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Mapping the Landscape of Sentiment Analysis Research in the United Arab Emirates: A Scientometric Review (2013–2023)

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ABSTRACT

This scientometric study examines sentiment analysis (SA) research output from the United Arab Emirates (UAE) between 2013 and 2023, using data from Scopus. A total of 243 publications were analyzed with tools like VOSviewer, Biblioshiny, and MS Excel to assess publication trends, collaboration networks, author productivity, institutional contributions, and keyword co occurrence. Findings reveal steady growth in UAE-based SA research, peaking in 2022 with 56 publications and an annual growth rate of 78%. K. Shaalan of the British University Dubai emerged as the most prolific author, while Zayed University, British University, and the University of Sharjah were the top contributing institutions. The UAE showed strong international collaboration, especially with the UK, Pakistan, and India. Open access publications received significantly higher citations, underscoring the importance of accessibility. Co-citation analysis identified K. Shaalan and N. Habash among the most influential UAE affiliated researchers, while globally, E. Cambria and B. Liu were frequently cited. Keyword analysis highlighted core themes, including "Sentiment Analysis," "Social Networking," "Machine Learning," and "Natural Language Processing." Despite a moderate correlation (r = 0.46) between publications and citations, the UAE's growing scholarly impact in SA particularly in Arabic language processing and pandemic related sentiment studies demonstrates its emerging role in this interdisciplinary field. The study concludes by affirming the UAE's increasing research visibility and collaborative strength in global SA scholarship.

Keywords: Sentiment Analysis, Scientometrics, United Arab Emirates (UAE), Natural Language Processing (NLP), Machine Learning, Research Collaboration, Open Access, Arabic Opinion Mining

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1. Introduction

Sentiment Analysis (SA) refers to the computational study of individuals' thoughts, emotions, feelings, and attitudes. It is receiving growing interest in both private and public domains, providing valuable insights while also facing numerous research challenges. Also referred to as opinion mining or emotion analysis, SA explores people's feelings and their attributes as represented in written content. This content can relate to various entities, including products, services, organizations, individuals, events, causes, or subjects [1] (Liu, 2012). As a subset of NLP, sentiment analysis uses computational linguistics to methodically examine text, enabling the identification, extraction, quantification, and investigation of emotional states conveyed in any language. SA is often employed to evaluate customer feedback, encompassing reviews and surveys. Moreover, sentiment analysis is frequently utilized in the examination of online media, particularly on social networks [2] (Majumdar, 2021). It employs a blend of statistics, NLP, and ML to derive subjective information from text documents. This information may encompass a reviewer's emotions, thoughts, opinions, or evaluations associated with a particular topic, event, company, or business activity [3] (AltexSoft, 2023). Sentiment analysis has numerous practical applications, including enhanced analytical capabilities for products, surveys, reputation management, accurate targeting, marketing analysis, public relations, product evaluations, Net Promoter Scores, product feedback, and customer support, among others [4] (Vodovatova, 2019).

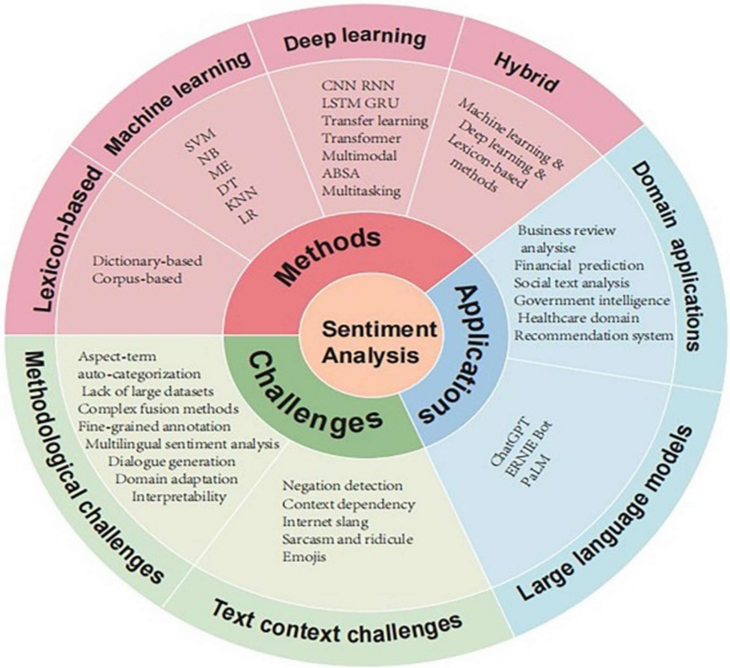

Figure 1. Methods, Challenges and Application of Sentiment Analysis

The Methods, Challenges, and Applications of Sentiment Analysis are illustrated in the figure above. The methods include lexicon based, machine learning, deep learning, and hybrid. The challenges are text based and methodological, whereas the applications include large language models and domain specific applications.

The significant steps for sentiment analysis are as follows:

- Data Gathering: Collect textual data from diverse origins such as social media platforms, customer feedback, news reports, or pertinent documents to use as input.

- Text Preparation: Refine and organize the text data by eliminating noise, irrelevant details, and inconsistencies. This may involve tasks like converting to lowercase, tokenization (dividing text into words or phrases), removing stop words, and applying stemming or lemmatization.

- Feature Derivation: Transform the cleaned text data into a numerical format that is compatible with machine learning models. Methods include term frequency inverse document frequency (TF-IDF) and word embeddings, such as Word2Vec or GloVe.

