Bibliometric Analysis of Academic Studies on Particleboard

Yongalevha Üzerine Yapılmış Akademik Çalışmaların Bibliyometrik Analizi

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Abstract

Particleboard has an important position in the forest products sector and has led to significant changes in terms of trade volume and scientific studies in the last 20 years. The aim of this study is to examine research in the field of particleboard through a systematic literature review. Bibliometric analysis of studies published in English in the Web of Science database between 1980 and 2023 was carried out using the R programming language. Constraints were created using relevant keywords and a data set consisting of 3235 articles, reviews and conference proceedings was obtained. The resulting data set was analyzed through "biblioshiny" in the RStudio program. The research results revealed data such as the number of production of studies on the subject of the study by year, the most frequently used words, prominent institutions and authors in the field, the countries where the most publishing institutions are located, the amount of studies and citation records. This study shows that studies in the field of particleboard have gradually increased in the last 20 years. The fact that many researchers from different countries have worked on this subject emphasizes the importance and global dimension of particleboard studies. Particleboard workspace has a potential for collaboration and development around the world.

Keywords: Bibliometric Analysis, Particleboard, R, Web of Science

Özet

Yongalevha, orman ürünleri sektöründe önemli bir konuma sahip olup son 20 yılda ticaret hacmi ve bilimsel çalışmalar açısından önemli değişimlere yol açmıştır. Bu çalışmanın amacı, yongalevha alanındaki araştırmaları sistematik bir literatür taramasıyla incelemektir. Web of Science veri tabanında 1980-2023 yılları arasında İngilizce olarak yayımlanan çalışmaların bibliyometrik analizi, R programlama dili kullanılarak gerçekleştirilmiştir. İlgili anahtar kelimeler kullanılarak kısıt oluşturulmuş ve 3235 makale, derleme ve konferans bildirisinden oluşan bir veri seti elde edilmiştir. Elde edilen veri seti, RStudio programındaki "biblioshiny" aracılığıyla analiz edilmiştir. Araştırma sonuçları, çalışma konusuyla ilgili yapılan çalışmaların yıllara göre üretim sayısı, en sık kullanılan kelimeler, alanda öne çıkan kurumlar ve yazarlar, en çok yayın yapan kurumların bulunduğu ülkeler, çalışmaların miktarları ile atıf kayıtları gibi verileri ortaya koymuştur. Bu çalışma, son 20 yılda yongalevha alanındaki çalışmaların giderek arttığını göstermektedir. Farklı ülkelerden birçok araştırmacının bu konuda çalışmış olması, yongalevha çalışmalarının önemini ve küresel boyutunu vurgulamaktadır. Yongalevha çalışma alanı, dünya çapında işbirliğine açık ve geliştirilebilir bir potansiyele sahiptir.

Anahtar Kelimeler: Bibliyometrik Analiz, R, Yongalevha, Web of Science.

1. Introduction

Particleboard is a type of board produced naturally or synthetically, wood-based, in different thicknesses and flat shapes. This versatile material finds applications ranging from exterior facades of architectural structures to interior coverings, as well as in furniture and packaging industries. Particleboard stands out with its advantages such as the material's durability, aesthetic appeal and workability. Over the past two decades, the particleboard industry has undergone significant transformations and advancements. Enhanced production machinery, automation, and the integration of digitalization processes have notably augmented both production efficiency and quality standards. These technological enhancements have facilitated an increase in production capacities concomitant with elevating product quality levels. (Şahin, 2013; İstek et al., 2017; Kara et al., 2019). In the 21st century, the importance of clean production and sustainability issues has increased. Therefore, there has been greater focus in the particleboard industry on environmental factors such as sustainable forest management practices and recycling processes. Such product and market diversity has also begun to become more diverse. Different types of board products are produced to appeal to different market segments. Furthermore, the surge in exports of particleboard products to international markets has instigated heightened competition among producing nations and enterprises. Technologies such as smart production systems, data analytics and artificial intelligence provide advantages to companies and countries in the competitive environment by optimizing production processes and improving product quality. These multifaceted changes and developments have significantly influenced the globalization of the particleboard sector, amplifying trade volumes, and stimulating the formulation of international standards and trade accords over the past two decades. As such, factors encompassing technological advancements, environmental imperatives, production diversification, digital transformation, and globalization dynamics are poised to exert considerable influence in shaping the future trajectory of the industry.

Particleboard serves as a crucial material within the construction industry, utilized across diverse structural elements including wall panels, flooring materials, ceiling coverings, and exterior cladding. Its application ensures structural durability, safety, and enhances the aesthetic appeal of edifices (Kurt, 2019). Within the furniture industry, particleboard is extensively favored for crafting cabinets, tables, chairs, and various other furniture pieces (Efe and Imirzi, 2007; Ayrilmis et al., 2015; Oliviera et al., 2016; Bazetto et

al., 2019). In the packaging sector, it presents a dependable solution for the transportation, storage, and safeguarding of products, manifesting in the form of cardboard boxes, pallets, and other packaging materials (Hwang et al., 2006; İstek et al., 2017). Beyond its commercial applications, particleboard holds paramount importance in environmental sustainability endeavors. Sourced from responsibly managed forest resources, particleboard mitigates environmental impacts and contributes to the preservation of forests. (Yener et al., 2012; Akın and Karaboyacı, 2021).

