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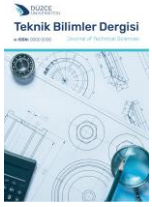

Research Article

Bibliometric Analysis of International Studies on the Use of Nanotechnology in Historical Wooden Structures and Their Surroundings

Özlem Özkan Önür[a,*], *Eda Kaya*[b]

[a]Nişantaşı University, Faculty of Engineering and Architecture, Department of Architecture, İstanbul, Türkiye.
[b]Düzce University, Faculty of Forestry, Department of Landscape Architecture, Düzce, Türkiye.
[*]**Corresponding Author:** ozlem.onur@nisantasi.edu.tr

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ABSTRACT

In recent years, innovative solutions offered by nanotechnology for the preservation and restoration of historic wooden structures have become the focus of scientific research and international cooperation. This development is of great importance for the preservation of cultural heritage and its transmission to future generations. Nanotechnology, revolutionizing materials science and engineering, provides innovative solutions in many sectors, and these solutions are finding increasing application in the field of preserving historical structures. In this study, a comprehensive bibliometric analysis of international scientific studies has been conducted, addressing the use of nanotechnology in historic wooden structures and their surroundings. By examining key criteria such as the development of studies over time, international cooperation networks, most cited publications, scientific publications, authors, number of publications, locations and years, and identifying prominent research themes, the study aimed to gain a deeper understanding of nanotechnology's role in preserving historic wooden structures. In conclusion, the bibliometric analysis presented in this study will provide strategic guidance for future research, allowing for a broader perspective in evaluating the potential effects of nanotechnology on historical structures.

Keywords: *Bibliometric Analysis, Historic Wooden Structures, Nanotechnology, VOSviewer.*

Tarihi Ahşap Yapılar ve Çevresinde Nanoteknolojinin Kullanımı Üzerine Uluslararası Çalışmaların Bibliyometrik Analizi

ÖZET

Son yıllarda, tarihi ahşap yapıların korunması ve restorasyonu konusunda nanoteknolojinin sunduğu yenilikçi çözümler, bilimsel araştırmaların ve uluslararası iş birliğinin odak noktası haline gelmiştir. Bu gelişme, kültürel mirasın korunması ve gelecek nesillere aktarılması açısından büyük önem taşımaktadır. Nanoteknoloji, malzeme bilimi ve mühendislik alanında devrim yaratarak birçok sektörde yenilikçi çözümler sunmakta, bu çözümler tarihi yapıların korunması alanında da giderek daha fazla uygulama alanı bulmaktadır. Çalışmada, tarihi ahşap yapılar ve çevresinde nanoteknolojinin kullanımı ele alınarak uluslararası bilimsel çalışmaların kapsamlı bir bibliyometrik analizi yapılmıştır. Çalışmaların zaman içerisindeki gelişimi, ülkeler arası iş birliği ağları, en çok atıf alan yayınlar, bilimsel yayınlar, yazarlar, yayın sayıları, yerleri ve yılları gibi temel ölçütleri incelenerek ve öne çıkan araştırma temaları belirlenerek nanoteknolojinin tarihi ahşap yapıların korunmasındaki rolünün daha derinlemesine anlaşılması hedeflenmiştir. Sonuç olarak, bu çalışmanın sunduğu bibliyometrik analiz, gelecekteki

araştırmalar için stratejik yönlendirmeler sağlayarak nanoteknolojinin tarihi yapılar üzerindeki potansiyel etkilerinin daha geniş bir perspektiften değerlendirilmesine olanak tanıyacaktır.

Anahtar Kelimeler: *Bibliyometrik Analiz, Nanoteknoloji, Tarihi Ahşap Yapılar, VOSviewer.*

I. INTRODUCTION

Wood, due to its natural structure, has a complex structure at the micro and nano scale. This structure consists of natural nanotubes or nanofibrils. This characteristic makes wood an ideal material for nanotechnology applications. Nanotechnology offers unique opportunities to improve the usability and structural performance of wood materials. This technology allows for precise control of the bonding and interlocking processes of fibers at the micro scale. Additionally, it enables the development of innovative features such as the creation of different nanofiber connections. As a result, the mechanical properties, durability, and functionality of wood materials can be significantly enhanced.

Applications of nanomaterials in wood are leading to revolutionary developments in the wood industry. For example, self-cleaning wood surfaces have begun to be created using nanocatalysts. These innovative surfaces increase the aesthetic value and lifespan of wood while reducing maintenance needs. In addition, early detection of problems such as decay, mold formation, and termite infestation in wooden structures has become possible through nanosensors. These developments provide significant advantages in the protection and maintenance of wooden structures. Thanks to nanomaterials, wood materials are becoming much more functional, which expands the areas of use for wood (Niroumand, Zain and Jamil, 2013).

Nanomaterials play a critical role in addressing the natural limitations of wood and wood-based composites. These materials can be applied in a wide range of ways to enhance various properties of wood. For example, nano-sized protectors that provide resistance against fire hazards can significantly increase the fire-retardant properties of wood. Nanominerals that enhance biological resistance strengthen wood's durability against insect and fungal attacks. When integrated into wood, nanoparticles increase the material's resistance to water and moisture, resulting in structures that are longer-lasting and require less maintenance. These developments allow wood to go beyond its traditional uses and become a preferred material even in more challenging environmental conditions (Verma and Yadav, 2021).

In the literature, there is a very limited number of studies on the combined use of nanotechnology in and around wooden structures. This situation indicates that the field in question has not yet been sufficiently explored and offers potential research opportunities. In this study, the current state of this field will be examined and evaluated in detail using the bibliometric analysis method. This evaluation will help identify gaps, trends, and future research directions in the field.

Bibliometric analysis is a method that provides researchers with access to accurate, reliable, and comprehensive information through data mining and classification techniques, alongside rapid advancements and developments in information technologies (Zeren and Kaya, 2020). This method offers valuable and multifaceted findings on scientific communication by deeply analyzing various characteristics of academic studies. These characteristics include many parameters such as the subject of studies, publication year, institutional affiliations, keywords, number of authors, citations received, co-citations, collaborations between authors, and publication languages (Çiçek and Kozak, 2012). This allows for obtaining a holistic perspective on the historical development, current state, and potential future trends of a research field.

Comprehensive and reliable academic databases such as Web of Science, Scopus, and Science Direct enable the effective acquisition of rich and detailed data necessary for bibliometric analyses (Kurutkan and Orhan, 2018). These databases contain millions of academic publications and are continuously updated. Thus, researchers can access the most current and relevant information.

