



## Reducing, reusing, and recycling in the furniture industry: A mini-review

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### ABSTRACT

This study explores sustainable practices within the furniture industry, focusing on the principles of reduce, reuse, and recycle. Through a comprehensive review of scholarly literature retrieved from databases like Scopus, Web of Science, and Google Scholar a moderate corpus of articles is identified. The analysis reveals a predominant emphasis on strategies aimed at minimizing resource consumption, extending product lifespans, and optimizing material recovery. While reduce, reuse and recycle serve as foundational pillars of sustainable furniture production, the literature also highlights complementary principles such as "rethink" and "refuse," urging critical reassessment and rejection of unsustainable practices. Despite the diversity in research interests and methodologies, the synthesis of findings underscores the need for standardization and comprehensive approaches to address environmental challenges throughout the furniture lifecycle. The study advocates for further research and collaboration to drive meaningful progress towards a more sustainable future for furniture production and consumption. This abstract encapsulates the key findings and implications of the study, providing a concise overview of the state of research on sustainable practices within the furniture industry. The aim of this short review is to analyse the scientific articles and their quantity relating to ecodesign in the furniture industry, with particular emphasis on the principles of reduce, reuse and recycle, as well as complementary concepts such as 'rethinking' and 'refuse'.

**Keyword:** Eco-design, Furniture Industry, Sustainable Practices



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## 1. Introduction

Alongside industrial advancement, there has been a substantial increase in waste generation, which adversely impacts the environment. Despite the gradual displacement of the linear economy, people persist in following a linear consumption pattern, wherein products are quickly discarded after use. In more eco-friendly scenarios, discarded items are sometimes incinerated for fuel, but the majority end up in landfills. Even though there may be opportunities for repair or alternative reuse, the prevalent practice is to discard and replace them with new products, often without considering the environmental consequences of production and disposal. The convergence of mass production with fast and inexpensive manufacturing in a linear economy escalates waste production significantly. The European Commission predicts that by 2050, Earth's resources will be exploited as if there were three planets, with each European generating an average of 5 tons of waste annually, and only 38% of waste being recycled in the EU [1].

Increasing awareness of pollution and resource exploitation has prompted measures to minimize environmental impact and manage existing waste. The concept of the circular economy is gaining momentum to address the current situation, mitigate industrial environmental impacts, and ultimately replace the linear take-make-waste model. The circular economy offers opportunities such as enhanced raw material security, innovation across various sectors, and the creation of new jobs, thereby boosting business competitiveness and fostering innovation [2]. Key principles involve the reuse of materials, energy source restoration or revitalization, and

minimizing waste production. Achieving positive outcomes requires the transformation of entire value chains and material flows into circular systems [3]. Tools, methods, and concepts have been developed to facilitate the transition to a circular economy, recognising its potential for significant economic and environmental changes. For instance, eco-labelling can drive sales and profits by providing consumers with information about a product's ecological credentials. Consumers increasingly prioritize environmental friendliness and sustainable sourcing, willing to pay premiums for products made from high-quality or recycled materials [4].

From the outset of product design, environmental considerations and circular economy principles should be integrated. Eco-design serves as a nexus between various disciplines such as ecological engineering, green architecture, and more, encompassing the entire product lifecycle [5]. Designers wield considerable influence over sustainable design, particularly when environmental considerations are incorporated early in the product development process [6]. Eco-design must encompass all aspects of the product lifecycle, including materials, transportation, manufacturing processes, waste management, and end-of-life considerations [7]. Implementing eco-design can significantly mitigate environmental impact, reduce waste generation, and enhance the company's image among consumers.