The trajectory of the particleboard industry's future growth hinges significantly on sustainability-driven innovations and its capacity to align with market demands. In this context, the particleboard sector is notable as an important factor in the evolution of the construction industry and has a wide range of interest and study among researchers, engineers and industry experts. These studies predominantly delve into particleboard production, properties, application scopes, environmental ramifications, and sustainability imperatives (Rivela et al., 2006; Archanowicz et al., 2013; Hussain et al., 2017; Güler and Yasar, 2018; Yaşar and Güler, 2021; Lao and Chang, 2023). Additionally, many studies have been conducted on the mechanical and physical properties of particleboards. These studies aim to determine the most suitable material options for different application areas by evaluating the durability, hardness, flexibility and other mechanical properties of particleboards (Beram and Yasar, 2018; Guler and Beram, 2018; Guler, 2019; Kowaluk et al., 2020; Yasar et al., 2020). Furthermore, environmental ramifications stemming from particleboard industry practices constitute a focal point of extensive research endeavors. These studies entail comprehensive assessments of particleboard production's impact on forest resources, energy consumption patterns, waste management protocols, and carbon emissions footprint. Issues pertaining to sustainable forest management practices and recycling initiatives also feature prominently within the focus of these researches (Engür and Kartal, 2001; Taramian et al., 2007; Güntekin et al., 2009; Ulusoy et al., 2016; Iždinský et al., 2020; Akın and Karaboyacı, 2021; Lee et al., 2022).

Bibliometric studies encompass the quantitative exploration of scientific information (Ayala et al., 2010). Recognized as a method conducive to evaluating research outcomes through statistical methodologies, such analyses serve to scrutinize the metrological attributes of information generated within specific fields, as highlighted by Ellegaard and Wallin (2015). These studies play an instrumental role in gauging the volume and progression of scientific output across nations, institutions, research entities, and scholars within pivotal subject domains. The bibliographic domain has witnessed an exponential

surge in recent decades, propelled by the advent of digitization, the systematic organization of information, and the proliferation of diverse scientific literature databases accessible worldwide in electronic formats (Ayala et al., 2010). This method is deemed a valuable tool to aid decision-making in setting research priorities, tracking scientific and technological developments, allocating funds, and recognizing scientific excellence (Mejia et al., 2021). A bibliometric study assesses annual publications, identifies the most prolific and noteworthy authors, highlights significant institutions and nations, and examines the most cited articles within a particular field of knowledge. This comprehensive analysis serves to evaluate the scientific significance and progression of the field, providing insights into research trends, influential contributors, and the dissemination of knowledge.

The aim of this study is to highlight the important information of scientific studies conducted in the field of particleboard and to draw attention to the subject. It is a systematic literature review of international studies in the field of particleboard, which has received increasing research attention in recent years. It will afford a comprehensive portrayal of the scientific community, facilitated by the application of bibliometric techniques, which scrutinize data and metadata from previously published works within the field. Consequently, the primary objectives encompass scrutinizing the annual publication trend, identifying the most prolific and extensively referenced journals and authors, and elucidating the prevalent keywords and articles within the literature.

2. Material and Method

2.1. Source of Data

This bibliometric study analyzed the published academic studies of particleboard indexed in the Web of Science (WOS) core collection database. As known, WOS is the most reliable global citation database with a collection of over 21,000 peer-reviewed journals and the most accepted one for analysis of academic papers (Liu et al, 2012; Nunen et al., 2018). In this study, between the years 1980 and 2023, a total of 3665 documents were extracted related to "particleboard" in "topic". Subsequently, the document types were filtered by selecting the "article", "review article," and "proceeding paper" and the language was restricted to English. Ultimately, 3235 studies were refined. All data were collected the same day from the Web of Science Core Collection (WOSCC) to avoid bias caused by database updates.

2.2. Statistical Analysis

In this study, Biblioshiny was employed for conducting bibliometric analyses (Cuccurullo et al., 2016; Aria et al., 2022). Biblioshiny, a free web-based interface, operates within the R operating system and integrates seamlessly with the open-source R software (Team, 2014). To initiate the analyses via the web interface in R, the necessary packages for bibliometric analysis was first installed using the following sequential commands: install.packages("devtools") and devtools::install_github (massimoaria/bibliometrix) (Aria et al., 2017). Following this, the package library was loaded with the command library(bibliometrix). Finally, access to the database was achieved using the code biblioshiny(maxUploadSize=500).

Within the Biblioshiny interface, the WOS database option was chosen, and a text file containing 3235 documents was imported. Subsequent bibliometric analyses were conducted across various tabs including Overview, Sources, Authors, Documents, Conceptual Structure, Intellectual Structure, and Social Structure. The analysis began with an examination of the annual production of the selected reference topics, followed by determining the percentages of the top 10 most frequently used keywords. A progressive analysis approach, moving from general to specific, was adopted, and further bibliometric analyses were performed for countries, affiliations, journals, and authors, respectively.

3. Results

In this study, 653 sources (Journals, Books, etc) analyzed encompass 3235 scientific studies spanning the period from 1980 to 2023. Table 1 encapsulates key information pertaining to these sources. Upon analysis of the source data, it was found that the annual citation rate per article was 16.99%, and the annual growth rate was 7.89%, as presented in Table 1. Additionally, there are 244 articles authored by a single individual, representing 7.5% of all studies conducted. Another notable finding from the study is the 23.18% international co-authorship rate, indicating that the research topic is conducive to collaboration among researchers from different regions.

Table 1. Main information about data.

Description	Results
MAIN INFORMATION ABOUT DATA	
Timespan	1980:2023
Sources (Journals, Books, etc)	653
Documents	3235
Annual Growth Rate %	7.89
Document Average Age	11,8
Average citations per doc	16,99
References	57884
AUTHORS	
Authors	6518
Authors of single-authored docs	202
AUTHORS COLLABORATION	
Single-authored docs	244
Co-Authors per Doc	3,9
International co-authorships %	23,18
DOCUMENT TYPES	
article	2807
proceedings paper	332
review	96

