ISPARTA UYGULAMALI BİLİMLER ÜNİVERSİTESİ

Turkish Journal of Forestry | Türkiye Ormancılık Dergisi
2024, 25(1): 56-63 | Research article (Araştırma makalesi)

A bibliometric evaluation on furniture joints studies

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Abstract: Furniture joint one of the most critical point in furniture construction and it is one of the most governor part of the furniture construction. Therefore, many studies focuses on furniture joint from USA to China. This study aims to reveal the current structure of studies conducted in the literature on furniture joints. The study is structured in three basic stages. Firstly, a comprehensive literature study on furniture joints was carried out. Then, the sample of the study was determined as 253 articles with the keyword furniture joint in the Web of Science database. In the third stage, bibliometric analyzes were carried out. VOSviewer and Biblioshiny programs were used in the analysis, and the sample group was determined according to some parameters such as country, author, study year, university and study name. The results indicated that 2018 was the year for the highest numbers of furniture joint studies. Eckelman, Zhang, and Erdil were the pioneers authors on furniture joints studies. USA and Canada were the first countries where furniture joints studies initiated. Currently, Türkiye is the leading country on furniture joint studies, and China is getting popular country in the subject of the study. Besides, Purdue University and Mugla Sitki Kocman University is the accommodations which published the highest number studies on furniture joints. Additionally, the biometric analisys of the study showed that Forest Products Journal published the highest number furniture joint papers.
Keywords: Furniture joints, Bibliometric analysis, Türkiye

Mobilya birleşim çalışmaları üzerine bibliyometrik bir değerlendirme

Özet: Mobilya birleştirmeleri, mobilya yapımındaki en kritik noktalardan biri olup mobilya yapımının en çok dikkat edilmesi gereken kısımlardan biridir. Bu nedenle, ABD'den Çin'e kadar birçok çalışma mobilya birleştirmelerine odaklanmaktadır. Bu çalışma, literatürde mobilya birleştirmeleri üzerine yapılan çalışmaların mevcut yapısını ortaya koymayı amaçlamaktadır. Çalışma üç temel aşamada yapılandırılmıştır. İlk olarak mobilya birleştirmeleri üzerine kapsamlı bir literatür çalışması gerçekleştirilmiştir. Ardından çalışmanın örneklemi Web of Science veri tabanında mobilya birleştirmeleri anahtar kelimesi ile 253 makale olarak belirlenmiştir. Üçüncü aşamada ise bibliyometrik analizler gerçekleştirilmiştir. Analizlerde VOSviewer ve Biblioshiny programları kullanılmış ve örneklem grubu ülke, yazar, çalışma yılı, üniversite ve çalışma adı gibi bazı parametrelere göre belirlenmiştir. Sonuçlar, 2018 yılının en fazla mobilya birleştirme çalışmalarının yapıldığı yıl olduğunu göstermiştir. Eckelman, Zhang ve Erdil mobilya birleştirmeleri çalışmaları konusunda öncü yazarlar olmuşlardır. ABD ve Kanada mobilya birleştirme çalışmalarının başladığı ilk ülkeler olmuştur. Şu anda, Türkiye mobilya birleştirme çalışmalarında lider ülke konumundadır ve Çin çalışma konusunda popüler bir ülke haline gelmektedir. Ayrıca Purdue Üniversitesi ve Muğla Sıtkı Koçman Üniversitesi mobilya birleştirmeleri konusunda en fazla çalışma yayınlayan kuruluşlardır. Ayrıca, çalışmanın biyometrik analizi, Forest Products Journal'ın en fazla sayıda mobilya birleştirme makalesi yayınladığını göstermiştir.
Anahtar kelimeler: Mobilya birleştirme, Bibliyometrik analiz, Türkiye

1. Introduction

Furniture, an integral part of human existence, has evolved over millennia to meet customers' ever-changing needs for comfort, aesthetics, and functionality. While the basic raw material of the furniture industry has been solid wood as furniture elements for years, developing technology has enabled the use of wood-based composite materials such as particleboard, MDF (medium density fibreboard) and plywood in furniture production (Kaya, 2018; Köksal and Kelleci, 2020).In joining furniture elements to each other, traditional techniques such as dowel and mortise-tenon joints have begun to be replaced by Ready-to-Assembly joints with mechanical fasteners, which are installed in houses or offices and their use is rapidly becoming widespread (Kasal, 2004; Karaman et al., 2020). Typically, furniture is made using either the frame (skeleton) approach, the case (panel-type) technique, or a blend of both, referred to as the enrich method (Kasal et al., 2020). Similar to everything that has changed since history, furniture also changes (Yılmaz Aydın, 2022).