One of the fundamental principles guiding the creation of eco-friendly products, such as furniture, within the circular economy paradigm, involves embracing the "6 Rs": Reduce, Reuse, Repair, Rethink, Recycle, and Recover. Repairing items has gained traction as an increasingly favoured practice among individuals committed to circular economy principles, prioritizing restoration over disposal to promote eco-friendliness. The concept of "Reduce" prompts a critical reassessment of the necessity for new products and their potential environmental implications [8]. In industrial settings, reduction strategies aim to curtail energy, material, and resource consumption in the early stages of a product's life cycle. Reusing products or their components after their initial use prolongs their functional lifespan until they are no longer viable in their original capacity. Subsequently, these items can be cleaned, disassembled, and their materials sorted for use in another product's life cycle—a process commonly referred to as recovery. Rethinking the design and consumption patterns prompts a shift towards more sustainable practices, encouraging innovative solutions and minimizing waste generation. Recycling is another integral aspect, repurposing materials that would otherwise be discarded as waste, and converting them into new materials or products for example furniture made from wind turbines. Wings of Living, a furniture enterprise with the Polish manufacturer Anmet is responsible for producing the upcycled furniture pieces in collaboration with design students from the University of Zielona Góra's Institute of Fine Arts [Figure 1]. Another example has been produced by IKEA, one of the largest furniture firms globally, is well-known for its furnishings and home décor, and they are an example of mass producing this type of furniture. Figure 2 shows one example of the KUNGSBACKA kitchen fronts ('KUNGSBACKA - Kitchen Fronts Made from Plastic Bottles'), which are constructed from recycled PET bottles and repurposed wood. A front composed of twenty-five half-liter bottles. The kitchen fronts may be recycled again and remain in use after they have fulfilled their intended function, which can last up to 25 years. As an example of redesign, you can take the example of kitchen crate shelves made of wooden crates that were reused to make kitchen cabinets [Figure 3].



Figure 1. Desk created from old wind turbine during the collaboration Wings of Living, a furniture enterprise with the Polish manufacturer Anmet and design students from the University of Zielona Góra's Institute of Fine Arts



Figure 2. IKEA "Kitchen front KUNGSBACKA"

source: <https://www.ikea.com/ma/en/this-is-ikea/design/kungsbacka-kitchen-fronts-made-from-plastic-bottles-pubda9167b9>



Figure 3. Kitchen crate shelves made from reused wooden crates,

source: <https://www.funkyjunkinteriors.net/white-white-walls-with-revamped-kitchen-crate-shelves/>

In the furniture industry, where mass production is highly significant, not all the "Rs" are utilized; some are challenging to implement and require time and effort. However, incorporating them early in the design and manufacturing process can have a positive impact on the environment. In this mini review, we aim to identify the "Rs" applicable to mass production that are most used and those that are yet to be considered and implemented.

## 2. Method

This review focused on searching and analysing available scientific articles (concerning furniture design, eco-design, 6'r principles. To expand the scope of the search, we used). The Google Scholar browser was used for the search, which is a robust academic search engine provided by Google, offering a comprehensive database of scholarly literature. It covers a wide array of scientific sources, including peer-reviewed journal articles, books, conference papers, theses, and patents. Serving as a valuable tool for researchers, academics, and students alike, Google Scholar facilitates access to a vast collection of scholarly works across diverse fields of study. Its user-friendly interface and extensive coverage make it a preferred resource for discovering and accessing academic research. Scopus, which is an extensive academic database maintained by Elsevier, serves as a comprehensive repository of scholarly research. It encompasses a wide range of scientific literature, including articles published in reputable academic journals, scholarly books, conference proceedings, and patents. As a valuable resource for researchers, academics, and professionals across various disciplines, Scopus offers access to a vast collection of peer-reviewed content, facilitating the dissemination and discovery of scientific knowledge, and Web of Science, which is a leading scholarly citation index provided by Clarivate

Analytics, offering an extensive database of academic literature. It comprises a wide range of scientific sources, including peer-reviewed journal articles, conference proceedings, books, and patents. As a vital resource for researchers, scholars, and institutions, the Web of Science enables users to access a vast repository of high-quality research publications across various disciplines. Its advanced search functionalities and citation analysis tools make it a preferred platform for discovering, accessing, and analysing scholarly information. Specific search terms were identified to narrow down the analysis area, focusing on the 6Rs principles. Keywords such as "recycle," "reduce," "reuse," "rethink," "refuse," "recover," "furniture design," "design," "eco-design," and "sustainable" were used. Each academic research engine included phrases to search for, followed by the scope of the search [Table 1]. Subsequently, each search result was analysed for relevance and consistency with the search criteria such as abstract, keywords and abstract.

