition, and the detection of abusive content, respectively.

Hence, the showcased studies demonstrate the broad potential for applying sentiment analysis to unravel perceptions and shape communication strategies across diverse fields. The constant evolution of methodologies and the growing recognition of unique challenges ensure that sentiment analysis remains an invaluable tool in the contemporary digital age.

3. Material and methods

We anchored our analysis on the reputable Web of Science (WoS) database, recognized for its stringent academic inclusion criteria. Our crafted search effectively encompassed the expansive terrain of sentiment analysis within the context of social media, ensuring the collected articles formed a comprehensive and pertinent groundwork for the study.

With the data sourced, our attention turned to its processing and intricate examination, for which we used RStudio, a preeminent environment for statistical computing. Its strength not only lies in handling vast data but also in seamlessly integrating specialized packages, particularly the "bibliometrix" package (Aria & Cuccurullo, 2023), which is tailored for bibliometric studies. This package facilitates the conversion of raw data into structured bibliographic data frames, a transformation essential for standardization and consistent analysis.

In the RStudio environment, we employed the biblioshiny() function—a constituent of the bibliometrix package. This function offers an intuitive interface for visual analysis, streamlining the process from data upload to intricate bibliometric investigations. It simplified the transformation of raw bibliographic records, paving the way for a variety of analytical tools that ranged from tracking publication trends to mapping complex collaboration networks.

Thus, the combination of the WoS database, RStudio, and the bibliometrix package constituted the core of our methodological approach. This fusion enabled a thorough exploration of the academic landscape of sentiment analysis in social media, revealing both existing patterns and potential future trajectories.

3.1. Database

In bibliometric evaluations, especially when addressing Sentiment Analysis in Social Media, the database selection critically determines the research's precision

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and depth. For this analysis, the exclusive choice of Clarivate Web of Science (WoS) was based on several factors.

WoS, renowned for its precision and authenticity, adheres to stringent inclusion criteria, ensuring that only publications meeting superior academic benchmarks are indexed. Such selectivity is paramount for a nuanced subject like Sentiment Analysis in Social Media. Moreover, the multifaceted nature of Sentiment Analysis, which bridges domains like computer science, linguistics, and social sciences, necessitates a database with an expansive scope. WoS, with its multidisciplinary orientation, pertinently addresses this need.

A salient feature of WoS is its global outreach, capturing influential research contributions across geographical boundaries—a critical aspect given the universal impact of social media. Complementing this is WoS's robust citation tracking mechanism, invaluable for bibliometric endeavours, facilitating a nuanced understanding of research trajectories.

From an operational standpoint, WoS's design facilitates efficient data extraction, streamlining the bibliometric analysis process. While other databases like Scopus or Google Scholar possess advantages, the consistency and rigor of WoS set it apart. For instance, Scopus, while comprehensive, might occasionally include journals not aligning with WoS's exacting standards. Similarly, Google Scholar's inclusivity, though creditable, can introduce less scrutinised sources. Thus, to maintain analytical consistency, WoS was considered optimal.

It's worth noting potential limitations—exclusivity to WoS might overlook articles in other databases. However, given WoS's thoroughness, such oversights are anticipated to be marginal, preserving the integrity of the findings.

In essence, the Clarivate Web of Science was chosen for its rigorous standards, extensive scope, and precise citation tracking—attributes aligning it as an ideal tool for a rigorous bibliometric assessment of Sentiment Analysis in Social Media.

3.2. Search strategy

In synthesizing a comprehensive bibliometric review focused on sentiment analysis within social media environments, an rigorous and analytical search strategy was indispensable. The intricacy of this topic mandates a rigorous method to encompass the breadth of academic discourse and to ensure the fidelity of the aggregated scholarly contributions.

The constructed query, ("social media" OR "Facebook" OR "Twitter" OR "Instagram") AND "sentiment analysis" AND "communication", was devised with particular attention to terminological precision and the inherent interdisciplinarity of the subject matter.

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The terms "social media", "Facebook", "Twitter", and "Instagram" were selected to encompass both specific platforms and the broader domain of digital social interactions. This ensures inclusivity of studies focused on individual platforms and those with a more generalized approach, hence providing a representative sample of the digital social landscape.

The inclusion of "sentiment analysis" is instrumental, targeting studies that engage with the algorithmic and computational methodologies developed to interpret and categorize affective expressions in textual digital content.

The term "communication" was integrated into the search to encapsulate the broader epistemological frameworks of communication studies. In doing so, the search sought to clarify the intersections between sentiment analysis methodologies and prevailing theories of digital communication.

The efficacy of this search strategy is reflected in the extraction of 764 scientific articles. This significant volume of literature underscores the expanding academic interest and the extensive research landscape at the nexus of sentiment analysis, social media, and communication.