The distribution of the number of articles produced on the topic over the years is depicted in Figure 1. It is evident from Figure 1 that only a small number of articles were produced from 1980 to 2000. However, since 2000, a steady annual growth in the number of articles has been observed. Particularly noteworthy is the significant increase since 2010, with more than 100 articles being published annually. Given this upward trend over the last two decades, it is reasonable to infer that the subject remains a contemporary issue, and it is anticipated that further research will be conducted in the coming years.
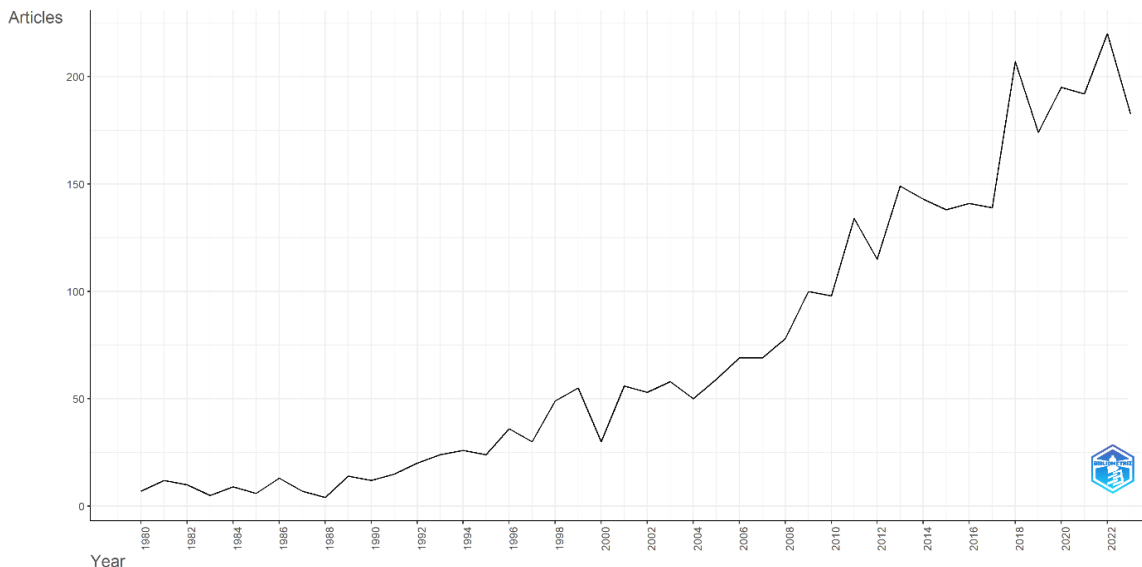
Figure 1. Annual scientific production.

3.1. Countries/regions and organizations analysis

The countries where the most cited studies were conducted are shown in Figure 2. When the most cited studies are examined, institutions in the USA appear to be at the first with 8201 citations. China comes in second with 5017 citations, behind the USA. Türkiye, France, Japan and Malaysia follow the ranking. It is noteworthy that our country ranks 3rd with 4684 citations. This indicates that researchers in Türkiye working in the this field of science produce studies that add valuable findings to the field and that these studies are accepted around the world.
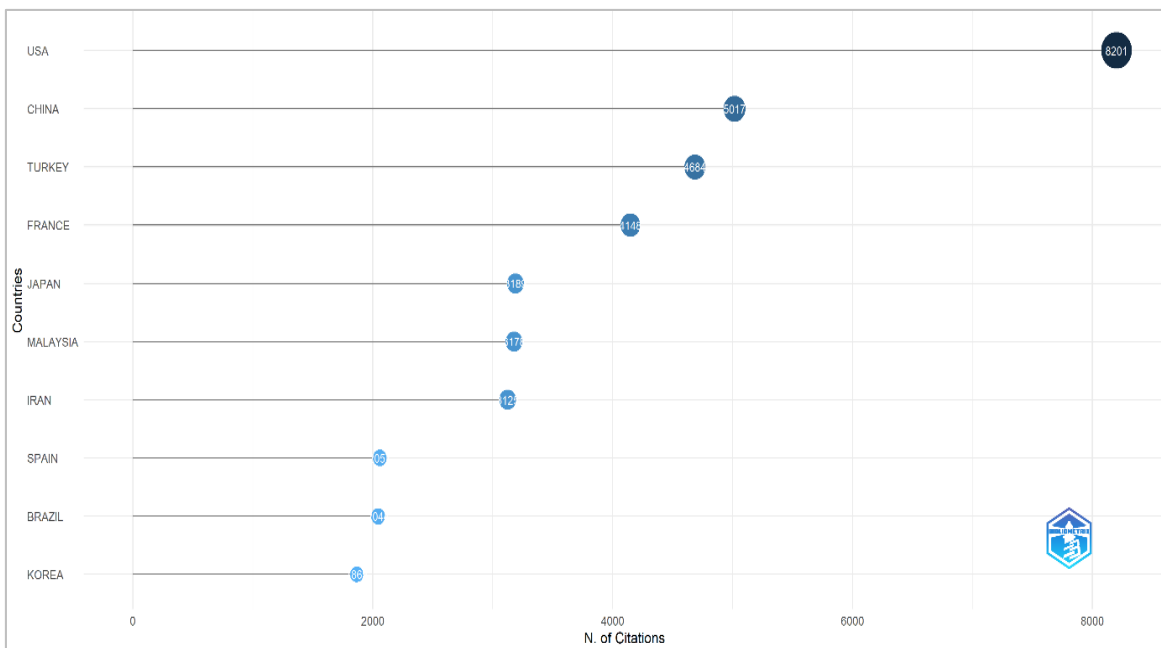
Figure 2. Most cited countries.