Table 1. Search criteria

6'r	phrase	criteria
Recycle, Reduce, Reuse	+furniture	keywords
Rethink, Refuse, Recover,	+furniture + design	keywords+abstract+title
	furniture + ecodesign	keywords+abstract+title
	furniture + design + sustainable	keywords+abstract+title

### 3. Results and Discussion

Reviewing the tables in the Scopus database, it is evident that there are significantly more search results compared to those obtained from the Web of Science database. However, it is notable that the number of results is not exceptionally high. Despite the comprehensive search phrases employed, the total number of articles retrieved for each category remains relatively moderate. This suggests that while there is a notable amount of literature available on sustainable practices in the furniture industry, further research may be necessary to fully explore the breadth and depth of this topic.

Tables containing relevant articles matching the search criteria were extracted from both Scopus and Web of Science. These tables provided a valuable set of data that was used for analysis and comparison of research outcomes on sustainable practices in the furniture industry. Through this analysis, a better understanding of the diversity of approaches and research directions in this field can be achieved. [Table 2. and 3.]

Table 2. Search results in the Scopus database

Search phrases	6'r							Total
	Without individual R	recycle	reduce	reuse	rethink	refuse	recover	
furniture - keywords		1	4	18	0	12	0	35
furniture+design - keywords+ abstract+title	9876	69	449	69	17	12	17	633
furniture + ecodesign - keywords+abstract+title	68	0	10	4	1	1	0	16
furniture + design + sustainable	473	6	39	27	4	0	1	77
Total		76	502	118	22	25	18	761

Table 3. Search results in the Web of Science database

Search phrases	Without individual R						Total
	recycle	reduce	reuse	rethink	refuse	recover	
furniture - keywords	19	3	2	x	x	x	24
furniture+design - keywords+ abstract+title	1	x	x	x	x	x	1
furniture + ecodesign - keywords+abstract+title	x	x	x	x	x	x	0
furniture + design + sustainable - keywords+abstract+title	7	x	x	x	x	x	0
<b>Total</b>	<b>20</b>	<b>3</b>	<b>2</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>25</b>

Table 1 provides a breakdown of the search results obtained from the Scopus database, showcasing the number of articles found for various search phrases related to sustainable practices in the furniture industry. Each search phrase corresponds to different aspects of sustainability, such as recycling, reducing, reusing, and so on. For instance, under the search phrase "Furniture - Keywords," it was found that there is 1 article related to recycling, 4 articles related to reducing, 18 articles related to reusing, 12 articles related to refusing, and no articles related to recovery. Similarly, for the search phrase "Furniture + Design - Keywords + Abstract," a significant number of articles were retrieved, with 9876 articles related to recycling, 69 articles related to reducing, 449 articles related to reusing, 69 articles related to rethinking, 17 articles related to refusing, and 12 articles related to recovery. Table 2 presents the search results from the Web of Science database using similar search phrases. However, it includes fewer search results compared to Table 1. For example, under the search phrase "Furniture - Keywords," 19 articles were found related to recycling, 3 articles related to reducing, and 2 articles related to reusing. The table also indicates "x" for certain categories where no results were found.

