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Circular design strategies in interior architecture: rethinking furniture design through reuse, recycling, and waste materials

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ABSTRACT: The aim of this study is to systematically examine the use of reuse, recycling, and natural or waste materials in the furniture design process in interior architecture. The research was based on systematic literature review and content analysis methods. Within the scope of the study, current publications on focal points such as "reuse," "recycling," "waste," "environmental furniture design," and "ecological approaches" were identified in the scientific literature. These publications were systematically analyzed and visualized using scientific maps. A rigorous systematic review was conducted during the literature analysis process using the PRISMA approach. The content analysis utilized VOSviewer and Biblioshiny to uncover significant themes and concepts associated with furniture design. The results highlighted key terms such as "furniture design," "wooden furniture," "recycling," "sustainability," "circular economy," "sustainable design," "wood products and waste," "recycled polypropylene," "3D printing techniques," "textile waste," "environmental impacts," interior architecture applications," "eco-design," and "green production" stand out. In conclusion, current academic publications hold considerable potential for enhancing scientific visibility and uncovering new research opportunities.

Keywords: Interior Architecture, Furniture, Design, Recycle, Waste Material

İç mimarlıkta döngüsel tasarım stratejileri: yeniden kullanım, geri dönüşüm ve atık malzemelerle mobilya tasarımı yeniden düşünmek

ÖZ: Bu çalışmanın amacı, iç mimarlıkta mobilya tasarım sürecinde yeniden kullanım, geri dönüşüm ve doğal veya atık malzemelerin kullanımını sistematik olarak incelemektir. Araştırma, sistematik literatür taraması ve içerik analizi yöntemlerine dayanmaktadır. Çalışma kapsamında, bilimsel literatürde "yeniden kullanım", "geri dönüşüm", "atık", "çevre dostu mobilya tasarımı" ve "ekolojik yaklaşımlar" gibi odak noktalarına ilişkin güncel yayınlar belirlenmiştir. Bu yayınlar sistematik olarak analiz edilmiş ve bilimsel haritalar kullanılarak görselleştirilmiştir. Literatür analizi sürecinde, PRISMA yaklaşımı kullanılarak titiz bir sistematik inceleme yürütülmüştür. İçerik analizi, mobilya tasarımıyla ilgili önemli temaları ve kavramları ortaya çıkarmak için VOSviewer ve Biblioshiny araçlarını kullandı. Bulgulara göre, mobilya tasarımıyla ilgili çeşitli temalar ve kavramlar öne çıkmaktadır. Sonuçlar "mobilya tasarımı", "ahşap mobilya", "geri dönüşüm", "sürdürülebilirlik", "döngüsel ekonomi", "sürdürülebilir tasarım", "ahşap ürünler ve atıklar", "geri dönüştürülmüş polipropilen", "3B baskı teknikleri", "tekstil atıkları", "çevresel etkiler "iç mimarlık uygulamaları", "eko-tasarım" ve "yeşil üretim" gibi önemli anahtar kelimeler öne çıkmaktadır. Sonuç olarak, güncel akademik yayınlar, bilimsel görünürlüğü artırma ve yeni araştırma fırsatlarını ortaya çıkarma konusunda önemli bir potansiyele sahiptir.

Anahtar kelimeler: İç mimarlık, Mobilya, Tasarım, Geri Dönüşüm, Atık Malzemeler

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1 Introduction

In interior architecture education, furniture design processes are undergoing a radical transformation in line with the principles of sustainability and the circular economy. The impact of traditional design approaches on natural resources, waste management issues, and environmental degradation in furniture design necessitates the adoption of circular models focused on "reuse, recycling, and regeneration." In this context, innovative practices such as the repurposing of waste materials in furniture design, the development of modular systems, and material identities support resource efficiency and ecological balance. Moreover, especially with the widespread adoption of the circular economy, scientific research on the use of materials such as recycled textiles, wood, and plastic in furniture design offers a solution for the transition to sustainable production models.

