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A Bibliometric Study on the Development of Radio Broadcasting Literature

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Abstract

Radio broadcasting is a significant communication medium in modern society. Since the early 1900s, radio broadcasting has progressed alongside technological advancements and scholarly discussions. Thus, a bibliometric analysis of radio broadcasting is essential. This study utilized a bibliometric framework to identify trends, patterns, and advancements in radio broadcasting literature. The Scopus database was utilized for data collection via a bibliometric literature review. The gathered data was assessed through bibliometric indicators such as author review, journal analysis, country evaluation, and trend analysis. The research methodology is quantitative, focusing on numerical data and statistical analysis for data processing. Selecting the quantitative methodology was driven by the need to integrate the numerical data with statistical computations. Consequently, this study adopted a quantitative research framework employing bibliometric techniques. The findings revealed that most authors published few articles, while some had high citation counts, reflecting low productivity in this field. The journal "Journal of Radio and Audio Media" is acknowledged for its quality. The United States is the leading country in scholarly publications on radio broadcasting. Recent trends in the field include "radio broadcasting," "radio," "television broadcasting," and "digital radio." Enhancing author productivity and fostering cross-institutional collaboration in radio broadcasting research is crucial for further advancement.

Keywords: author collaboration impact; analysis literature development; radio broadcasting; radio broadcasting development; radio broadcasting trend

Abstrak

Penyiaran radio merupakan media komunikasi yang signifikan dalam masyarakat modern. Dimulai pada awal abad ke-20, bidang penyiaran radio telah berkembang seiring dengan kemajuan teknologi dan diskusi akademik. Oleh karena itu, analisis bibliometrik terhadap penyiaran radio menjadi sangat penting. Penelitian ini bertujuan untuk memanfaatkan kerangka kerja bibliometrik untuk mengidentifikasi tren, pola, dan kemajuan dalam literatur penyiaran radio. Database Scopus digunakan sebagai sumber pengumpulan data melalui tinjauan literatur dengan menggunakan teknik bibliometrik. Data yang terkumpul dinilai melalui indikator bibliometrik seperti tinjauan penulis, analisis jurnal, evaluasi negara, dan analisis tren. Metodologi penelitian yang digunakan adalah kuantitatif, berfokus pada data numerik dan analisis statistik untuk pemrosesan data. Pemilihan metodologi kuantitatif berasal dari integrasi data numerik dan perhitungan statistik. Akibatnya, penelitian ini mengadopsi kerangka kerja penelitian kuantitatif dengan menerapkan teknik bibliometrik. Temuan menunjukkan bahwa sebagian besar penulis menerbitkan sedikit artikel, sementara beberapa penulis memiliki jumlah sitasi yang tinggi, mencerminkan produktivitas yang rendah di bidang ini. Jurnal "Journal of Radio and Audio Media" diakui memiliki kualitas yang baik. Amerika Serikat menjadi negara terkemuka dalam publikasi akademik tentang penyiaran radio. Tren terbaru di bidang ini meliputi "penyiaran radio", "radio", "penyiaran televisi", dan "radio digital". Meningkatkan produktivitas penulis dan memupuk kolaborasi lintas institusi dalam penelitian penyiaran radio sangat penting untuk kemajuan lebih lanjut.

***Kata kunci**: dampak kolaborasi penulis; pengembangan literatur analisis; penyiaran radio; perkembangan penyiaran radio; tren penyiaran radio*

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INTRODUCTION

Radio serves as a crucial medium for delivering information, entertainment, news, and educational content through audio channels. Its significance lies in the ability to tailor programs to meet listeners' preferences while ensuring that broadcasters effectively engage with their audience. This role is vital in rural areas as radio helps bridge communication gaps. As a mass medium widely accessible and affordable, radio empowers communities to participate in decision-making and social development (Irianto et al., 2019, p. 31). For example, studies show that radio stations in Pakistan effectively promote socio-economic development in rural regions by providing essential information on education, healthcare, and agriculture (Saleem et al., 2019, p. 389). Similarly, community radio stations in South Africa enable rural populations to be actively involved in content production and represent their identity (Leketanyane et al., 2021, p. 75). These instances illustrate how radio can effectively integrate local needs with content that promotes rural development. Furthermore, radio functions as a device for digital information exchange, encompassing both wired and wireless communication. With a long history in broadcasting, radio has evolved from public monopolies to commercial enterprises, playing a significant role in national integration and addressing issues of liberalization in a global context (Grayver, 2013, p. 1; Hayes, 2015, p. 877). Broadcasting involves transmitting information via radio waves, where messages are encoded and decoded by receivers (Shushnov, 2024, p. 216; Sjuchro, 2023, p. 33). Over time, broadcasting has connected diverse communities, initially focusing on building national identity and serving as a public information source. With advancements in technology, the impact of broadcasting has expanded, which proves its importance in contemporary society (Poole, 2003, p. 19). Thus, radio is vital for communication and community engagement.

