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# Factors influencing circular transition towards the adoption of remanufacturing in the furniture sector

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ABSTRACT

*Background:* The transition to a circular economy presents both opportunities and challenges for traditional manufacturing sectors. Remanufacturing is a key strategy for extending product lifecycles and reducing environmental impact, yet its adoption remains limited in the furniture industry.
*Purpose:* This study explores the factors influencing the adoption of remanufacturing in the furniture sector.
*Method:* A structured literature review and qualitative empirical study were conducted, including 21 interviews and two workshops with actors across the furniture value chain. A multi-level framework (macro, meso, micro) was used to analyze factors influencing the adoption of remanufacturing.
*Findings:* The results reveal that regulations and policies, customer attitudes, and procurement practices are critical macro-level factors. At the meso level, collaboration in the value chain was identified as a key factor. Micro-level factors include business models, operational practices, and design strategies.
*Contribution:* This study therefore expands existing literature about remanufacturing by identifying the factors on macro, meso and micro level for the original manufacturers, remanufacturers and customers in public sector in this study. Specifically, the study demonstrates the importance of collaboration in the value chain as well as need for new business models in this complex environment.

## 1. Introduction

The transition to a circular economy (CE) represents a paradigm shift in how organizations approach resource utilization and waste management (Pichlak and Szromek, 2022). Unlike the traditional linear economy, which follows a 'take-make-dispose' model, the circular economy aims to create closed-loop systems where resources are continuously reused, refurbished, and recycled (Kirchherr et al., 2017). Laws and regulations, such as the European Green Deal and EcoDesign directives, are expected to accelerate the circular transition (European Commission, 2025, Srisathan et al., 2025). Recent research emphasizes that advancing circular economy practices requires openness and shared learning across organizational boundaries, aligning closely with the principles of open innovation, as such transitions cannot be achieved by isolated actors (Ghisellini et al., 2016; Bauwens et al., 2020; Pichlak and Szromek, 2022; Krmela et al., 2022; Hadi and Khan, 2025).

One of the strategies within the circular economy concept is remanufacturing (Potting et al., 2017; Kirchherr et al., 2017). Remanufacturing is an industrial process that restores the end-of -life products to their original functionality and condition (Sundin, 2019). The interest in remanufacturing has evolved across various sectors, including electrical products (Kernbaum et al., 2009; Shahbazi et al., 2021), heavy equipment (Casper and Sundin, 2021, Kanazawa et al., 2022), automotive (Xiao et al., 2018; Saidani et al., 2020), medical equipment (Kodhelaj et al., 2019) and white goods (Franzè et al. 2023). Despite its potential, the adoption of remanufacturing practices varies significantly across sectors. While sectors such as automotive and electrical products have begun embracing remanufacturing, others, like the furniture sector, are still in the early stages of adoption remanufacturing (Pei et al., 2024; Wulf et al., 2024). The furniture sector, which frequently involves wood-based products, presents significant opportunities for remanufacturing to extend product lifecycles and reduce the use of virgin materials (Kans and Löfving, 2024). When furniture is replaced due to wear, damage, or outdated design, the majority is discarded (Vanacore et al., 2021; FURN360 2025). For example, of the 10.78 million tons of total annual furniture waste generated in Europe,

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80–90 % is either incinerated or ends up in landfill (FURN360 2025). A sustainable alternative would be to extend the lifespan or increase the number of lifecycles and retain the value of the product by remanufacturing (Kurilova-Palisaitiene et al., 2023). However, the circular transition is a challenging process that requires an expansion of the producer's responsibility (Gupt and Sahay, 2015; Mejía-Moncayo et al., 2023; UN Environment programme, 2025) while in parallel considering policies and regulations, business models and technological developments (Lieder and Rashid, 2016; Mejía-Moncayo et al., 2023). When companies adopt remanufacturing practices, the companies are often required to rethink their traditional linear business models and shift toward new circular business models that prioritize product life extension. This transformation involves innovative approaches to value creation, pricing, customer engagement, and services (Linder and Williander, 2017). Circular transitions also require strong collaboration and information exchange across the value chain, including sharing product information, coordinating material flows, and co-developing circular solutions, conditions that reflect the collaborative, cross-boundary knowledge flows emphasized in open-innovation scholarship (Blomsma et al., 2019; Chen and Huang, 2021; Mejía-Moncayo et al., 2023; Psarommatis et al., 2025; Prado et al., 2025; Mohammadian et al., 2025).

The complexity of the industry affects its adaptability to circular practices (Lahrour et al., 2019; Wang et al., 2023, 2023). The furniture sector comprises a wide range of actors, including subcontractors, original producers, and retailers. Consumers and end-users are also highly diverse as furniture is used by private consumers and organizations, and public sectors such as schools and government agencies. Unlike the relatively straightforward and well-established linear value chain, circular value flows are inherently more complex and less thoroughly understood, particularly due to the multiple actors involved and the dynamic nature of material recovery, reuse, and redistribution processes (Lahrour et al., 2019). Moreover, the characteristics of the original manufacturing enterprises further contribute to this complexity. In Europe, the furniture industry is characterized as a dynamic and labor-intensive sector, predominantly composed of small and medium-sized enterprises (SMEs) and micro-enterprises (Wulf et al., 2024; European Commission, 2025). In Sweden, the industry reflects a similar structure, with most original manufacturers being SMEs that primarily operate in the business-to-business (B2B) market by selling their products through retailers (TMF, 2020). This stands in contrast to the large multinational furniture company IKEA, which focuses on a business-to-consumer (B2C) model. While IKEA plays a leading role in shaping the global furniture industry and advancing circular initiatives, replicating such strategies at the SME level involves business-related risks due to limited resources and scalability challenges (Wulf et al., 2024; Alcalde-Calonge et al., 2024). This study adopts a holistic approach to examining actors in the furniture sector from a business-to-business (B2B) perspective, with a focus on original manufacturing SMEs.Therefore, the purpose of the study is to explore factors that influence circular transition towards the adoption of remanufacturing in the furniture sector.