- Sentiment Analysis Model Choice: Select a suitable sentiment analysis model or technique, such as rule-based approaches, machine learning models (e.g., Naïve Bayes, Support Vector Machines, LSTM, BERT), or hybrid methods.

- Model Development: When utilizing machine learning models, train the chosen model on labeled data where each text sample is assigned a sentiment label (positive, negative, neutral). The model identifies patterns and correlations between text features and sentiment labels.

- Sentiment Categorization: Utilize the trained model to determine the sentiment of the text, assigning labels such as positive, negative, or neutral

- Post Analysis and Review: Examine results and conduct post analysis if necessary, which may include adjusting thresholds or addressing specific situations. Tools and APIs like Monkeylearn, Scikit learn, Tweepy, Pandas, Jupyter, Tensor Flow, Rapid Miner, etc., can facilitate this analysis.

- Visualization and Reporting: Present sentiment analysis findings through visual tools like charts, graphs, or summary statistics to effectively communicate insights.

- Evaluation (Optional): Measure the model's performance using metrics such as accuracy, precision, recall, F1-score, or confusion matrices to evaluate its effectiveness.

- Implementation: If the sentiment analysis system is intended for real time or ongoing usage, deploy the model to provide predictions on new incoming text data.

In recent times, sentiment analysis has undoubtedly emerged as a significant area of research across various sectors. A scientometric analysis was performed to gain a comprehensive understanding of the current landscape of sentiment analysis research, yielding fascinating insights. The analysis revealed a notable increase in sentiment analysis publications in recent years, as evidenced by trends in publishing, citation practices, and

research themes across multiple academic databases. The most commonly investigated domains in sentiment analysis comprised text categorization, opinion mining, and emotion detection. Overall, this scientometric analysis presents convincing evidence regarding the present state of sentiment analysis research and its possible future avenues. Scientometrics, a statistical approach, is utilized to evaluate and clarify research trends within specific fields.

2. Scope and Limitations

The focus of this study is divided into three distinct areas: firstly, a scientific bibliographic exploration; secondly, sentiment analysis; and thirdly, the UAE. A recent investigation analyzed publications related to sentiment analysis in the UAE as a measure of the country's research output, with primary objectives including bibliographic metrics such as publication counts, citations, most prolific authors, institutions, and sources, among others. This investigation centers on the UAE and highlights its research output and collaboration with international scholars and scientists. This study is limited to sentiment analysis research conducted in the UAE or by researchers based in the UAE.

3. Related Work

Sentiment analysis has recently gained significant popularity as a research topic across various industries. A scientometric study was conducted to gain a deeper understanding of the current state of sentiment analysis research. The study examined research themes, citation patterns, and publishing trends across multiple academic databases. The findings show that sentiment analysis research has been steadily gaining popularity, as evidenced by a notable increase in publications in recent years. The study also found that among the most popular subjects in sentiment analysis research are text classification, opinion mining, and emotion recognition. In conclusion, the scientometric study provides valuable insights into the current state of sentiment analysis research and its projected future direction.

A combination of bibliometric and text mining analyses brings interesting insights. [5] (Mohamed Kayet) The value of studies on opinion mining, sentiment analysis, and emotion understanding in various domains has been rising exponentially over the last few years. [6] (Sánchez-Núñez) Advanced sentiment analysis employs sophisticated algorithms to scan and extract text, decoding human emotions, opinions, and perceptions to provide in-depth insights into individual reactions on a given topic. [7] (Sandhu A et al)

[8] Keramatfar, et al analyzed sentiment analysis research indexed in Web of Science through 2016, examining trends in subject categories, publication venues, geographic contributions, methodologies, and terminology. It finds that computer science and related fields dominate the literature, with the U.S., China, and Singapore leading in institutional output, Twitter as the primary data source, SVM as the top classification method, and "sentiment analysis" preferred over "opinion mining.

[9] Yousif and others presented the first comprehensive survey of sentiment analysis in scientific citations, outlining the standard process including citation context extraction, data sources, and feature selection and reviewed recent methods, challenges, and related areas such as citation function classification and recommendation. While most existing approaches rely on classical machine learning, the authors argue that hybrid and deep learning techniques hold greater promise for overcoming current limitations in performance and manual feature engineering.

Sentiment Analysis enables future research and enhances bibliometric methods with advanced text mining for unstructured data. [10] Chen used bibliometrics and structural topic modelling to analyse soft computing research in sentiment analysis and recommender systems, revealing a surge in output, shifting focus from recommenders to sentiment analysis, and identifying 17 key topics.

A sentiment analysis study annotated an Altmetrics dataset across five disciplines, performed the analysis on English and multilingual tweets about scientific papers, and found that a Support Vector Machine with uni-grams outperformed other models, achieving over 85% accuracy. [11](Hassan)

4. Aim

This study presents a scientometric analysis of Sentiment Analysis research originating from the UAE, using established scientific indicators. Its key objectives are to: trace the chronological growth of publications and citations; investigate the relationship between research output and visibility; identify the most collaborative and influential authors, institutions, and countries; determine key publication characteristics (e.g., sources, document types, subject areas); evaluate retrieval related factors such as open access availability and keyword frequency; and examine supportive elements like cited references and source materials.

5. Methodology

- Selecting the Research Theme: This study is designed to evaluate the research productivity of the United Arab Emirates within the field of sentiment analysis. This choice is driven by the UAE's robust global economic development, substantial GDP, and abundant natural resources. Thus, the researchers have focused their investigation on the UAE to scrutinise its scholarly output and advancements in this particular research domain.