Broadcasting, which includes both radio and digital platforms, has become a vital medium for sharing information, entertainment, and diverse viewpoints. With rapid technological advancements, broadcasting has evolved from solely audio formats to those that integrate visual elements (Wulandari & Wahyudin, 2024, p. 75). This transformation has woven broadcasting into our daily lives through television and online platforms (Gissani et al., 2024, p. 67). Consequently, radio and television mirror societal changes and drive significant transformation (Gandhi, 2024, p. 147). For instance, in Indonesia, community radio stations have played a crucial role in voicing local issues and promoting cultural narratives. It allows communities to engage actively in societal discussions (Pratama et al., 2024, pp. 1–2).

The integration of digital technology with radio has established it as a primary medium for distributing a lot of information and entertainment. Historically, communication tools were limited, but as society progressed, broadcasting technology advanced from simple radio transmissions to advanced live video broadcasts. This evolution has made broadcasting an integral part of our routines. Moreover, radio and television can influence cognitive processes and behaviors through audio and visual stimuli, which help the construction of narratives (Tufan, 2014, p. 105). The rise of digital broadcasting technologies has further diversified and enhanced content accessibility, significantly impacting the political and economic landscape of the media industry (Kind-Kovacs, 2022, p. 134; Lax, 2003, p. 276; Ramadhani et al., 2022, p. 20; Sudiartha et al., 2022, p. 51). Thus, the media effectively shape contemporary social norms and practices.

In contemporary society, wireless communication has become an essential means of interaction. The groundbreaking work of James Clerk Maxwell in the 19th century on electromagnetic waves marked significant strides in this field (Antoniou, 2011, p. 15). Initially, these waves were utilized for scientific purposes, but the development of commercial radio

technology in the early 1900s enabled the broadcasting of music and news. Guglielmo Marconi was pivotal in this evolution. in 1895, he successfully transmitted signals over long distances, laying the foundation for wireless communication. His notable achievement in 1901 of establishing transatlantic radio communication further exemplified this progress (Jeszenszky, 2011, p. 221). Additionally, in the same year, Reginald Fessenden made history by transmitting the human voice via radio waves (Riccardi et al., 2023, p. 2023).

The early form of audio broadcasting relied on amplitude modulation (AM). Key advancements followed the introduction of the electron tube by Lee de Forest in 1906 and Edwin Armstrong's development of frequency modulation (FM) in 1933 (Hendricks & Mims, 2018, pp. 50–52). These innovations were crucial for the evolution of broadcasting technology, leading to the first commercial radio station, KDKA, which began operations in 1920 (Razlogova, 2020, p. 29). During the 1950s and 1960s, radio broadcasting transformed with the emergence of pop music, talk shows, and sports broadcasts (Wall, 2016, p. 259). The miniaturization and enhanced reliability of transistors made radios more affordable for the public. Today, the digitization of media has revolutionized entertainment, with platforms like Spotify and Noice, which facilitate new ways of consuming music and news through internet radio and podcasts.

The radio landscape has experienced significant transformation recently due to digital technology. It empowers listeners to create personalized audio experiences through streaming rather (Falkowski-Gilski, 2021, p. 2). Similar to other mass media, radio broadcasting has evolved alongside advancements in communication and entertainment. Since its inception in the early 20th century, radio has undergone substantial growth and technological improvements, remaining a prominent source of news, music, and entertainment.

Technological innovations, such as satellite radio and internet radio, have diminished geographical barriers, enabling access to virtually any radio station worldwide (O'Neill, 2007, p. 15). The introduction of digital radio has revolutionized broadcasting. It offers features like HD Radio and Digital Audio Broadcasting (DAB) that enhance sound quality and expand programming options (Ala-Fossi, 2005, pp. 20–22). This shift allows listeners to enjoy a broad range of music and specialized content (Maxson, 2007, pp. 45–47).

Over the years, the medium of radio has transitioned from AM/FM modulation to MP3 broadcasting (Dissanayake, 2024; Sullivan, 2019). Traditional music and entertainment spaces have increasingly been occupied by television news, discussions, educational programming, and cultural advocacy. This shift enables broadcasters to target specific demographics and musical genres effectively (Krause, 2020, pp. 7–9). A notable transformation in the broadcasting landscape is the rise of podcasts, which provide a platform for creating customized audio content tailored to individual interests (Berry, 2016, pp. 172–174; Sullivan, 2019, pp. 3–5). The podcast format eliminates barriers to traditional radio as it allows users to craft their own audio experiences (Berry, 2016, p. 662).

In the digital age, radio stations have become more personalized. Platforms like Spotify and Apple Music enable users to curate personal playlists based on their preferred songs. This shift empowers listeners, transforming radio from a passive medium into an interactive experience. Spotify, for instance, leverages machine learning and user-generated playlists to deliver personalized music recommendations, significantly enhancing user engagement and satisfaction (Jacobson et al., 2016, p. 373). Additionally, studies show that Spotify's algorithm-driven recommendations and curated playlists have redefined how users interact with music, by which it automatically creates a "soundtrack to daily life" for personal preferences (Åker, 2017, p. 2). As media consumption habits evolve, radio adapts by embracing technological

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advancements, such as mobile apps and on-demand music services, to remain relevant in an increasingly personalized media landscape (Piñeiro-Otero & Martínez-Rolán, 2015, p. 245).