Figure 3 illustrates the number of articles published by various countries on particleboard over time. There has been a notable increase in publications from the USA since the early 1990s, and a similar trend is observed in other countries since 2000. Notably, China's production output has surged over the past decade, currently rivaling that of the USA. Additionally, Türkiye, Brazil, and Malaysia have demonstrated significant growth in the last two decades. This achievement is supported by the expansion of particleboard production and trade, the increase in export volume, and the overall growth of the sector within the country. The growth of the industrial sector has attracted the attention of researchers around the world and has been reflected in scientific studies.
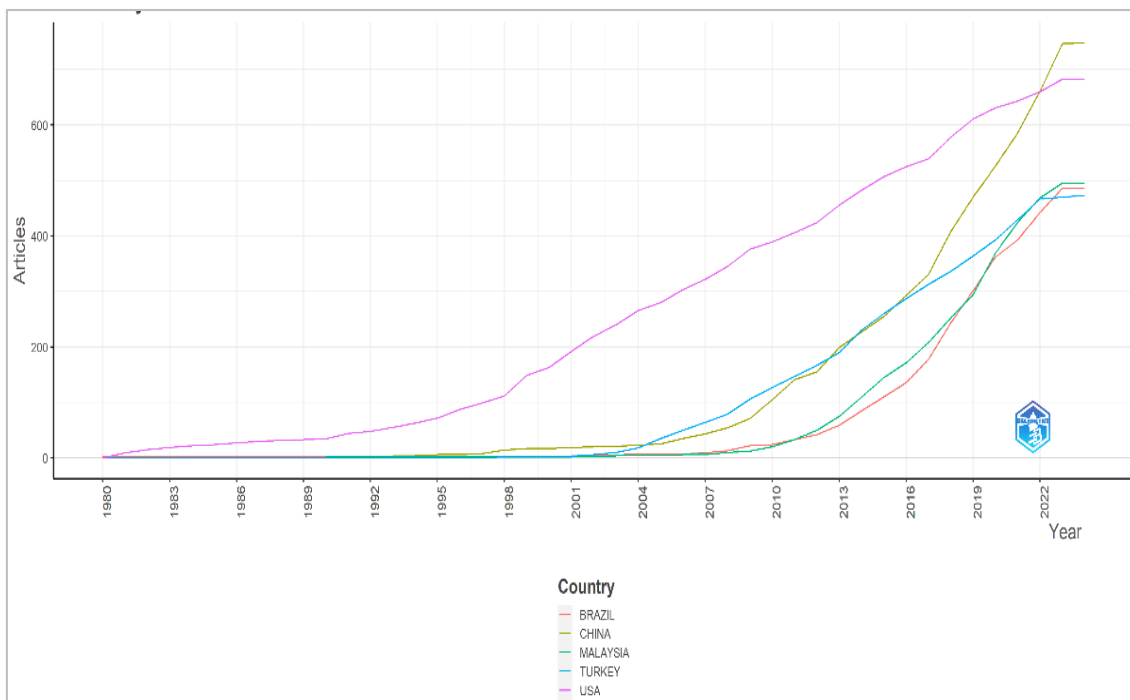
Figure 3. Country production on number of articles over time.

Figure 4 illustrates the scientific output of nations across the depicted World Map, employing a gradient of colors to delineate varying levels of scholarly contribution. The spectrum ranges from deep blue hues to lighter shades and grays, each indicative of the volume of research articles attributed to the respective countries. Those regions rendered in grey signify a lack of discernible scholarly presence within the database under consideration. Notably, the transition from darker to lighter blues denotes a diminishing count of articles per nation, thus highlighting the differential levels of scientific productivity across the geographic landscape. Consequently, nations depicted in darker shades of blue are emblematic of heightened scholarly output within the subject domain under investigation.
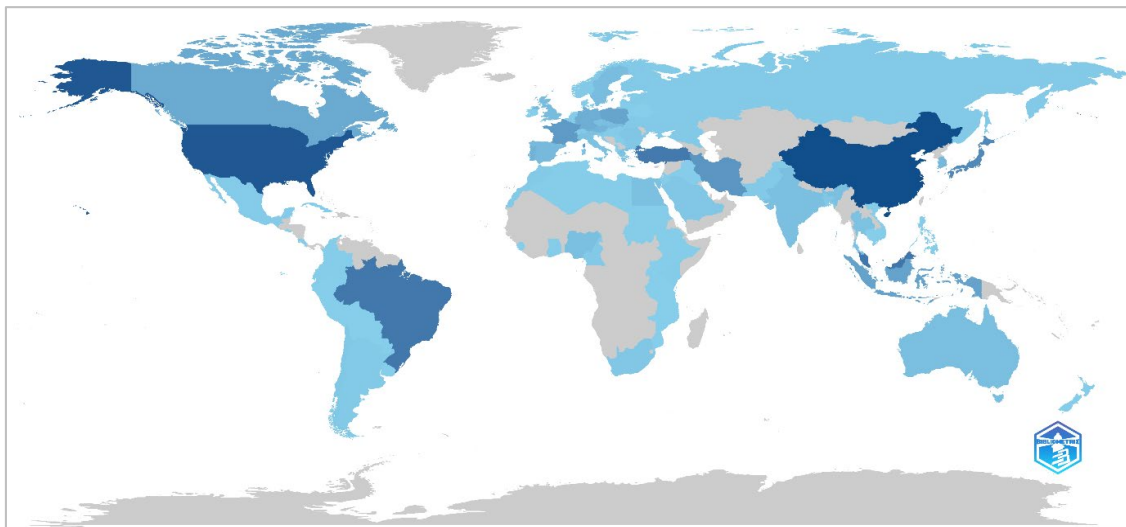
Figure 4. Country scientific production.