Hence, the chosen search approach, grounded in terminological accuracy and interdisciplinary factors, has enabled the attainment of a substantial collection of scholarly literature, laying the foundation for a thoroughgoing bibliometric investigation.

3.3. Bibliometric indicators

In the field of scientific research, bibliometric indicators offer a quantifiable lens through which we can determine patterns, evolutions, and trends in a specific domain. In our comprehensive review on sentiment analysis in social media, several such indicators have been meticulously employed to explain the depth and extensiveness of contributions to this enriching field.

The Temporal Evolution of Publications serves as an initial indicator, offering insights into the pace at which the topic has gained influence. By mapping the chronology of publications, we can discern periods of heightened activity, potentially influenced by technological advancements, socio-political events, or the introduction of novel analytical methods. This linear perspective is crucial for identifying landmark papers, paradigm shifts, and essential moments in the evolution of sentiment analysis within social media.

Parallel to this, the Temporal Evolution of Citations provides a measure of the impact and relevance of the published works overtime. While a surge in publications denotes activity, the citation count reflects the recognition and importance of these contributions in shaping subsequent research. It's an indicator of the

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community's acknowledgment of influential works that set precedents or introduce innovative methodologies.

Our focus on Productive Authors accentuates individual contributions and highlights scholars who have persistently driven the domain forward. Recognizing these authors is not merely about quantifying output but understanding the nuances and intricacies they introduce, which become central to subsequent research endeavours.

On a broader scale, evaluating Productive Countries and Corresponding Author's Countries offers a geographical mapping of sentiment analysis research. This dual approach elucidates both the collective national contributions and the locations where foundational research is being orchestrated. It's particularly enlightening to observe the interplay between these indicators, revealing whether a country's overall output is steered by a few important researchers or a wider scholarly community.

The Collaboration between Countries is an indicator of the interdisciplinary and transnational nature of sentiment analysis in the age of globalized research. By analysing these collaborations, we understand the synergies between nations, the fusion of diverse linguistic and cultural insights, and the mutual exchange of methodologies that enrich the field.

Lastly, our Thematic Analysis dives deep into the content of the publications. Beyond the quantitative aspects, this indicator qualitatively assesses the recurrent themes, novel propositions, and emerging trends within the corpus of literature. It enables us to cluster research into coherent categories, identify intersections between themes, and predict potential trajectories for future research.

4. Results and discussion

4.1. General Information and Dynamics

The bibliometric review spans over a 13-year period from 2011 to 2023. This time frame captures the emergence and growing importance of sentiment analysis, particularly in the age of social media. The sources for the data include a substantial 538 different journals, books, and other types of publications, resulting in a sum of 764 documents. This sizable dataset suggests the growing relevance and interdisciplinary nature of sentiment analysis.

The annual growth rate of 39.75% signifies a growing interest in this domain. To put it in perspective, a steady annual increase of close to 40% underscores the rapid progression and significance of sentiment analysis in the contemporary digital landscape. With an average age of 3.18 years per document, we observe that

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most contributions are relatively recent, underlining the contemporary relevance and evolving nature of this research field.

An average of 13.06 citations per document is quite remarkable. It indicates the influence and significance of the research in the domain. High citation rates generally suggest the foundational or transformational nature of the research, thus emphasizing the importance of sentiment analysis studies in academic and applied settings.

The breadth and depth of research are evident from the 963 'Keywords Plus' and a whopping 2,136 'Author's Keywords'. These numbers suggest a diverse array of sub-topics and angles from which sentiment analysis in social media is approached. Such diversity is indicative of an expansive and multifaceted research domain that encapsulates various nuances, methodologies, and applications.

The data lists 2,337 authors, a testament to the field's multidisciplinary nature, attracting scholars and experts from diverse academic backgrounds. However, it's notable that only 48 have ventured into single-authored documents, emphasizing the complexity and collaborative nature of the research. Such a trend could be indicative of the multifaceted nature of sentiment analysis, often requiring interdisciplinary expertise.

Collaboration is further highlighted by the statistic that each document averages 3.41 co-authors. Nearly 27% of these collaborations are international, underscoring the global relevance and universal application of sentiment analysis techniques across different cultures, languages, and regions.

Most contributions come in the form of articles (501), emphasizing peer-reviewed scholarly input. This is followed by 'proceedings papers' (197), which hints at the active discussions and advancements being presented in conferences—a hotspot for contemporary ideas and innovations.

The presence of articles in conjunction with 'early access' (29) or 'book chapters' (8) highlights the urgency and significance of timely dissemination of findings in this domain. Moreover, 24 reviews signify attempts to periodically consolidate and reflect upon the vast amount of knowledge being generated.