Overall, these tables offer a comprehensive overview of the availability of scholarly literature on sustainable practices in the furniture industry across different databases and search criteria. In the pursuit of comprehensively exploring the domains of furniture design, eco-design, and the principles of the 6Rs (reduce, reuse, recycle, rethink, refuse, and recover), researchers employ a diverse array of methodologies and tools to navigate the extensive corpus of scholarly literature. Among these tools, Google Scholar stands out as a preeminent academic resource renowned for its expansive repository, encompassing peer-reviewed journal articles, books, conference proceedings, theses, and patents. Despite its vast coverage, Google Scholar occasionally encounters limitations in precisely quantifying the corpus of literature meeting predetermined criteria, even with the utilization of its advanced search functionalities. These limitations stem from inherent challenges associated with the indexing process, leading to potential discrepancies in search results. Additionally, researchers leverage Web of Science, a prominent scholarly citation index curated by Clarivate Analytics, esteemed for its meticulous curation of high-quality research across diverse disciplines. However, researchers often face challenges in the form of insufficient results for specific search queries. The occurrence of the message "Your search found no results" underscores the complexities inherent in navigating scholarly databases and highlights the nuanced process of identifying literature that precisely aligns with predefined search parameters. In contrast, Scopus, a comprehensive academic database maintained by Elsevier, emerges as a pivotal resource in the scholarly landscape. With its exhaustive repository encompassing peer-reviewed journal articles, scholarly books, conference proceedings, and patents, Scopus provides researchers with an unparalleled breadth of coverage. Its capabilities prove instrumental in elucidating the multifaceted dimensions of furniture design, eco-design, and the principles of the 6Rs, facilitating the discovery of scholarly works that resonate with predefined search criteria. In summation, the pursuit of knowledge in the domains of furniture design, eco-design, and sustainable practices necessitates a strategic blend of persistence, innovation, and adaptability. While each academic research engine presents unique challenges and opportunities, it is through the synergistic integration of these tools and methodologies that researchers navigate the intricate tapestry of scholarly discourse, unveiling insights that inform and shape sustainable design practices for present and future generations.

One noteworthy study [9] delves deep into the intricate realm of recycling design. This research embarks on an exhaustive exploration of the significance of recycling design within the production framework of sustainable furniture goods. Through an analytical lens, it delves into the nuanced techniques of detachable design and modularization design. By placing a keen emphasis on the reuse of furniture products, the study underscores its pivotal role in mitigating environmental impact, conserving energy, and extending product lifespans. In doing so, it advocates for the adoption of recycling design principles as a cornerstone of sustainable furniture production practices.

Conversely, the reduction aspect finds elucidation in another seminal study [10]. Here, traditional Chinese mortise and tenon joints, once revered for their craftsmanship, face scrutiny in the context of contemporary environmental imperatives. The study seeks to unravel novel concepts and fresh approaches to the structural design of mortise and tenon joints, aligning them with modern-day carbon reduction and environmental protection criteria. By conducting a methodical examination of current structural design paradigms, the study propels forward the ethos of reduction within the green design ethos, thereby paving the way for sustainable furniture manufacturing practices.

In a bid to address the pressing issue of sedentary behaviour among office workers, a rigorous inquiry [11] comes to the fore. Through a pragmatic cluster randomized controlled trial, the study scrutinizes the efficacy of a dynamic work intervention in curtailing sitting time among office workers. While the intervention yielded moderate effectiveness, its findings underscore the imperative for comprehensive workplace solutions that transcend mere ergonomic modifications. It underscores the need for interventions that holistically address individual, organizational, and environmental factors contributing to prolonged sitting, thereby championing employee health and well-being.

The domain of reuse beckons further exploration, as evidenced by studies [12]. How value-retention processes can contribute to material efficiency and circularity." Here, the study probes the potential of value-retention processes like refurbishment, reuse, and repair in fostering material efficiency and circularity within the wood products industry. By quantifying specific environmental benefits accruing from cascading-use practices, the study sheds light on the pivotal role of reuse in the broader narrative of sustainable material management.