Bibliometrics is defined as the examination of scientific studies through numerical analysis and statistics (Al, Sezen and Soydal, 2019). The bibliometric analysis method is widely used to reveal the current state and trends of research conducted in various fields. This method provides a quantitative

approach for identifying, evaluating, and monitoring publications (Zupic and Čater, 2015). Bibliometric analysis includes qualitative and quantitative methods used to assess the impact of individual researchers, research groups, countries, institutions, or journals (Krauskopf, 2018). It provides researchers with the opportunity to explore the literature, identify the most influential studies, and guide their work, while also revealing factors such as how many articles a study has produced and its impact on subsequent research. These methods allow researchers to collaborate and share ideas by basing their findings on the bibliographic data of other scientists (Zupic and Čater, 2015). The bibliometric analysis method is used for performance analysis and science mapping. While performance analysis evaluates the research of individuals and institutions, science mapping reveals the structure and dynamics of a field. Bibliometric studies can be conducted with three different focuses: focusing on a narrow research question, dynamic analysis according to time intervals, and structural focus. While structural focus examines the relationships between institutions, authors, and publications, science mapping analyzes the connections between disciplines, fields, and articles through classification and visualization (Durieux and Gevenois, 2010).

Citation analysis may fall short in determining connections between academics while evaluating the impact of publications (Zupic and Čater, 2015). This analysis measures the impact of an article by examining how much it influences other articles, its citation frequency, and patterns (Al, Sezen and Soydal, 2019; Zan, 2013). Bibliographic coupling, on the other hand, measures similarity by using the number of references shared by two documents, increasing the strength of the connection between two articles as their bibliographic overlap increases (Al, Sezen and Soydal, 2019; Zan, 2013; Durieux and Gevenois, 2010).

Raw data is typically collected from databases such as Web of Science (WOS), Scopus, or Dimension for the application of bibliometric methods. In this study, the WOS Core Collection, used as the primary source, is a large and high-quality database containing more than 20,000 peer-reviewed journals, books, and articles worldwide from over 250 scientific, social sciences, and humanities disciplines. This database serves as a highly valuable and comprehensive resource for bibliometric analyses (Kurutkan and Orhan, 2018). The data obtained from these databases is visualized and used in analyses using software programs such as Citespice, Vivo, Gephi, Histcite, Bibeexcel, Ucinet, Pajek, Vantage Point, Scimat, and VOSviewer (Şeref, and Karagöz, 2019). Table 1 summarizes the types of VOSviewer analyses used in the study (Table 1).

Table 1. Types of VOSviewer Analysis Used in the Study (Alkılınç and Palabıyık, 2023).

Citation	Documents
	Sources
	Authors
	Organizations
	Countries
Bibliographic coupling	Documents
	Sources
	Authors
	Organizations
	Countries

VOSviewer is a software used for structuring bibliometric networks. This software typically employs analysis methods such as citation analysis, co-citation, and bibliographic coupling. In this study, in addition to these analyses, text mining analysis was also conducted (Burmaoğlu, Kıdak, Sur and Demir, 2016).

The study is organized in five stages:

- In the first stage, general information and objectives were presented.
- In the second stage, the fundamental concepts have been defined.

- In the third stage, the materials and methods used have been explained.
- In the fourth stage, the findings were presented.
- In the fifth stage, the findings were discussed, results were evaluated, and recommendations for the future were made.

II. MATERIAL AND METHOD

The use of nanotechnology in historic wooden structures and their surroundings promises significant innovation in both preservation and renovation processes. This innovative approach allows for more effective conservation of cultural heritage by combining traditional restoration techniques with modern technological advancements. Nanotechnology offers the potential to increase the durability of wooden structures, slow down deterioration processes, and preserve the characteristic features of the original material. However, international studies addressing these two fields together are limited, and there are few bibliometric analyses in the literature that examine this topic in depth. This situation makes it difficult to systematically evaluate the accumulated knowledge in the field and determine future research directions.

The main questions of the study are as follows;

- In which countries and regions are such studies concentrated?
- What topics and themes are prominent in these studies?
- Which research methods and technological applications are widely used
- What challenges and opportunities have been identified regarding the use of nanotechnology in the preservation of historic wooden structures?

The aim of this study is to examine the international academic literature on the integration of historical wooden structures and nanotechnology using bibliometric analysis method to reveal current trends and gaps in the literature. This comprehensive analysis aims to systematically evaluate the existing knowledge in the field, identify research trends, and define potential research areas for future studies. The study aims to systematically review the scientific literature to understand current developments in the combination of historical wooden structures and nanotechnology and to contribute to research in this field.

A. Methods

In the methodology of the study, VOSviewer software was used for bibliometric analysis, which enables systematic review of scientific literature. The current state in the relevant field was evaluated in detail using the VOSviewer program, which is frequently preferred for visual representation of data and offers free access to researchers. VOSviewer is essentially a powerful software that visualizes similarities. Thanks to this feature, it can effectively reveal relationships between scientific studies, co-authorship networks, co-occurrence of keywords, and citation patterns. VOSviewer provides great convenience to researchers and offers in-depth insights, especially in the analysis and visualization of data obtained from comprehensive academic databases such as Web of Science.

As a result of the search conducted with the selected keywords, it was observed that studies on this topic were carried out in the Web of Science (WOS) database in 2013, 2017, and 2021. Only 3 studies were found within these years, indicating that a limited number of research was conducted related to these keywords during this period. In the bibliometric analysis performed, indicators such as citation analysis, keyword frequencies, and publication trends were used. This analysis aims to determine the general trends in the literature of the field and to identify the prominent elements.

A.1. Stages of the Nanotechnology Process for Historic Wooden Structures

The process of using nanotechnology in historic wooden structures consists of three stages: Planning, implementation, and reporting. In the planning stage, goals for the integration of these two fields are set and strategies are developed. In the implementation stage, the determined strategies are applied, and the preservation of historic wooden structures is ensured using nanotechnology. In the reporting stage, process results are collected, analyzed, and shared with stakeholders. Effective management of these

stages ensures efficient use of nanotechnology in the preservation of historic wooden structures and contributes to sustainable preservation solutions.