- Data Collection: To accomplish this objective, comprehensive data were retrieved from the Scopus database, a comprehensive source of bibliographic information encompassing publications related to sentiment analysis. The following search string was meticulously crafted and employed for data extraction: *TITLE-ABS-KEY ("Sentiment Analysis" OR "Emotion Analysis" OR "Opinion Mining") AND (LIMIT-TO (AFFILCOUNTRY, "United Arab Emirates"))*. This yielded a total of 243 records pertinent to sentiment analysis publications.

- Data Analysis: The collected dataset underwent a rigorous analysis utilising various analytical tools and software, specifically MS Excel, VOSviewer, and the R package

- Biblioshiny: The analysis was executed by applying scientific metrics and bibliographic parameters. VOSviewer was leveraged to construct a visually informative network visualisation map, illustrating collaborative efforts and contributions within and among researchers and institutions.

6. Results and Discussion

6.1. Chronological trends

This study presents a comprehensive analysis of publications and citation metrics spanning from 2013 to 2023. It focuses on key parameters, including Total Publications (TP), Total Citations (TC), Citation Per Paper (CPP), Total Authors (TA), and Relative Citation Impact (RCI) (Figure 2). During this period, the total

publications (TP) displayed steady growth, with a notable surge in 2022 (n=56). Similarly, Total Citations (TC) exhibited an upward trend, albeit with significant fluctuations, indicating an increasing influence and impact of these publications. On average, 22 publications were published each year, with an impressive 78% annual growth rate in publications over this time frame.

The annual average citations per year ranged from 0 (2015) to 654 (2020), with an average of 269. CPP fluctuated from 0 (2015) to 53 (2014) over the years, averaging 20 citations per paper. These fluctuations reflect the diverse impact of individual publications. TA consistently increased over the years, with an average of 89 authors per year, indicating collaborative research efforts. On average, four authors contributed to each paper. Notably, RCI experienced fluctuations, peaking in 2018 (n = 51.26). These findings provide valuable insights into the evolving landscape of publications and citations in the research field under investigation.

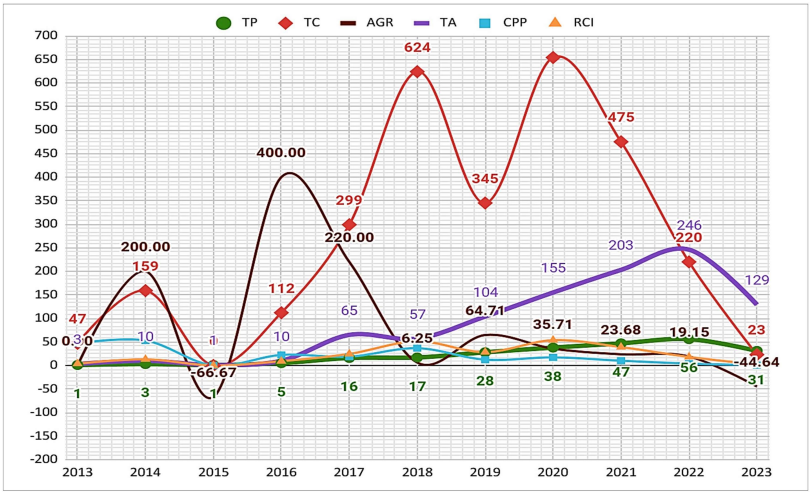

Figure 2. Yearly Trends of publications and citations of the UAE

6.2 Correlative Measures of Productivity and Publicity

Correlation analysis is used to measure the relationship or association between two variables, and it is represented by the correlation coefficient (r). The coefficient of correlation depends on both magnitude and direction, which can be positive or negative. It can take on values in the range of -1 to +1. A positive correlation

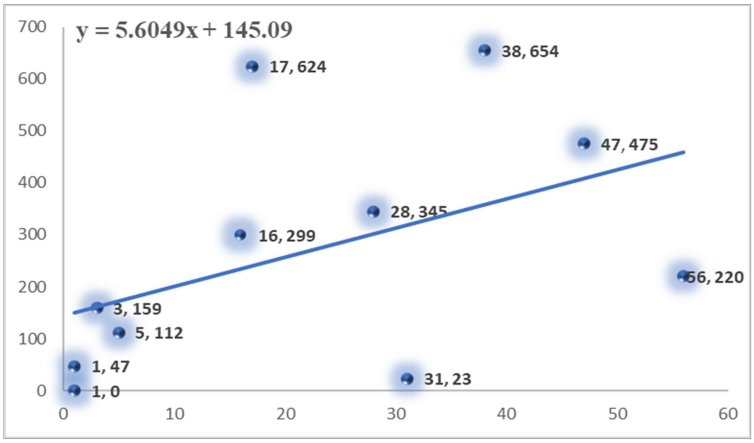

Figure 3. Relationship of Productivity and Publicity

coefficient indicates that an increase in the first variable is associated with a corresponding increase in the second, suggesting a potential causal relationship between the two variables. Conversely, a negative correlation indicates an inverse relationship, where one variable increases while the other decreases *(Taylor, 1990; Patel et al., 2023)*. In this paper, the correlation coefficient between publications and citations is found to be 0.46. This value suggests a relatively low relationship between publications and citations. $R^2 = 0.216$, which indicates that publications are less correlated with citations, differing by 20% from the mean points. The regression equation is $y = 5.6x + 145$, which shows approximately a 6.6-unit increase in the dependent variable (citations) for every unit of publications (Figure 3).