The crucial aspects of furniture construction revolve around the joints. In contemporary industrialized nations, the application of all-wood joints is predominantly confined to the production of high-end custom furniture. Conversely, joints employed in mass-produced furniture predominantly rely on adhesives or fasteners manufactured from steel or diverse polymers. These alternatives demand less complex manual work, making them generally more straightforward and cost-effective to manufacture and assemble compared to traditional methods. Commonly utilized joints in modern industrial furniture contain adhesives, dowels, screws, nuts and bolts, and cam connectors (Braun, 2021). These joints

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✓ **Received** (Geliş tarihi): 10.11.2023, **Accepted** (Kabul tarihi): 22.02.2024

Citation (Atıf)**:** Demirel, S., Eyümoğlu, H., 2024. A bibliometric evaluation on furniture joints studies. Turkish Journal of Forestry, 25(1): 56-63. DOI: 10.18182/tjf.1389049

can be established using various types of joints, including glued and unglued varieties. Examples of glued joints include dowels and mortise and tenon joints, while non-glued joints encompass nails, screws, metal fasteners, and plastic connectors. Fasteners for ready-to-assemble (RTA) furniture joints are gaining popularity steadily, particularly for their convenience in shipping and transportation (Kasal et al., 2023).

Throughout history, an array of joint types have been used (Segovia and Pizzi, 2009), each with its own merits and shortcomings. These joints range from dovetail and mortise-and-tenon joints to metal fasteners such as screw or staple. The choice of joint type is influenced by factors such as the intended use of the furniture, material selection, aesthetic considerations, and production methods. As a result, the science and art of furniture joint design have witnessed continuous evolution.

Furniture joints play crucial roles in furniture construction, serving essential purposes related to strength, technology, and the operational and aesthetic aspects. This has been affirmed through extensive literature, which has examined how various factors affect the strength of constructional furniture joints. These factors include the type of joint, the materials used in the composite, the adhesive employed, and their effects on the distribution of stress (Kociszewski, 2005; Smardzewski and Papuga, 2004).

People live in the digital age, therefore furniture industry also move trend of using computer technology. The new furniture production is based on computer numerical control (CNC), computer aided-design (CAD) and so on (Ke and Ruimin, 2009). Besides, the field of furniture joint research has experienced a resurgence of interest, driven by a confluence of factors such as advances in materials science CAD, and the growing emphasis on sustainable and eco-friendly furniture production. Moreover, the increased demand for furniture with superior strength, stability, and adaptability has necessitated the exploration of novel joint designs and the refinement of traditional ones (Hidayetoğlu and Yıldırım, 2017).

Furniture joint studies contribute to the ongoing discourse on design and durability. They presents a comprehensive review of existing joint types, highlighting their strengths and weaknesses, and explores emerging trends in joint technology. Furthermore, this research investigates the impact of various factors, including material properties, environmental conditions, and load-bearing requirements, on the performance of furniture joints. By combining theoretical analysis with practical experimentation, these studies seek to provide a holistic understanding of the key considerations in optimizing furniture joint design.

Bibliometric analyses enable the identification of present patterns in research and the exploration of connections between different research domains. Conversely, these analyzes reveal tendencies in the field by allowing a broader perspective on the field of study (Samiee and Chabowski, 2012; Verma and Gustafsson, 2020). Bibliometric analysis studies conducted on large data sets provide information about developments in the field of research, scientific productivity, country/author collaborations, and global and local contributions (Baker et al., 2021).

In this paper furniture joint studies were evaluated according to some parameters such as years of study, authors name, author citation, country, university, and publishing journal. Therefore, a bibliometric evaluation was carried out on furniture joint in order to see who is working what around the world. Through this extensive analysis, it is aimed to provide a valuable resource for reader, designers, craftsmen, engineers, and researchers involved in furniture design and manufacturing. This scientific paper also aimed to provide a comprehensive analysis of advancements in furniture joint design.

2. Material and methods

Figure 1 shows the bibliometric analysis and three basic steps. In the first step, a comprehensive literature review was conducted regarding furniture and furniture joints details. The literature review was used to create the conceptual framework and identify the limitations of the study. The second step was to determine the sample and design in four stages. First, the database was determined. In bibliometric analyses, data was downloaded from various databases such as Web of Science, Scopus, Dimension, and PubMed. In selecting the database within the scope of the study, care was taken to include a data set that represents the literature. Web of Science was chosen as the database within the scope of the study, considering its widespread use, comprehensive indexing speed, user-friendly interface, ease of access to current research data, and wide documentation and search options. Web of Science, one of the oldest and most widely used databases in the world, is a daily updated database containing studies conducted since the 1900s. Then, in order to obtain the studies in the literature on the subject of the study, "furniture joint" was determined as the keyword group that best expresses the literature. Afterwards, a search was carried out in the title, abstract and keywords of the studies in the Web of Science database. As a result of the search, 568 studies were found. Considering that the studies found are related to various different disciplines, the search result was limited to the categories "Forestry" and "Material Science Paper Wood" in order to obtain reliable and directly related data. Then the search was repeated and 280 studies were identified. Finally, the results obtained were limited to "article" and "review article", which are thought to be a more effective publication type in guiding the academic field, and 253 articles were determined as the sample of the study.