A.2. Planning Results Phase in the Planning Process of Historical Wooden Structures and Nanotechnology

Bibliometric analysis is a method used for the quantitative examination of scientific literature and evaluation of relationships (McBurney and Novak, 2002). In this study, works published from 2013 to the present and included in major bibliographic databases have been examined. Web of Science (WOS) was chosen as a comprehensive and reliable source for such analyses due to its wide range of disciplines and high-impact publications (Thomson Reuters, 2017). Other databases were not included in this study (Donthu et al., 2021).

A.3. Execution Phase of Results

The search operations were conducted using relevant keywords for the concepts of "historical wooden structures" and "nanotechnology". As a result of the literature review, it was observed that bibliometric analyses regarding the integration of historical wooden structures with nanotechnology are limited in number. The keyword search results are summarized in Table 2.

Table 2. Search results for keywords on August 8, 2024.

Combination of Words	*Result*
Use of Nanotechnology in Historical Wooden Structures and Their Surroundings	*3*
TITLE-ABS-KEY (Nanotechnology and Historıical Wooden)	

III. RESULTS AND DISCUSSIONS

In the search conducted in the Web of Science database, the distributions of studies that jointly address the concepts of "Historical Wooden Structures" and "Nanotechnology" are presented below. These distributions have been examined according to years, authors, publication subjects, publishing institutions, countries of publication, and sources. Figure 1 shows the distribution by year of studies in which the concepts of "Historical Wooden Structures" and "Nanotechnology" are used together, based on data obtained from the Web of Science database.

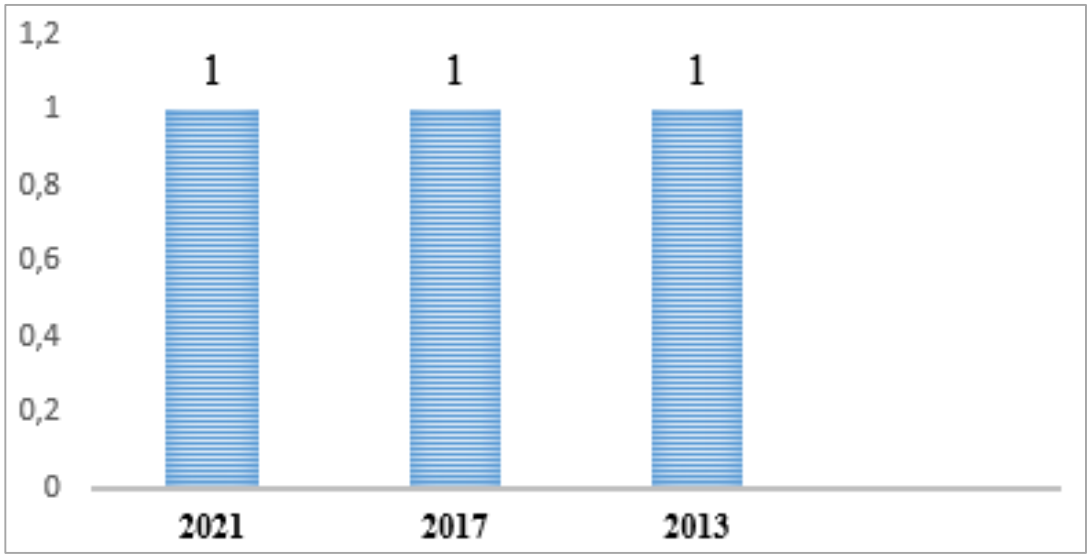

Figure 1. Distribution of publications by year (2013-2017-2021 from Web of Science).

Figure 1 shows the distribution of studies on "Historical Wooden Structures and Nanotechnology" by year. The first publication was made in 2013. In 2017 and 2021, with only one publication each, no significant increase was observed in this field.

As a result of evaluating studies that address historical wooden structures and nanotechnology concepts together based on the number of publications, a list of authors with the most publications has been presented. The distribution of publications by authors is given in Figure 2.

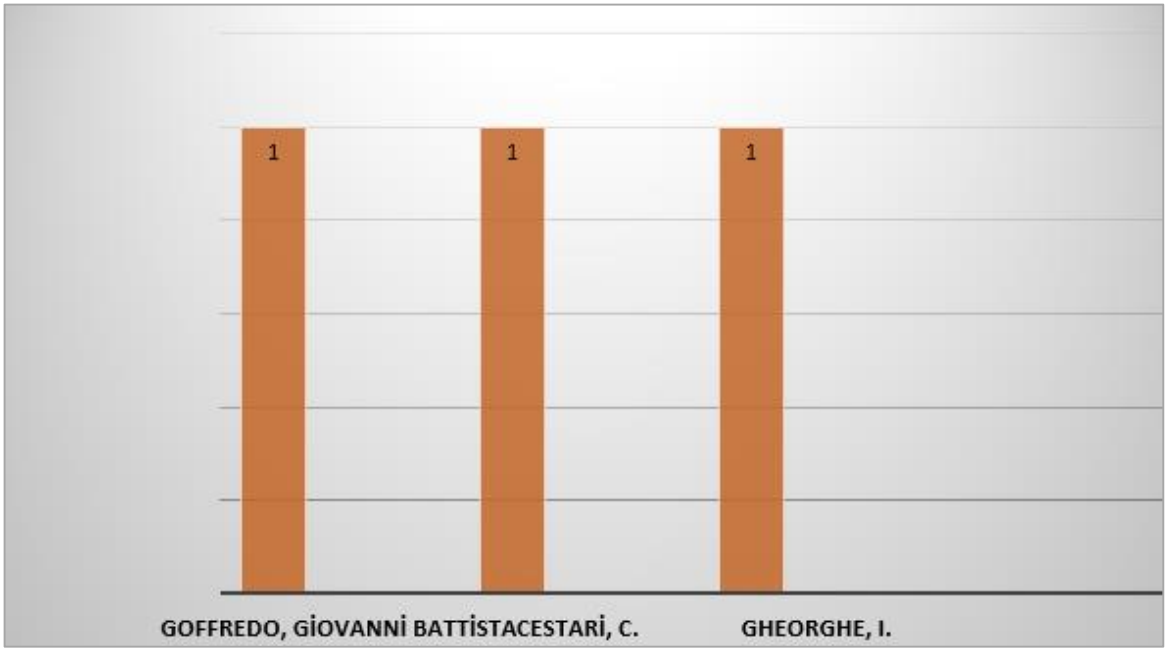

Figure 2. Distribution of publications by authors (Web of Science, 2013,2017,2021).