6.3 Most Prolific Author

This study unveils the most prolific authors in the UAE who have made significant contributions to the development of sentiment analysis. Table 1 provides a detailed account of the top 25 highly productive authors, comprising 16 authors from the UAE and 9 collaborative authors from other countries. *K. Shaalan* from the *British University* stands out as the most prolific author with the highest publications (23) with 32 links, the second-highest citation count (377), the highest h index (10), and a relative citation impact of 1.35. Following closely is *A. Elnagar* from the *University of Sharjah* with 14 publications, 356 citations, h index (8), and a relative citation impact of 2.09. *M. El Barachi* from the *University of Wollongong* has 11 publications, 54 citations, *h* index (3), and a relative citation impact of 0.40, among others. Notably, *N. Habash* from *New York University, Abu Dhabi,* has an impressive 44 citations per publication. The top productive authors from the UAE have collaborated with researchers from five countries, including four authors from Lebanon, two from Pakistan, and one each from the *UK, Qatar*, and *Egypt*. It's worth mentioning that collaborations involving a minimum of four publications with foreign authors have all resulted in the highest relative citation impact, except for E.U. Munir, which has a relative citation impact of 0.78. Additionally, *R. Baly* from the *American University of Beirut*, boasts the highest relative citation impact at 5.01, followed by *W. El-Hajj* with 4.52, *H. Hajj* and *G. Badaro*, both from the *American University of Beirut,* with 4.24, among others.

6.4 Collaborative Mapping of Authors

The process of creating visual representations or networks that illustrate collaborations among authors in a particular research field or domain. These maps illustrate the collaborative efforts of authors on research projects and co authored papers. The purpose of collaborative mapping is to provide insights into the interconnectedness of researchers and the extent of collaboration within a specific academic or scientific community. Co authorship analysis is a significant factor and one of the key criteria for assessing the quality of research results in an academic discipline.

Figure 4 displays a network visualisation of the top 84 collaborative authors, out of a total of 698. This network is divided into eight clusters, each represented by a different colour. Cluster 1, represented in red, comprises 19 authors, including *K. Shaalan* (23 publications, 32 links, 50 TLS), *A.A. Monem* (4 publications, 4 links, 9 TLS), *S. Siddiqui* (4 publications, 3 links, 8 TLS), and others. Cluster 2, in green, consists of 18 authors, including *S. Urolagin* (7 publications, 13 links, 15 TLS), *R. K. Mishra* (5 publications, 11 links, 15 TLS), *N. Nawaz* (2 publications, 7 links, 8 TLS), and more. Cluster 3, shown in blue, comprises 14 authors, including *M. Alkhatib* (10 publications, 11 links, 28 TLS), *F. Oroumchian* (7 publications, 12 links, 28 TLS), *M. El Barachi* (6 publications, 10 links, 19 TLS), and others. Additionally, there are ten authors in Cluster 4, seven in Cluster 5, six in Cluster 6, and five in Clusters 7 and 8.

Authors	Affiliation	TP	TC	CPP	CA	FA	RCI	h-I	C
Shaalan, K.	British University, Dubai	23	377	16.39	1	0	1.35	10	UAE
Elnagar, A.	University of Sharjah, Sharjah	14	356	25.43	6	6	2.09		UAE
El Barachi, M.	University of Wollongong, Dubai	11	54	4.91	4	2	0.40	3	UAE
Habash, N.	New York University, Abu Dhabi	10	440	44.00	0	0	3.61	8	UAE
Alkhatib, M.	British University, Dubai	10	53	5.30	0	6	0.44	3	UAE
Oroumchian, F.	University of Wollongong, Dubai	7	48	6.86	0	0	0.56	3	UAE
Urolagin, S.	BITS Dubai Campus, Dubai	7	79	11.29	1	1	0.93	4	UAE
El-Hajj, W.	American University of Beirut, Lebanon	6	330	55.00	0	0	4.52	6	OC
Hajj, H.	American University of Beirut, Lebanon	6	310	51.67	0	0	4.24	5	OC
Iqbal, S.	Al Ain University, Al Ain	6	39	6.50	0	1	0.53	3	UAE
Mathew, S.S.	Zayed University, UAE	6	11	1.83	1	1	0.15	2	UAE
Al-Obeidat, F.	College of Technological Innovation, UAE	5	8	1.60	1	4	0.13	2	UAE
Badaro, G.	American University of Beirut, Lebanon	5	258	51.60	0	3	4.24	5	OC
Baly, R.	American University of Beirut, Lebanon	5	305	61.00	1	3	5.01	5	OC
Hussain, A.	University of Stirling, UK	5	244	48.80	1	0	4.01	4	OC
Mishra, R.K.	BITS Dubai Campus, Dubai	5	147	29.40	3	3	2.42	5	UAE
Salloum, S.A.	British University, Dubai	5	103	20.60	7	2	1.69	3	UAE
Afyouni, I.	University of Sharjah, Sharjah	4	12	3.00	0	0	0.25	2	UAE
Aoudi, S.	Higher Colleges of Technology, Sharjah	4	6	1.50	0	1	0.12	2	UAE
Shaban, K.B.	Qatar University, Qatar	4	172	43.00	0	0	3.53	4	OC
Asghar, M.Z.	Gomal University, Pakistan	4	63	15.75	1	0	1.29	4	OC
Khattak, A.	College of Technological Innovation, UAE	4	63	15.75	2	4	1.29	4	UAE
Monem, A.A.	Ain Shams University, Egypt	4	84	21.00	0	0	1.73	4	OC
Munir, E.U.	COMSATS University Islamabad, Pakistan	4	38	9.50	0	0	0.78	3	OC
Siddiqui, S.	British University, Dubai	4	34	8.50	4	3	0.70	4	UAE