The aim of this study is to present current publications in the field, to present a conceptual and normative perspective, and to contribute to the education of interior architecture, interior design, furniture and decoration departments through student studies after providing information about current studies. Historically, with the rise of environmental awareness towards the end of the 20th century, the use of recycled materials in furniture design gained importance. This approach, initially experimental and artistic, has since taken sustainable products into consideration in the 2000s. Furthermore, the *3R (Reduce, Reuse, Recycle)* principles have been integrated into furniture design (Baik and Lee, 2010; Pralat et al., 2024). In recent studies, significant innovations such as 3D printing technologies, composite materials, and waste recycling and reuse have added a new dimension to the field of furniture design (Fauzan et al., 2022; Elessawy et al., 2024).

1.1 Theoretical framework and conceptual background

In recent years, literature reviews on sustainability, sustainable furniture, and recycled materials have yielded a comprehensive body of work and a variety of methodological and theoretical approaches. Significant research in this area focuses particularly on circular economy practices, the use of recycled furniture, and promoting the widespread adoption of environmentally friendly interior design. Specifically, when examining the theoretical framework and conceptual background of interior architecture, which is the focus of this research, the following emerge. There are current publications on interior architecture, interior design and furniture design. Sustainability and environmental awareness, green/eco-friendly materials and applications.

It emphasizes the use of recycled, renewable, and low-environmental-impact materials. This includes materials such as sustainable wood, bamboo, recycled plastic, and natural fibers (Hayles, 2015; Hartini et al. 2020; Mrinalini et al., 2023; Elessawy et al., 2024). Energy efficiency and ecological design. ıt likely focuses on ecological design strategies that improve the energy performance of indoor spaces, promote passive heating/cooling methods, and enhance healthy indoor air quality (Celadyn, 2019). Circular economy, it may discuss the transition from the “take-make-dispose” model to the “circular economy” model, where furniture can be repaired, reused, and recycled (Marsahala et al. (2023). User experience and ergonomics, it may have investigated the functionality, comfort, and responsiveness of furniture and spaces to user needs. Ergonomics, anthropometry, and user-centered design methodologies fall within this scope (Máté; 2007; Li, 2016; Trela, 2017).

The influence of human-centered and psychological design impact of design on human health, well-being, and emotional state is significant. Lubonja and Ovidiu (2019), Celadyn (2019), and Afifi (2025) explore how design elements affect human psychology, offering

deeper insights into the connection between thoughtful design and its effects on mental and emotional well-being. They focus on how color, light, texture, and spatial arrangement can help reduce stress, increase focus, and support overall well-being. This approach is particularly prominent in spaces such as hospitals, offices, and homes. Technology and digital ıntegration digital production techniques: publications such as may address the opportunities created by technologies such as 3D printing, CNC milling, and robotic production in furniture and interior design. These technologies enable the production of personalized and complex forms. Smart furniture and spaces: more recent studies may explore furniture and interior solutions that integrate with IoT (Internet of Things) and smart home systems, adapting to user needs. Virtual and augmented reality (VR/AR): These technologies are transforming the design process by allowing designers and customers to experience and modify spaces and furniture in currently (Hayles, 2015; Afifi, 2025).

Recent studies draw attention to the intersection of interior design and sustainability, showcasing practical solutions and applications that resonate with broader ecological goals. Research delves into the pedagogical aspects of incorporating recycled materials into educational practices, examining how curricula can integrate sustainability and foster environmental awareness among students. This includes both theoretical frameworks and hands-on approaches that enhance learning environments (Al-Saud et al., 2024). Similarly, some investigate how recycled furniture merges aesthetics with functionality while addressing sustainability in design education, emphasizing innovative transformations of waste materials into usable furniture pieces and recycled materials (Ali et al., 2013; Grotowska et al., 2024; Afifi, 2025; Ibrahim and Putri, 2025), waste plastic and furniture (Bal et al., 2023).