In the graph in Figure 2, studies that jointly address the concepts of historical wooden structures and nanotechnology are evaluated according to the number of publications. The graph lists authors, each of whom has one publication, accounting for 33% of the total. In three articles published in 2017, 2013, and 2021, various researchers conducted significant studies on nanotechnology and biodeterioration. Goffredo et al. (2017) examined the protective effectiveness of photocatalytic nanocoatings applied to wooden surfaces against fungi such as Aspergillus niger. Cestari and colleagues (2013) investigated the

reinforcement capacity of carbon nanocomposites to enhance the durability of ancient wooden joints. Gheorghe and team (2021) evaluated the effect of MgB2 powders against fungal biological deterioration, developing new nanotechnology-based methods for protecting cultural heritage structures. These studies emphasize the importance of nanotechnology in both preserving cultural heritage and combating biological deterioration.

Data obtained from indexes scanned in the Web of Science database are ranked according to the research areas of studies that use the concepts of "Historical Wooden Structures and Nanotechnology" together. Figure 3 shows the distribution of publications using these concepts together based on subject matter. The results show that studies in this field were limited to only one publication each in the years 2013, 2017 and 2021. There has been no significant increase outside of these years. Although the number of studies is limited, these three publications were carried out with the participation of many different authors. According to the analyses conducted, the publication topics have spread across various scientific fields. 33 % of the publications belong to the fields of Archaeology, Art, Analytical Chemistry, Multidisciplinary Geosciences, and Mechanics. The field with the most publications is Materials Science (Multidisciplinary) with two publications (67%). Additionally, one publication related to Spectroscopy is also included at a rate of 33%. This distribution reveals that the relevant studies are published across a wide range of disciplines and are present in various scientific fields.

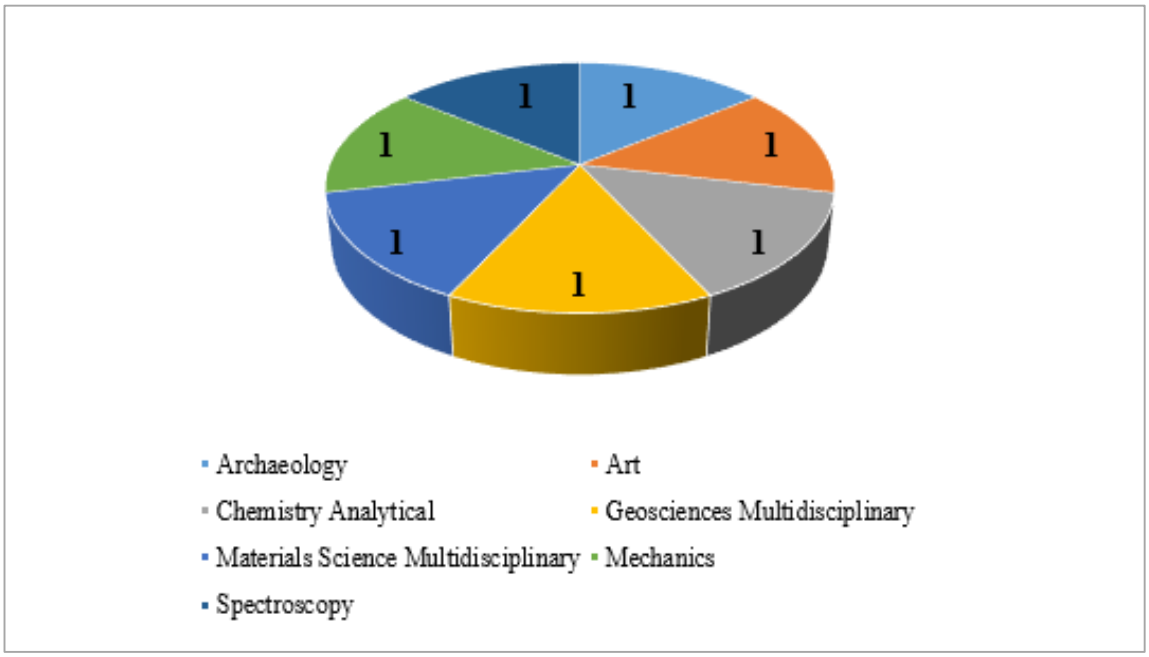

Figure 3. Distribution of publications by subject (Web of Science, 2012-2024).

Figure 4 presents the distribution of publications that jointly address the concepts of "Historical Wooden Structures and Nanotechnology" according to the publishing institutions, based on data obtained from indexes scanned in the Web of Science database. In the ranking of institutions associated with the publications, the Department of Applied Science and Technology and the Department of Architecture and Design at Politecnico di Torino are equally positioned with one publication each. The Department of Life and Environmental Sciences and the Faculty of Sciences at Politecnico University of Marche are also included in the ranking with one publication each. Additionally, the Research Institute, Faculty of Biology, and Faculty of History at the University of Bucharest have each contributed to this field with one publication. This distribution reflects the scientific studies of various academic and research institutions related to the subject. The studies conducted at these three institutions have investigated the protective potential of nanotechnology on historical wooden structures and its effectiveness against biological deterioration. The Department of Applied Science and Technology and the Department of Architecture and Design at Politecnico di Torino focused on increasing structural durability by examining the role of

carbon nanocomposites in strengthening old wooden connections (Cestari et al., 2013). The Department of Life and Environmental Sciences at Politecnico University of Marche studied the effectiveness of photocatalytic nanocoatings against fungal-induced biological deterioration on wooden surfaces (Goffredo et al., 2017). Researchers from the Research Institute, Faculty of Biology, and Faculty of History at the University of Bucharest evaluated the potential use of MgB2 powders in protecting cultural heritage structures against biological deterioration caused by fungi (Gheorghe et al., 2021). These institutions have made significant contributions to developing innovative solutions for the preservation of cultural heritage using nanotechnology.