In the third step of the study, bibliometric analyzes of the sample group were conducted. Bibliometric analysis is defined as the evaluation of studies on a determined field using statistical and mathematical techniques (Pritchard, 1969; Borgman and Furner, 2002; Andrés, 2009). On the other hand, bibliometric analysis determines the conceptual, social and intellectual structure of the field by measuring various research components such as author, year, keyword, citation, country and the relationships among these components (Aria and Cuccurullo, 2017; Gutiérrez-Salcedo et al., 2018). In addition, it allows to reveal the evolution of the research subject over time and the current situation dynamics. The main purpose of bibliometric analysis, which allows looking at the research topic from a broad perspective, is to recognize, understand and evaluate the literature in the field (Samiee and Chabowski, 2012). In addition, bibliometric analysis of the obtained data can be done manually or through various programs such as VOSviewer, Biblioshiny, CiteSpace, Pajek, due to the rapid increase in scientific information production in recent years. Bibliometric analyzes are more preferred today, considering the ability to analyze large data sets quickly, low margin of

error, and saving time and resources. On the other hand, analysis programs offer various network analyzes and visualizations (Cobo et al., 2011; Chadegani et al., 2013; Baker et al., 2021; Donthu et al., 2021). In this study, bibliometric analyzes were carried out in two stages: performance analysis and science mapping in VOSviewer and Biblioshiny programs, which are compatible with the Web of Science database and have various visualization possibilities. As a performance analysis of the data set specifically for the study, the contribution of year, author, country, university and journal to the field was revealed using metrics. On science maps, network visualizations were made for author and country collaborations.

3. Results and discussion

Figure 2 shows furniture joint studies according to the years. Based on the figure, the dissipation according years on the furniture joint studies has increased at recent years. Maximum furniture publication was reached in 2018 until Covid-19 pandemy which is right before 2019. Covid-19 pandemy may have negatively effected the studies based on due to decrease after 2018 as shown in Figure 2.

Figure 3 shows the name of authors who have been working on furniture joint studies. As shown in the Figure 3, C.A. Eckelman is the author who started furniture joint studies first and he was followed by J. Zhang who got started publishing such papers at the beginning of 1990's. Smardewski started furniture joints studies at the end of 1990's. Figure 3 illusrates that most of studies started publishing these studies in the beginning of millenium. Dr. Demirel, author of this study, started his furniture joint studies in 2014.

Figure 4 shows the citations of authors who studied on furniture joints. Based on the figure, Eckelman, Zhang and Erdil are earliest authors who were cited by other studies. These are followed by Mohammad, Kasal, Haviarova, Quin, Tankut, Ertan, Frederiksson, Kamperidou, Kouzimu, Madriz-Quiros. The lastest authors who have been cited recently on furniture joint studies are Wengang, Demirel, Zhu, Genchev, Milch, Gric, Bayatkashkoli, Zhu, Polacik. Figure 5 illustrates furniture joints studies according to countries around the world.

As shown in Figure 5, Türkiye is the number one country where the most furniture joint studies has been carried out and published so far. This is being followed by USA, China, Poland, Czech Republic, Iran and so on. Figure 6 also shows the connection among countries on furniture joint studies. Based on the figure, Türkiye seems a bridge similar to its georaphical location between the continents of Europe and Asia. Then USA and China seems the other bigger countries where most of furniture joints studies have been carried out.

As shown in Figure 7, the studies on furniture joints has been started around 2000's in USA, Canada based on time scale in left corner of Figure 7. Later Türkiye, Poland, Iran, Crotia, Slovakia, Bosnia and Herseg, France, England showed up based on the scale in the figure. Chine seems the lastest and recent country where furniture joints studies have become popular among the colleagues or scientists. Figure 8 illustrates furniture joint studies based on university names around the world.