4.2. Temporal Evolution of Publications

The trajectory of publications over the 13-year period offers profound insights into the evolution and maturation of the field of sentiment analysis in social media, according to Figure 1.

2011-2013: Nascent Stages: Starting with a modest 2 articles in 2011, the subsequent years witness a tripling (2012) and then more than a doubling (2013) of this figure. This period could be seen as the genesis of formalized research on sentiment

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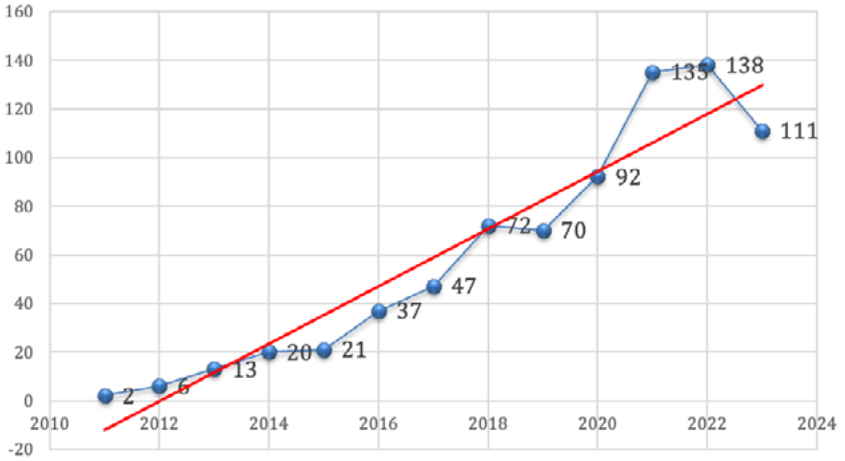
Figure 1. Annual Scientific Production



Source: compiled by authors.

analysis in the context of social media, with scholars recognizing and embarking on exploring its potential implications.

2014-2017: Steady Growth and Recognition: The subsequent phase, spanning from 2014 to 2017, is marked by a steady and significant increase in annual contributions. Notably, 2016 and 2017 both see substantial jumps, nearly doubling from the preceding years. This pattern hints at the field gaining recognition, possibly due to the increasing importance of social media in both business and societal contexts. By this time, sentiment analysis might have begun establishing itself as an indispensable tool for understanding online user behaviour and preferences.

2018-2020: Rapid Expansion and Mainstreaming: The years 2018 and 2019 both contribute around 70 articles annually, with 2020 witnessing a substantial spike, amassing a total of 92 articles. This surge might be reflective of the expanding importance of social media analytics, with sentiment analysis at its core. The near constancy between 2018 and 2019, followed by a spike in 2020, suggests that while the field had entered its mainstream phase, the need for refined methods and newer applications became more pronounced, triggering more intensive research.

2021-2023: Pinnacle of Research and Possible Saturation: An unprecedented 135 articles in 2021 and an even higher 138 in 2022 mark the zenith of scholarly contributions in this domain. However, 2023 sees a slight dip, with 111 articles. While still a formidable figure, this decline might hint at the onset of saturation or possibly a

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shift of research focus within the broader domain of sentiment analysis. It's also plausible that after a decade of rigorous research, more comprehensive and holistic frameworks have emerged, leading to a gradual consolidation of knowledge.

4.3. Temporal Evolution of Citations

In 2011, the mean total citation per article stood at 7, hinting at the emergent stage of sentiment analysis in social media within scholarly discourse. The corresponding annual citations averaged 0.54, suggesting a modest academic engagement with the subject matter at this juncture (Figure 2).

A significant surge was observed in 2012, with the mean total citation per article increasing dramatically to 35.83, and the mean total citations per year registering at 2.99. This substantial increment indicates a heightened scholarly interest and possibly the introduction of pioneering methodologies or frameworks.

The year 2013 observed a mild deceleration with the mean total citation per article at 24 and the mean total citations per year at 2.18. While this represents a diminishment from the previous year, the values still considerably surpass those of 2011, suggesting sustained academic relevance.

From 2014 to 2016, a somewhat rippling pattern emerges. In 2014, both the mean total citation per article and the mean total citations per year receded to 16.8 and 1.68 respectively. Contrastingly, 2015 observed a revitalization, with values rising to 31.14 and 3.46. However, 2016 marked a zenith in this bibliometric journey, with the mean total citation per article reaching an impressive 57.16 and mean total citations per year at 7.14, possibly pointing towards the publication of seminal works that year.

The ensuing years, from 2017 to 2019, witnessed a general attenuation in the bibliometric indicators. Values oscillated in the mid-teens for mean total citation per article and mid-2s for mean total citations per year, indicating a potential saturation or transition in the research arena.