In particular, the studies explore circular economy principles, waste minimization, and lean manufacturing processes, integral to achieving eco-friendly production standards in furniture design. These works further discuss examples like recycled wood scraps being repurposed into furniture, alongside advancements such as the application of recycled materials in 3D printing technology for interior components (Pringle et al., 2018; Elessawy et al., 2024). Environmental benefits such as reduced waste and improved resource efficiency form key outcomes highlighted in this body of research (Ramadan, 2023; Zheng et al., 2025). Also, from theoretical analyses to commercial implementations, the collective research underscores the growing demand for sustainable practices within interior design and furniture production. This includes fostering ecological responsibility in design studios and furniture construction courses through circular economy teachings and supporting eco-conscious innovations. Particular emphasis has been placed on 3D printing filaments derived from recycled inputs, which enable functional and sustainable design solutions while catering to environmentally driven market trends (Hayles, 2015; Pringle et al., 2018; Lin et al., 2020). These developments contribute significantly to the attainment of sustainability goals whiles objectives but also reflect a harmonious blend of economic viability and social responsibility. Academic initiatives, such as integrating sustainability into interior design curricula, are fostering the development of second nature sections in reporting and instilling sustainable thinking in architectural projects. Case studies demonstrate the widespread adoption of recycled materials in interior design, from affordable housing solutions to high-end management facilities, highlighting the importance of recycled materials as a significant trend in sustainable development.

The aim of this study is to use recycled furniture in interior architecture to raise awareness of the principles of recycling and circular economy. It seek to encourage environmentally friendly conscious interior design by demonstrating how waste materials can be transformed

into creatice and innovative furniture designs. In addition, this study provides a comprehensive theoretical background and literature review of circular approaches to furniture design, reuse, recycling, and waste materials in interior architecture, including lists of existing publications and conceptual images and scientific maps.

2 Material and method

The methodology and working scheme of this research are explained step by step below. The research was based on systematic literature review and content analysis methods. A systematic review was conducted during the literature analysis process using the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) approach (Figure 1). This approach is widely preferred by numerous researchers in contemporary studies (Butdisuwan et al., 2024; Geçimli, 2024). After reviewing using the PRISMA protocols, the metadata has been carefully verified to ensure completeness (Figure 2). The research method is explained step by step (Figure 3).

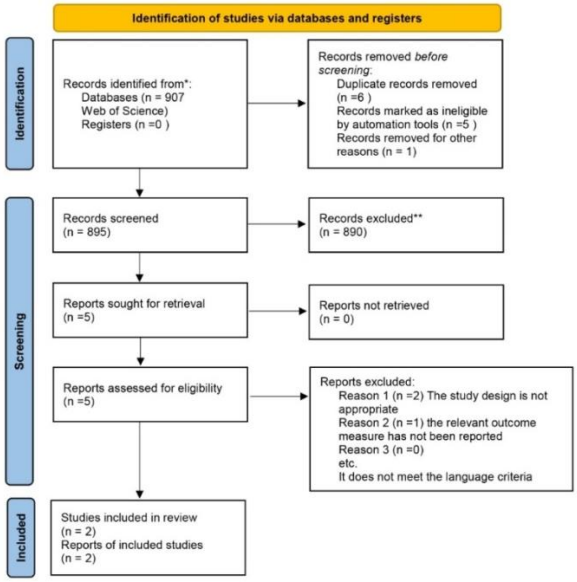


Figure 1 Research methodolgy for PRISMA flow diagram (Prepared by the author according to PRISMA 2020 protocols.)

Metadata	Description	Missing Counts	Missing %	Status
DT	Document Type	0	0.00	Excellent
SO	Journal	0	0.00	Excellent
LA	Language	0	0.00	Excellent
PY	Publication Year	0	0.00	Excellent
WC	Science Categories	0	0.00	Excellent
TI	Title	0	0.00	Excellent
TC	Total Citation	0	0.00	Excellent
AU	Author	1	0.10	Good
CR	Cited References	10	1.00	Good
C1	Affiliation	11	1.10	Good
RP	Corresponding Author	14	1.40	Good
AB	Abstract	19	1.90	Good
DI	DOI	85	8.50	Good
DE	Keywords	87	8.70	Good
ID	Keywords Plus	362	36.20	Poor

Figure 2 Completeness of metadata; description, missing counts, missing %, status. (cretad by author R Studio sofware)