Figure 1. Research design

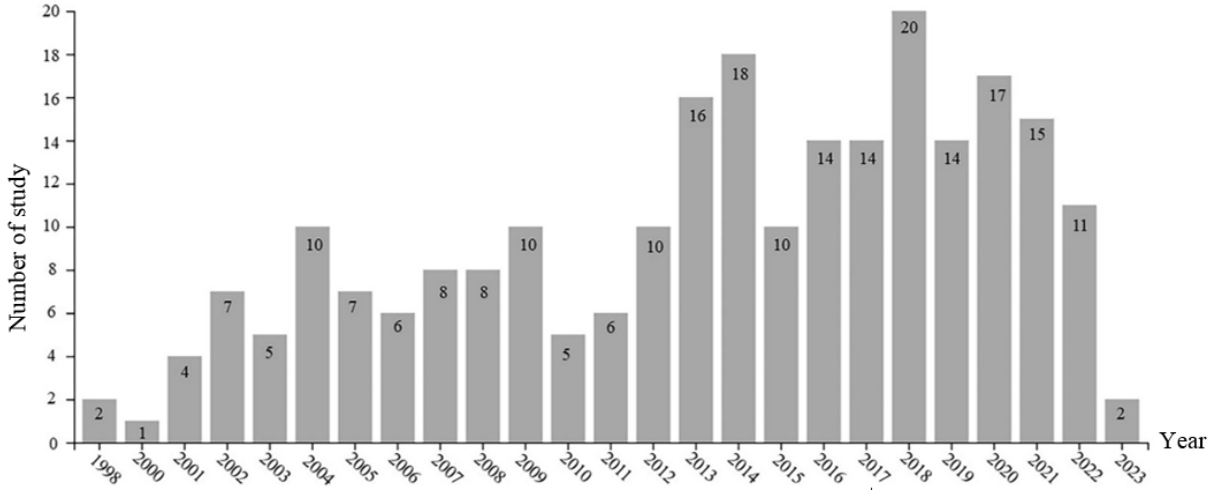

Figure 2. Number of furniture joints studies based on years

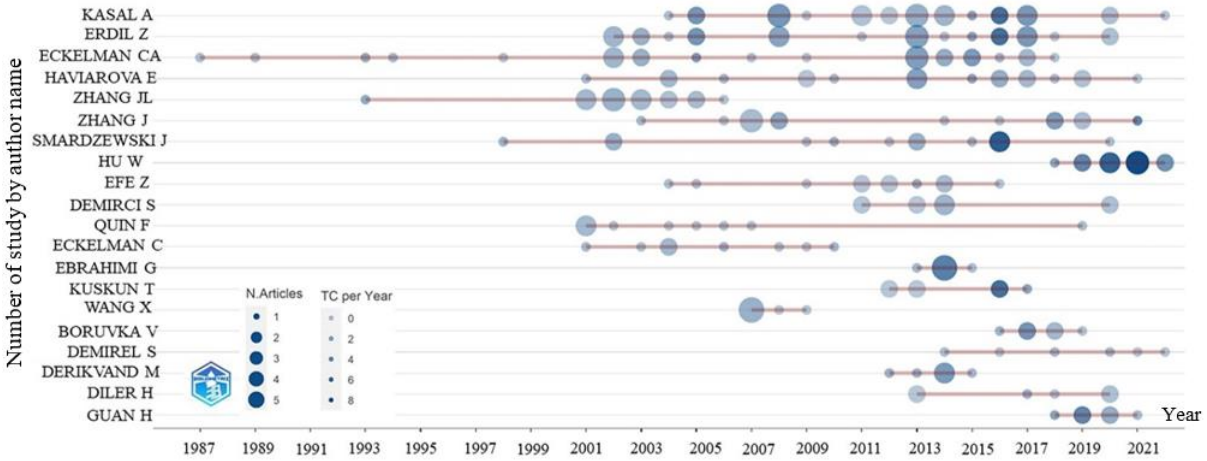

Figure 3. Furniture joints studies based author names

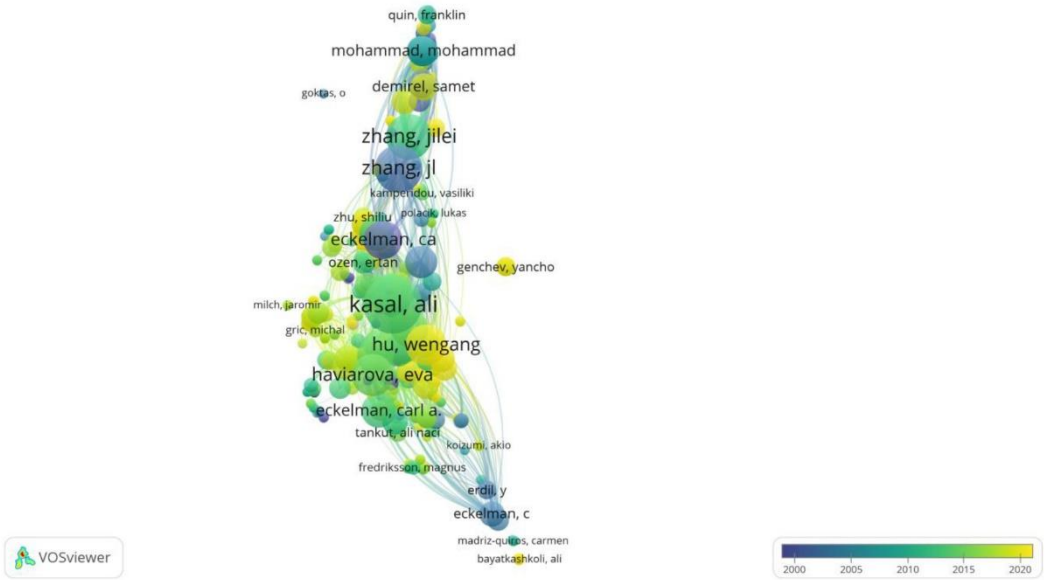

Figure 4. Furniture joints studies according to author citation

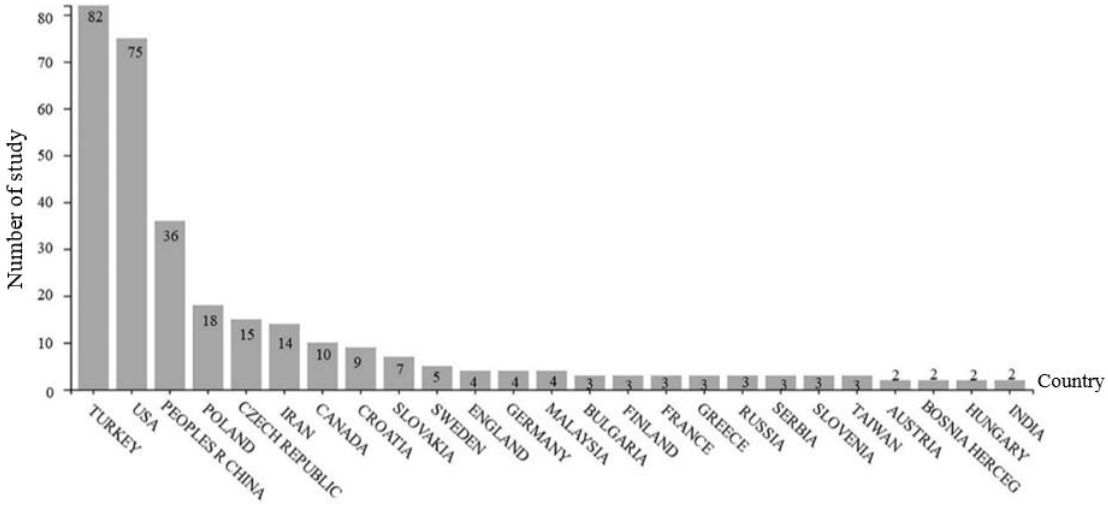

Figure 5. Furniture joints studies according to countries

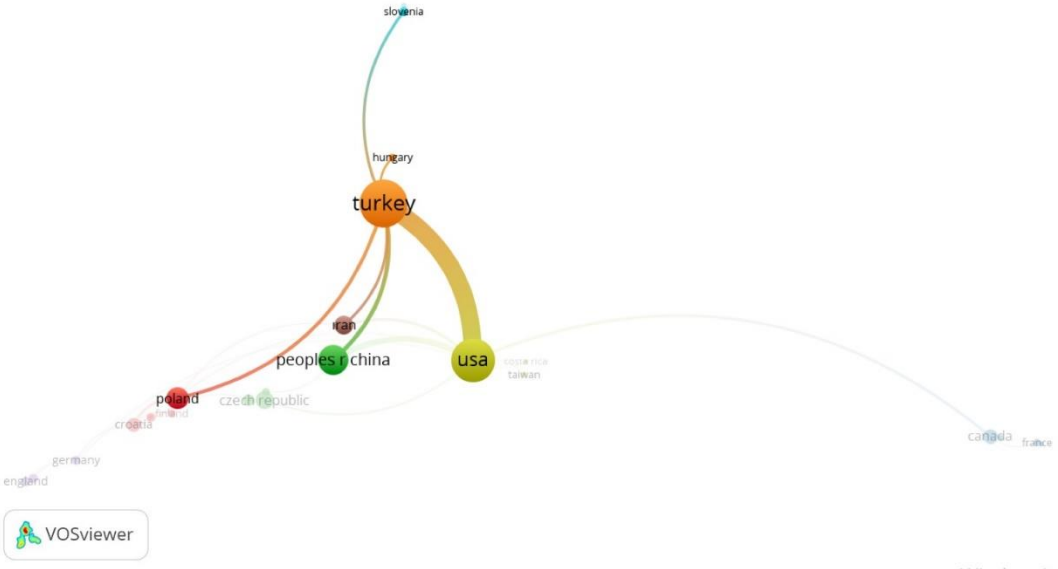

Figure 6. Furniture joints studies carried out by different countries around the world

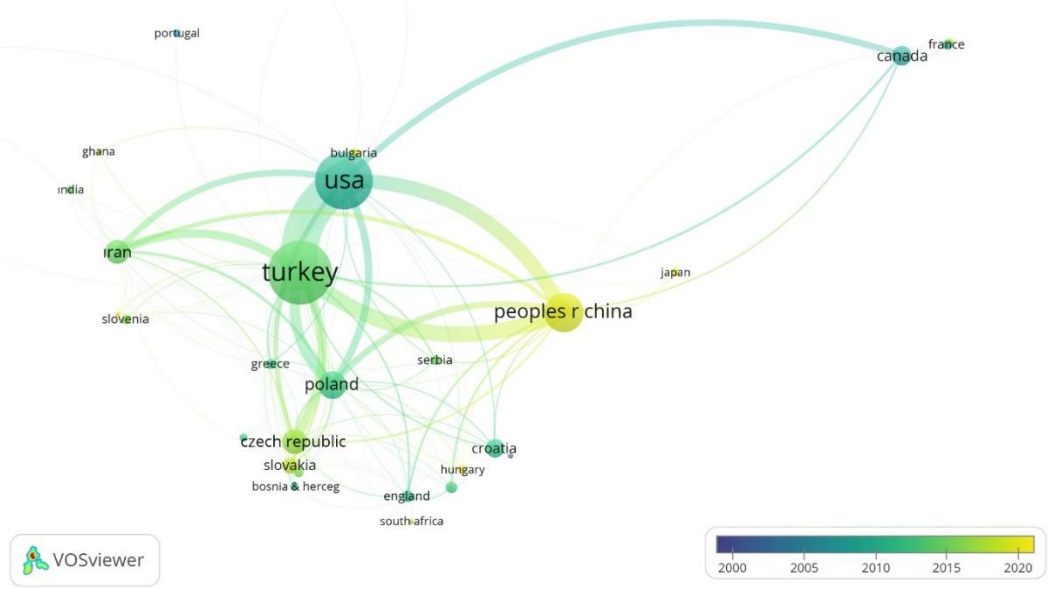

Figure 7. Furniture joints studies carried out by different countries by considering time from past to present

As seen in Figure 8, Mugla Sıtkı Kocman University in Türkiye and Purdue University in USA are the universities where most of published work on furniture joints is observed. All these are followed by Mississippi State University, Nanjing University, Gazi University, Poznan University of Life Science, University of Tehran, Bulent Ecevit University, Czech University of Life Science, Ege University, University of Zagrep, Karadeniz Technical University, Laval University, Akdeniz University, Bartin University, Technical University Zloven, Mendel University in Brno, Annui Agricultural University, Karabük University, Kastamonu University, Yalova University, Buckinghamshire New University. For overall consideration, ten universities from Türkiye are the intitutions where the most furniture studies has been carried out and published. Additionally, two universities from USA, one universities from China, Poland, Iran, Crotia, Canada, Check Republic, Slovakia, Finland, and England published such studies. Figure 9 shows the journal names where the furniture joint studies are published.