The evolution of radio broadcasting—from analog AM formats to digital radio and podcasting—has solidified its relevance in contemporary society. These advancements facilitate better information dissemination with improved sound quality. Radio has historically served as a reliable communication tool, and its adaptation to new media continues to influence public discourse. For instance, digital platforms and podcasting have enabled radio to transcend its traditional limitations, offering mobility and personalized listening experiences that enhance engagement (Pérez-Alaejos et al., 2022, p. 3). Moreover, academic research highlights podcasting as an emerging sound format that fosters creativity and supports the creation of a diverse sonic culture (Kruglova, 2024, p. 2). Staying informed about recent developments in these domains enhances researchers' productivity and their comprehension of the literature surrounding radio broadcasting and digital transformations.

A comprehensive approach to identifying barriers in broadcasting literature involves conducting a detailed review of existing academic work. By analyzing previous research, scholars can pinpoint gaps in knowledge. This process is crucial for grasping the foundational concepts of broadcasting. Understanding current trends, including technological innovations and evolving broadcast practices, is important. For instance, studies show that addressing barriers to innovation often requires systematic approaches, such as formulating policies and incentives to overcome obstacles like epistemic closure and regulatory challenges (Campuzano et al., 2023, p. 2). Additionally, reviewing the literature on technological adoption highlights the importance of design considerations and cost-efficiency for sustainable broadcasting advancements (Allesina & Pedrazzi, 2021, p. 5). These aspects are often documented in long-term studies and publications, providing critical context for researchers to apply their findings effectively.

Lighting, for instance, can assist in strategic planning within the broadcasting industry, as it is influenced by contemporary literature. Studies have shown that artificial lighting transcends its basic function of illumination. It is vital for communication, productivity enhancement, and environmental beautification. For example, integrating lighting considerations early in the design process can significantly reduce costs and time inefficiencies (Sholanke et al., 2021, p. 2). A thorough literature review is invaluable for shaping policies, programs, and decisions in broadcasting, enabling professionals to address the industry's dynamic needs effectively. By incorporating robust data with cutting-edge research, we can deepen our appreciation for the evolving role of lighting in broadcasting.

Furthermore, bibliometric analysis should focus on identifying research trends and promoting collaboration among scholars. This analysis assesses publication volumes, authorship patterns, and contributions from various countries to enhance the field of broadcasting. By employing a time series approach to observe research trends over time, we can gain a comprehensive understanding of how broadcasting literature evolves and its implications for knowledge dissemination. Such collaborative efforts among academics and practitioners are essential for advancing the discipline effectively.

Library science encompasses a significant subfield known as bibliometrics, which employs mathematical and statistical methods to analyze communication channels, including books. This approach assesses authors' productivity and the intellectual contributions within their disciplines. Originating in the 1980s as an evaluative tool, bibliometrics has evolved to play a crucial role in understanding the quantity and quality of scientific publications and their influence on research (Gupta & Dhawan, 2024, p. 8). Recent studies have underscored

bibliometrics' increasing importance across diverse fields, including clinical psychology and science education, by revealing trends and key contributors (Gao & Lou, 2024, p. 26). This research explores the literature on radio broadcasting through a bibliometric lens, focusing on trends, authors, source journals, and country contributions.

RESEARCH METHOD

This research adopted bibliometrics as a quantitative research methodology. It was grounded in mathematical analysis that necessitates numerical data and statistical computations (Gupta & Dhawan, 2024). Information science also has a specialized field called quantitative bibliometrics, which is concerned mainly with an analysis of the structure of literature and knowledge in relevance to the discipline. In bibliometric research, statistical techniques were employed to tackle bibliographic sources to quantify the performance and impact of various actions in this context. Bibliometric analysis, initiated in the 1800s, allows us to understand the trend of a field. By this method, the study of the historical changes and development can be done very comprehensively. We followed this methodological framework that allowed us to sort the set of data by year, count citations, and identify patterns within journals relevant to the research domain of interest. The bibliometric framework advances a conservative, stable system for measuring the impact of scientific inquiry (Lazarides et al., 2023, p. 5).

In this study, two software applications were employed in the bibliometric analysis phase, VosViewer and Biblioshiny. VosViewer is a software that allows the visualization and analysis of networks of citations or collaborations among authors/scientific articles. Biblioshiny, on the other hand, works as a platform to augment bibliometric analysis tools with data processing, visualization, and interactive display of bibliographic information. Leveraging these applications, the researcher was positioned to successfully perform bibliometric analysis and attain more substantial insights into the dynamics of scientific publications, citations, and collaborations among authors. Data acquisition is based on the Scopus database. The subsequent steps outlined were undertaken in the data collection process, implemented using VOSviewer and Biblioshiny.

The subsequent phase entailed the collection of data utilizing VOSviewer and Biblioshiny within the framework. Initially, a metadata search was performed for articles about the subject of "radio broadcasting" from 1923 to 2023. This search aimed to construct a holistic representation of the progression of radio broadcasting literature throughout the past century. Upon the retrieval of article metadata, the information was cataloged in both Bibtex and CSV formats; Bibtex serves as a format for the systematic organization of bibliographic information, while CSV facilitates further data manipulation and examination. Furthermore, data was analyzed employing VOSviewer and Biblioshiny: the VOSviewer instrument was utilized to illustrate the relational dynamics among the gathered articles while Biblioshiny afforded more elaborate bibliometric analytical capabilities. Through the application of these two tools, the authors aspired to attain an enriched comprehension of the trends, collaborative efforts, and academic influences within the literature associated with broadcasting. The outcomes derived from the data analysis conducted via VOSviewer and Biblioshiny were subsequently interpreted.