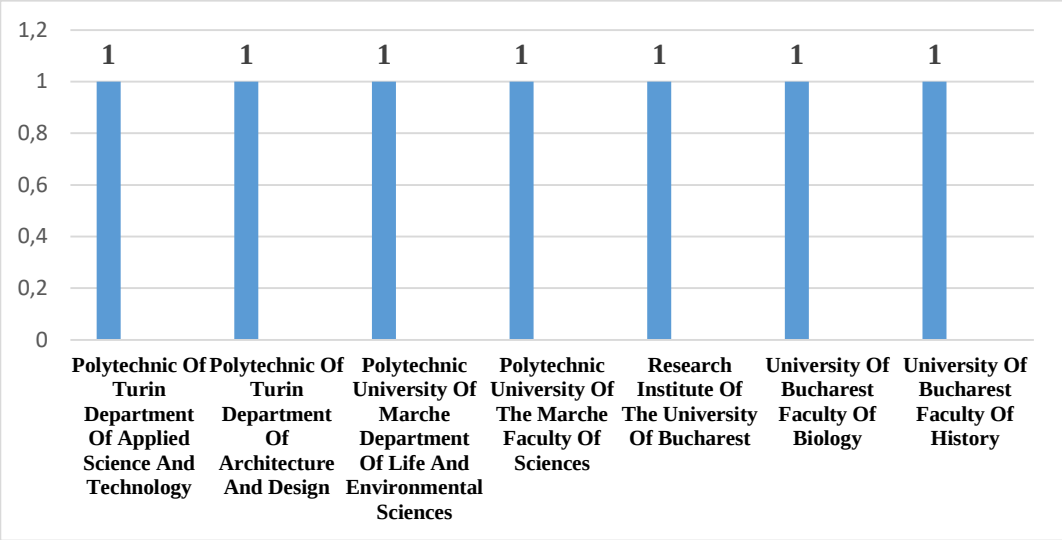

Figure 4. Distribution of publications by institutions (Web of Science, 2012-2024).

Figure 5 shows the two countries with the highest number of publications on Historical Wooden Structures and Nanotechnology. According to the data, the majority of studies come from Italy 2 studies, 67%. Romania ranks second with 1 study 33%. This distribution reflects the scientific contributions and concentrations of countries conducting research in the relevant field.

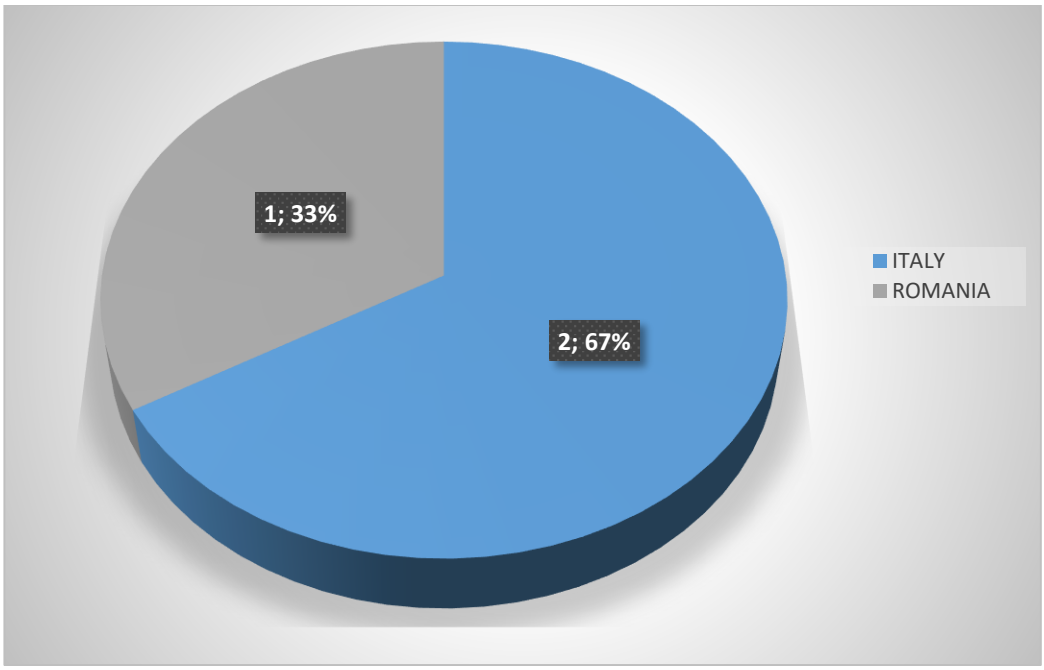

Figure 5. Distribution of publications by country of publication (Web of Science, 2013-2017-2021).

Figure 6 shows the distribution of publishers in publications on Historical Wooden Structures and Nanotechnology. Elsevier, Frontiers Media SA, and Springer Nature publishers are equally represented. Each accounts for 33% of total publications. This indicates that these three publishers make a significant contribution to the relevant topics and constitute a large portion of academic publications in this field.

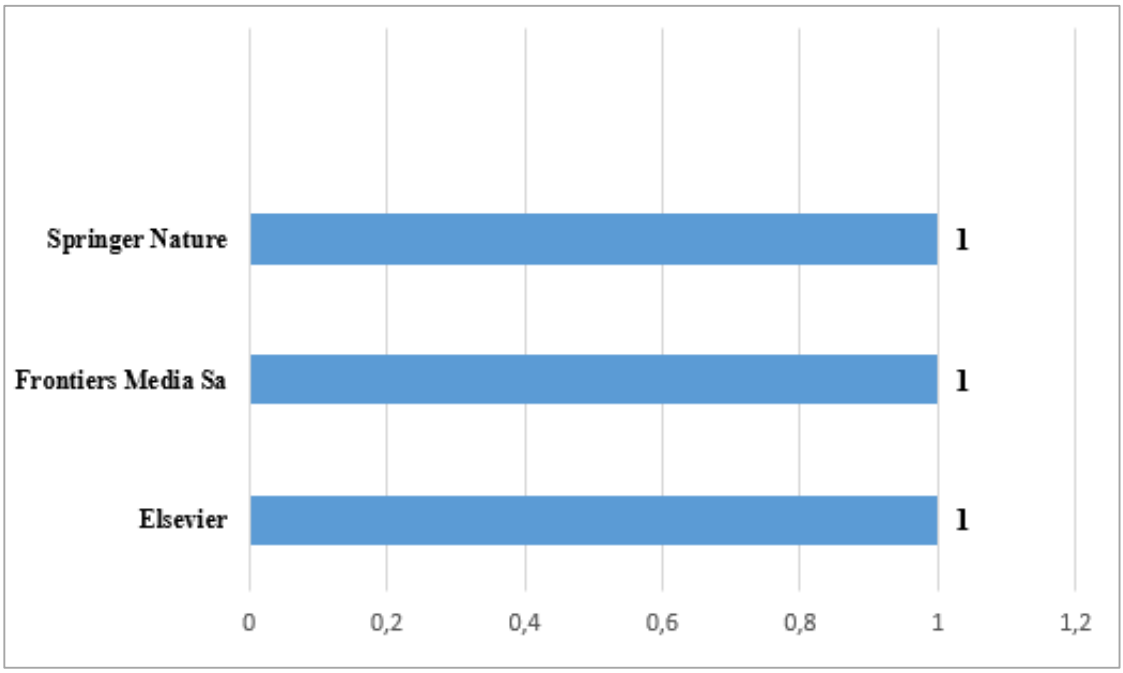

Figure 6. Distribution of publications by publishers (Web of Science, 2013, 2017, 2021)

This distribution reflects the diversity and frequency of contributions made by publishers to the academic field over a specific period. This variation among publishers provides an important indicator for understanding research on a particular subject or scientific discipline and evaluating the impact of publishers in academic literature. This data helps in assessing publishers' contributions to the subject and their roles within the scientific community.