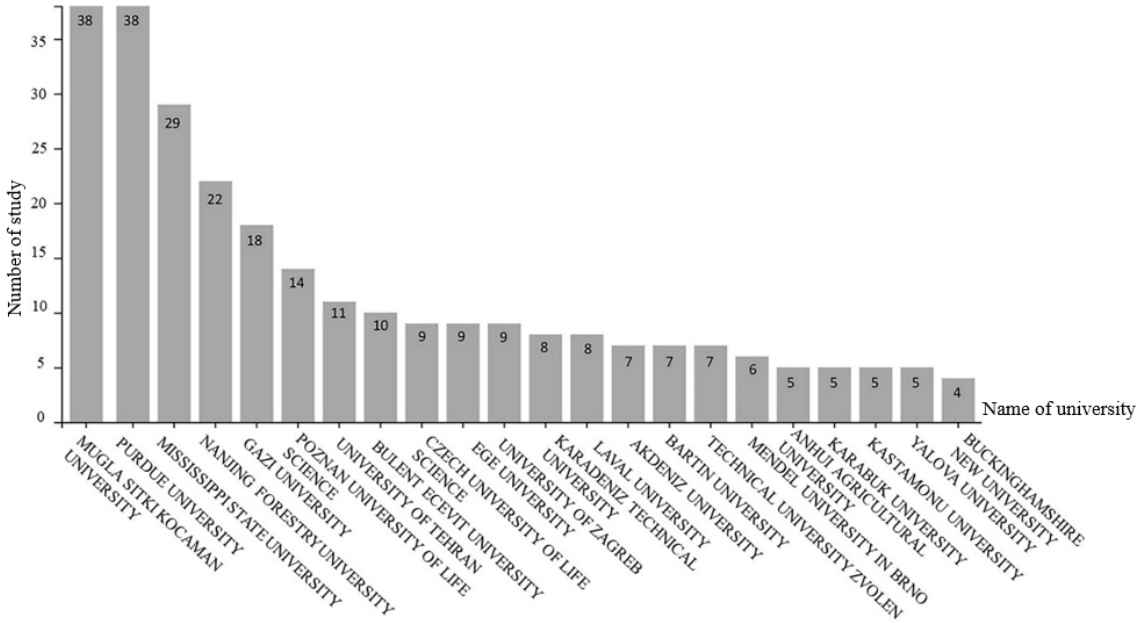

Figure 8. Furniture joints studies according to university names

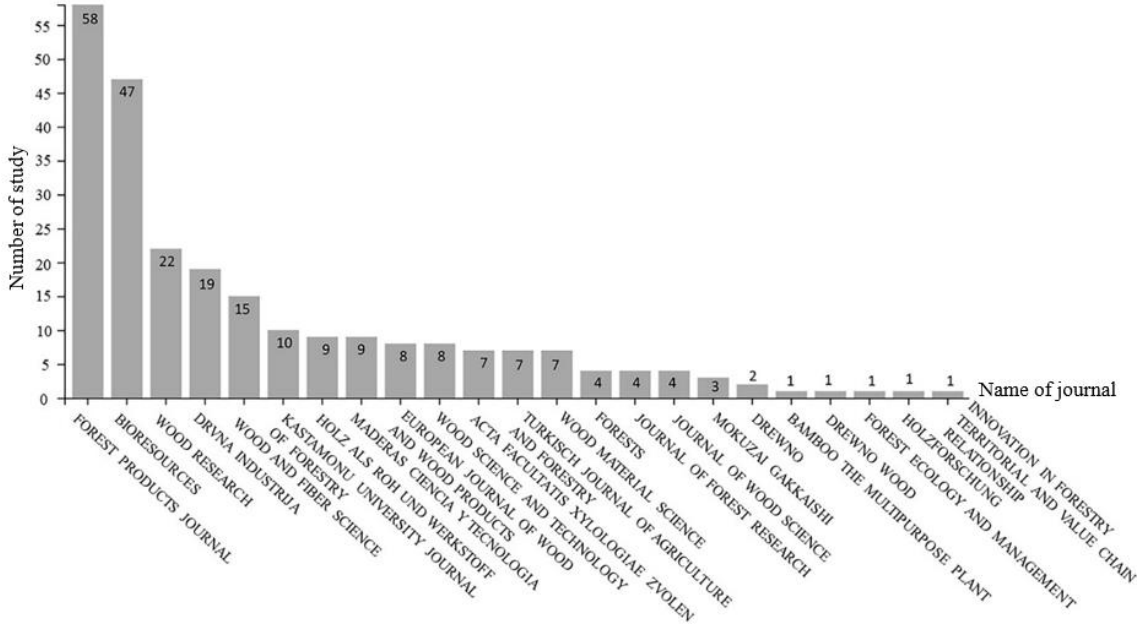

Figure 9. Furniture joint studies according publishing journal names

As shown in Figure 9, Forest Products Journal with 58 papers is the most furniture joint study publishing journal so far. This is followed by BioResources, Wood Reserach, Drvna Industrija, Wood and Fiber Science, and Kastamonu University Journal of Forestry Faculty with the publication number of 47, 22, 19, 15 and 10, respectively. The other journals with the name of Holz Als Roh Und werkstoff, Maderas Ciencia Y Tecnologia, Eurpoean Journal of Wood and Wood Products, Wood Science and Technology, Acta Facultatis Zilologiae Zloven, Wood Material Science, Forests, Journal of Forest Research, Journal of Wood Science, Mokuzai Gakkishi, Drewno, Bamboo the Multi Purpose Plant, Drewno Wood, Forest Ecology and Management, Holzforshung, Innovation ForestryTerritorial and Value Chain Realtionship have published several funiture joint studies.

