International Journal of Modern Education
IJMOE
EISSN: 2637-0905
Volume 7 Issue 26 (September 2025) PP. 405-422
DOI: 10.35631/IJMOE.726027

INTERNATIONAL JOURNAL OF MODERN EDUCATION (IJMOE)
www.ijmoe.com

A BIBLIOMETRIC ANALYSIS OF MALAY VOWEL PHONOLOGY RESEARCH: MAPPING TRENDS FROM TRADITIONAL TO CONTEMPORARY SOURCES

Afifah Zainal Abidin[1*], Nor Aisyah Ahmad[2], Zuliana Zubir[3], Rabihah Othman[4], Nur Nabilah Ibrahim[5], Anis Aleeya Hashim[6]

[1] Pusat Bahasa & Pengajian Umum, Universiti Islam Antarabangsa Tuanku Syed Sirajuddin (UniSIRAJ), 02000 Kuala Perlis, Perlis, Malaysia
Email: afifahzainal@unisiraj.edu.my
[2] Pusat Bahasa & Pengajian Umum, Universiti Islam Antarabangsa Tuanku Syed Sirajuddin (UniSIRAJ), 02000 Kuala Perlis, Perlis, Malaysia
Email: noraisyahahmad@unisiraj.edu.my
[3] Pusat Bahasa & Pengajian Umum, Universiti Islam Antarabangsa Tuanku Syed Sirajuddin (UniSIRAJ), 02000 Kuala Perlis, Perlis, Malaysia
Email: zuliana@unisiraj.edu.my
[4] Pusat Bahasa & Pengajian Umum, Universiti Islam Antarabangsa Tuanku Syed Sirajuddin (UniSIRAJ), 02000 Kuala Perlis, Perlis, Malaysia
Email: rabihah@unisiraj.edu.my
[5] Pusat Bahasa & Pengajian Umum, Universiti Islam Antarabangsa Tuanku Syed Sirajuddin (UniSIRAJ), 02000 Kuala Perlis, Perlis, Malaysia
Email: nurnabilahibrahim@unisiraj.edu.my
[6] Pusat Bahasa & Pengajian Umum, Universiti Islam Antarabangsa Tuanku Syed Sirajuddin (UniSIRAJ), 02000 Kuala Perlis, Perlis, Malaysia
Email: anisaleeya@unisiraj.edu.my
[*] Corresponding Author

Article Info:

Article history:
Received date: 26.06.2025
Revised date: 14.07.2025
Accepted date: 25.08.2025
Published date: 01.09.2025

To cite this document:

Abidin, A. Z., Ahmad, N. A., Zubir, Z., Othman, R., Ibrahim, N. N., & Hashim, A. A. (2025). A Bibliometric

Abstract:

This bibliometric analysis examines the development and research patterns of Malay vowel phonology by systematically tracing its progression from traditional linguistic approaches to recent computational perspectives. Despite the expanding body of research in this field, a comprehensive mapping of its intellectual trends and major contributions remains lacking. The analysis was structured around a rigorous data search in the Scopus database, employing eight targeted keywords: Malay language, linguistic, accent, phonology, vowel, syllable, speech, and voiced sounds. Only English-language articles and conference papers published between 2010 and 2025 were included, resulting in a final dataset of 896 documents. The methodology incorporated a combination of Scopus Analyzer for

International Journal of Modern Education
EISSN: 2637-0905
IJMOE
Volume 7 Issue 26 (September 2025) PP. 405-422
DOI: 10.35631/IJMOE.726027

Analysis of Malay Vowel Phonology Research: Mapping Trends from Traditional to Contemporary Sources. *International Journal of Modern Education, 7* (26), 405-422.

DOI: 10.35631/IJMOE.726027

extracting bibliometric indicators, OpenRefine for meticulous data cleaning and normalization, and VOSviewer for visualizing keyword co-occurrence, co-authorship networks, and international collaboration patterns. The results demonstrate a notable surge in publication output over the last five years, reflecting an increasing interest in both theoretical and applied aspects of Malay vowel research. Subject area analysis reveals a marked shift from traditional domains in arts and humanities towards more interdisciplinary integration with computer science, social sciences, and engineering. Thematic keyword analysis highlights core research clusters in speech perception, computational linguistics, and speech technology, with the United States, United Kingdom, and Germany leading in scholarly influence and collaborative strength. Meanwhile, the participation and visibility of Malaysia in global citation networks remain modest despite its direct contextual relevance. In conclusion, this study offers a data-driven perspective on the research landscape of Malay vowel phonology, identifying key thematic shifts, mapping collaborative networks, and providing valuable insights to inform future directions in both linguistic research and practical applications.

Keywords:

Malay Language, Vowel Phonology, Voiced Sounds, Linguistics, Bibliometric, Mapping Trends

Introduction

The study of Malay vowel phonology has evolved significantly over the years, transitioning from traditional descriptive methods to contemporary analytical techniques. This bibliometric analysis aims to map the trends in Malay vowel phonology research, highlighting the progression from early phonological descriptions to modern instrumental and computational analyses. By examining the body of research, we can identify key developments, methodologies, and findings that have shaped our understanding of Malay vowel phonology.

Early studies on Malay vowel phonology primarily focused on descriptive analyses of vowel sequences and their phonological processes across different dialects. For instance, research on the Johor, Kedah, Perak, and Kelantan dialects revealed that these dialects generally disfavor vowel sequences in surface representation, employing various phonological processes such as vowel deletion, coalescence, diphthongization, and ambisyllabification to resolve these sequences (Ahmad et al., 2011). These studies laid the groundwork for understanding the phonological variations and constraints in Malay dialects.

The advent of formant frequency analysis marked a significant shift in the study of Malay vowels. Researchers began to quantify vowel sounds using tools like Praat to measure formant frequencies (F1-F4), providing a more precise understanding of vowel characteristics. Studies have documented the formant contours of eight Malay vowels, including /ɔ/ and /ɛ/, which were previously overlooked (Ramli et al., 2020). This approach has been instrumental in refining the International Phonetic Alphabet (IPA) representations of Malay vowels and has applications in speech synthesis, rehabilitation, and reproduction.

Further research has explored the variations in vowel pronunciation across different Malay dialects. For example, studies on the vowels of the Perlis, Kelantan, and Terengganu dialects using spontaneous speech data revealed distinct formant frequency patterns, with Kelantan and

International Journal of Modern Education
EISSN: 2637-0905
Volume 7 Issue 26 (September 2025) PP. 405-422
DOI: 10.35631/IJMOE.726027

Terengganu vowels showing broader formant ranges compared to the more narrowly positioned vowels of the Perlis dialect (Jamil et al., 2019). These findings contribute to a deeper understanding of regional phonetic variations within the Malay language.

Recent advancements have incorporated acoustic and articulatory analyses to study Malay vowels. Magnetic resonance imaging (MRI) has been used to visualize the vocal tract during vowel production, correlating articulatory parameters with formant frequencies (Zourmand et al., 2014). This method provides dynamic insights into the tongue's movement and position, enhancing our understanding of the physical mechanisms underlying vowel production.

Sociophonetic studies have examined the influence of social variables on vowel pronunciation, revealing how factors like socio-economic status, gender, age, and geographical location affect vowel articulation (Aman & Mustaffa, 2013). Additionally, research on language contact, such as the interaction between Iban and Malay, has highlighted phenomena like first language interference and the dilution of phonological systems, further enriching our understanding of vowel phonology in multilingual contexts (Shahidi et al., 2015). The integration of technology in vowel phonology research has led to innovations in automatic speech recognition and vowel classification. Studies have applied machine learning techniques to classify Malay vowels, achieving high accuracy rates and demonstrating the potential for automated analysis in linguistic research (Zourmand & Nong, 2012).