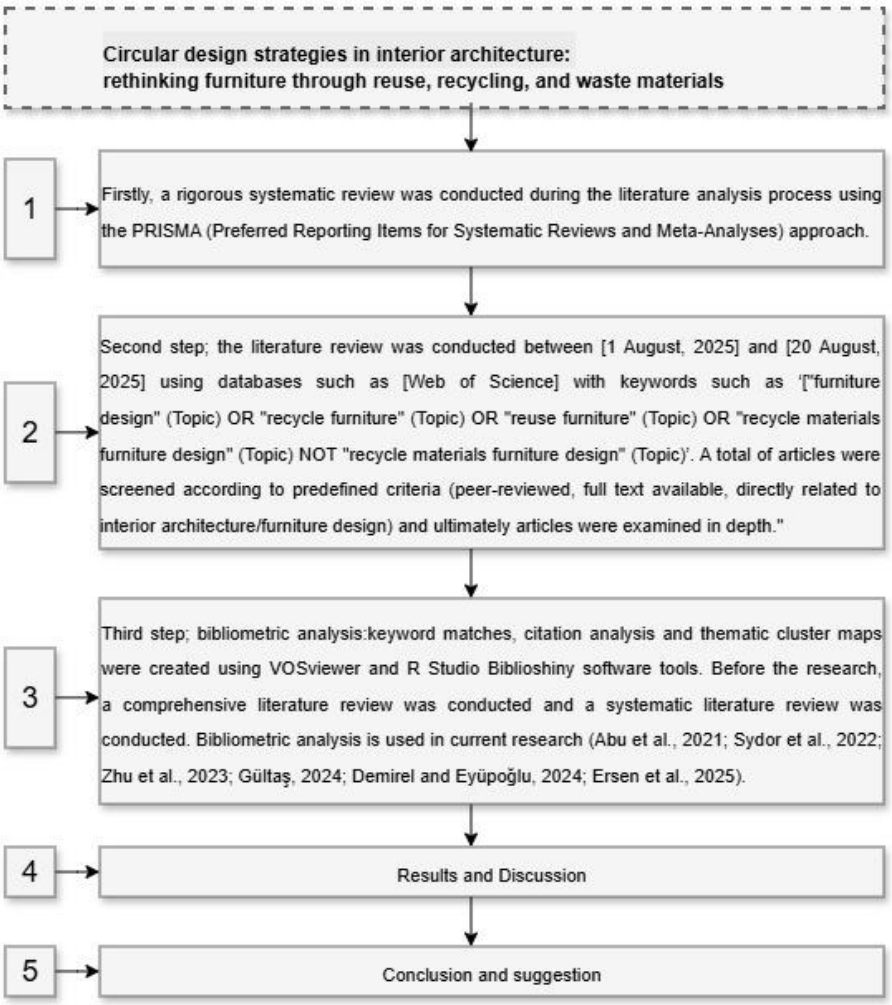


Figure 3 Research method are explained step by step

3 Results and Discussion

The first section, which presents conceptual findings on circular approaches to reuse, recycling, and waste materials in furniture design, presents conceptual approaches, theoretical outcomes, visual outcomes, and lists of relevant trends, active topics, and concepts. The second section includes findings from student projects prepared within the furniture design and construction course and presentations of student work.

3.1. Conceptual findings of circular approaches to reuse, recycling and waste materials in furniture design

The results in the table below, conceptual findings of circular approaches to reuse, recycling and waste materials in furniture design, are given according to general search criteria in the Web of Science database. Furthermore, as seen as Figure 3 specific applications and industry concerns are captured with keywords like "waste management" and "school furniture," illustrating practical implementations within the broader realm of furniture design and production.

In additionally; “smart furniture”, “urban furniture”, “market research”, “multifunctional furniture”, “textile waste”, “environmental impact”, “lean manufacturing”, “upholstery

furniture", "ergonomic design", "industrial design", "total quality management (tqm)"," urban areas", "product design", "interior design", "architecture", "eco-design", "children", "recyling", "upcycling", "innovative design", "waste management", "circular economy", and "green manufacturing" (Figure 4). In additionally, thematic cluster (co-word/overlay analysis) keyword networks are centered on three core clusters. Design principles: design for disassembly, modularity, repairability, adaptability. Material and process: recycled plastics, reclaimed wood, bio-based composites, textile waste, remanufacturing, CNC/3D printing. Use and impact: LCA/LCC, user participation, maker culture, social innovation, heritage/craft.