A. Visualization of Studies on "Historical Wooden Structures" and "Nanotechnology" in the Web of Science Database Using the Vosviewer Mapping Technique

Within the scope of the Bibliometric Analysis on international studies regarding the combined use of historical wooden structures and nanotechnology, it is aimed to examine the studies in the Web of Science database and visualize these studies using the VOSviewer mapping technique. This technique visually presents the trends and connections in scientific literature by analyzing the distribution of research on the subject by years, the most published authors, fields of study, and countries. This method helps us better understand the place of studies that address nanotechnology and historical wooden structures together in the literature. Using the VOSviewer program, the relationships between 34 authors who have worked on Historical Wooden Structures and Nanotechnology are visualized in Figure 7 and Figure 8. This analysis covers not only the three identified studies but also authors from different studies based on a broader literature review. In this analysis conducted using the VOSviewer program, criteria such as an author having at least two studies and these studies receiving at least two citations were used. The works of 24 authors meeting these criteria were evaluated, and 276 connections were identified. On the map, all authors are visualized within a single network, with the sizes of the representative circles determined according to the number of publications. Additionally, authors involved in the same projects are shown in the same color, while the lines between authors represent their mutual relationships. Therefore, the 34 authors are part of a broader collaboration network that encompasses not only the three identified

studies but also different works. This has allowed for the analysis of research intensity in the field and collaboration among authors from a wider perspective.

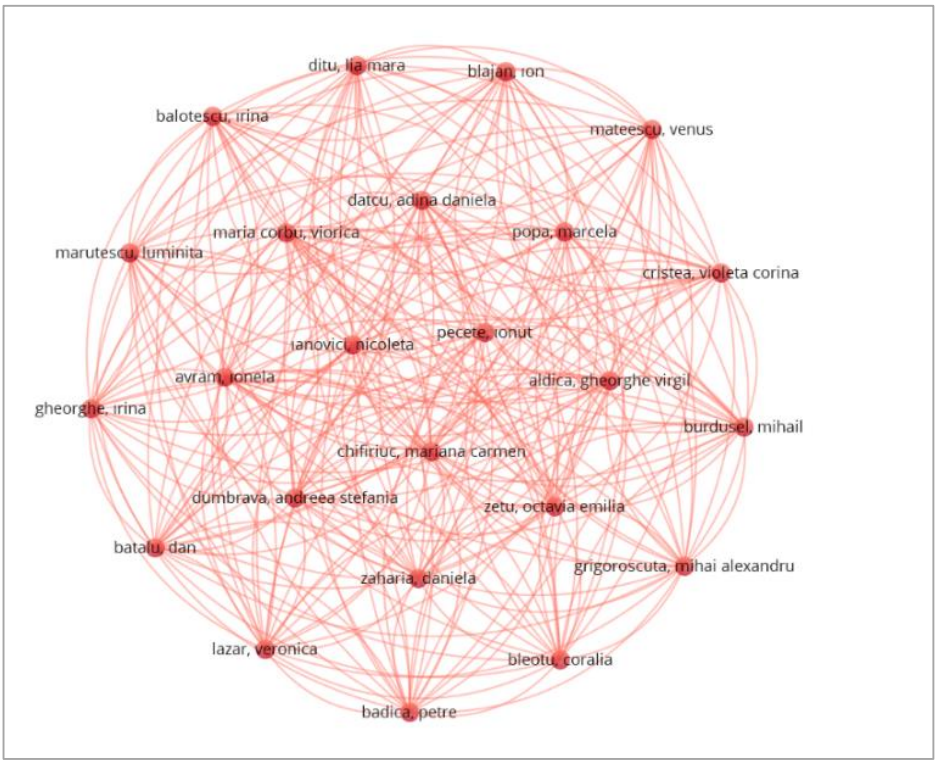

Figure 7. Bibliometric network analysis of research on historical wooden structures and nanotechnology based on author distribution.

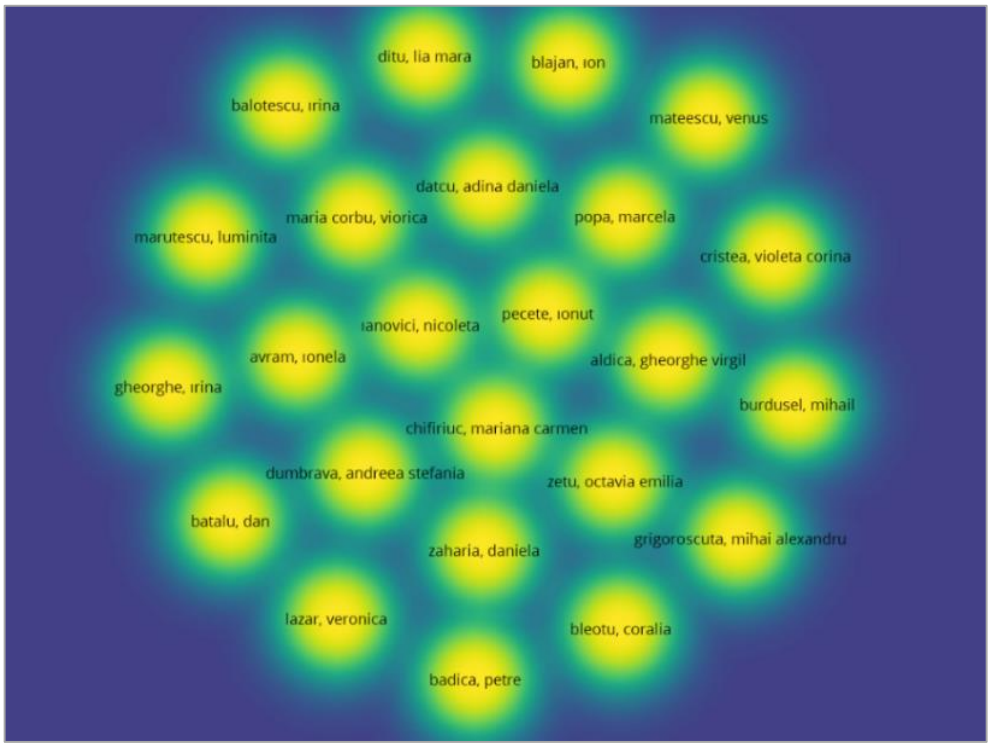

Figure 8. Bibliometric network analysis of research on historical wooden structures and nanotechnology based on author distribution.