Table 1. Top Contributive Authors

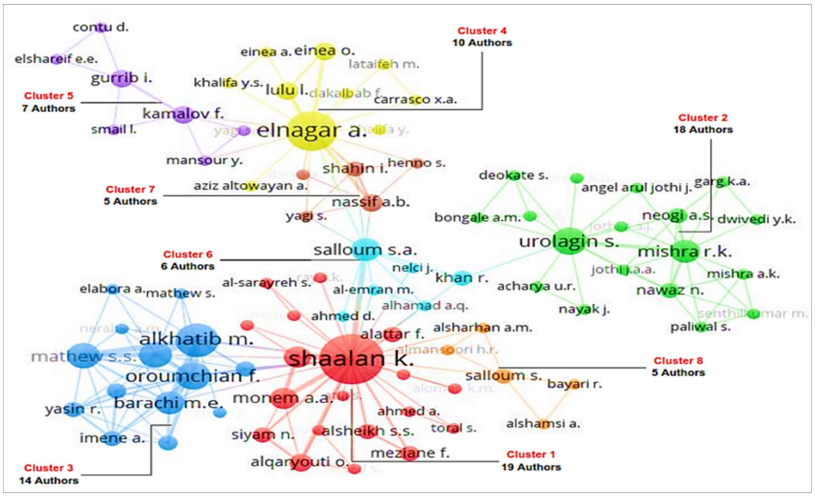

Figure 4. Collaborative Mapping of Authors

6.5 Collaborative Countries with the UAE

This current study examines the collaboration between the UAE and other countries worldwide in scholarly industries, similar to industrial collaborations. The researchers set the parameters to include countries with a minimum of 5 collaborative publications and a minimum of 20 citations. Out of 45 countries analysed, 16 countries emerged as the most collaborative partners. The network visualisation depicted in Figure 5 uses circles (nodes/entries) and straight lines (linkages) to illustrate the connections between these top collaborative countries. The size of the circles represents the quantity of publications, while the thickness of the lines indicates the strength of collaboration between countries. Notably, the UAE exhibits the highest level of cooperation with the *United Kingdom*, as evidenced by 36 publications, 640 citations, and a linkage strength of 0.36. This is followed by collaborations with *Pakistan* (27 publications, 258 citations, 27 TLS), and *India* (26 publications, 101 citations, 26 TLS), among others. Conversely, among these top collaborative countries, the UAE has the least collaboration with Algeria, with only 5 publications and a linkage strength of 5.

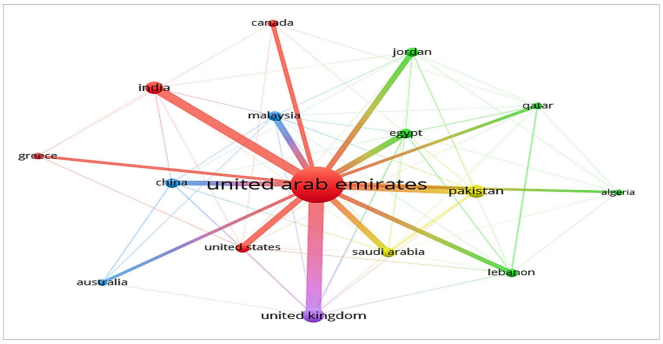

Figure 5. Network Visualisation of Collaborative Countries

6.6 Collaborative Institutions

An institute is a prominent factor in publications, as any author with an affiliation is promoted for further research and development. The productivity of the UAE is supported and dependent on its institutions. In this study, the researchers measure the collaborative effort of UAE's institute and reveals that Zayed University has the highest publications (n=39), followed by British University with 37 publications, University of Sharjah with 32 publications, Birla Institute of Technology and Science with 16 publications, United Arab Emirates University and University of Wollongong with 15 publications each, and others having less than 15 publications (Table 2).

6.7 Link Visualisation

Three hundred fourteen institutes in the UAE are collaborating on publications related to Sentiment Analysis. The researchers selected, based on a minimum of 3 publications and a minimum of 4 citations from an institute, the 40 most productive collaborators from a total of institutes and visualised their collaborative network (Figure 6). This diagram consists of circles (nodes/entries) and lines (linkages), where the size of the circles represents the number of collaborations and the thickness of the lines indicates the strength of the connections between them. It found that Zayed University (48 links) has the highest collaboration with University of Wollongong (9 links) and British University (7 links), followed by British University with University of Wollongong (9 links), University of Edinburgh (8 links); University of Sharjah with British University (4 links), Ain Shams University (4 links), Ajman University (2 links); New York University, Abu Dhabi with American University of Beirut (7 links); and others. The Birla Institute of Technology and Science is a highly productive but least collaborative institute in the network mapping.