The evolution of Malay vowel phonology research from traditional descriptive methods to contemporary analytical techniques reflects the dynamic nature of the field. By mapping these trends, this bibliometric analysis provides a comprehensive overview of the key developments and methodologies that have shaped our understanding of Malay vowel phonology, offering valuable insights for future research.

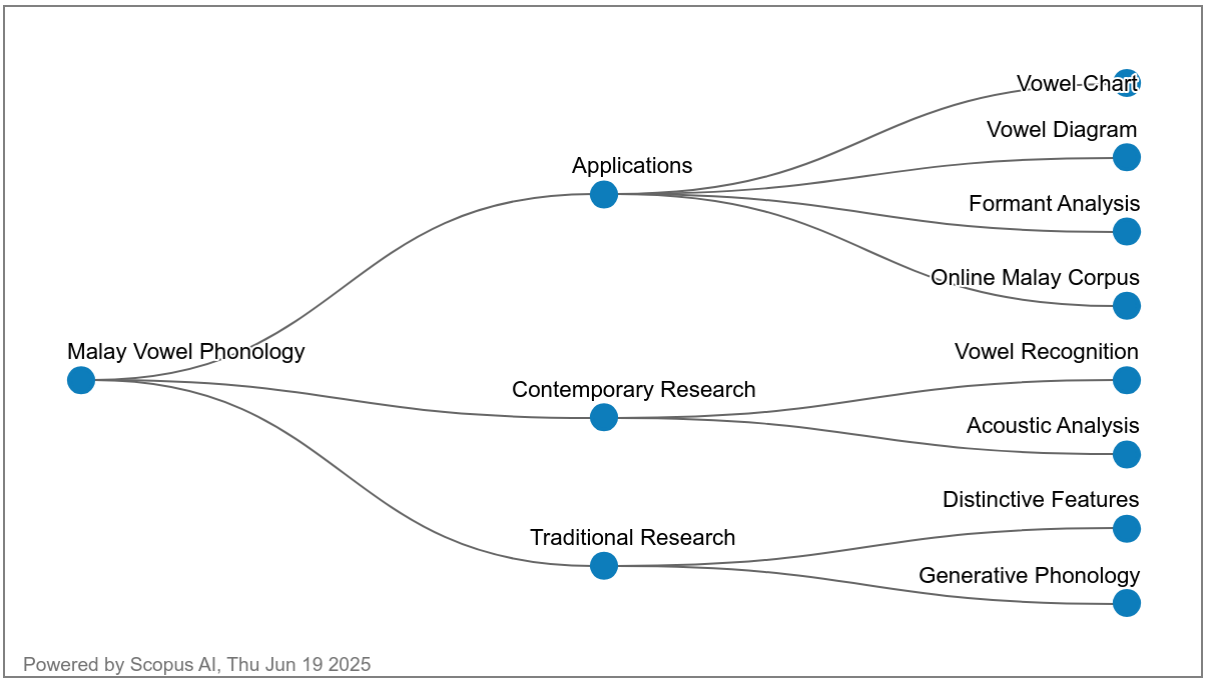

Figure 1: Concept Map of Research Trends in Malay Vowel Phonology

International Journal of Modern Education
EISSN: 2637-0905
IJMOE
Volume 7 Issue 26 (September 2025) PP. 405-422
DOI: 10.35631/IJMOE.726027

Research Question

1. What are the research trends in Malay vowel phonology studies based on the annual distribution of publications from 2005 to 2025?
2. What are the research trends in research on Malay Vowel Phonology Studies according to the subject area?
3. What are the most cited articles?
4. What are the most countries in publication?
5. What are the popular keywords related to the study?
6. What is co-authorship based on countries' collaboration

Methodology

Bibliometric analysis involves the organized and systematic gathering, arrangement, and interpretation of bibliographic data from academic publications (Alves et al., 2021; Assyakur & Rosa, 2022; Verbeek et al., 2002). Initially, this approach centres on descriptive statistics, including the number of publications, leading authors, and source journals (Wu & Wu, 2017). However, more sophisticated techniques, such as co-citation and co-occurrence analyses, are now frequently employed to reveal underlying trends and relationships within the literature. A thorough literature review is critical, requiring careful keyword selection, repeated searches, and meticulous data cleaning to ensure the compilation of a robust and representative collection of references (Fahimnia et al., 2015). Given the significance of theoretical relevance, this research focused on high-impact publications, as these works provide essential perspectives on the growth and organization of the research area.

To guarantee the reliability of the data, the Scopus database was chosen as the main indexing platform due to its comprehensive subject coverage and dependable indexing (Al-Khoury et al., 2022; di Stefano et al., 2010; Khiste & Paithankar, 2017). Only peer-reviewed journal articles and conference papers were included, with non-scholarly sources such as books and lecture notes deliberately omitted to maintain academic standards in the analysis (Gu et al., 2019). Data collection spanned from 2010 to June 2025, in line with the aim of identifying the latest and most influential trends in Malay vowel phonology research

Data Search Strategy

To conduct this bibliometric investigation on research related to Malay vowel phonology, a structured and replicable data retrieval strategy was employed using the Scopus database, known for its extensive and reliable indexing of peer-reviewed academic literature across disciplines. The advanced search query used in this study was: TITLE (["malay language" OR linguistic OR accent] AND [phonology OR vowel OR syllable OR speech OR "voiced sound"]) AND PUBYEAR > 2009 AND PUBYEAR < 2026 AND (LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "cp")) AND (LIMIT-TO (SRCTYPE , "j") OR LIMIT-TO (SRCTYPE , "p")) AND (LIMIT-TO (LANGUAGE , "English")). This query was deliberately designed to extract documents in which the titles explicitly mention the Malay language or related linguistic features (e.g., *linguistic*, *accent*), alongside phonological elements such as *vowel*, *syllable*, *voiced sound*, or *speech*. The application of Boolean operators (AND, OR) allowed for a focused and logical combination of terms to ensure that only relevant publications intersecting both themes were included. The publication year filter was set between 2010 and 2025, capturing both recent developments and emerging research trends over a 15-year period.

International Journal of Modern Education
EISSN: 2637-0905
IJMOE
Volume 7 Issue 26 (September 2025) PP. 405-422
DOI: 10.35631/IJMOE.726027

To ensure the academic integrity and relevance of the dataset, a set of well-defined inclusion and exclusion criteria was applied. Only documents written in English were retained, to maintain linguistic consistency and ensure accessibility of content. Furthermore, the analysis was confined to peer-reviewed journal articles and conference papers, as these represent primary sources of original research. Publications such as books, book chapters, and reviews were excluded due to variations in review standards and the secondary nature of their content. In terms of source type, only outputs indexed under journals and conference proceedings were considered, while books and book series were excluded to focus on more citable, formally indexed publications.

Following the application of these criteria, a total of 896 documents were retrieved and included in the final dataset. This corpus formed the basis of the bibliometric analysis and enabled a comprehensive evaluation of scholarly contributions, research trajectories, and thematic patterns related to Malay vowel phonology within the academic literature.