By 2021, a more pronounced decline was evident, with the mean total citation per article and mean total citations per year registering at 10.59 and 3.53 respectively. This trend intensified in 2022, as the metrics decreased to 2.36 and 1.18. The year 2023 saw these values converge at 0.78.

Thus, our bibliometric analysis offers a view of the research trajectory of sentiment analysis in social media from its first use, reaching a peak in 2016, followed by a subsequent decline. The observed patterns could be emblematic of the natural evolution of a research domain — from emergence to maturation, and eventually towards saturation or diversification into more nuanced sub-domains. Further inquiries would be necessary to decode the precise reasons underpinning these bibliometric trends.

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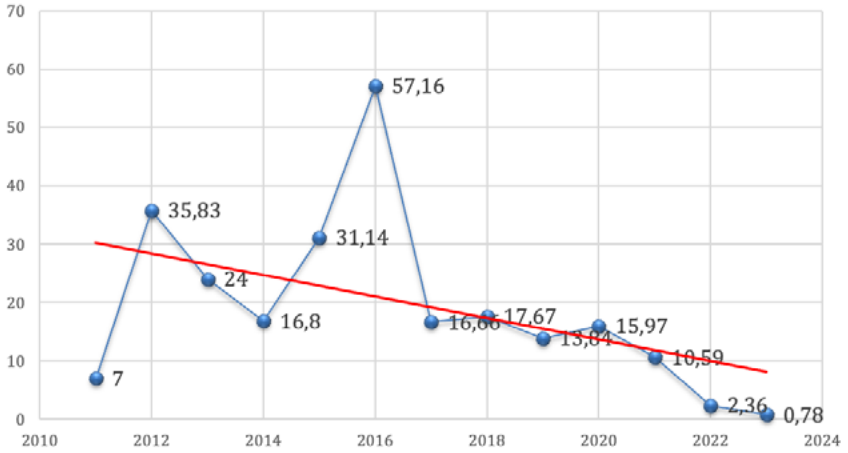
Figure 2. Average Citations per Year



Source: compiled by authors.

4.4. Productive authors

In the realm of sentiment analysis in social media, the academic landscape is dotted with scholars whose prolific contributions have laid down foundational frameworks, provided novel insights, and furthered the dialogue in myriad ways. The matrix of research (see Table 1), while vast, has a select group of researchers whose consistent and valuable contributions stand out. This subsection endeavours to shed light on the most productive authors in this area, providing both a quantitative and qualitative lens to understand their impact.

Among the vanguard is Wang y, with a notable 7 articles, albeit with a fractionalized count of 1.92619048, indicating collaborations and shared authorships. LI J follows closely, contributing to 6 articles with a fractionalized count of 1.6047619, further emphasizing the collaborative nature of research in this domain.

Kumar A's contribution is particularly intriguing, as the 5 articles credited to his name have a high fractionalized count of 2.36666667, underscoring the potential centrality of his role in these scholarly works. Li X, Singh P, Tse Yk, and Zhang M also have credited 5 articles each, with fractionalized counts suggesting varying degrees of shared authorships, thereby highlighting the inherent interdisciplinary and collaborative nature of sentiment analysis research in the realm of social media.

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Table 1. Productive authors

Authors	Articles	Articles Fractionalized
WANG Y	7	1.92619048
LI J	6	1.6047619
KUMAR A	5	2.36666667
LI X	5	0.97142857
SINGH P	5	1.28333333
TSE YK	5	1.23333333
ZHANG M	5	1.1047619
ARCILA-CALDERON C	4	2.25
ATLURI V	4	1
CERON A	4	2.83333333
CHUN SA	4	1
GIACOMINI D	4	1.11666667
KUMAR S	4	1.53333333
REYES-MENENDEZ A	4	1.33333333
VAIDYA J	4	1
WANG X	4	1.58333333
YAQUB U	4	1

Source: compiled by authors.

A cohort of researchers with 4 credited articles each, notably Arcila-Calderon C, Atluri V, Ceron A, Chun Sa, Giacomini D, Kumar S, Reyes-Menendez A, Vaidya J, Wang X, And Yaqub U, have enriched the field with their diverse perspectives. Among them, CERON A's fractionalized count of 2.83333333 is noteworthy, suggesting a central role in the conceptualization and execution of these projects. Similarly, Arcila-Calderon C's fractionalized count of 2.25 indicates a significant collaborative influence in the concerned works.

The importance of collaboration in the academic sphere cannot be overstressed, and the fractionalized article counts offer a window into the interwoven tapestry of shared knowledge, expertise, and scholarly endeavour. These fractionalized counts provide nuanced insights, allowing us to appreciate not just the volume but also the qualitative essence of contributions, emphasizing the integral or collaborative roles played by these authors.