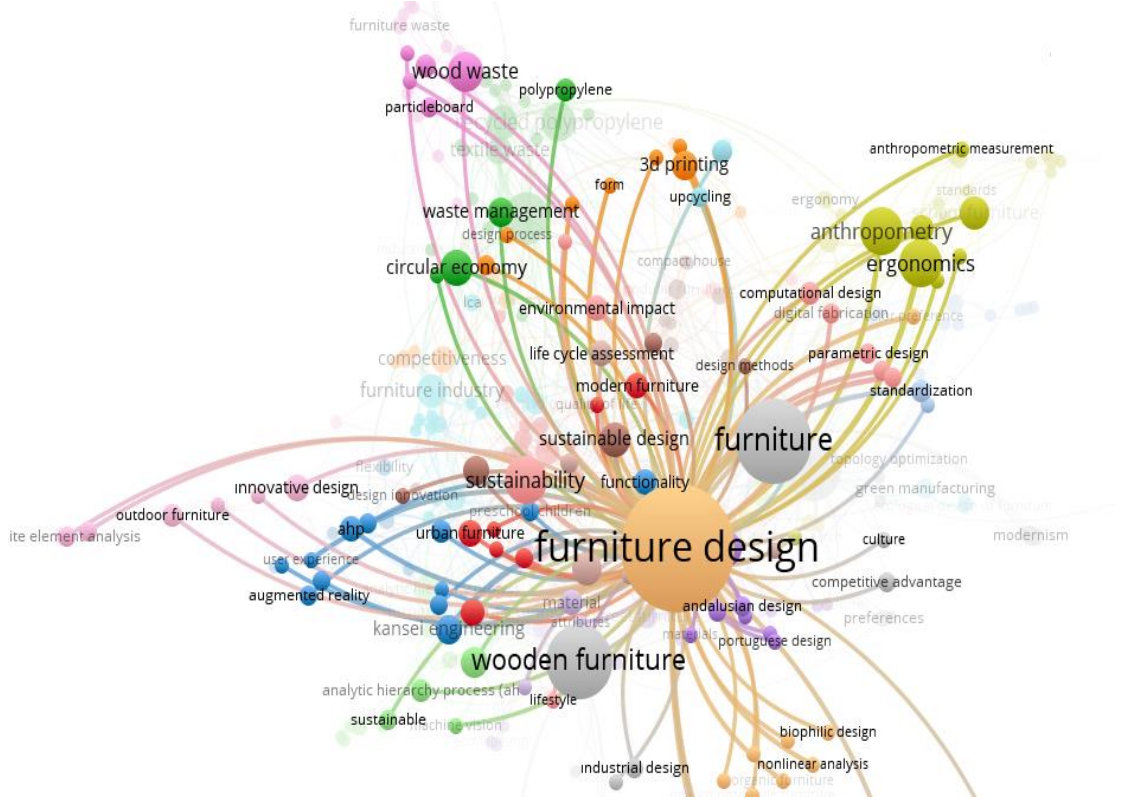


Figure 4 Visualization of furniture design (created by author using VOSviewer sofware)

The Figure 4 was created by the author using VOSviewer software (Figure 4). The chosen keywords encompass a broad spectrum of themes in furniture design and sustainability. Core focus areas are highlighted through terms like "furniture design," "furniture," and "wooden furniture. The list also integrates sustainability concepts such as "recycling," "sustainability," "circular economy," and "sustainable design," underscoring the importance of environmentally friendly practices. Functional and user-centered design considerations are addressed through technical keywords like "ergonomics," "anthropometry," and "mechanical properties." Material aspects are represented by terms such as "wood," "wood waste," "wood products," and "recycled polypropylene," while "3D printing" and "supply chain" shed light on modern manufacturing techniques and logistics.