The evaluation of the most relevant affiliations engaged in research on the subject is depicted in Figure 5. Upon examination of the affiliations involved in the research, it becomes apparent that the top 10 institutions predominantly comprise universities based in Malaysia, China, France, Japan, Brazil, USA, and Türkiye. Notably, Universiti Sains Malaysia secures the top position in this ranking. Among the diverse range of institutions, Karadeniz Technical University from Türkiye also garners recognition within this group.
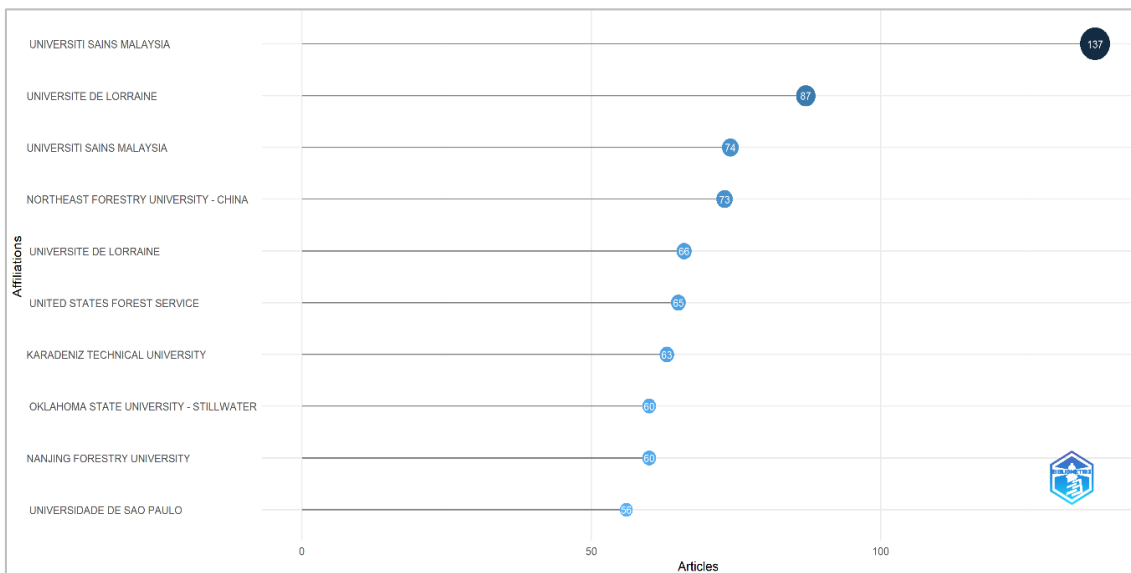
Figure 5. Most relevant affiliations on particleboard papers.

Corresponding Author's Countries and Publication Production Together or Alone are given in Figure 6. Upon examination of the figure, it is evident that a considerable number of articles are attributed to single-country publications (SCP), while multiple-country publications (MCP) are relatively scarce. Notably, a balanced distribution is observed in

France and Malaysia. However, the substantial presence of multi-country publications suggests that the subject is conducive to collaborative research endeavors.
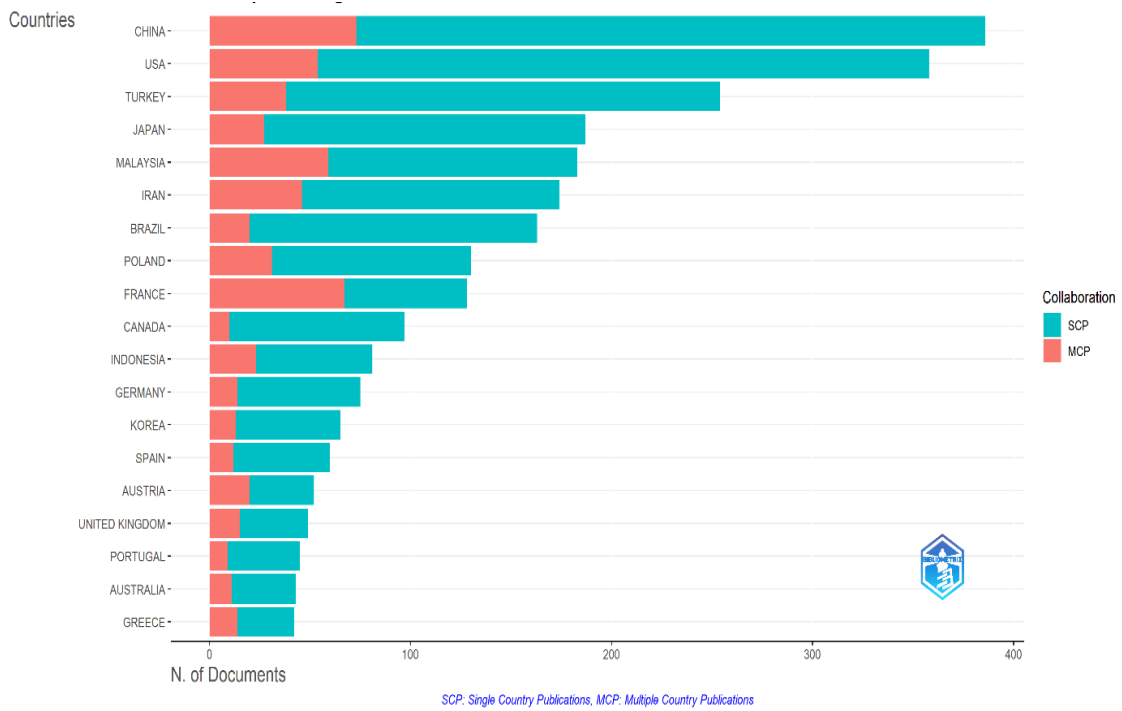

Figure 6. Corresponding author countries and publication production single or together.