Top Fifteen Affiliations	TP	TC	TLS	CPP	ICP	% ICP	RCI	TA	*h*-index	HC
Zayed University	40	275	77	6.88	26	65.00	0.56	184	9	74
British University	37	447	57	12.08	20	54.05	0.99	125	12	81
University Of Sharjah	32	476	36	14.88	16	50.00	1.22	119	11	84
Birla Institute of Technology and Science	16	282	10	17.63	4	25.00	1.45	43	8	81
United Arab Emirates University	15	186	13	12.40	6	40.00	1.02	51	7	45
University Of Wollongong	15	79	29	5.27	5	33.33	0.43	63	4	25
New York University Abu Dhabi	14	454	35	32.43	11	78.57	2.66	85	9	133
Ajman University	12	112	31	9.33	8	66.67	0.77	47	4	43
Al Ain University	12	36	21	3.00	10	83.33	0.25	64	4	14
Khalifa University	8	78	23	9.75	6	75.00	0.80	41	6	25
Higher Colleges of Technology Sharjah	7	10	4	1.43	3	42.86	0.12	20	4	4
Abu Dhabi University	6	119	16	19.83	4	66.67	1.63	24	4	81
Skyline University College	6	30	19	5.00	5	83.33	0.41	27	3	19
Middlesex University	5	153	2	30.60	2	40.00	2.51	17	4	126
Canadian University	5	17	4	3.40	1	20.00	0.28	15	2	10

Table 2. Highly Collaborative Institutes of the UAE

6.8 Accessibility of Publications

The accessibility of literature is one of the most essential features, as it enhances the visibility and publicity of research. Ease of retrieval plays a crucial role in supporting the dissemination of publications, benefiting researchers and future research endeavours. In this study, researchers examine the impact of publication accessibility on their future growth and understanding. The dataset comprises a total of 145 publications, with the following access types and citation counts: all open-access publications have 1,817 citations. Specifically, 50 publications with Gold access have 568 citations, 11 publications with Bronze access have 49 citations, 8 publications with Green access have 115 citations, and 2 publications with Hybrid Gold access have 29 citations (Figure 7). This analysis highlights that publications with open access achieve the highest citations, thus demonstrating that increased accessibility contributes to their effectiveness and publicity. Additionally, some publications employ a combination of access modes, such as 20 publications with both Gold and Green access, which have received 568 citations. Similarly, 4 publications with both Bronze and Green access have garnered 12 citations, and 3 publications with Hybrid Gold and Green access have accrued 33 citations.

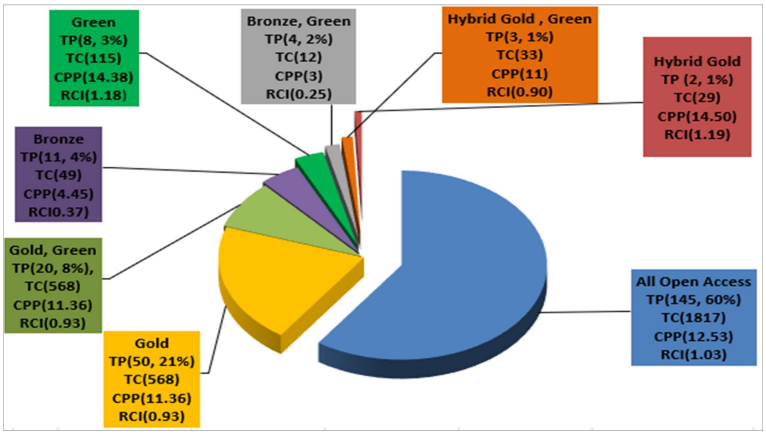

Figure 7. Accessibility of Publications

6.9 Forms distribution

The researchers aimed to identify the types of publications preferred by authors from the UAE, as publication type is a critical criterion in any research field. Scientists and researchers highly favour periodicals due to their relevance to current trends. This study reveals that the majority of publications take the form of articles (periodicals), followed by conference papers, book chapters, and other formats (Figure 8). Authors prefer periodicals for disseminating information due to their periodicity and their ability to effectively capture current trends.

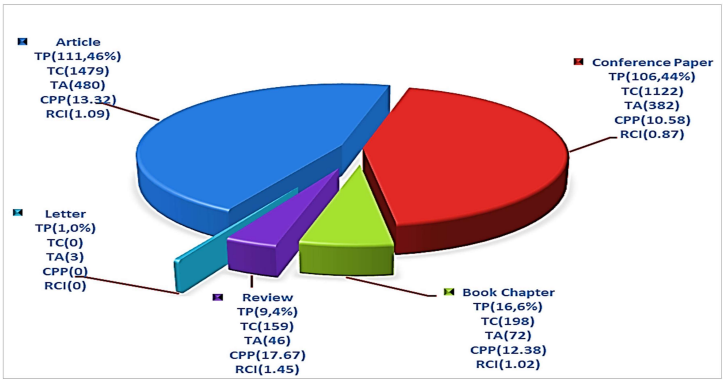

Figure 8. Proportion of Form Distributions

6.10 Co-citation Analysis of Cited Authors

The study employs co-citation analysis to evaluate renowned authors who have been frequently referenced in the literature of the research field under investigation. A total of 15,505 authors are cited in the scientific literature related to this assessment, and network visualisation is used to represent 89 authors who have received more than 20 citations (Figure 9). The findings reveal that K. Shaalan is the most cited author among UAE scientists and researchers, with 148 co-citations and a total link strength of 7,074. Following closely is E. Cambria, with 116 co-citations and 4,344 TLS, N. Habash, with 108 co-citations and 10,042 TLS, B. Liu [1], with 106 co-citations and 2,360 TLS, and S.A. Salloum, with 101 co-citations and 3,441 TLS, among others, each with fewer than 100 co-citations. The most frequently cited authors are categorised into four distinct clusters and represented by different colours. Cluster 1 (Red) comprises 54 authors, all of whom have made significant contributions to the field of sentiment analysis research. Cluster 2 includes 28 authors, renowned for their work in applied sentiment analysis. Cluster 3 consists of five authors, and Cluster 4 (Yellow) contains four authors.