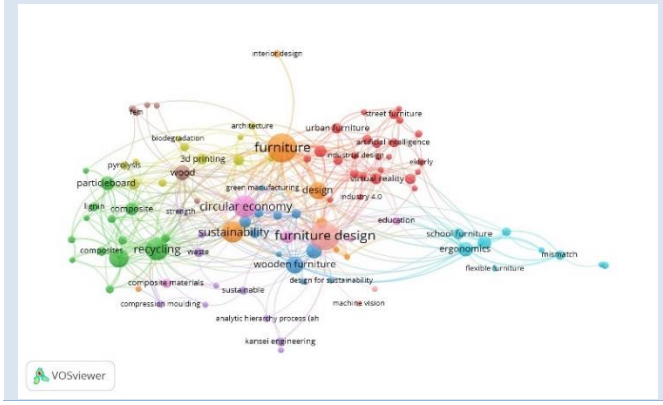
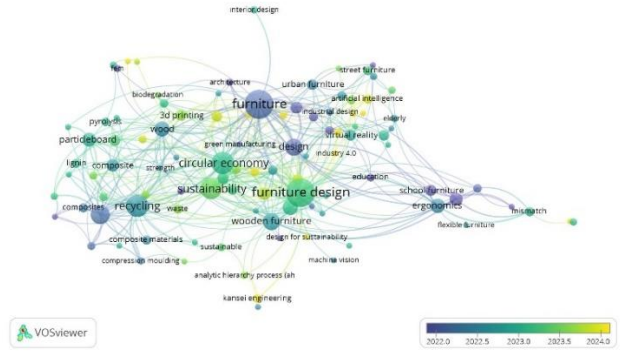
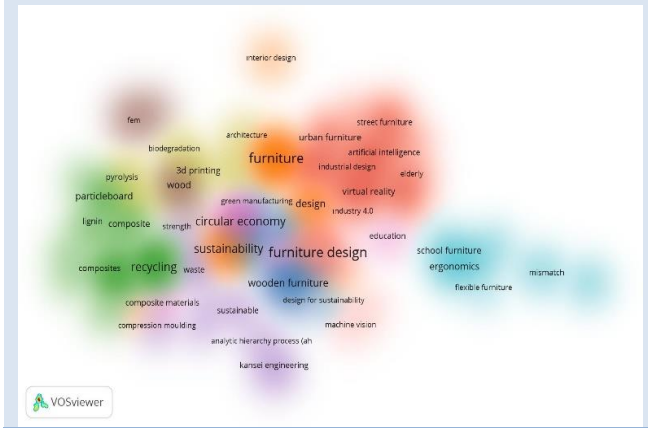
Table 1 provides a comprehensive overview of scholarly publications themes of related to reuse, recycling, and the utilizaiton of waste materials within the context of furniture design. These publications were thoroughly read and a content analysis was conducted. This analysis evaluated the keywords used by the authors in their publications. These analysis focused specifically on the keywords selected by authors, which serve to highlight reveal current and future trends in furniture design scholarship. Furthermore, this examination facilitates the

identification of gaps in the existing body of literature, with particular emphasis on the disciplines of interior architecture, interior design, and furniture design and construction.