Additionally, studies [13]-[14] underscore the importance of reusing and recycling materials as integral components of sustainable development. These studies leverage service design principles and circular economy concepts to offer innovative solutions for repurposing idle furniture and extracting hidden value from discarded materials, thereby championing sustainability in the furniture industry. In conclusion, while the diversity in topics and methodologies may seem disparate, these studies collectively form a rich tapestry of insights that contribute to the advancement of sustainable practices within the furniture industry. Further research and collaboration are imperative to standardize methodologies and drive meaningful progress towards a more sustainable future for furniture production and consumption. Some articles explore complementary principles such as "rethink" and "refuse". The "rethink" principle encourages a critical reassessment of existing design and consumption patterns, prompting a shift towards more sustainable practices and innovative solutions. Meanwhile, the "refuse" principle advocates for the rejection of harmful or unsustainable materials and practices, promoting the use of alternative materials and production methods that align with environmental objectives.

Upon reviewing the tables in the Scopus database, it is evident that there are significantly more search results compared to those obtained from the Web of Science database. However, it is notable that the number of results is not exceptionally high. Despite the comprehensive search phrases employed, the total number of articles retrieved for each category remains relatively moderate. This suggests that while there is a notable amount of literature available on sustainable practices in the furniture industry, further research may be necessary to fully explore the breadth and depth of this topic.

#### **4. Conclusion**

Upon analysing the tables extracted from both Scopus and Web of Science databases, it becomes apparent that the available literature on sustainable practices within the furniture industry is not as extensive as initially anticipated. While the Scopus database yields a considerably higher number of search results compared to the Web of Science, the overall quantity of articles remains moderate. Despite the comprehensive search phrases employed, it is evident that the corpus of literature meeting the predefined criteria is not exceptionally large.

However, within this limited pool of articles, a few notable trends and themes emerge. Primarily, the principles of reduce, reuse, and recycle (often referred to as the "3 Rs") dominate the landscape of sustainable practices within the furniture industry. These principles are widely recognized as foundational pillars of sustainable design and production, applicable across various stages of the product lifecycle. Articles focusing on the "reduce" principle delve into strategies aimed at minimizing resource consumption, energy usage, and waste generation in the early stages of furniture production. These strategies are crucial for mitigating environmental impact and promoting resource efficiency, particularly in the context of mass production and industrial manufacturing processes. Similarly, research addressing the "reuse" principle explores innovative approaches to prolonging the functional lifespan of furniture products. By emphasizing repair, refurbishment, and repurposing, these studies highlight the potential for extending the utility of furniture beyond its initial use, thereby reducing the demand for new materials, and minimizing waste generation. The "recycle" principle, which involves repurposing materials from discarded products to create new items, is also a focal point of many articles. Researchers investigate various recycling techniques and technologies applicable to different materials commonly used in furniture production, such as wood, metal, and plastics. These studies aim to optimize resource recovery and minimize the environmental footprint associated with furniture disposal. In addition, research on sustainable practices within the furniture industry, as extensively documented in academic databases like Scopus, reflects a multifaceted landscape of inquiries and investigations. Despite the absence of uniformity in thematic alignment and keyword consistency, these studies collectively contribute to the overarching goal of fostering environmental conservation and sustainability through a triad of approaches: recycling, reducing, and reusing materials. Despite the absence of uniformity in thematic alignment and keyword consistency, these studies collectively contribute to the overarching goal of fostering environmental conservation and sustainability through a triad of approaches: recycling, reducing, and reusing materials. Despite the prevalence of these principles in the literature, it is important to note the absence of uniformity in thematic alignment and keyword consistency across the articles. This lack of standardization reflects the diverse array of research interests, methodologies, and disciplinary perspectives within the field of sustainable furniture design. While this diversity enriches the scholarly discourse, it also poses challenges in terms of synthesizing findings and identifying overarching trends. Furthermore, most articles tend to focus on specific aspects of sustainable practices within the furniture industry, such as material reuse, recycling technologies, or design innovation. Few studies offer comprehensive analyses spanning the entire product lifecycle or address the interplay between different sustainability principles. In conclusion, while the number of articles may be limited, they provide valuable insights into sustainable practices within the furniture industry, particularly focusing on the fundamental principles of reducing, reusing, and recycling. However, further research and collaboration are imperative to standardize methodologies, address thematic inconsistencies, and drive meaningful progress towards a more sustainable future for furniture production and consumption.

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