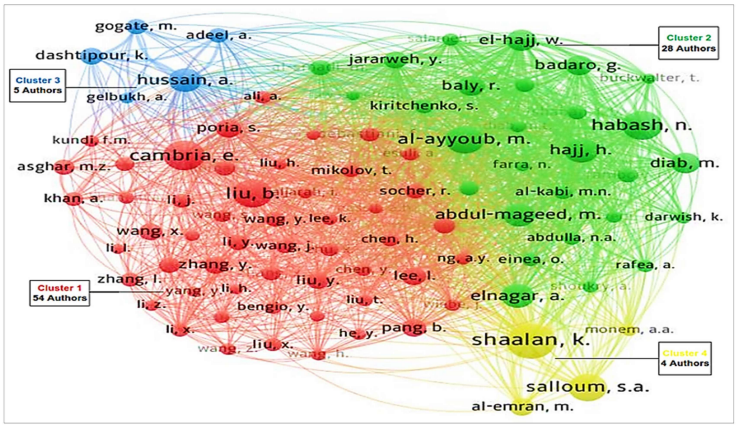

Figure 9. Co-citation Analysis of Authors

6.11 Highly Cited Publications

This analysis highlights the highly cited publications on sentiment analysis by UAE scientists and researchers. Among the 243 publications considered, fifteen have garnered a minimum of 50 citations each (Table 3). The article titled 'Sentic LSTM: a Hybrid Network for Targeted Aspect-Based Sentiment Analysis,' authored by Ma et al., and published in Cognitive Computation in 2018, holds the highest citations (n=216). It is followed by the conference paper titled 'A Large Scale Arabic Sentiment Lexicon for Arabic Opinion Mining Topics,' authored by Badaro et al., with 133 citations, presented in the Proceedings of the EMNLP 2014 Workshop on Arabic Natural Language Processing (ANLP) in 2014. Additionally, the article 'Topics, Trends, and Sentiments of Tweets about the COVID-19 Pandemic: Temporal Infoveillance Study,' authored by Chandrasekaran et al., has received 126 citations and was published in the Journal of Medical Internet Research in 2020. Another noteworthy publication is the conference paper 'CAMeL tools: An opensource python toolkit for Arabic natural language processing,' authored by Obeid et al., with 90 citations, presented at the 12th International Conference on Language Resources and Evaluation in 2020. The remaining publications have received fewer than 90 citations. These highly cited publications are primarily from 2018 (n=4), followed by 2019 and 2020, each with three publications. Additionally, there are 2 publications from 2017 and one publication each from the years 2014, 2016, and 2021.

6.12 Retrieval Indexed Keywords

Keyword occurrence analysis was conducted using VOSviewer visualisation software. With a minimum occurrence of one keyword, a total of 1,639 keywords were indexed in the research output on sentiment analysis. Among these 1,639 keywords, 81 terms were highly occurring, with a minimum of 5 occurrences, as visualised in Figure 10. The term 'Sentiment Analysis' had the highest occurrence in research output, with 211 instances and a total of 913 link strengths. It was followed by 'Social Networking' (66 occurrences, 394 TLS), 'Data Mining' (58 occurrences, 324 TLS), 'Social Media' (42 occurrences, 217 total link strength), 'Machine Learning' (41 occurrences, 234 TLS), 'Natural Language Processing' (41 occurrences, 218 TLS), 'Deep Learning' (34 occurrences, 200 TLS), and others with fewer than 200 occurrences. These retrieval indexes were divided into six separate clusters, each represented by a different colour. Cluster 1 (Red) contains 26 items, including 'Sentiment Analysis', 'Data Mining', 'Natural Language Processing' and others related to purely sentiment research publications. Cluster 2 (Green) includes 18 items, such as 'Social Networking', 'Deep Learning', 'Social Aspects' related to social tagging for sentiment research. Cluster 3 (Blue) contains 13 items, including 'Learning Systems', 'Learning Algorithms', and 'Support Vector Machine', representing processing tools for sentiment research. Cluster 4 (Yellow) consists of 12 items, including 'Artificial Intelligence', 'Forecasting', 'Commerce', related to applications of sentiment analysis. Cluster 5 (Violet) includes 10 items like 'Social media', 'Twitter', 'Facebook' grouped for social networking tools. Cluster 6 (Sky) contains only two items, 'Sentiment Classification' and 'Students'.