Table 1: The Search String

Scopus	TITLE (["malay language" OR linguistic OR accent] AND [phonology OR vowel OR syllable OR speech OR "voiced SOUND"]) AND PUBYEAR > 2009 AND PUBYEAR < 2026 AND (LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "cp")) AND (LIMIT-TO (SRCTYPE , "j") OR LIMIT-TO (SRCTYPE , "p")) AND (LIMIT-TO (LANGUAGE , "English")) Date access: 19th June 2025.

Table 2: The Selection Criterion Is Searching

Criterion	Inclusion	Exclusion
Language	English	Non-English
Timeline	2010 – 2025	< 2009
Document Type	Article, Conference Paper	Book Chapter, Review, Book
Source Type	Journal, Conference Proceeding	Book, Book Series

Data Analysis

VOSviewer is a widely adopted bibliometric analysis tool, created by Nees Jan van Eck and Ludo Waltman at Leiden University in the Netherlands (van Eck & Waltman, 2010, 2017). Known for its intuitive interface and robust functionality, the software is extensively used for the visualization and analysis of scientific literature. It specializes in producing network visualizations, clustering similar items, and generating density maps, making it a versatile platform for examining co-authorship patterns, co-citation relationships, and keyword co-occurrence networks. Its interactive and continually updated interface allows researchers to efficiently explore large bibliometric datasets. With its capacity to compute bibliometric metrics, support various data formats, and customize visualizations, VOSviewer serves as a powerful resource for scholars aiming to explore and interpret complex research landscapes.

International Journal of Modern Education
EISSN: 2637-0905
IJMOE
Volume 7 Issue 26 (September 2025) PP. 405-422
DOI: 10.35631/IJMOE.726027

A notable strength of VOSviewer lies in its ability to convert complex bibliometric datasets into visually accessible maps and network structures. The software's focus on network-based visualization enables it to efficiently identify clusters, examine keyword relationships, and develop insightful density maps. Both novice and seasoned researchers benefit from its user-centric design, which simplifies the process of mapping academic contributions and thematic patterns. Continued enhancements to the software ensure it remains at the forefront of bibliometric analysis, offering advanced metrics and visual tools. Its adaptability to various bibliometric formats, including co-authorship and citation networks, solidifies its role as an essential platform for comprehensive research mapping and thematic exploration.

For this study, bibliometric data were extracted from the Scopus database, covering publication details such as title, author, journal, year, citation count, and keywords in PlainText format from 2010 to June 2025. The analysis was conducted using VOSviewer version 1.6.20. Using the software's clustering and mapping features, visualizations were generated to represent patterns within the data. Unlike traditional Multidimensional Scaling (MDS), VOSviewer places items in a low-dimensional space such that their distances accurately reflect similarity levels (van Eck & Waltman, 2010), a method similarly acknowledged by Appio et al. (2014). While MDS emphasizes cosine and Jaccard similarity indices, VOSviewer employs an alternative normalization method for co-occurrence frequency known as association strength (AS_{ij}), calculated as (Van Eck & Waltman, 2007):

$$AS_{ij} = \frac{C_{ij}}{w_i w_j}$$

where C_{ij} represents the observed co-occurrence and w_i, w_j are the total occurrences of terms i and j. This approach reflects the proportion between observed and statistically expected co-occurrences under the assumption of independence (Van Eck & Waltman, 2007), ensuring more accurate network proximity and relatedness estimation.

International Journal of Modern Education
EISSN: 2637-0905
IJMOE
Volume 7 Issue 26 (September 2025) PP. 405-422
DOI: 10.35631/IJMOE.726027

Findings

What Are the Research Trends in Malay Vowel Phonology Studies Based on the Annual Distribution of Publications From 2005 To 2025?

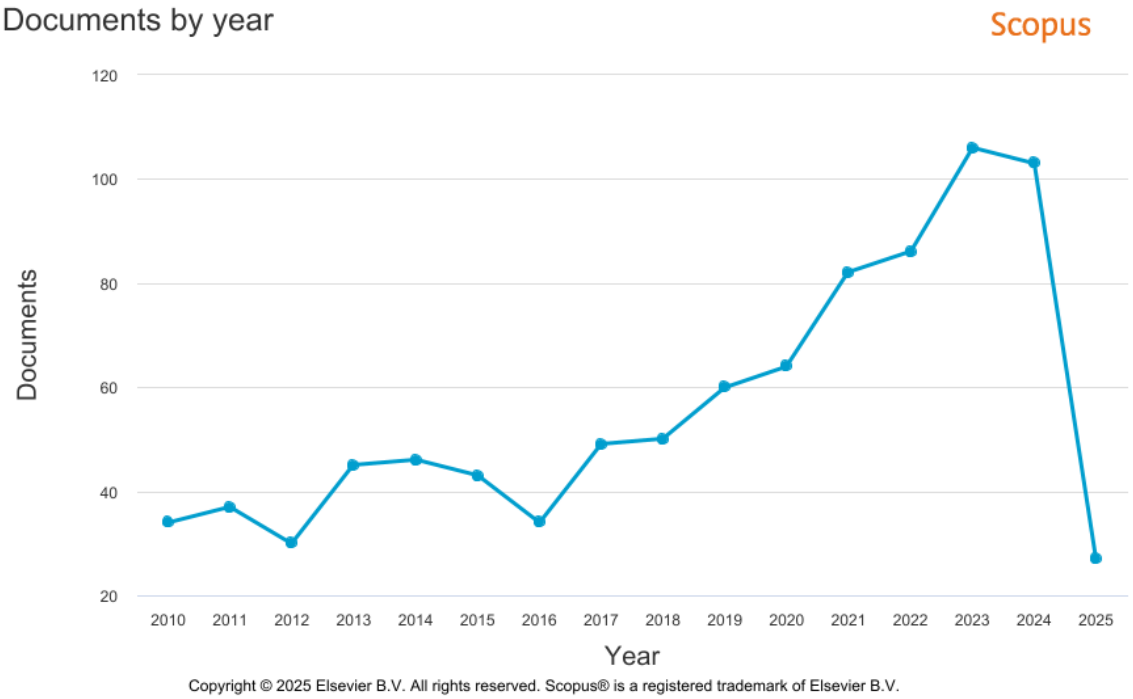

Figure 2: Graph Of the Level of Research Development on Malay Vowel Phonology Studies by Year within 15-Year Period

Table 3: The Development of Research on Malay Vowel Phonology Studies Within 15-Year Period

Year	Number Of Document	Percentage %
2025	27	3.01
2024	103	11.50
2023	106	11.83
2022	86	9.60
2021	82	9.15
2020	64	7.14
2019	60	6.70
2018	50	5.58
2017	49	5.47
2016	34	3.79
2015	43	4.80
2014	46	5.13
2013	45	5.02
2012	30	3.35
2011	37	4.13
2010	34	3.79

International Journal of Modern Education
EISSN: 2637-0905
Volume 7 Issue 26 (September 2025) PP. 405-422
DOI: 10.35631/IJMOE.726027

Figure 2 and Table 3 together illustrate the evolving landscape of research in Malay vowel phonology over the past decade and a half. From 2010 to 2015, the number of annual publications remained relatively stable, fluctuating between 34 and 46 documents. This period reflects a foundational stage in the field, marked by consistent yet modest research activity. However, a notable shift occurs from 2016 onwards: while 2016 saw a slight dip (34 documents), the subsequent years show a steady climb, with 2017 and 2018 each surpassing previous averages. The most significant transformation is observed from 2019, where annual publications consistently increase reaching 60 in 2019 and surging to 64 in 2020. This upward trajectory accelerates dramatically between 2021 and 2024, peaking at 106 documents in 2023 and maintaining a high output with 103 in 2024. The sharp growth during this period likely coincides with advancements in digital linguistic tools (e.g., Praat), greater academic attention on Southeast Asian languages, and expanded interdisciplinary research, such as computational and sociophonetic studies.