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4.5. Productive Countries

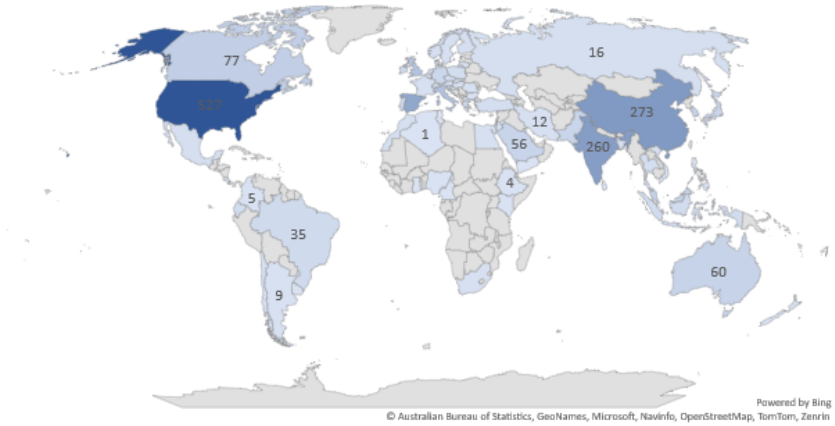
In the quest to understand sentiment analysis within the domain of social media, it is paramount to identify the primary nexuses of academic thought and research. A segmentation of the country-wise scientific production provides a holistic view of global research activity, shedding light on the geographies that significantly influence this academic discourse (Figure 3).

Leading the echelons of this research domain is the USA, with a remarkable production of 527 articles. Such a prodigious contribution underscores its status as a cradle of technological and social research, acting as a touchstone for other nations in the sphere of sentiment analysis.

Following closely, China and India emerge as prominent Asian contributors with 273 and 260 articles, respectively. Their significant contributions reflect not just flourishing technological advancements but also the vast user bases of social media platforms within these nations. This has driven a need to decipher user sentiments, emotions, and opinions at a granular level, spurring extensive research endeavours.

European nations manifest their academic prowess vividly. Spain and Italy, with 222 and 123 articles, respectively, exhibit robust research environments that resonate with a confluence of technological ability and sociological intricacies. The UK, contributing 118 articles, further consolidates Europe's significant role in the field.

Figure 3. Countries' Scientific Production



Source: compiled by authors.

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The chart of country scientific production is vividly coloured by diverse global contributors. Nations like Canada, Malaysia, South Korea, and Australia range from 60 to 77 articles, showcasing the global import of sentiment analysis in social media. Middle Eastern countries, represented by Saudi Arabia, and South Asian regions, represented by Pakistan, also have commendable contributions, highlighting the transcontinental nature of this research area.

European contributors like Germany, Greece, Portugal, and Ireland intensify the research landscape with their varied perspectives. Their contributions, combined with those from Asian nations like Japan, Singapore, and Indonesia, underscore the multifaceted nature of sentiment analysis, necessitating varied cultural and technological viewpoints.

The Eastern European bloc, with countries like Czech Republic, Poland, Romania, and Croatia, underscores the breadth of the European scholarly community. Meanwhile, nations from Latin America, such as Mexico, Chile, Argentina, and Colombia, showcase the southern hemisphere's increasing interest in the domain.

From Egypt in Africa to Norway in Northern Europe, and from Turkey at the crossroads of Europe and Asia to Vietnam in Southeast Asia, the diversity is astounding. Each nation, irrespective of the volume of their contributions, adds a unique dimension to the global research paradigm.

Thus, the extensive geographical spread of country scientific production is a testament to the universality of sentiment analysis within the realm of social media. This wide-ranging participation reflects both the global ubiquity of social media platforms and the universal human curiosity to decode emotions and sentiments. The global academic community's collaborative efforts are paramount to navigate the complexities of this interdisciplinary domain, as each nation brings forth its unique lens, coloured by cultural, social, and technological nuances.

Moreover, the academic landscape is incomplete without appreciating the significance of citations, an indicator of the influence and significance of the research output from each country. Citations offer a view into the academic resonance of the work in the broader scholarly community.

The USA continues its dominance with a staggering 3,055 total citations, equating to an average of 23.1 citations per article. Such robust figures reiterate its research's global acknowledgment and applicability, endorsing its central role in sentiment analysis studies within social media.

Asian heavyweights, India and China, follow with 885 and 768 total citations, respectively. With average citations of 9.4 and 10.2 per article, these nations underline the scholarly community's acknowledgment of their contributions.