3.2. Journals/sources analysis

Figure 7 depicts the top 10 journals that publish the most relevant sources on the subject. BIORESOURCES leads the list with 250 articles, followed by FOREST PRODUCTS JOURNAL with 202 articles.
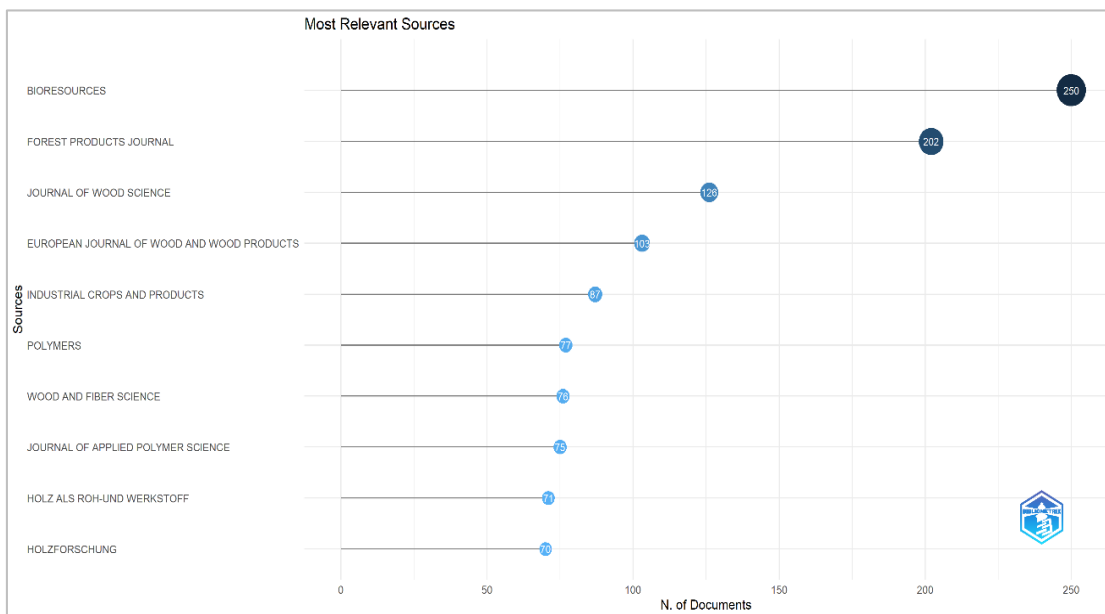

Figure 7. Most relevant sources.

Figure 8 depicts the top 10 journals that publish the most local cited sources on the subject. FOREST PRODUCTS JOURNAL leads the list with 3255 local citations, followed by BIORESOURCES with 3036 local citations.
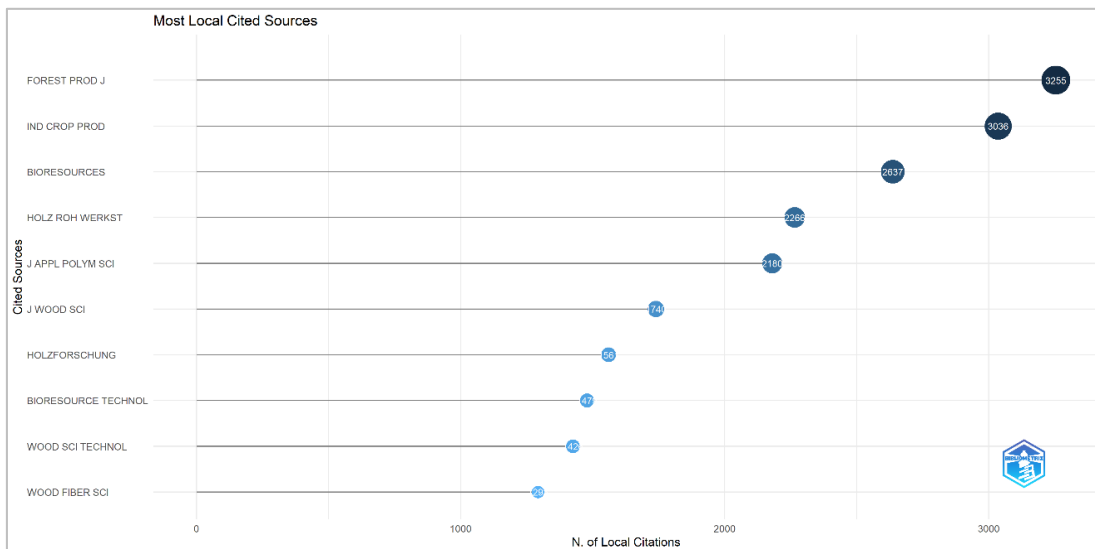

Figure 8. Most local cited sources.

Figure 9 depicts the top 10 journals that publish the sources' production over time on the subject. While FOREST PRODUCTS JOURNAL is making progress every year, there is a significant increase in BIORESOURCES, especially as of 2010. Other sources in the top 5 continue to make progress with the same determination. This indicates the increasing quality and contribution levels of scientific studies.
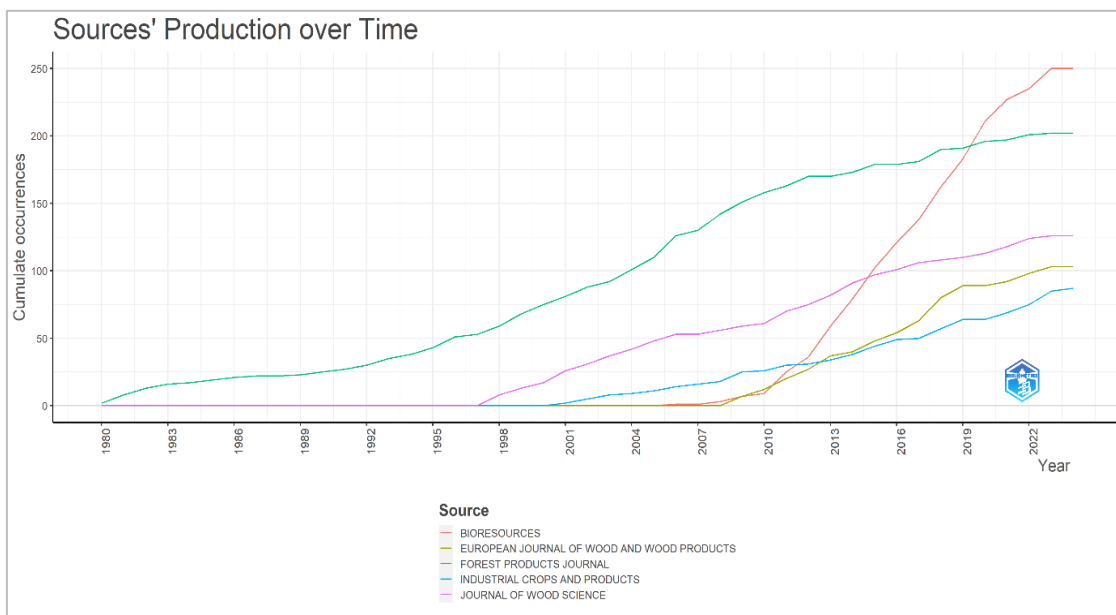

Figure 9. Sources' production cited soures.