The sudden drop to 27 publications in 2025 should be interpreted with caution; it is probable that the data for this year is incomplete, as it reflects only part of the publication cycle. Despite this, the overall trend underscores a maturing and expanding research field. The surge in recent years indicates that Malay vowel phonology has moved beyond its early developmental phase, establishing itself as a significant and dynamic area of study. The consistency of scholarly output over the past decade demonstrates a robust academic community and signals sustained interest and investment in this area. Looking ahead, the ongoing growth and periodic surges in publication numbers suggest that research in Malay vowel phonology is poised to continue its upward trajectory, especially as new linguistic technologies and methodologies emerge.

What Are the Research Trends in Research on Malay Vowel Phonology Studies According to The Subject Area?

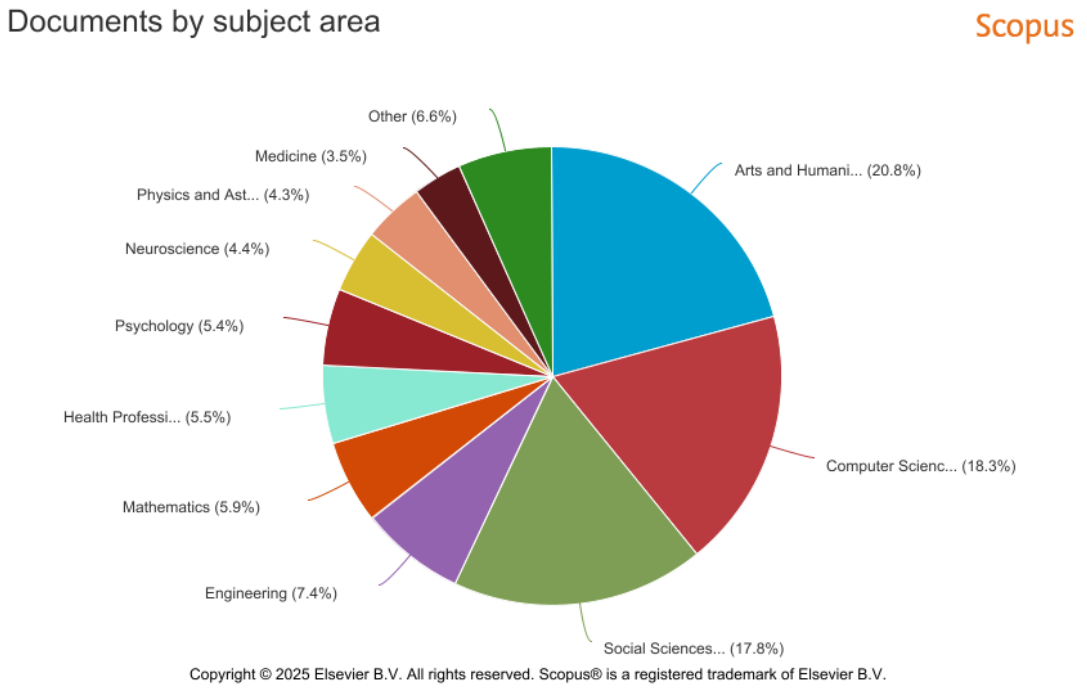

Figure 3: Percentage Distribution of Malay Vowel Phonology Publications by Subject Area

International Journal of Modern Education
EISSN: 2637-0905
IJMOE
Volume 7 Issue 26 (September 2025) PP. 405-422
DOI: 10.35631/IJMOE.726027

Table 4: Percentage of Research on Malay Vowel Phonology by Subject Area

Subject Area	Number of Document	Percentage %
Arts and Humanities	406	45.31
Computer Science	357	39.84
Social Sciences	348	38.84
Engineering	144	16.07
Mathematics	115	12.83
Health Professions	107	11.94
Psychology	106	11.83
Neuroscience	86	9.60
Physics and Astronomy	84	9.38
Medicine	68	7.59

The distribution of research on Malay vowel phonology, as depicted in Figure 3 and summarized in Table 4, demonstrates the highly interdisciplinary nature of the field. The Arts and Humanities dominate the landscape, accounting for 45.3% of total publications, reflecting the foundational role of linguistics, phonetics, and phonological theory in shaping the discourse. This is closely followed by Computer Science (39.8%) and Social Sciences (38.8%), highlighting a significant paradigm shift in recent years. The strong presence of Computer Science underscores the integration of computational techniques, such as speech recognition, acoustic modelling, and digital signal processing, which have become pivotal in advancing empirical phonological research. The substantial contribution from the Social Sciences indicates a burgeoning interest in sociophonetics, language acquisition, and educational applications, further evidencing the expansion of the field beyond traditional linguistic inquiry.

Beyond these core disciplines, notable representation from Engineering (16.1%) and Mathematics (12.8%) signifies the increasing importance of technical and quantitative approaches, particularly in the development and application of tools for speech analysis and modelling. Contributions from the Health Professions (11.9%), Psychology (11.8%), and Neuroscience (9.6%) reflect the growing emphasis on clinical, cognitive, and neurological perspectives in vowel phonology research, particularly in areas such as speech therapy, language disorders, and brain-language relationships. Additionally, Physics and Astronomy (9.4%) and Medicine (7.6%), while less directly associated, likely contribute through interdisciplinary research in bioacoustics, auditory science, and medical speech assessment.

Overall, the subject area distribution clearly illustrates a dynamic shift in Malay vowel phonology studies from a primarily humanities-driven field to a multidisciplinary enterprise. This evolution mirrors broader trends in linguistics, where collaboration with technology, health, and the sciences has become essential for advancing knowledge and addressing complex questions related to speech and language. The breadth of disciplinary engagement not only enhances the scientific rigor of research but also opens new pathways for innovation and practical application in language education, technology, and clinical practice.

International Journal of Modern Education
EISSN: 2637-0905
IJMOE
Volume 7 Issue 26 (September 2025) PP. 405-422
DOI: 10.35631/IJMOE.726027

What Are the Most Cited Articles?

Table 5: Most Top 10 Cited Authors

Authors	Title	Year	Source title	Cited by
Ding N.; Melloni L.; Zhang H.; Tian X.; Poeppel D. (Ding et al., 2015)	Cortical tracking of hierarchical linguistic structures in connected speech	2015	Nature Neuroscience	671
Fraser K.C.; Meltzer J.A.; Rudzicz F. (Fraser et al., 2015)	Linguistic features identify Alzheimer's disease in narrative speech	2015	Journal of Alzheimer's Disease	581
Veaux C.; Yamagishi J.; King S. (Veaux et al., 2013)	The voice bank corpus: Design, collection and data analysis of a large regional accent speech database	2013	2013 International Conference Oriental COCOSDA Held Jointly with 2013 Conference on Asian Spoken Language Research and Evaluation, O-COCOSDA/CASLRE 2013	352
Keitel A.; Gross J.; Kayser C. (Keitel et al., 2018)	Perceptually relevant speech tracking in auditory and motor cortex reflects distinct linguistic features	2018	PLoS Biology	184
Brodbeck C.; Hong L.E.; Simon J.Z. (Brodbeck et al., 2018)	Rapid Transformation from Auditory to Linguistic Representations of Continuous Speech	2018	Current Biology	174
ElSherief M.; Kulkarni V.; Nguyen D.; Wang W.Y.; Belding E. (ElSherief et al., 2018)	Hate lingo: A target-based linguistic analysis of hate speech in social media	2018	12th International AAAI Conference on Web and Social Media, ICWSM 2018	173
Gosztolya G.; Vincze V.; Tóth L.; Pákáski M.; Kálmán J.; Hoffmann I. (Gosztolya et al., 2019)	Identifying Mild Cognitive Impairment and mild Alzheimer's disease based on spontaneous speech using ASR and linguistic features	2019	Computer Speech and Language	152
Baese-Berk M.M.; Bradlow A.R.; Wright B.A.	Accent-independent adaptation to foreign accented speech	2013	Journal of the Acoustical Society of America	137