By adhering to these methodological steps, this study is expected to deliver a comprehensive and enlightening bibliometric analysis of the expanding corpus of literature concerning radio broadcasting. The data collection phase commenced with the establishment of pertinent objectives, including the selection of Scopus as the research database, a coverage span of three decades from 1994 to 2023, and the stipulation of the English language, with an emphasis placed solely on theses. A sample of 206 theses was selected using keywords such

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as "Radio Broadcasting," "Broadcasting Radio," "*Penyiaran Radio*," or "Radio Broadcast". The data from these articles was extracted, exported in Bibtex format with complete notes, and cited references for further analysis using Biblioshiny, while the data in CSV format was analyzed using VOSviewer.

RESULTS AND DISCUSSION

Following a thorough data extraction and processing using Biblioshiny, along with a search in Scopus for the term "Radio Broadcasting" within the timeframe of 1903 to 2023, we have gathered significant findings. Over the past 30 years, from 1994 to 2023, at least 206 articles have been published on the subject of radio broadcasting. Notably, these articles involved 406 authors with an annual growth rate of 3.86%. Each document received an average of approximately 7.88 citations, which suggests that the discourse surrounding radio broadcasting remains vibrant and continues to develop.

To comprehend the evolution of the literature on this topic, we analyzed it through various lenses, including author analysis, journal analysis, country analysis, and trend analysis. Statistical evaluations indicated that the primary aim of scientific research is to produce scholarly articles, averaging 2.5 articles per author. For instance, Barik and Jena (2021, p. 10) employed Lotka's law to investigate author productivity in library and information science journals. Their findings highlighted collaboration trends, even though actual productivity did not entirely align with expected values from Lotka's law.

In this academic context, the accumulation of scientific publications has emerged as a central focus. Quantitative analysis reveals that one author stands out with the highest number of publications, totaling seven articles. Additionally, Winoto and Yuliani (2022, p. 30) utilized Lotka's law to enhance the understanding of publication efficiency among authors in the "Visi Pustaka" journal, further illustrating the dynamics of scholarly output in this field.

The graphic illustrates the top ten authors in the radio broadcasting field, highlighting their productivity over the past 30 years. Authors such as Bennack S, Blettner M, and Brüggemeyer H have each contributed three publications during this period. The list concludes with Berry St, who has published two articles. Figure 1 further details the publication years for each author, revealing that most contributions occurred between 1999 and 2023, with a noticeable gap from 1994 to 1998. The peak activity was observed between 2007 and 2009 when seven authors published their works. In contrast, two authors were active from 1999 to 2006, while Maclennan Af continues to publish articles actively from 2007 to the present.

In addition, Figure 1 illustrates the author's productivity through the lens of Lotka's Law. Introduced by Alfred Lotka in 1926, this bibliometric principle assesses how author publications are distributed within a specific field. Essentially, Lotka's Law establishes an

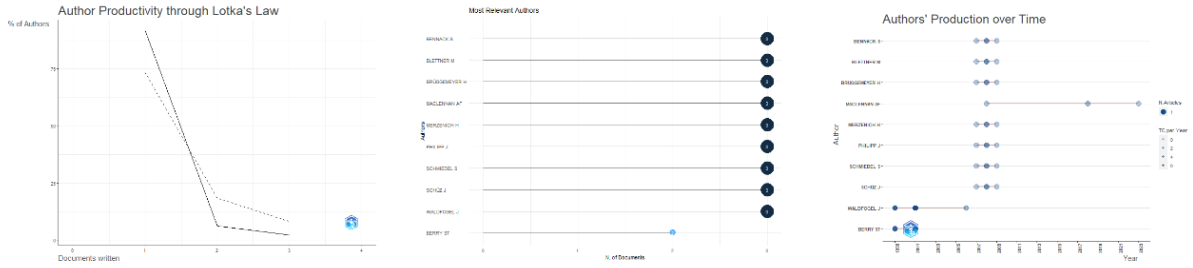

Figure 1. Author Productivity Analysis
Source: Biblioshiny Data Processing Results, 2023

indirect correlation between the number of published articles and the frequency of authors producing them (Atlasi et al., 2022, p. 7; Batra et al., 2023, p. 340; Tunga, 2020, p. 2).

According to this law, the ten most prolific authors contributed approximately 29 articles out of a total of 206 published in the past 30 years. This suggests that many authors have only published once or twice. Specifically, among the 406 authors analyzed, over 91% have written just one article, around 6% have authored two, and only about 3% have produced more than three articles. This data indicates a relatively low level of productivity in the field of radio broadcasting.

Moreover, of the 206 articles, only 95 were single-authored, highlighting the prevalence of collaborative efforts in research. Scientific collaboration, where two or more researchers work together to achieve common objectives, is recognized as an effective strategy for enhancing productivity. Such partnerships foster the creation and sharing of new knowledge, expertise, and techniques within a discipline, allowing for a division of labor and better utilization of skills (Fonseca et al., 2016, p. 34; Sjuchro, 2023).