Italy, with an average of 16.7 citations across its 669 total, and the United Kingdom, averaging 21.5 citations for its 646 total, spotlight European research's far-

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reaching implications. These figures echo the depth, rigor, and novelty offered by these nations.

The figures become particularly interesting when examining countries with standout average citations per article. A remarkable case is Slovenia, garnering a total of 326 citations, but with an outstanding average of 163 citations per article. Such a statistic reflects the profound impact of individual articles originating from Slovenia in the discourse of sentiment analysis.

Similarly, Norway, though producing fewer articles, registers a significant average of 30.5 citations, underscoring the influential nature of its research. Thailand, with an average of 28.3, and Germany and the Netherlands, both averaging 26.2 citations, further demonstrate that volume alone doesn't dictate influence; the gravitas of the content plays a significant role.

Emerging contributors, such as Singapore, Portugal, Jordan, and Romania, illustrate their expanding influence with average citations ranging from 15.5 to 21.4. These figures showcase the global community's recognition of novel insights and methodologies these nations bring to the table.

Countries like Malaysia, Saudi Arabia, Pakistan, and Ecuador, with averages ranging from 3.4 to 6.5, signify the budding nature of their research. Though the influence is nascent, the journey of these countries is worthy of observation as their academic narratives evolve.

4.6. Corresponding Author's Countries

The intricate landscape of sentiment analysis in social media is undeniably enriched by the diverse array of perspectives emerging from various parts of the globe. The corresponding author's country is an important parameter, as it often delineates the primary institutional and regional affiliation associated with the research (see Table 2). This becomes especially salient in revealing geographical epicentres of scholarship and potentially, hubs of expertise and resources.

At the pinnacle is the USA, claiming the corresponding authorship for 132 articles. This dominant contribution, consisting of 102 Single Country Publications (SCP) and 30 Multiple Country Publications (MCP), underscores the nation's foundational role in shaping and driving the discourse on sentiment analysis within social media contexts.

India, standing at 94 articles, predominantly leans towards domestic explorations with 80 SCPs, further testifying to its intrinsic research capabilities. Yet, the 14 MCPs also hint at India's burgeoning engagement with international academic dialogues. China, charting 75 articles and an MCP ratio of 0.293, manifests a similar trend, balancing between a strong internal research foundation and cross-border academic exchanges.

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Table 2. Corresponding Author's Countries

Country	Articles	Single Country Publications (SCP)	Multiple Country Publications (MCP)	Freq	MCP_Ratio
USA	132	102	30	0.17277487	0.22727273
INDIA	94	80	14	0.12303665	0.14893617
CHINA	75	53	22	0.09816754	0.29333333
SPAIN	65	51	14	0.08507853	0.21538462
ITALY	40	28	12	0.05235602	0.3
UNITED KINGDOM	30	13	17	0.03926702	0.56666667
MALAYSIA	20	11	9	0.02617801	0.45
AUSTRALIA	19	14	5	0.02486911	0.26315789
CANADA	19	15	4	0.02486911	0.21052632
KOREA	18	10	8	0.02356021	0.44444444
GERMANY	17	12	5	0.02225131	0.29411765
PAKISTAN	14	4	10	0.01832461	0.71428571
JAPAN	13	10	3	0.01701571	0.23076923
SAUDI ARABIA	12	6	6	0.01570681	0.5
GREECE	11	10	1	0.01439791	0.09090909
BRAZIL	10	7	3	0.01308901	0.3
CZECH REPUBLIC	8	5	3	0.0104712	0.375
ECUADOR	8	4	4	0.0104712	0.5
INDONESIA	8	7	1	0.0104712	0.125
IRELAND	8	5	3	0.0104712	0.375

Source: compiled by authors.

European nations, represented prominently by Spain and Italy, offer valuable contributions with 65 and 40 articles, respectively. Their mix of SCPs and MCPs suggests a dynamic research environment that values both home-grown scholarship and international collaborations.

The narrative from the United Kingdom is especially compelling. With a total of 30 articles, its elevated MCP count (17 articles) underscores a pronounced affinity for international scholarly collaborations, evidenced by its high MCP ratio of 0.567.

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Countries like Malaysia, Australia, Canada, and Korea, each with articles hovering around the 20-mark, emphasize the wide geographic dispersion of primary corresponding authors in this research area. Meanwhile, Germany and Pakistan exhibit strong international collaboration tendencies, as indicated by their significant MCP ratios.

Nations such as Japan, Saudi Arabia, Greece, Brazil, the Czech Republic, Ecuador, Indonesia, and Ireland further contribute to the mosaic, each presenting a unique blend of domestic and collaborative research, thereby enriching the global conversation on sentiment analysis in social media.