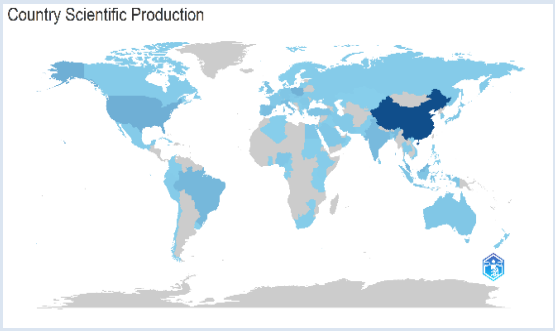
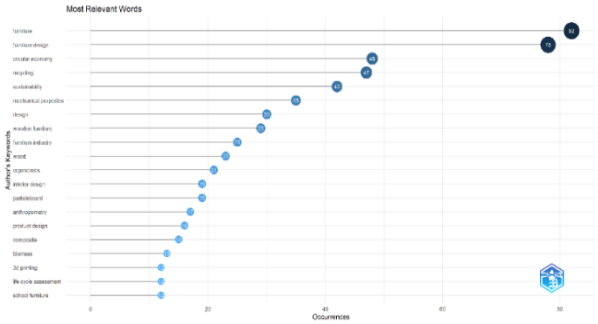
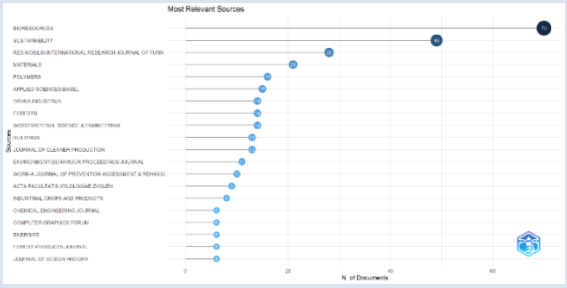
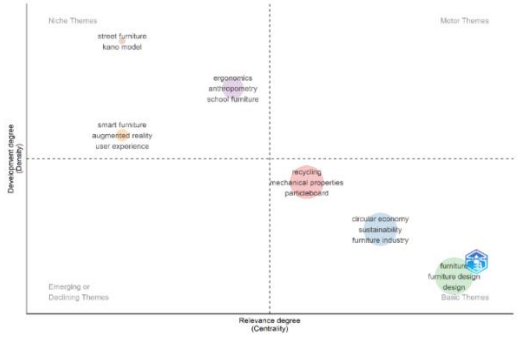
Table 1 Table of relevant publications furniture design (Web of Science, 2025)

Authors	Article Title	Year	Source Title
Wang et al.,	"Research on Sustainable Furniture Design Based on Waste Textiles Recycling"	2023	“Sustainability”
Galluccio et al.,	"Design for Resilient Post-Disaster Wood Waste Upcycling: The Katrina Furniture Project Experience and Its Legacy in a Digital Perspective"	2024	“Buildings”
Sari et al.,	"Assessing Environmental Impact and Eco-Efficiency of Wood Waste Gallon Holders Using Life Cycle Assessment"	2025	“Journal of Ecological Engineering”
Xue and Chen	"Strategies for Applying Shape Grammar to Wooden Furniture Design: Taking Traditional Chinese Ming-Style Recessed-Leg Table as an Example"	2024	“Bioresource”
Suandi et al.,	"A Review on Sustainability Characteristics Development for Wooden Furniture Design"	2022	“Sustainability”
Lähtinen et al.,	"Designers' Wooden Furniture Ecodesign Implementation in Scandinavian Country-Of-Origin (COO) Branding"	2014	“Journal of Product and Brand Management”
Abjaghou et al.,	"Incorporation of Wooden Furniture Wastes in Fired Clay Bricks for Improved Thermal Insulation: A Feasability Study"	2020	“Waste and Biomass Valorization”
Liu	"Brief Analysis on Green Design and Manufacture of Furniture Products"	2013	Manufacturıng Process and Equıpment
Knosková and Garasová	"Consumer Perception of Product Features in Buying Process of Wooden Furniture"	2021	“Ad Alta-Journal of Interdısciplinary Research”
Zhang	"Rational Consideration on Package Design of Wooden Furniture"	2011	“Mechatronıcs and Intellıgent Materıals”
Yang and Zhu	"Recycling and Value-added Design of Discarded Wooden Furniture"	2021	“Bioresources”
Zheng et al.,	"Measures and Suggestions for Recycling and Reuse of Waste Wooden Furniture"	2025	“Wood Material Science and Engineering”
Zhang et al.,	"Research on the Recyclable Design of Wooden Furniture Based on the Recyclability Evaluation"	2023	“Sustainability”

Table 2. Scientific mappings and descriptions of data

Scientific Mapping	Description
	This visual is a bibliometric network vizualization map created with VOSviewer software tools.The map shows the co-occurrence relationships of keywords in academic publications on topics such as furniture design, sustainability, and circular economy. Orange cluster: furniture, interior design, architecture, green manufacturing, urban furniture, street furniture. Green cluster: recycling composite materials wood particleboard biodegradation bio-composite, compression molding
	This visual is a bibliometric overlay vizualization map created with VOSviewer software tools.Yellow cluster; circular economy 3D printing biodegradable materials green manufacturing. Red cluster: artificial intelligence industry 4.0 smart furniture IoT smart city. Blue cluster: ergonomics, school furniture mismatch, and flexible furniture design for sustainability
	This visual is a bibliometric density vizualization map created with VOSviewer software tools.
	This visual is a bibliometric word cloud visualization map of author keywords created using R Studio Bibliometrix Biblioshiny software tools.