International Journal of Modern Education
EISSN: 2637-0905
IJMOE
Volume 7 Issue 26 (September 2025) PP. 405-422
DOI: 10.35631/IJMOE.726027

(Baese-Berk et al., 2013)				
Saito K.; Trofimovich P.; Isaacs T. (Saito et al., 2015)	Second language speech production: Investigating linguistic correlates of comprehensibility and accentedness for learners at different ability levels	2015	Applied Psycholinguistics	136
Cristia A.; Seidl A.; Vaughn C.; Schmale R.; Bradlow A.; Floccia C. (Cristia et al., 2012)	Linguistic processing of accented speech across the lifespan	2012	Frontiers in Psychology	129

The top 10 most cited works in the domain of Malay vowel phonology examined within the broader contexts of linguistics, phonetics, and speech science underscore the profoundly interdisciplinary nature of impactful scholarship in this area. Notably, the highest-cited publication by Ding et al. (2015) in *Nature Neuroscience* (671 citations) exemplifies the integration of cognitive neuroscience with linguistic analysis, demonstrating how cortical mechanisms underpin the processing of hierarchical linguistic structures in connected speech. Similarly, Fraser et al. (2015) highlight the practical clinical application of linguistic analysis in diagnosing Alzheimer's disease, reflecting the growing trend of leveraging speech features as sensitive markers for neurological disorders. These high-impact studies emphasize that research in vowel phonology and related fields has significant implications for understanding brain-language relationships and developing innovative diagnostic methodologies in healthcare.

In addition to neuroscience and clinical linguistics, technological advancements are prominently represented among the most cited works. Publications such as Veaux et al. (2013) and Gosztolya et al. (2019) reveal a strong orientation toward computational linguistics and speech technology, particularly in the construction of speech corpora and the use of automatic speech recognition (ASR) for cognitive impairment detection. Further, research by Saito et al.(2015) and Baese-Berk et al. (2013) addresses the complexities of second language speech production and accentedness issues highly pertinent to Malay vowel phonology in multilingual societies. Collectively, these influential studies illustrate that the most impactful research arises from the synergy of linguistic theory with computational tools, engineering methodologies, and clinical applications. This trend sets a valuable precedent for future Malay vowel phonology research to pursue interdisciplinary and translational approaches, thereby expanding both its academic reach and real-world utility.

International Journal of Modern Education
IJMOE
EISSN: 2637-0905
Volume 7 Issue 26 (September 2025) PP. 405-422
DOI: 10.35631/IJMOE.726027

What Are the Most Countries in Publication?

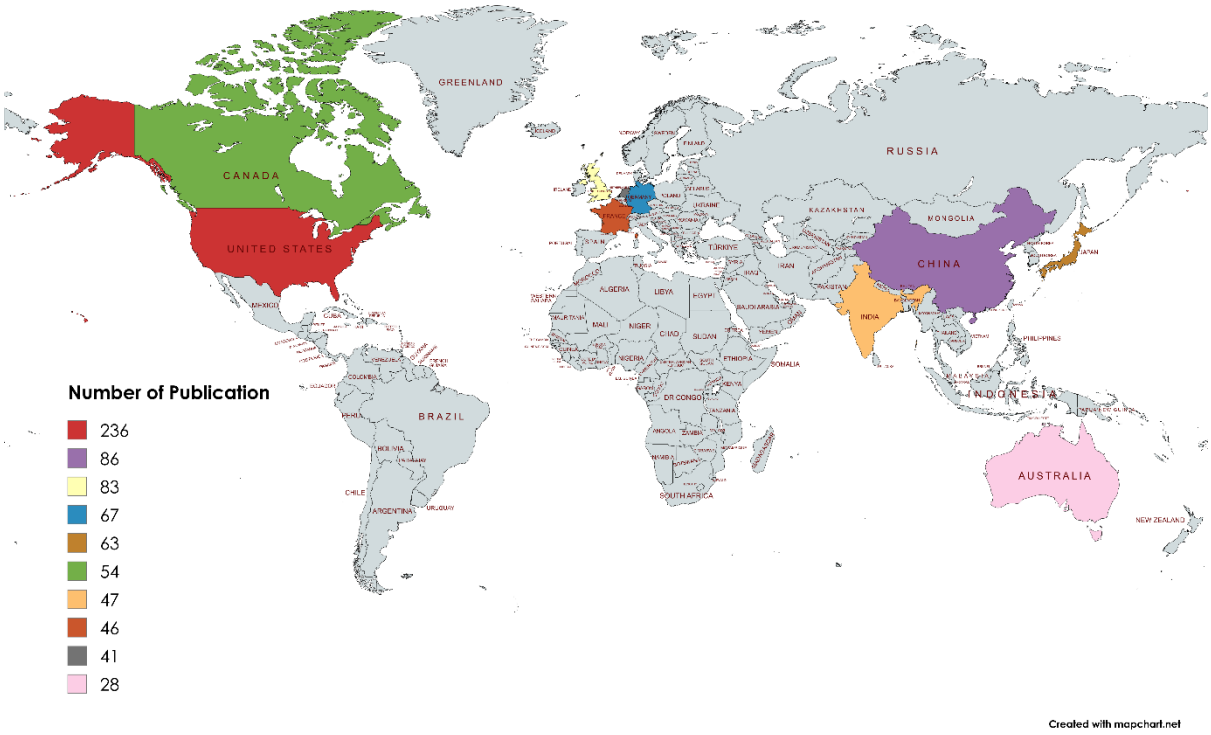

Figure 4: Country-wise Distribution and Leading Contributors of Publications in the Field of Malay Vowel Phonology

Table 6: Most Top 10 Countries in Publication of Malay Vowel Phonology

Country/Territory	Number of Publication	Percentage %
United States	236	26.34
China	86	9.60
United Kingdom	83	9.26
Germany	67	7.48
Japan	63	7.03
Canada	54	6.03
India	47	5.25
France	46	5.13
Netherlands	41	4.58
Australia	28	3.13

The country-wise distribution of publications in the field of Malay vowel phonology, as illustrated in Figure 4 and detailed in Table 6, highlights the genuinely international scope and growing scholarly interest in this research area. The United States leads as the most prolific contributor, accounting for 26.34% of total publications. This leadership position underscores the nation's well-established academic infrastructure, early adoption of interdisciplinary approaches, and integration of linguistics with neuroscience and computational modelling. Major European and Asian contributors namely China (9.60%), the United Kingdom (9.26%), Germany (7.48%), and Japan (7.03%) reflect strong traditions in experimental phonetics, language technology, and sociolinguistic research. The presence of Japan among the leading

International Journal of Modern Education
EISSN: 2637-0905
IJMOE
Volume 7 Issue 26 (September 2025) PP. 405-422
DOI: 10.35631/IJMOE.726027

countries may also be attributed to its advancements in speech processing technology and a regional commitment to the study of phonological variation across Asian languages.