Collaboration has emerged as a key focus in scientometric studies. While some collaborative efforts may not be immediately visible, bibliometric data enables the measurement and analysis of these partnerships through scientific publications. Common methodologies involve categorizing authors based on the number of contributors to each article, providing valuable insights into collaboration patterns and their influence on knowledge advancement (Garg & Padhi, 2001, p. 415; Guan & Ma, 2007, p. 107).

Figure 2 reveals that collaboration among authors is relatively limited, with most partnerships occurring within the same institution. Out of 406 authors, only 27 participated in collaborative efforts, forming 10 distinct groups. The largest group comprises five authors from Japan working together. When focusing on authors with at least five citations, we identified 112 individuals organized into seven clusters that reciprocally cite one another. Among these, Alfosi Pizzi, Barnouw, and Sterling are notable for their mutual citations. Additionally, physicist Jorge Hirsch introduced the h-index in 2005 as a method to evaluate the quality and volume of scientific work. The h-index offers a quantitative assessment that combines both the number of citations and the number of publications associated with a researcher or journal. For instance, if a researcher has 17 articles, each cited at least 17 times, their h-index would be 17. The primary aim of the h-index is to filter out atypical publications that could misrepresent a researcher's true influence. It correlates directly with citation counts and reflects the academic tenure of the researcher. This metric serves as an alternative to traditional journal impact factors, offering a clearer picture of a researcher's output and quality. Consequently, the h-index provides a useful framework for non-experts to gauge both the impact and productivity of a researcher or journal (Hodge & Lacasse, 2011, p. 225).

The g-index offers a distinct approach to evaluating researchers' academic performance. It focuses on citation distribution across their publications. Introduced by Leo Egghe in 2006,

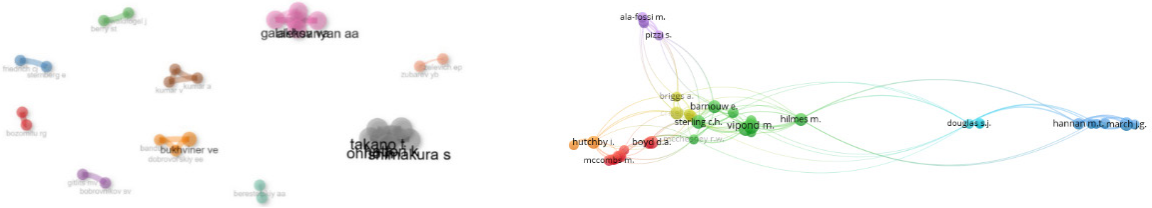

Figure 2. Analysis of Collaborative Writing and Citations
Source: Data Processing Results from Biblioshiny and VosViewer, 2023

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Table 1. Impact Measurement

Journal	h_index	g_index	TC	NP	PY_start
IEEE Transactions on Broadcasting	2	3	29	3	1998
Journal of Radio and Audio Media	3	4	21	10	2010
Communicatio	2	3	3	3	1994
Ebu Technical Review	2	2	2	2	1995
Estudios Sobre El Mensaje Periodistico	2	2	2	2	2013

Source: Data processing result, 2023

this metric calculates the average citation per article based on total citations (Egghe, 2006). To determine the g-index, one lists a researcher's publications in descending order of citation counts. The g-index represents the number of articles that have received at least 'n' citations. This index is considered more effective than the h-index in capturing a researcher's overall impact because it emphasizes highly cited works. For instance, Schreiber (2013, p. 558) illustrates that adjusting the threshold for calculating the g-index can lead to fewer articles being recognized for high citations. Furthermore, Du et al. (2019, p. 665) developed deep learning models to predict g-index growth, taking into account the structural features of academic collaboration networks. According to Costas and Bordons (2008, p. 275), the g-index and h-index are not interchangeable; rather, they complement each other, serving different yet significant roles in measuring researcher productivity and effectiveness.

According to Table 1, the "Journal of Radio and Audio Media" stands out as the leading journal in terms of both h-index and g-index, boasting an h-index of 3, a g-index of 4, and a total of 21 citations from 10 publications since 2010. This positions it as the most relevant journal in the field of radio broadcasting. Following closely is the "IEEE Transactions on Broadcasting," which also has an h-index of 3 and a g-index of 3, albeit with a total of 29 citations from just three publications dating back to 1998.

Moreover, scientific collaboration networks between countries play a crucial role in the academic landscape. In these networks, each node represents individuals engaged in various collaborative efforts, such as research projects and article writing. These collaborations can span a wide range of entities, including organizations, academic institutions, and even nations. Understanding the strength of these relationships is vital for identifying key players and facilitating information exchange among participants. In global scientific cooperation, social factors and interpersonal relationships are pivotal for successful collaborations. Engaging in these networks enables researchers to share ideas, tools, and expertise with colleagues worldwide, leading to enhanced understanding, improved research quality, and accelerated scientific innovation (Meštrović, 2018, p. 115; Szymanski et al., 2018).