4.7. Collaboration between countries

Sentiment analysis in social media has increasingly become an area of extensive research, demanding a multidisciplinary approach. The data presented in Figure 4 indicates a substantial degree of international collaborations, providing a quantitative perspective on the dynamics of joint scholarly efforts in this domain.

The United States stands prominently as a central node of collaborative research, engaging most frequently with China with a count of 20 collaborations. This trend is possibly due to China's extensive online user base and technological growth combined with the U.S.'s advancements in computational techniques. Subsequent significant collaborations involve the U.S. with Korea (11 instances) and the United Kingdom (10 instances), suggesting a strategic alignment of research objectives and shared technological resources between these countries.

European countries also exhibit robust collaborative tendencies, evidenced by the UK's consistent partnerships, notably with Italy (6 collaborations) and lesser but significant ties with Spain (5 collaborations) and Portugal (4 collaborations). Such intra-European collaborations hint at a combined effort to tackle linguistic and cultural complexities inherent in sentiment analysis within the European context.

The data also reveals an interesting pattern of collaboration involving Pakistan, which has engaged in research partnerships with diverse countries like the USA, Korea, Saudi Arabia, and China. Such collaborations underscore the cross-cultural and multi-linguistic challenges in sentiment analysis and the efforts to contextualize these analyses in varying socio-cultural settings.

Other noteworthy collaborations include China with Australia (5), indicating a bridging of research efforts between the Eastern and Western hemispheres. Moreover, the pattern of Austria partnering with countries such as the Netherlands, Bulgaria, and Poland suggests an interdisciplinary approach, where diverse linguistic and cultural contexts are integrated into computational models.

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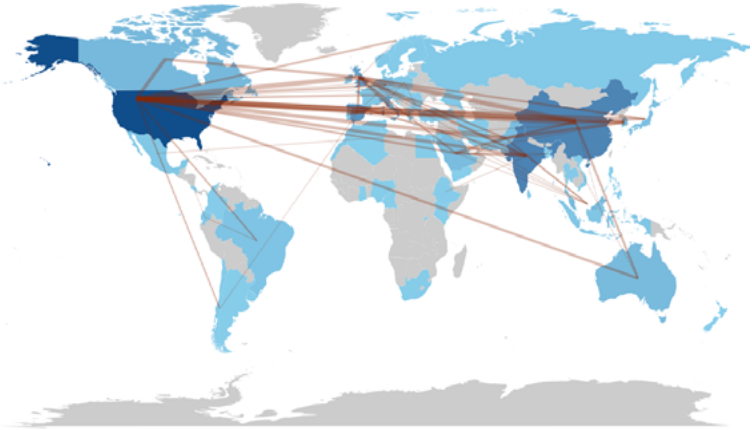
Figure 4. Collaboration between countries



Source: compiled by authors.

4.8. Thematic Analysis

Sentiment analysis in social media has gained considerable traction in recent research literature. A structured bibliometric assessment aids in understanding the evolving themes in this domain. Through a thematic map (Cobo et al., 2011) delineated by Development degree (density) and Relevance degree (centrality), we classify topics into four primary categories (Figure 5):

1. Emerging or Declining Themes: Within this category, "lexicon extraction" stands out. This topic emphasizes the methodological advancements and challenges in creating and refining lexicons tailored for sentiment detection on social media platforms. Its positioning indicates a dynamic evolution, necessitating regular re-evaluation to determine its long-term relevance in the field.
2. Niche Themes: These themes demonstrate the specialized applications of sentiment analysis across different sectors. "Ratings health-care safety" focuses on assessing public sentiment regarding healthcare safety standards. "Fear humour systems" delves into the classification of sentiments in content spanning fear and humour. The theme "public-health awareness equity" evaluates sentiment pertaining to public health campaigns, emphasizing disparities in awareness levels. "Agenda evolution public-opinion" and "algorithm investor sentiment language" respectively spotlight the use of sentiment analysis in public policy and finance sectors.