A secondary tier of contributing nations, including Canada (6.03%), India (5.25%), France (5.13%), the Netherlands (4.58%), and Australia (3.13%), reflects both established and emerging research environments. These countries' contributions are marked by strengths in applied linguistics, clinical phonetics, and corpus linguistics, as well as focused work on sociophonetic variation and minority language studies. Australia's notable involvement, though numerically smaller, is significant for its emphasis on sociophonetic research and the documentation of regional and indigenous languages. Collectively, the geographic distribution revealed in both Figure 4 and Table 6 underscores the evolution of Malay vowel phonology into a vibrant, globally relevant discipline. The field now thrives on international, multilingual, and interdisciplinary collaborations, illustrating its dynamic growth beyond traditional linguistic boundaries.

What Are the Popular Keywords Related to the Study?

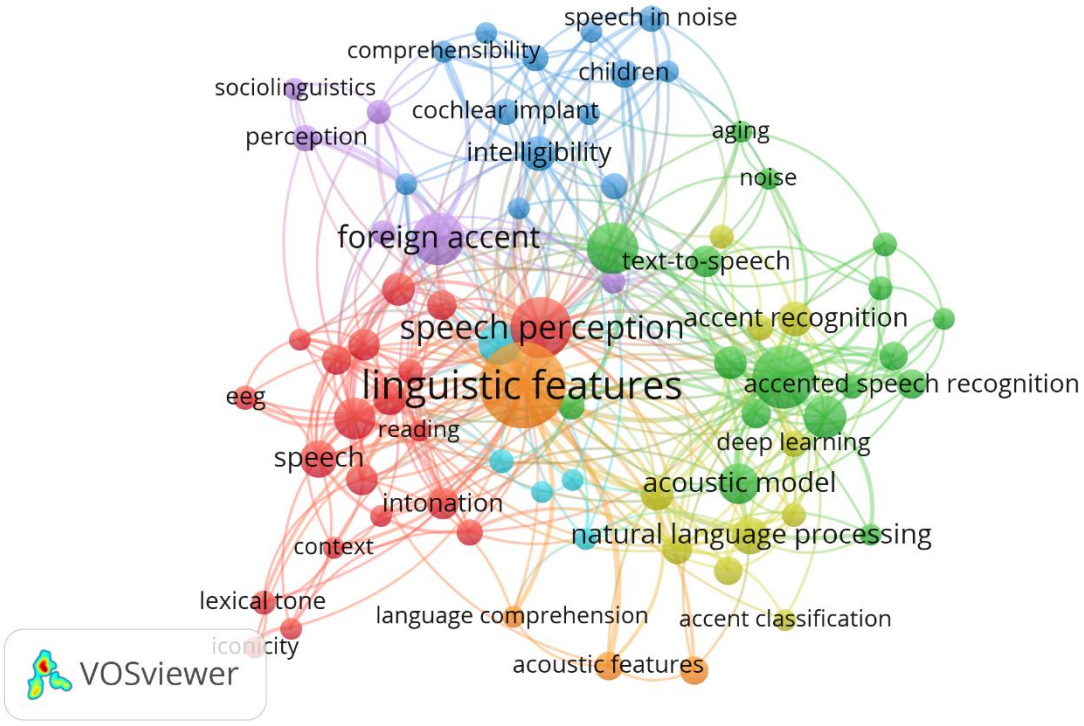

Figure 5: Network Visualization Map of Keywords' Co-Occurrence

The keyword co-occurrence analysis, as visualized in Figure 5 and detailed in the accompanying table, highlights the central concepts and evolving thematic directions within Malay vowel phonology research. Notably, "linguistic features" stands out with the highest occurrence (74) and total link strength (88), underscoring its fundamental role as a conceptual anchor in the literature. Closely linked are "speech perception" (37 occurrences, 54 link strength), "speech recognition" (39, 49), and "speech synthesis" (26, 29), reflecting a strong scholarly emphasis on both the perceptual and technological aspects of vowel studies. The prominence of these terms suggests that the field is deeply invested not only in understanding

International Journal of Modern Education
EISSN: 2637-0905
IJMOE
Volume 7 Issue 26 (September 2025) PP. 405-422
DOI: 10.35631/IJMOE.726027

the intrinsic properties of vowel sounds but also in applying this knowledge to advancements in speech technology and automated processing.

Additionally, the analysis reveals a vibrant interplay between cognitive, clinical, and technological research clusters. Keywords such as "foreign accent," "intelligibility," "automatic speech recognition," "deep learning," and "natural language processing" appear with high frequencies and strong interconnections in the network map. This indicates a significant shift towards interdisciplinary approaches, where computational methods and machine learning algorithms are increasingly employed to tackle questions of pronunciation variability, speech intelligibility, and accent recognition. The presence of clinical and psycholinguistic terms like "cochlear implant," "intelligibility," "aging," and "Alzheimer's disease" further signifies the expanding application of phonological research in health sciences, especially in the domains of diagnosis and rehabilitation.

Moreover, the co-occurrence network structure reveals robust cross-linkages between traditional phonological concepts (such as "intonation," "prosody," and "bilingualism") and emerging topics like "self-supervised learning" and "deep neural networks." The visualization demonstrates that research in Malay vowel phonology is not siloed but rather characterized by multidimensional and cross-disciplinary collaboration, integrating sociolinguistic, clinical, and engineering perspectives. Collectively, these patterns illustrate a dynamic and evolving research landscape, in which foundational linguistic principles are continuously recontextualized in light of technological innovation and broader interdisciplinary integration. This synergy positions Malay vowel phonology as a vibrant field at the intersection of linguistic theory, computational modelling, and applied sciences

What Is Co-Authorship Based on Countries' Collaboration?