Continuation of Table 2

	This visual is a bibliometric word cloud visualization map of author titles created using R Studio Bibliometrix Biblioshiny software tools.
	This visual is a country scientific production vizualization map in world created with R Studio Bibliometrix Biblioshiny software tools. This visual is a world science map showing countries' levels of scientific production within the scope of bibliometric analysis. The map is color-coded according to the publication outlet for countries in a specific research field (likely “sustainable furniture design” or “furniture-ergonomics-recycling”).
	Most relevant words graphic created by R Studio Bibliometrix Biblioshiny software. According to this graph, furniture design, circular economy, recycling, sustainability, mechanical properties, design, wooden furniture, the furniture industry, wood, ergonomics, and interior design. Author’s keywords occurrences graphic.
	The most relevant sources graphic was generated using R Studio's Bibliometrix and Biblioshiny software. Based on this graphic, the key sources identified include Bioresources, Sustainability, Res Mobilis - International Research Journal of Furniture, Materials, Polymers, Applied Sciences-Basel, Drvna Industrija, Forests, Wood Material Sciences & Engineering, Building, Journal of Cleaner Production, and Environmental Behavior Proceedings Journal.
	This diagram and analysis support bibliometric studies, highlighting themes in a research field. The axes show theme development (density) and relevance (centrality). Motor Themes (Upper Right): recycling, mechanical properties, particleboard, circular economy, sustainability, furniture industry. Basic Themes (Lower Right): foundation of the field, focusing on design and furniture design, though less advanced or specialized. Niche Themes (Upper Left): street furniture, canoe model, ergonomics, anthropometry, school furniture, smart furniture, augmented reality, user experience.

4. Conclusion and suggestion

In this study, a review of existing literature reveals that while numerous studies exist on the application of recycled and natural materials in furniture design, the application of circular approaches to reuse, recycling, and waste materials within interior design curricula has been insufficiently explored. This research provides a concrete example of these issues. Future research is recommended to focus on the research, design, and production dimensions. According to the findings of this study, considering furniture design on a global scale and addressing waste, recycling, reuse, and the circular economy in collaboration with education, industry, and production will become important elements in the future. In this era of global resource depletion and increased environmental importance, the contribution of this study to the field will be immense.

- Unlike previous studies, this one thoroughly explores the systematic literature review, the creation of scientific concept maps using visuals, and the development of new and innovative furniture designs based on this data.
- This study provides a solid theoretical and applied research framework for future researchers. In the future, the methodology of this research could be refined, a new study could be prepared, or this study could be collaboratively translated into a furniture production process.
- Furniture design competitions, which were not included in this study, are also an important research topic. Today, furniture design competitions emphasize waste, recycling, and reuse. They offer both students and professionals the opportunity to present their original work. The aim is to provide research ideas that will contribute to the field of science in the future.
- This study conducts an in-depth analysis of design approaches centered on sustainability and environmental impact, utilizing a systematic literature review and concept mapping techniques. By incorporating these principles into innovative furniture design, the work establishes a robust framework for transforming theoretical insights into practical applications.
- It also explores the integration of digital design and manufacturing technologies, such as digital fabrication and 3D modeling, within furniture design processes. This investigation emphasizes the potential of these technologies to enhance design adaptability, production efficiency, and opportunities for customization, setting a strong foundation for further research in the field.

Additionally, the study underscores the necessity of strengthening interdisciplinary connections between materials science and furniture design. Areas such as the experimental use of innovative and alternative materials, including smart materials, composites, and natural fibers, are identified as critical directions for future research and development.

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Author Contributions

Emine Banu Burkut: Conceptualization (developing the research idea and objectives), Determining the methodology, Conducting the research, Conducting analyses, Data curation, Resources, Auditing, Validation, Visualization, Drafting the article, Writing, reviewing and editing the article

Conflict of interest statement

The authors declare no conflict of interest.

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