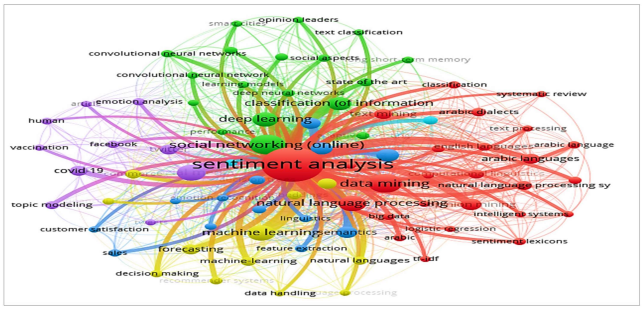

Figure 10. Network Visualisation of Retrieval Indexed Keywords

Authors	Title	Year	Source Title	TC
Ma et al.	*Sentic LSTM: a Hybrid Network for Targeted Aspect Based Sentiment Analysis*	2018	Cognitive Computation	216
Badaro et al.	*A Large Scale Arabic Sentiment Lexic on for Arabic Opinion Mining*	2014	ANLP 2014 - EMNLP 2014	133
Chandra- sekaran et al.	*Topics, Trends, and Sentiments of Tweets about the COVID-19 Pande mic: Temporal Infoveillance Study*	2020	Journal of Medical Internet Research	126
Obeid et al.	*CAMeL tools: An open source python toolkit for arabic natural language processing*	2020	12th ICLREC 2020 Conference Proceedings	90
Elnagar et al.	*Hotel arabic reviews dataset construction for sentiment analysis applications*	2018	Studies in Computational Intelligence	84
Alomari et al.	*Arabic tweets sentimental analysis using machine learning*	2017	Lecture Notes in Computer Science	81
Rane A. and Kumar A.	*Sentiment Classification System of Twitter Data for US Airline Service Analysis*	2018	ICSA - Conference Proceedings	81
Neogi et al.	*Sentiment analysis and classification of Indian farmers' protest using twitter data*	2021	International Journal of Information Management Data Insights	7 7
Iqbal et al.	*A Hybrid Framework for Sentiment Analysis Using Genetic Algorithm Based Feature Reduction*	2019	IEEE Access	74
Badaro et al.	*A survey of opinion mining in Arabic: A comprehensive system perspective covering challenges and advances in tools, resources, models, applications, and visualizations*	2019	ACM Transactions on Asian and Low-Resource Language Information Processing	61
Elnagar A. and Einea O.	*BRAD 1.0: Book reviews in Arabic dataset*	2016	Proceedings of IEEE/ ACS- AICCSA	59
Alqaryouti et al	*Aspect based sentiment analysis using smart government review data*	2019	Applied Computing and Informatics	56
Salloum et al.	*A survey of Arabic text mining*	2018	Studies in Computational Intelligence	53

Bally et al.	*A sentiment treebank and morphologically enriched recursive deep models for effective sentiment analysis in Arabic*	2017	ACM Transactions on Asian and Low-Resource Language Information Processing	52
Hassonah et al.	*An efficient hybrid filter and evolutionary wrapper approach for sentiment analysis of various topics on Twitter*	2020	Knowledge-Based Systems	50

Table 3. Highly Cited Publications on Sentiment Analysis in UAE

7. Conclusion

This study examines the development of literature in the UAE in relation to the growth of other industries and businesses. It also supports the development of UAE research institutes for future scenarios. Sentiment Analysis is an essential and dominant evaluation technique for sectors and companies as well as across all disciplines, making it effective for this study. Sentiment Analysis tools reveal all hidden errors and quality or drawbacks of any products and services in the current scenario, which are all dependent on all types of products and services.

Overall, this data underscores the growth and impact of publications over the years, with 2022 standing out as a particularly productive year. However, it's essential to consider the context and specific factors that influence these metrics to gain a deeper understanding of the research landscape. It is discovered that there is a 0.46 association between publications and citations. This indicates a weaker correlation between publications and citations. The regression equation suggests that for every unit of publications, the dependent variable (citations) increases by around six units. The most prolific author is *K. Shaalan* from the *British University*. The most productive UAE authors have worked with academic research from five other nations, including *Lebanon, Pakistan, the UK, Qatar, and Egypt*. The UAE has the highest level of collaboration with the *United Kingdom*, followed by collaborations with *Pakistan* and *India*. The highly productive institutions are *Zayed University, British University, University of Sharjah, Birla Institute of Technology and Science, United Arab Emirates University,* and *University of Wollongong*. It reveals that the majority of publications are unrestricted open access, followed by Gold-accessible, Bronze accessible, Green accessible, and Hybrid Gold-accessible. The results unequivocally underscore *K. Shaalan's* prominence as the most frequently co-cited author within the UAE's scientific community, followed by *E. Cambria, N. Habash, B. Liu, and S.A. Salloum*. Moreover, the term "*Sentiment Analysis*" emerged as the predominant keyword in research publications, signalling its prevalence. It was succeeded in frequency by *'Social Networking' ', Data Mining', 'Social Media', 'Machine Learning', 'Natural Language Processing' and 'Deep Learning',* highlighting the key themes and areas of focus in the scholarly discourse.

The present study evaluates the UAE's productivity, revealing its impact on the country's growth and advancement, as reflected in sentiment analysis research across various sectors, including industries, businesses, manufacturing, and academic research disciplines. This work was made necessary by the scope and limitations, which involve sentiment analysis applied in every discipline and limited to the country of the UAE, one of the most resource rich countries in the world.

Abbreviations

AGR - Annual Growth Rate
FA - First Author
C - Country
CA - Corresponding Author
CPP - Citation Per Paper
***h*-I** - *h*-Index
HC - Highest Citations
ML - Machine Learning
NLP - Natural Language Processing
OC - Other Countries
OMSA - Opinion Mining Sentiment Analysis
RCI - Relative Citation Impact
SA - Sentiment Analysis
TA - Total Authors
TC - Total Citations
TLS - Total Link Strength
TP - Total Publications
WOS - Web of Science

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