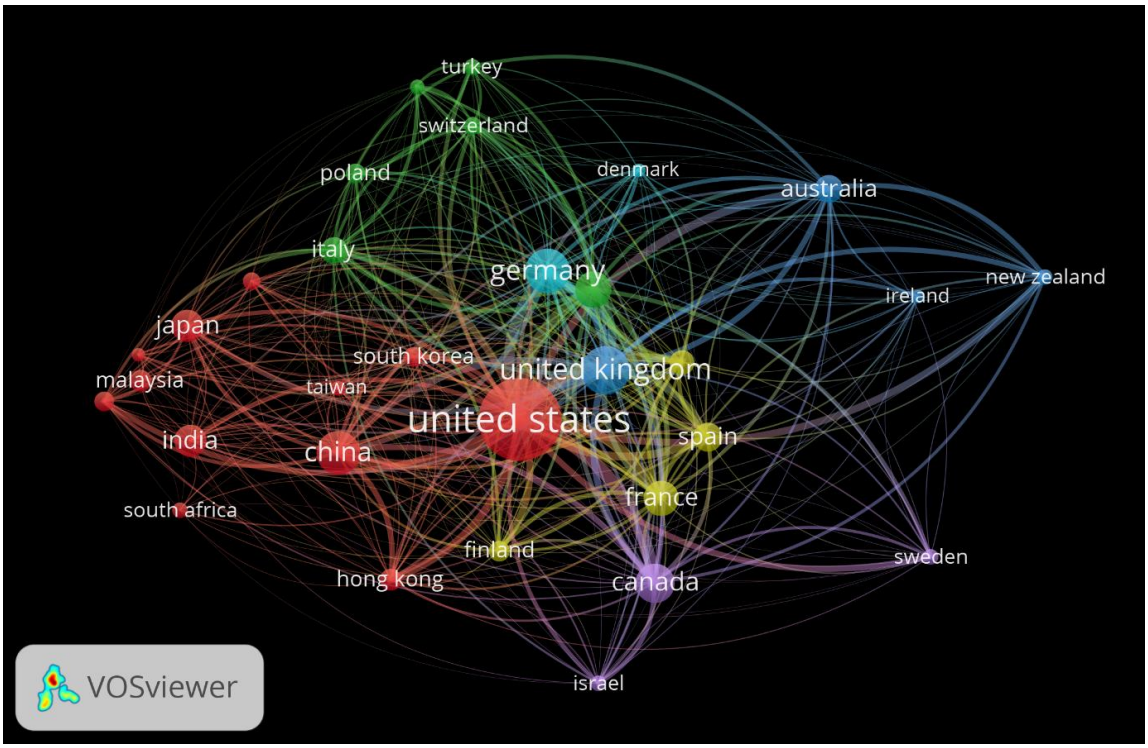

Figure 6: Network Visualization Map of Country Collaboration

International Journal of Modern Education
IJMOE
EISSN: 2637-0905
Volume 7 Issue 26 (September 2025) PP. 405-422
DOI: 10.35631/IJMOE.726027

The keyword co-occurrence analysis, as detailed in the table and visualized in Figure 5, underscores the prevailing focus and thematic structure of Malay vowel phonology research. "Linguistic features" emerges as the most frequently occurring keyword, with 74 mentions and the highest total link strength (88), establishing it as the conceptual core around which much of the research is organized. This centrality is reinforced by closely associated terms such as "speech perception," "speech recognition," and "foreign accent," all of which exhibit high frequencies and strong linkage values. The presence of "prosody" and "speech synthesis" further highlights the broadening of research interests from fundamental linguistic properties to include speech production, perception, and technological applications.

In addition to core linguistic concerns, the network reveals substantial integration of computational and interdisciplinary approaches. Notably, keywords like "machine learning," "automatic speech recognition," "acoustic model," and "natural language processing" display significant occurrences and link strengths, reflecting the growing impact of artificial intelligence and computational linguistics in this field. These connections are echoed in the visualization, where green and yellow clusters suggest vibrant cross-disciplinary interactions between linguistics, engineering, and computer science. The frequent occurrence of clinical and cognitive-related terms, such as "intelligibility," "bilingualism," "speech emotion recognition," and "phonological processing," signals a pronounced engagement with psycholinguistic and applied health domains, illustrating the multifaceted nature of contemporary vowel phonology research.

The structure of the co-occurrence network, with its dense clusters and overlapping thematic areas, demonstrates that Malay vowel phonology research is characterized by multidimensional collaboration and knowledge integration. Traditional topics like "intonation," "phonology," and "language variation" remain relevant, yet they increasingly intersect with emerging themes in deep learning, self-supervised learning, and advanced speech technologies. This dynamic interaction between longstanding linguistic principles and cutting-edge methodologies not only enriches the field's intellectual landscape but also positions Malay vowel phonology as a critical hub for broader interdisciplinary research and practical innovation in speech science.

Conclusion

This bibliometric analysis was conducted to map the evolution and research landscape of Malay vowel phonology, with the aim of identifying significant trends, key contributors, and emerging themes from both traditional and contemporary perspectives. The study sought to answer core research questions regarding patterns of publication growth, subject area distributions, influential works and authors, global research collaborations, and the shifting focus of thematic keywords within this field.

The results highlight a consistent upward trajectory in research output, particularly over the past five years, indicating an expanding scholarly interest in Malay vowel phonology. The distribution of publications reveals a marked transition from foundational work within the arts and humanities to more interdisciplinary efforts involving computer science, engineering, health sciences, and social sciences. High-frequency keywords such as "linguistic features," "speech perception," and "speech recognition" indicate a research landscape that now places equal emphasis on both theoretical linguistics and technology-driven approaches. The analysis of collaborative networks underscores that most of the impactful research is concentrated in regions with advanced academic infrastructures, while regional contributors in Southeast Asia,

International Journal of Modern Education
IJMOE
EISSN: 2637-0905
Volume 7 Issue 26 (September 2025) PP. 405-422
DOI: 10.35631/IJMOE.726027

despite their contextual relevance, still face challenges in achieving greater international visibility.

Several important contributions arise from this analysis. By presenting a data-driven overview of intellectual, collaborative, and thematic structures in Malay vowel phonology research, the study clarifies how traditional approaches are being complemented and, in some cases, transformed by computational and applied methodologies. The findings point to an increasingly interconnected research environment, which has the potential to enhance speech technology development, clinical assessment practices, and language education. These insights are valuable for academics, educators, and practitioners seeking to advance the practical and scientific impact of work in this field.

The practical implications extend to the design of automated analysis tools, clinical applications, and curriculum development, particularly as interdisciplinary research continues to grow. At the same time, certain limitations should be acknowledged. The focus on English-language, peer-reviewed journal articles may have excluded other relevant studies published in different languages or formats. Additionally, the scope of the analysis was limited to the Scopus database, which, while comprehensive, does not cover all possible sources. Future research should consider including a wider array of publication types, expanding linguistic coverage, and increasing regional collaboration to bridge existing gaps in visibility and impact. In summary, bibliometric analysis serves as an effective approach to understanding trends, intellectual relationships, and emerging priorities in Malay vowel phonology research. The current findings emphasize the need for continued interdisciplinary integration and international cooperation to advance knowledge in this area. Ongoing monitoring of academic developments and broader engagement with global research communities will be essential for sustaining innovation and relevance within the field of vowel phonology.

Acknowledgement
The authors wish to extend their sincere appreciation to Ts. Dr. Wan Azani, Senior Lecturer at Universiti Malaysia Perlis (UniMAP), for his invaluable guidance and support throughout the course of this research. Gratitude is also directed to Universiti Islam Antarabangsa Tuanku Syed Sirajuddin Perlis (UniSIRAJ) and to the Research Management and Innovation Centre (RMIC) for facilitating an article writing workshop, which provided essential support and a productive environment for the completion of this work.

References

Ahmad, Z., Jalaluddin, N. H., & Malek, S. (2011). The phonology of vowel sequences and the diversity of Malay dialects: An optimality theoretic account. *GEMA Online Journal of Language Studies*, *11*(3), 5–30. https://www.scopus.com/inward/record.uri?eid=2-s2.0-80052731886&partnerID=40&md5=a370a135ac6e5d9d3bd011072b6fd3bf

Al-Khoury, A., Hussein, S. A., Abdulwhab, M., Aljuboori, Z. M., Haddad, H., Ali, M. A., Abed, I. A., & Flayyih, H. H. (2022). Intellectual Capital History and Trends: A Bibliometric Analysis Using Scopus Database. *Sustainability (Switzerland)*, *14*(18). https://doi.org/10.3390/su141811615

Alves, J. L., Borges, I. B., & De Nadae, J. (2021). Sustainability in complex projects of civil construction: Bibliometric and bibliographic review. *Gestao e Producao*, *28*(4). https://doi.org/10.1590/1806-9649-2020v28e5389

International Journal of Modern Education
IJMOE
EISSN: 2637-0905
Volume 7 Issue 26 (September 2025) PP. 405-422
DOI: 10.35631/IJMOE.726027
Aman, I., & Mustaffa, R. (2013). Profiles of Malaysian Malay standard accent and identity values. *Pertanika Journal of Social Science and Humanities*, *21*(1), 179–202. https://www.scopus.com/inward/record.uri?eid=2-s2.0-84877000386&partnerID=40&md5=7b1f0ac3a228a87331df90288a3b5989