The map has been created based on the criteria of an author having at least 2 works and receiving a minimum of 2 citations for their works. In this analysis, the works of 24 authors have been evaluated and 276 connections have been identified among them. The map displays all authors in a single network, as 1 cluster. The sizes of the circles are determined according to the number of publications by the authors. While the circles of authors working on the same projects are shown in the same color, the lines between them represent their mutual relationships.

In the analysis conducted using VOSviewer, a visualization was created considering 6 out of 16 keywords used in the topics of "Historical Wooden Structures and Nanotechnology". In this analysis, a total of 15 connections were identified among the selected 6 keywords (items). These keywords are grouped into a single cluster, indicating that they are highly related to each other. The number of connections within the cluster reveals the frequency of co-occurrence of these terms and the strength of their relationships. As a result, this visualization clearly presents which keywords the research in the field of historical wooden structures and nanotechnology is concentrated around and how these terms are interconnected. Figure 9 shows the co-occurrence network of keywords generated with the help of VOSviewer software.

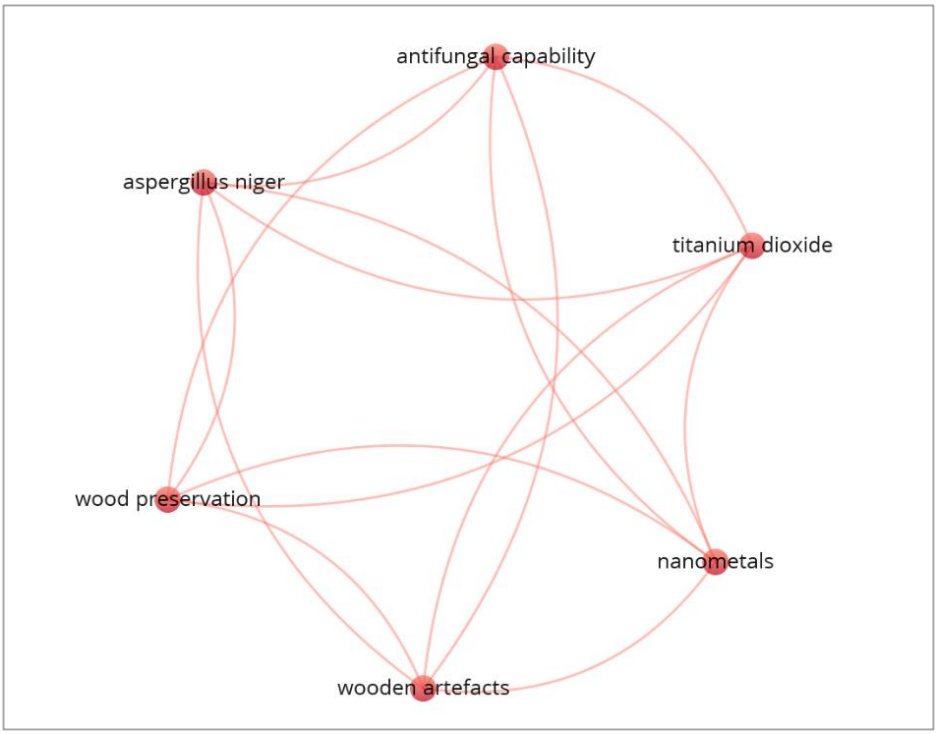

Figure 9. Bibliometric network analysis based on the distribution of keywords in research on historical wooden structures and nanotechnology.

The lack of a sufficient number of countries in this research depends on a specific minimum dataset for the validity and generalizability of research results in bibliometric analyses. Especially in international studies, it is important to have at least three different countries on a particular topic. This ensures the diversity and comparability of data from different geographical regions and scientific communities.

When an insufficient number of countries are represented, the data may be specific to a particular region or country and may not accurately reflect global trends. Therefore, it is critical to include at least three countries in the analysis to maintain the validity of the results in a broader scientific context. This diversity is also important for understanding how the study is received in different scientific cultures and research environments.

Figure 5 shows the two countries with the most publications on historical wooden structures and nanotechnology. According to the data, most of the studies come from Italy (2 studies, 67%), while

Romania ranks second with 1 study (33%). However, as mentioned earlier, at least three different countries should be included in such analyses.

This situation is important in terms of being able to address studies from a broader perspective in a global context and compare scientific contributions from different geographical regions. Although this analysis, which includes two countries, reflects the trends in the existing literature, it demonstrates that more countries need to be included for a more comprehensive global understanding. This is a critical necessity to understand how the subject is addressed at an international level and how it resonates in different scientific communities.

IV. CONCLUSIONS

In this study, a comprehensive bibliometric analysis of international scientific studies has been conducted, focusing on the use of nanotechnology in and around historical wooden structures. International research on historical wooden structures and nanotechnology has been examined using bibliometric analysis methods, with data obtained from the Web of Science database and visualized through VOSviewer software. The bibliometric analyses show that most of the relevant studies come from only a few countries, which does not provide a broad perspective in a global context. The analyses emphasize that the representation of at least three countries is a significant shortcoming. It has been observed that Italy has the highest number of publications with two studies, while Romania has one. This situation reveals the need for a wider geographical coverage to fully reflect global trends and international collaborations.

The bibliometric and VOSviewer analysis conducted in this study yielded three main conclusions. Firstly, it was determined that the number of publications on Historical Wooden Structures and Nanotechnology is limited, with only one publication each in 2013, 2017, and 2021. This situation indicates that research in this field has not yet been explored in sufficient depth and presents a significant research gap for future studies. Secondly, it was observed that the analyzed keywords are highly correlated and clustered within a single group. This reveals that certain concepts and terminology are tightly linked among studies in this field, suggesting that researchers can conduct more effective and comprehensive studies using these keywords. Thirdly, the fact that a large portion of the research has been limited to specific countries, with Italy and Romania having the highest number of publications, emphasizes the importance of international collaboration and multidisciplinary approaches. This finding suggests that future studies require more collaboration among researchers from different geographical regions and that increasing knowledge sharing in this field could accelerate developments in Historical Wooden Structures and Nanotechnology. These results provide a guiding framework for future research and demonstrate that this field needs more attention from both academic and practical perspectives.