3.3. Keywords and research area analysis

The most frequently used words in the studies are shown with word cloud graphics in Figure 10. It is noteworthy that in these studies, the words mechanical-properties, adhesive, formaldehyde, wood, composites, performance, density and physical properties are mostly used. Word cloud and word tree map are among the text mining techniques used to visually represent the most frequently used words in a given text. In a word cloud, the proximity to the center and the size of the words indicate their relevance to the subject and frequency of usage. Conversely, words that are farther from the center and smaller in size are less preferred or used less frequently (Aslancı, 2022).
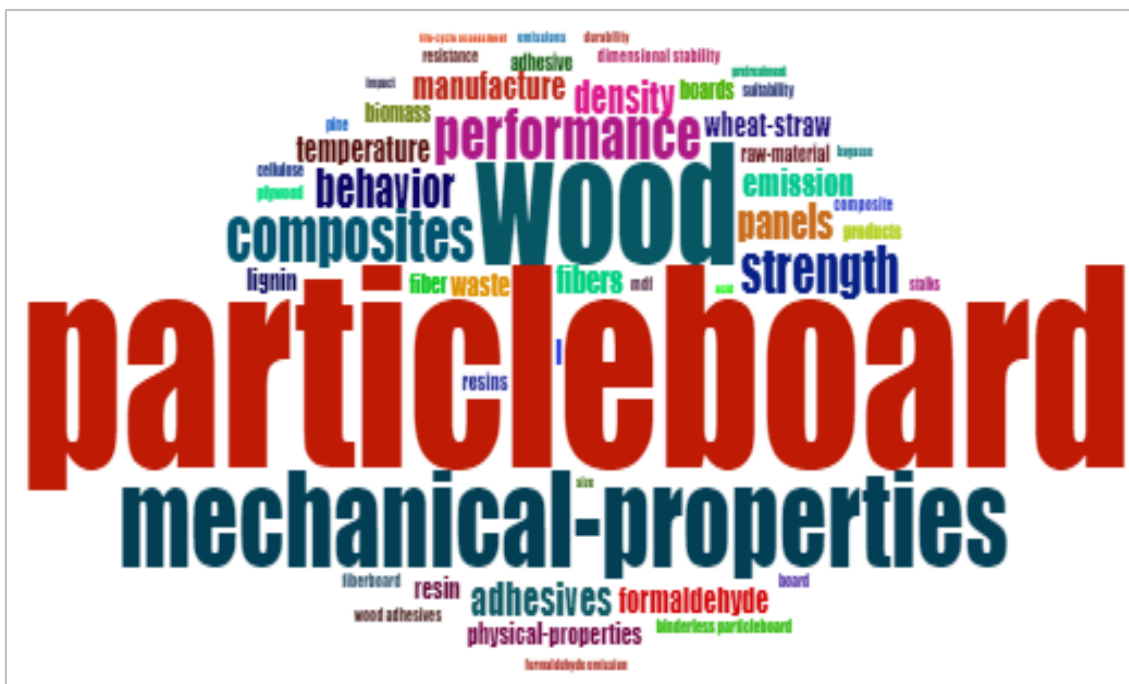

Figure 10. Word cloud analysis

Figures 11 and 12 illustrate the rates and usage patterns of the most frequently employed words. According to these figures, the most utilized term is "wood," followed by "mechanical-properties," "composites," "performance", "strenght", "behavior", "panels", and "adhesives" respectively. The analysis presented in Figures 11 and 12 aligns with that of Figure 10, shedding light on the predominant terminology within studies on the subject.
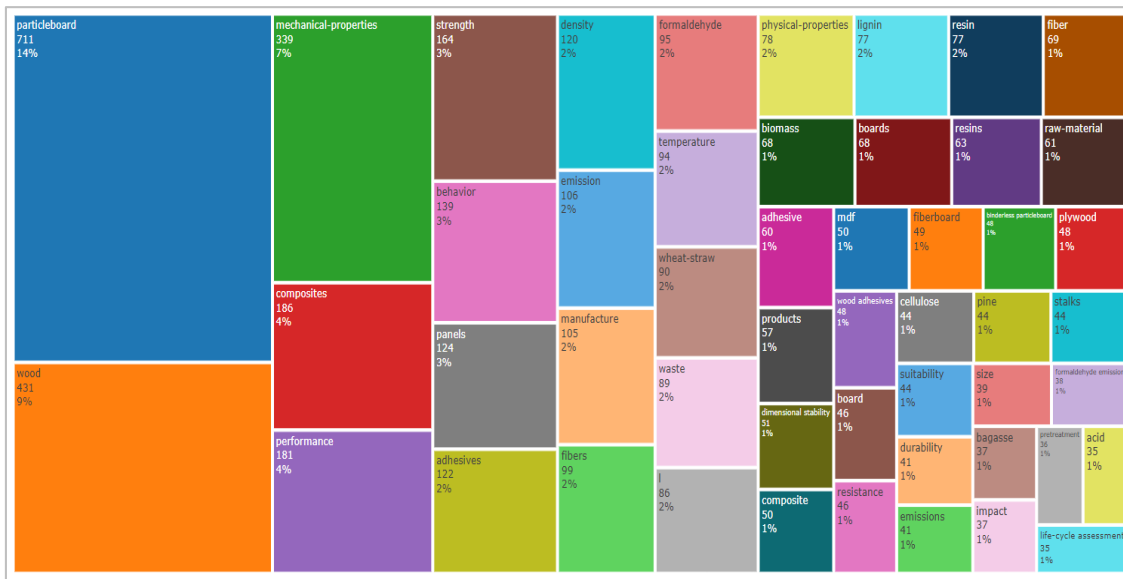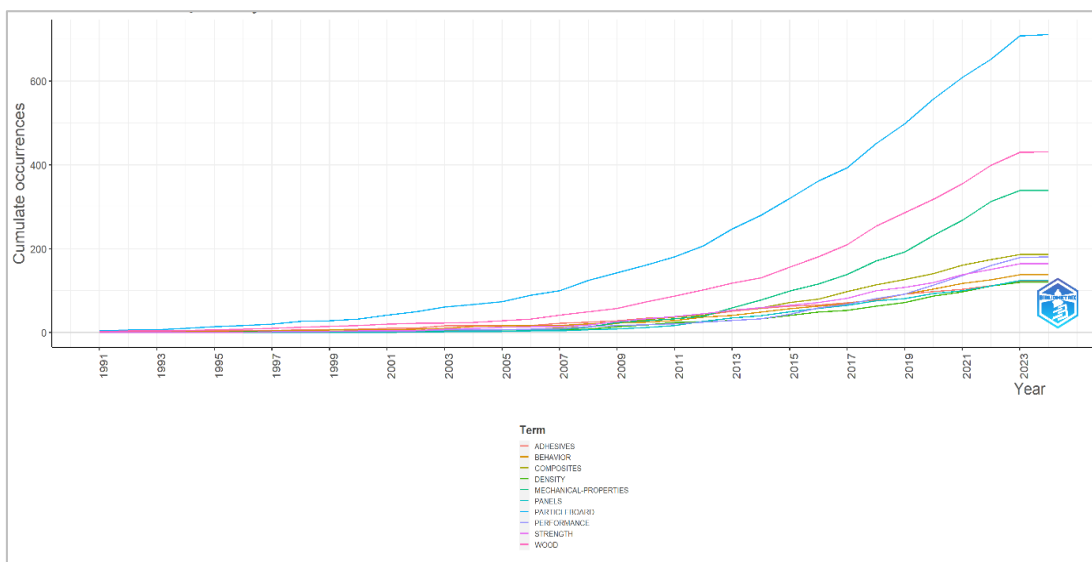
Figure 11. Word tree map.