Appio, F. P., Cesaroni, F., & Di Minin, A. (2014). Visualizing the structure and bridges of the intellectual property management and strategy literature: a document co-citation analysis. *Scientometrics*, *101*(1), 623–661. https://doi.org/10.1007/s11192-014-1329-0

Assyakur, D. S., & Rosa, E. M. (2022). Spiritual Leadership in Healthcare: A Bibliometric Analysis. *Jurnal Aisyah : Jurnal Ilmu Kesehatan*, *7*(2). https://doi.org/10.30604/jika.v7i2.914

Baese-Berk, M. M., Bradlow, A. R., & Wright, B. A. (2013). Accent-independent adaptation to foreign accented speech. *Journal of the Acoustical Society of America*, *133*(3), EL174–EL180. https://doi.org/10.1121/1.4789864

Brodbeck, C., Hong, L. E., & Simon, J. Z. (2018). Rapid Transformation from Auditory to Linguistic Representations of Continuous Speech. *Current Biology*, *28*(24), 3976-3983.e5. https://doi.org/10.1016/j.cub.2018.10.042

Cristia, A., Seidl, A., Vaughn, C., Schmale, R., Bradlow, A., & Floccia, C. (2012). Linguistic processing of accented speech across the lifespan. *Frontiers in Psychology*, *3*(NOV). https://doi.org/10.3389/fpsyg.2012.00479

di Stefano, G., Peteraf, M., & Veronay, G. (2010). Dynamic capabilities deconstructed: A bibliographic investigation into the origins, development, and future directions of the research domain. *Industrial and Corporate Change*, *19*(4), 1187–1204. https://doi.org/10.1093/icc/dtq027

Ding, N., Melloni, L., Zhang, H., Tian, X., & Poeppel, D. (2015). Cortical tracking of hierarchical linguistic structures in connected speech. *Nature Neuroscience*, *19*(1), 158–164. https://doi.org/10.1038/nn.4186

ElSherief, M., Kulkarni, V., Nguyen, D., Wang, W. Y., & Belding, E. (2018). Hate lingo: A target-based linguistic analysis of hate speech in social media. *12th International AAAI Conference on Web and Social Media, ICWSM 2018*, 42–51. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85050586928&partnerID=40&md5=9fc5cbe54c363d50a620404ee72225b6

Fahimnia, B., Sarkis, J., & Davarzani, H. (2015). Green supply chain management: A review and bibliometric analysis. In *International Journal of Production Economics* (Vol. 162, pp. 101–114). https://doi.org/10.1016/j.ijpe.2015.01.003

Fraser, K. C., Meltzer, J. A., & Rudzicz, F. (2015). Linguistic features identify Alzheimer's disease in narrative speech. *Journal of Alzheimer's Disease*, *49*(2), 407–422. https://doi.org/10.3233/JAD-150520

Gosztolya, G., Vincze, V., Tóth, L., Pákáski, M., Kálmán, J., & Hoffmann, I. (2019). Identifying Mild Cognitive Impairment and mild Alzheimer's disease based on spontaneous speech using ASR and linguistic features. *Computer Speech and Language*, *53*, 181–197. https://doi.org/10.1016/j.csl.2018.07.007

Gu, D., Li, T., Wang, X., Yang, X., & Yu, Z. (2019). Visualizing the intellectual structure and evolution of electronic health and telemedicine research. *International Journal of Medical Informatics*, *130*. https://doi.org/10.1016/j.ijmedinf.2019.08.007

Jamil, N., Ramli, I., & Ardi, N. (2019). Formant characteristics of Malay vowels of Perlis, Kelantan And Terengganu. *Journal of Information and Communication Technology*, *18*(4), 529–544. https://doi.org/10.32890/jict2019.18.4.6

International Journal of Modern Education
EISSN: 2637-0905
IJMOE
Volume 7 Issue 26 (September 2025) PP. 405-422
DOI: 10.35631/IJMOE.726027
Keitel, A., Gross, J., & Kayser, C. (2018). Perceptually relevant speech tracking in auditory and motor cortex reflects distinct linguistic features. *PLoS Biology*, *16*(3). https://doi.org/10.1371/journal.pbio.2004473

Khiste, G. P., & Paithankar, R. R. (2017). Analysis of Bibliometric term in Scopus. *International Research Journal*, *01*(32), 78–83.

Ramli, I., Jamil, N., & Ardi, N. (2020). Formant characteristics of Malay vowels. *International Journal of Evaluation and Research in Education*, *9*(1), 144–152. https://doi.org/10.11591/ijere.v9i1.20421

Saito, K., Trofimovich, P., & Isaacs, T. (2015). Second language speech production: Investigating linguistic correlates of comprehensibility and accentedness for learners at different ability levels. *Applied Psycholinguistics*, *37*(2), 217–240. https://doi.org/10.1017/S0142716414000502

Shahidi, A. H., Langgau, S., & Aman, R. (2015). The pattern of language contact in malay language communication amongst native Iban. *Jurnal Komunikasi: Malaysian Journal of Communication*, *31*(2), 585–599. https://doi.org/10.17576/jkmjc-2015-3102-33

van Eck, N. J., & Waltman, L. (2010). Software survey: VOSviewer, a computer program for bibliometric mapping. *Scientometrics*, *84*(2), 523–538. https://doi.org/10.1007/s11192-009-0146-3

van Eck, N. J., & Waltman, L. (2017). Citation-based clustering of publications using CitNetExplorer and VOSviewer. *Scientometrics*, *111*(2), 1053–1070. https://doi.org/10.1007/s11192-017-2300-7

Van Eck, N. J., & Waltman, L. (2007). Bibliometric mapping of the computational intelligence field. *International Journal of Uncertainty, Fuzziness and Knowldege-Based Systems*, *15*(5), 625–645. https://doi.org/10.1142/S0218488507004911

Veaux, C., Yamagishi, J., & King, S. (2013). The voice bank corpus: Design, collection and data analysis of a large regional accent speech database. *2013 International Conference Oriental COCOSDA Held Jointly with 2013 Conference on Asian Spoken Language Research and Evaluation, O-COCOSDA/CASLRE 2013*. https://doi.org/10.1109/ICSDA.2013.6709856

Verbeek, A., Debackere, K., Luwel, M., & Zimmermann, E. (2002). Measuring progress and evolution in science and technology - I: The multiple uses of bibliometric indicators. *International Journal of Management Reviews*, *4*(2), 179–211. https://doi.org/10.1111/1468-2370.00083

Wu, Y. C. J., & Wu, T. (2017). A decade of entrepreneurship education in the Asia Pacific for future directions in theory and practice. In *Management Decision* (Vol. 55, Issue 7, pp. 1333–1350). https://doi.org/10.1108/MD-05-2017-0518

Zourmand, A., Mirhassani, S. M., Ting, H.-N., Bux, S. I., Ng, K. H., Bilgen, M., & Jalaludin, M. A. (2014). A magnetic resonance imaging study on the articulatory and acoustic speech parameters of Malay vowels. *BioMedical Engineering Online*, *13*(1). https://doi.org/10.1186/1475-925X-13-103

Zourmand, A., & Nong, T. H. (2012). Vowel classification of children's speech using fundamental and formant frequencies. *Proceedings of International Conference on Computational Intelligence, Modelling and Simulation*, 282–287. https://doi.org/10.1109/CIMSim.2012.95