In this study, we employed VOSviewer to analyze international collaboration among nations on radio broadcasting. Our analysis focused on countries that published between three and twelve articles, resulting in a sample of fifty-nine nations. Within this framework, we identified six distinct clusters, represented by colors: red, yellow, green, blue, light blue, and purple. The red cluster includes the United Kingdom, China, and Nigeria, while Spain, Australia, and Hong Kong are part of the yellow cluster. The green cluster consists of Germany, New Zealand, and Switzerland, and the purple cluster includes Japan, Italy, and Russia. The largest cluster, light blue, is dominated by the United States. Notably, other countries did not form clusters due to a lack of collaborative connections.

Figure 3 illustrates the frequency of scientific output from each country. The data indicates that the United States leads significantly in radio broadcasting research, contributing 57 articles,

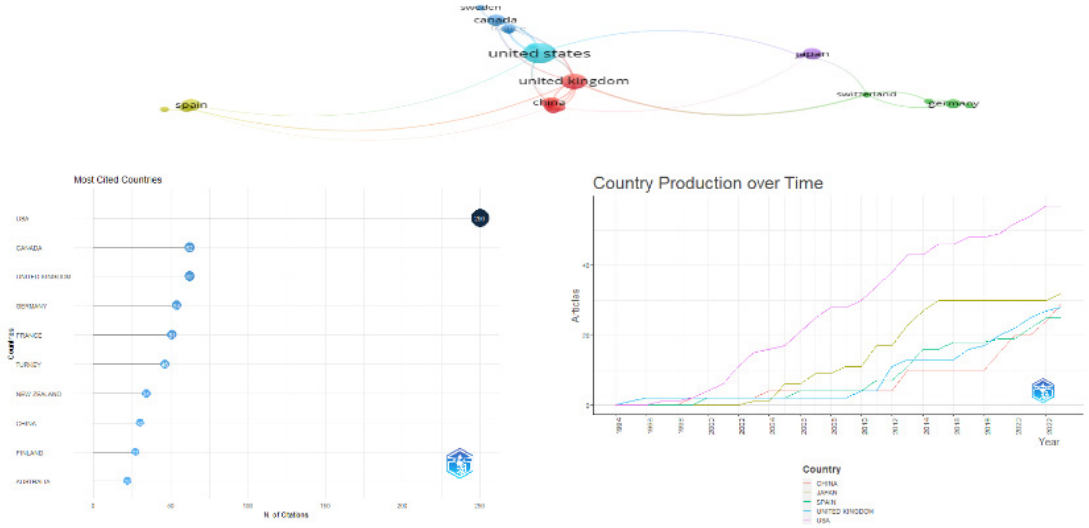

Figure 3. Country Analysis
Source: Biblioshiny Data Processing and VosViewer, 2023

compared to Japan's 32 articles. This trend underscores the United States' dominance in this field, having consistently produced the highest number of scientific articles worldwide since 1996, with an upward trajectory that continues through 2023. This sustained output highlights the ongoing relevance and activity in radio broadcasting research within the United States.

As previously explained, the United States is the most productive country in scientific publications related to radio broadcasting. This is also reflected in the number of citations received, with at least 250 citations related to articles representing authors from the United States, with an average of 13.2 citations per article. This achievement is followed by Canada and the United Kingdom, both with the same number of citations, 62. This data also indicates that the United States is the most productive country and has a significant influence in the field of radio broadcasting, as the majority of articles related to radio broadcasting originate from the United States, and the highest number of citations also come from the United States.

Last, analyzing trends in research involves using methodologies to collect and analyze data to make projections about recurring behaviors or patterns in the future based on past and current data. This practice helps identify recurring patterns over time. In this research, the analysis is based on the subject matter that frequently appears from the beginning to the end. Additionally, the analysis is complemented by thematic mapping analysis and thematic evolution. In the context of research, trend analysis enables researchers to understand changes and patterns that occur in data over time, providing better insights and generating research relevant to current societal needs.

Radio broadcasting has become a crucial communication medium in modern society. Since its invention in the early 20th century, radio has undergone rapid development and has become an integral part of daily life. The development of radio broadcasting has experienced remarkable transformations since its inception in the early 20th century. This development is evident not only in radio broadcasting technology itself but also in the literature related to this field. Therefore, bibliometric studies related to radio broadcasting are of great importance. By using keywords such as "Radio Broadcasting" OR "Broadcasting Radio" OR "Penyiaran Radio" OR "Radio Broadcast" within a 30-year timeframe from 1994 to 2023, we can observe that out of 206 articles, 406 authors were involved in producing those articles, with a growth rate of 3.86% per year, and an average citation per document ranging around 7.88. This indicates that

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the topic of radio broadcasting is still alive and continuously developing until the present time.

Further discussions regarding bibliometric studies on radio broadcasting literature were analyzed based on 4 factors: authors, journals, countries, and research trends. The data shows that the majority of authors only published one or two articles, while only about 3% of authors were productive with more than 2 articles. Additionally, regarding author collaboration, most collaborations were limited to authors with the same affiliation, with Japanese authors being the largest group engaging in collaborations. These findings indicate that author productivity in the field of radio broadcasting is still low, with most authors publishing only a few articles. However, several authors have achieved high citation counts, and author collaborations occur within limited scopes. Moving forward, increasing author productivity and cross-institutional collaborations can be a focus to advance research and development in the field of radio broadcasting.