Figure 12. Words' frequency over time.

Determining the co-occurrence of keywords is a crucial analysis for gaining a clear understanding of the study's content. The keywords selected by the authors meticulously represent the fundamental message of the study and the focal point of the research. The network depicted in Figure 13 illustrates the connections and flow between words. The thickness of the connecting lines between the results signifies the relationship between words and the strength of their interconnectivity (Oraee et al., 2017). Upon examination of the combinations of words used in the studies, three distinct clusters have emerged. These clusters are formed based on the words present in the content of the studies and their combined usage patterns. Figure 13, unlike the Word Analysis of Studies, Word Tree Map,

and Most Related Words graphs, also provides insight into the combined utilization of the most frequently used words in the studies (Alkın and Kuşat, 2023).
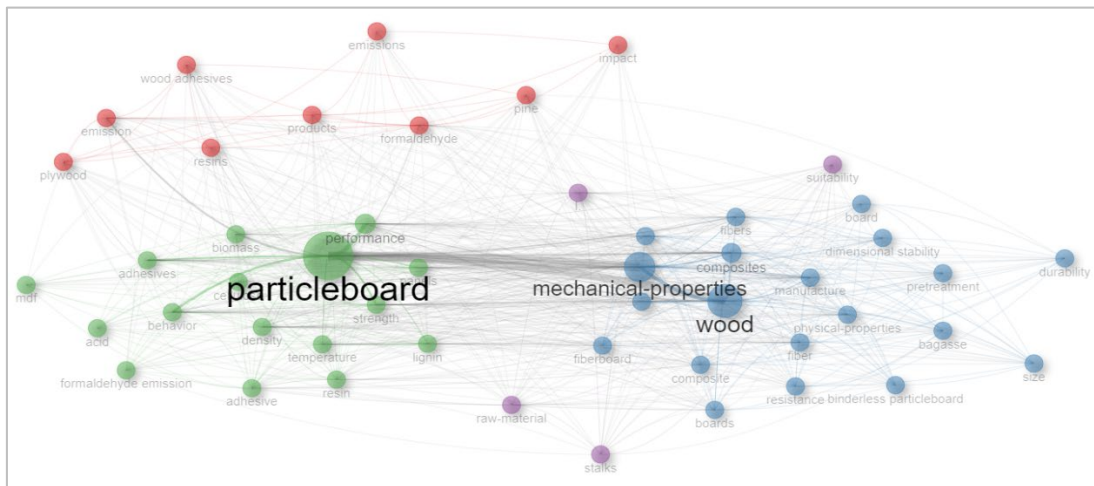

Figure 13. The keywords and their co-occurrence.

4. Conclusion

The bibliometric analysis conducted on particleboard research have provided valuable insights into the trends, dynamics, and global engagement within this field. Over the past two decades, particleboard has emerged as an important material in the forest products sector, catalyzing significant changes both in terms of trade volume and scientific studies. Through an examination of studies published in the Web of Science database from 1980 to 2023, this study has determined on various aspects of particleboard researches. The utilization of the R programming language facilitated a comprehensive bibliometric analysis, enabling the identification of key words, influential sources, and geographical distributions of scholarly activities.

The findings underscore a notable increase in the production of particleboard studies over the analyzed period. This upward trajectory in researches reflects the significance of particleboard within the broader context of forest products and sustainable materials. Additionally, the identification of prominent institutions and authors highlights the collaboration of particleboard research across the globe. This international collaboration underscores the importance of advancing knowledge in particleboard production, utilization, and sustainability on a global scale.

Overall, the findings of this study suggest that the particleboard field offers significant potential for collaboration, innovation, and development. The researchers can further advance differences of particleboard and contribute to its continued growth and

sustainability within the forest products sector with interdisciplinary cooperation and leveraging diverse expertise.

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