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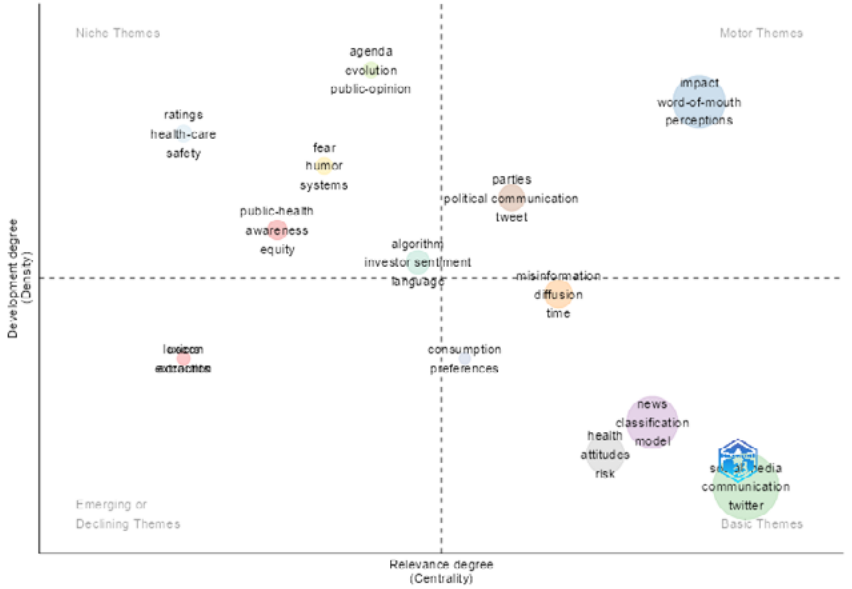
3. Basic Themes: Core to the field of sentiment analysis in social media, these themes encapsulate foundational research areas. "Consumption preferences" investigates user preferences and behaviours through sentiment-driven data. "Misinformation diffusion time" studies the speed and patterns of misinformation spread. "News classification model" represents the ongoing work in creating efficient algorithms for sentiment-based news categorization. The theme "health attitudes risk" focuses on gauging public sentiment on health risks, and "social media communication twitter" explores sentiment analysis specific to the Twitter platform.
4. Motor Themes: These are the central pillars driving the discourse in sentiment analysis research. "Parties political communication tweet" examines the integration of sentiment analysis in political campaigns and strategy, especially on platforms like Twitter. "Impact word-of-mouth perceptions" underscores the influence of digital sentiments on shaping perceptions, emphasizing the role of digital platforms in amplifying traditional word-of-mouth communication.

Figure 5. Thematic Analysis



Source: compiled by authors.

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5. Discussion and conclusions

The bibliometric review of sentiment analysis in social media highlights the field's rapid development and growing importance from 2011 to 2023. The notable annual growth rate of nearly 40% indicates a burgeoning interest in understanding how sentiments are expressed and disseminated across social media platforms. This reflects the increasing recognition of sentiment analysis as a vital tool in various domains, including marketing, political analysis, and social sciences.

The thematic diversity observed in this review underscores the multidisciplinary nature of sentiment analysis. Lexicon-based methods, machine learning techniques, and hybrid approaches each offer distinct advantages and address different aspects of sentiment detection. Lexicon-based methods provide straightforward and interpretable results but often struggle with context-specific sentiment detection. In contrast, machine learning techniques can handle complex patterns in large datasets but require substantial annotated data for training. Hybrid approaches combine the strengths of both, enhancing the accuracy and robustness of sentiment analysis (Baek & Yi, 2021; Deori et al., 2021).

Key contributors to the field, including prominent authors and collaborative research efforts, have significantly advanced our understanding of sentiment analysis in social media. The high level of international collaboration, with 27% of research involving cross-border partnerships, reflects the global relevance and widespread application of sentiment analysis techniques. This collaborative nature not only enriches the research but also ensures a diverse range of perspectives and methodologies (Goldman et al., 2021).

Geographically, the prominence of research from the USA, China, and India underscores these countries' strong technological capabilities and large user bases on social media platforms. However, significant contributions from Europe, Canada, Malaysia, South Korea, and Australia indicate a broad global interest in sentiment analysis. Smaller research communities, such as those in Slovenia, achieving high citation rates, highlight the impact of quality research over quantity (Peterson et al., 2021; Xu et al., 2021).

Emerging themes, such as lexicon extraction and the impact of digital word-of-mouth, reflect the evolving challenges and applications of sentiment analysis. The emphasis on political communication, particularly on platforms like Twitter, demonstrates the field's relevance in contemporary societal issues. These themes indicate that sentiment analysis is not just about understanding consumer behavior but also about gauging public reactions to political events and other significant occurrences (Minango Negrete et al., 2023; Park et al., 2023; Yaqub et al., 2021).

In conclusion, the bibliometric review reveals the dynamic and interdisciplinary nature of sentiment analysis in social media. The field's rapid growth, diverse methodologies, and extensive international collaboration highlight its comprehen-

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sive approach to understanding digital sentiments. As sentiment analysis continues to evolve, future research should focus on refining techniques and addressing new challenges to deepen our understanding of social media dynamics and human behavior. By continuing to foster global collaborations and methodological innovations, the field can ensure sustained growth and significant contributions to various domains (Baek & Yi, 2021; Goldman et al., 2021; Peterson et al., 2021).

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