Figure 10 shows keywards related the topic on the right, the authors in the middle and keywards assigned by database on the left. As shown in the figure, the main keyward is furniture joint on the right top and strength is the main keyward in the left top. This results also showed that how furniture joints is related with strength in a furniture construction because the strength performance of an upholstered furniture frame depends heavily on the joints that hold its structural members together (Zhang et al., 2001; Erdil et al., 2003; Demirel et al., 2018).

4. Conclusions

In this study, a bibliometric evaluation of the furniture joint studies were considered according to years of study, authors name, author citation, country, university, publishing journal. With this study, the important parameters were highlighted. Accordingly, following outputs were revealed with the bibliometric analysis of current researches.

- The most of furniture-related publications was achieved in 2018.
- The earliest authors cited by other studies are Eckelman, Zhang, and Erdil.
- Türkiye stands out as the leading country in terms of conducting and publishing the most studies on furniture joints. Notably, research on furniture joints appears to have gained momentum around the 2000s, with the United States and Canada being among the earliest contributors, followed by Türkiye, Poland, Iran, and Croatia. China appears to be the most recent entrant to the field of furniture joint studies
- Mugla Sitki Kocman University in Türkiye and Purdue University in the USA have produced a significant portion of the published work on furniture joints among other countries.
- Among the all journals, the Forest Products Journal has emerged as the primary publication journal for research on furniture joints.
- This study revealed that how furniture joint is strongly related to strength.
- This study showed that how the insterest of the science such as focusing on furniture joint studies started to move from western countries to eartern countries.

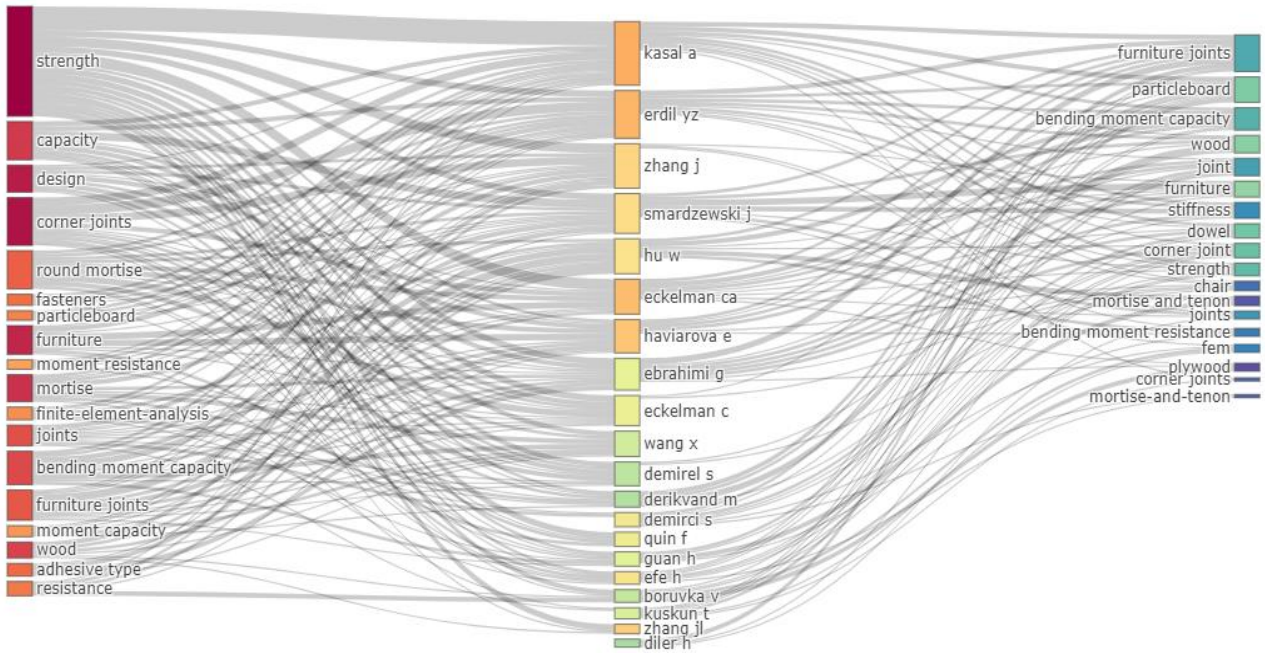

Figure 10. The keywords and author connection

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