In journal analysis, the "Journal of Radio and Audio Media" ranks highest in terms of h-index and g-index compared to other journals, with an h-index of 3 and a g-index of 4. It has received a total of 26 citations from 11 publications starting in 2010. The "IEEE Transactions on Broadcasting" journal also has an h-index of 3 and a g-index of 3, with 29 citations from 3 publications since 1998.

By extracting keywords such as "Radio Broadcasting" OR "Broadcasting Radio" OR "Penyiaran Radio" OR "Radio Broadcast" and processing them using VOSviewer and Biblioshiny, we can observe the overview depicted in the figure. Figure 4 visualizes the data using word clouds, where the size of the text corresponds to the frequency of appearance of each subject. The larger the text, the higher the frequency, while smaller texts represent lower frequencies and are positioned towards the sides. Additionally, the data is visualized using network and bubble diagrams, where the size of the bubble indicates the frequency of appearance of each subject. The farther away a bubble is from the central bubble, the lower the frequency of that subject's appearance.

Figure 4 demonstrates that the subject "Radio Broadcasting" is the most frequently mentioned, followed by "Radio," "Digital Radio," "Frequency Modulation," "Radio Frequency," and others, as shown in the figure. The figure illustrates the most frequently appearing subjects or keywords in the last 40 years related to radio broadcasting. The subject

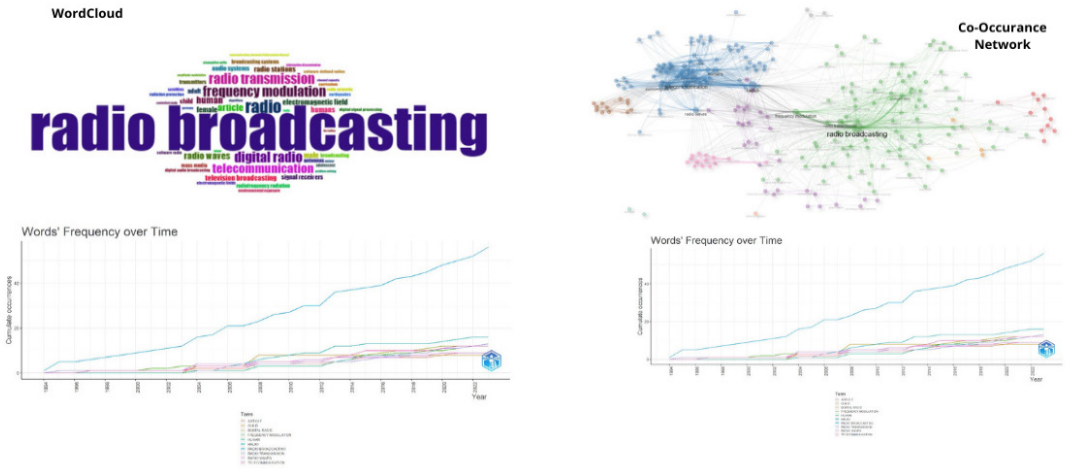

Figure 4. Analysis of trend data
Source: Results from Biblioshiny and VOSviewer Data Processing, 2023

or keyword “Radio Broadcasting” appears most frequently, far surpassing other subjects. Its growth is also significant as it consistently shows growth since 1994 with a frequency below 5, increasing steadily to over 50 occurrences in 2023. However, if we set aside the “Radio Broadcasting” subject, the subject of “Radio” appears most frequently with 16 occurrences from 1994 to 2023, followed by “Digital Radio” with 13 occurrences.

A thematic map is a visual representation of geographic distribution often related to demographic, sociological, cultural, and economic aspects. It can be used in various research fields, including bibliometric studies. Bibliometric analysis quantitatively examines scientific publications and bibliographies within a particular field or profession. In bibliometric research, topic maps are an invaluable tool for exploring and visualizing collaboration patterns among researchers, trends in research topics, and other relevant variables (Tennekes, 2018, p. 1).

Thematic maps are a common type of topic visualization in the field of bibliometric analysis, which uses color coding to show how and where research trends have traveled over academic departments or institutions. The utilization of thematic maps in bibliometrics gives an understanding of dissemination, locations of research centers, interrelations, as well as collaborative works among the scholars within a given research domain. Topic maps function as visual aids in interpreting geographic information and are important tools in bibliometric research for outlining patterns and trends that can be observed from the literature regarding a particular correspondence.