In the future, research in the fields of Historic Wooden Structures and Nanotechnology can be further deepened in light of the fundamental references provided by current studies. The present analysis indicates that strong connections between key words will promote interdisciplinary interaction and allow for the enrichment of this field. In particular, the integration of these two areas may increase the applicability of nanotechnological innovations in the processes of preservation and restoration of historic structures. Therefore, future studies can provide significant contributions at both academic and practical levels, paving the way for the development of new methods for the sustainability and preservation of historic structures. In this context, researching this topic not only contributes to academic literature but also carries the potential to develop concrete applications for the preservation of cultural heritage.

In conclusion, it has been determined that research on historical wooden structures and nanotechnology needs to be expanded. This expansion aims to develop a more comprehensive understanding in the global scientific context and to increase the diversity of data from different geographical regions by including more countries and various international collaborations. This approach is critical both for improving research quality and for better representation of the global scientific community. To increase the generalizability of study results and make them more meaningful in an international context, participation of more countries in such research should be encouraged.

REFERENCES

Al, U., Sezen, U., & Soydal, İ. (2019). Türkiye'nin bilimsel yayınlarının sosyal ağ analizi yöntemiyle değerlendirilmesi .Hacettepe Üniversitesi Proje Raporları No: 110K044, Ankara.

Alkılınç, E., & Palabıyık, S. (2023). Bibliyometrik analiz yöntemi üzerinden yer seçimi ile ilgili karar destek sistemi yöntemlerinin incelenmesi. *International Journal Of Socİal Humanities Siences Research, 10*(98), 2016-2026.

Burmaoğlu, S., Kıdak, L. B., Sur H., & Demir, H. (2016). Sistem yaklaşımı ve sağlık alanında sistem dinamikleri uygulamaları: Current bibliyometrik bir analiz. *Hacettepe Sağlık İdaresi Dergisi, 19*(4), 443-463.

Cobo, M. J., Jürgens, B., Herrero-Solana, V., Martinez, M. A., & Herrera-Viedma, E. (2018). Endüstri 4.0: bibliyometrik analize dayalı bir bakış açısı. *Procedia Bilgisayar Bilimi, 139,* 364-371.

Çiçek, D., & Kozak, N. (2012). Anatolia: turizm araştırmaları dergisi'nde yayımlanan hakem denetimli makalelerin bibliyometrik profili. *Türk Kütüphaneciliği, 26*(4), 734-756.

Demir, H., & Erigüç, G. (2018). Bibliyometrik bir analiz ile yönetim düşünce sisteminin incelenmesi. *İş ve İnsan Dergisi,* 5(2), 91-114.

Donthu, N., Kumar, S., Mukherjee, D., Pandey, N., & Lim, W. M. (2021). How to conduct a bibliometric analysis: An overview and guidelines. *Journal of Business Research, 133*(20), 285-296.

Dos Santos, B. S., Steiner, M. T. A., Fenerich, A. T., & Lima, R. H. P. (2019). Data mining and machine learning techniques applied to public health problems: A bibliometric analysis from 2009 to 2018. *Computers & Industrial Engineering*, 138, 106120.

Durieux, V., & Gevenois, P. A. (2010). Bibliometric indicators: quality measurements of scientific publication. *Radiology,* 255(2), 342-351.

Kaya, E., & Uzun, O. (2024). Kentsel Açık ve Yeşil Alan Planlamasında Katılımcılık Görüşlerini Birlikte Kullanan Uluslararası Çalışmaların Bibliyometrik Analizi, *Kent Akademisi Dergisi, 17*(3), 1060-1085.

Kurutkan, M. N., & Orhan, F. (2018). Kalite Prensiplerinin Görsel Haritalama Tekniğine Göre Bibliyometrik Analizi. Sageya Yayınevi. Ankara.

Knani, M., Echchakoui, S., & Ladhari, R. (2022). Artificial intelligence in tourism and hospitality: Bibliometric analysis and research agenda. *International Journal of Hospitality Management, 107,* 103317.

Krauskopf, E. (2018). A bibiliometric analysis of the Journal of Infection and Public Health: 2008–2016. *Journal of Infection and Public Health, 11*(2), 224-229.

McBurney, M. K., & Novak, P. L. (2002). What is bibliometrics and why should you care. In Proceedings. IEEE international professional communication conference, 108-114.

Niroumand, H., Zain , M., & Jamil, M. (2013). The Role of Nanotechnology in Architecture and Built Environment. *Procedia - Social and Behavioral Sciences*, *89,* 10-15.

Palabıyık, S., & Demircan, D. (2020). Mimarlıkta hesaplamalı tasarım yöntemlerine ait potansiyellerin yaşam döngüsü modeli üzerinden değerlendirilmesi. *Uluslararası Hakemli Tasarım ve Mimarlık Dergisi*, *21,* 91-123.

Reuters, T. (2017). Bilgi Ağı- Gerçek Gerçekler- IP ve Bilim- Thomson Reuters. Online Available: https://en.wikipedia.org/wiki/Web_of_Science#cite_note-Web_of_Science-2014-12.

Şeref, İ., & Karagöz, B. (2019). Türkçe eğitimi akademik alanına ilişkin bir değerlendirme: Web of Science veri tabanına dayalı bibliyometrik inceleme. *Dil Eğitimi ve Araştırmaları Dergisi, 5*(2), 213-231.

Verma, A., & Yadav, M. (2021). Application of nanomaterials in architecture – An overview. *Materialstoday: Proceedings, 43* (5), 2921.

Zan, B. U. (2013). Türkiye'de bilim dallarında karşılaştırmalı bibliyometrik analiz çalışması. Yayınlanmamış Yüksek lisans tezi, Ankara.

Zeren, D., & Kaya, N. (2020). Dijital pazarlama: ulusal yazının bibliyometrik analizi. *Çağ Üniversitesi Sosyal Bilimler Dergisi, 17*(1), 35-52.

Zupic, I., & Čater, T. (2015). Bibliometric methods in management and organization. *Organizational Research Methods*, 18(3), 429-472.