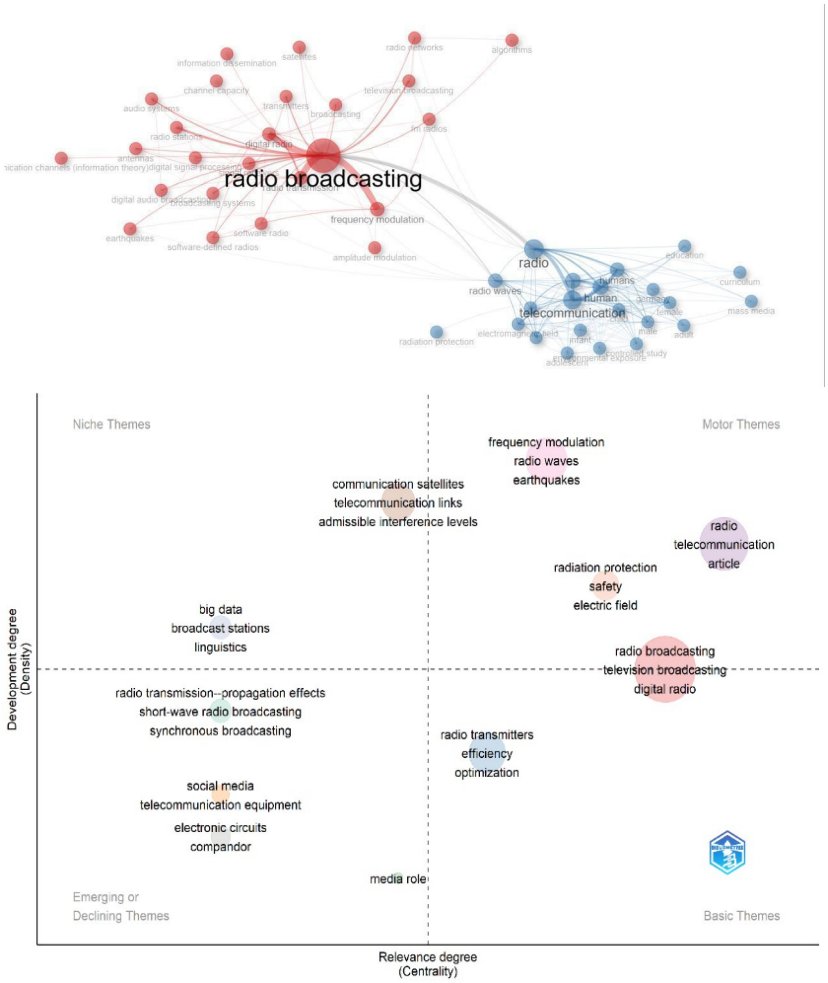

Figure 5. Thematic Map & Thematic Evolution
Source: Results from Biblioshiny Data Processing, 2023

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Two clear clusters can be seen in Figure 5. These clusters are organized in the radio broadcasting cluster and radio cluster. In this instance, the primary cluster is the radio broadcasting cluster, encompassing digital radio, broadcasting, software radio, television broadcasting, and other related components. In contrast, the radio cluster encompasses themes such as telecommunications, radio waves, humans, radiation protection, and other topics that differ from those in the main cluster. In the thematic evolution analysis of the field of radio broadcasting depicted in the figure, several major themes and one overlapping theme can be identified.

Basic Theme: The bibliometric analysis of the radio broadcasting literature reveals that certain themes or subjects maintain consistent relevance over time, as they are associated with fundamental aspects of the field. The basic themes identified in the study include radio transmitters, efficiency, and optimization, indicating their enduring significance in the scholarly discourse on radio broadcasting. These core themes serve as the foundation for understanding the evolution and current state of this vital medium of communication.

Emerging or Declining Themes: These themes experience increasing or decreasing relevance over time and are often related to evolving aspects or challenges in radio broadcasting. Within the figure, multiple themes fall into this category and are divided into three clusters. The first cluster encompasses themes such as radio transmission, propagation effects, shortwave radio broadcasting, and synchronous broadcasting. The second cluster includes themes related to social media, telecommunications equipment, electronic circuits, and computers. The third cluster addresses the role of media.

Niche Themes: These themes have relatively low relevance to radio broadcasting in general. The figure illustrates two clusters within this category. The first cluster discusses communication satellites, telecommunications links, and permissible interference levels. The second cluster explores big data, broadcasting stations, and linguistics.

Motor Themes: These themes demonstrate relatively high relevance to radio broadcasting in general. Three clusters are shown in the Figure for this category. The themes in the first cluster are frequency modulation, radio waves, and earthquakes. The second cluster (13 papers) includes themes about radiation protection, safety, and electromagnetic fields. Another concentration is radio telecommunications and headlines.

Development Degree: A growth diploma is an important issue within the bibliometric evaluation. Therefore, the authors examined thematic maps in influences of some fields such as radio broadcasting. This dimension relates to the completeness or progressiveness of mapped topics. These are widely representative themes that can provide complex contexts of the research, with themes such as “Radio broadcasting,” “Television broadcasting,” and even imperceptible “Digital radio” showing the degree of development in this environment.

The trend analysis from the bibliometric analysis shows that the radio broadcasting field has improved over time. Over the past century, these trends have been as diverse in subject matter as “radio broadcasting,” “radio,” “television broadcasting,” and “digital radio.” It illustrates how much the field of ionospheric radio sounding has evolved and continues to advance with technological developments in radio science.

CONCLUSION

Over the century, radio broadcasting has been evolving, including the technology and literature. Most authors published few articles, but a portion of authors had high numbers of citations (low author productivity). Journal of Radio and Audio Media is a high-quality journal. In the area of scientific articles on radio broadcasting, the United States has led. Recent

developments in this field include "radio broadcasting," "radio," "television broadcasting," and "digital radio."

For further progress, increased author productivity and cross-institutional collaboration in radio broadcasting research are required. Future research can examine the influence of technological developments and AI in the field of radio broadcasting studies. Besides, researchers can add the significant factors influencing radio broadcasting studies.

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