To achieve the purpose of the study, a literature review on factors influencing the adoption of remanufacturing was conducted. Moreover, a qualitative study including interviews and workshops was conducted with representatives from actors in the B2B furniture value chain. By examining the interplay among micro, meso, and macro-level factors within the furniture sector, this study will provide insights into how the factors influence the adoption of remanufacturing. The study contributes to theory by emphasizing the need for more empirical studies to understand circular transition from linear economy to circular economy and the adoption of the circular strategies in broader terms (De Jesus and Mendonça, 2018), and particular the furniture sector as emphasized by Kans and Löfving (2024). The contribution to practitioners includes strategic insights for businesses looking to transition to a circular economy model, actionable recommendations for extending the product lifecycle, and policy recommendations to regulatory bodies.

The remainder of this paper is structured as follows: 2 presents the research methodology, 3 reviews the literature on remanufacturing and presents the theoretical framework. 4 describes the empirical findings, and Sections 5 and 6 provide the discussion and conclusions

## 2. Applied research methods

This research adopts a qualitative case study approach to explore the adoption of remanufacturing within the furniture sector in Sweden. The case study methodology is appropriate as it enables an in-depth investigation of a contemporary within its real-life context (Yin, 2018).

### 2.1. Literature review

To identify factors influencing the adoption of remanufacturing as reported in previous research, we conducted a structured literature review.

An initial literature review was conducted in 2023, focusing on remanufacturing within the wood and furniture industry. The methodology and findings of this review are detailed in Kans and Löfving (2024). Based on an analysis of 26 publications, this review served as a foundation for identifying key factors influencing the adoption of furniture remanufacturing. To broaden the scope, the review was subsequently extended to include factors influencing the adoption of remanufacturing in a more general context.

A structured literature review (SLR) was conducted in 2025 to synthesize current knowledge on barriers and enablers in remanufacturing across micro, meso, and macro system levels. The review followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework (Page et al., 2021) to ensure methodological transparency and rigor.

Systematic research was carried out on the Web of Science and Scopus databases, focusing on review articles published between 2016 and 2025. The search strategy targeted literature that explicitly addressed remanufacturing in relation to challenges, barriers, and enabling factors (keyword combinations remanufacturing AND hinder* OR challenge* OR barrier* OR enabl*). The search was conducted within both the title and abstract fields to ensure a comprehensive overview of the relevant content. After removing duplicates, a total of 153 unique articles were identified.

To ensure relevance and quality, articles were screened based on the following inclusion criteria:

Explicit focus on remanufacturing,
Coverage of micro, meso, or macro levels of analysis,
Classification as review articles,
Written in English

Titles and abstracts were reviewed against these criteria, resulting in 47 articles deemed relevant for inclusion. The majority of these focused on the micro level, with fewer contributions addressing meso and macro perspectives. Notably, themes related to automation and digitalization were particularly prominent at the micro level. In total, 20 factors were identified.

Based on this synthesis, a theoretical framework was developed to structure the identified influencing factors across system levels. The framework was constructed through thematic analysis, enabling the identification and categorization of recurring patterns and relationships across the selected literature. This framework presented in Table 1, provides a structured lens for analyzing the empirical findings in the subsequent phase of the study.

### 2.2. Study context and case selection

The context of this study is Sweden and the Swedish furniture sector, which has a strong tradition of furniture products. This sector is characterized by strong sustainability regulation, public procurement, and B2B market structures. While industrial structures and consumer

**Table 1**
Study participants.

| Respondent # | Actor type | Role of respondent |
|---|---|---|
| 1 | Original manufacturer A | Product development manager |
| 2 | Original manufacturer B | CEO |
| 3 | Original manufacturer C | CEO |
| 4 | Original manufacturer D | Environmental, social and governance manager |
| 5 | Original manufacturer E | CEO |
| 6 | Original manufacturer F | R&D manager |
| 7 | Original manufacturer G | CEO with a responsibility of sales |
| 8 | Original manufacturer H | Sustainability expert |
| 9 | Original manufacturer I | CEO |
| 10 | Original manufacturer J | CEO |
| 11 | Remanufacturer K | CEO |
| 12 | Remanufacturer L | CEO |
| 13 | Remanufacturer M | CEO |
| 14 | Retailer N | CSR |
| 15 | Retailer O | Sustainability manager |
| 16 | Public sector P | Business developer |
| 17 | Public sector Q | Environmental coordinator |
| 18 | Public sector R | Environmental strategist |
| 19 | Public sector S | Sustainability strategist |
| 20 | Public sector T | Environmental developer |
| 21 | Public sector U | Environmental manager |

behavior vary across regions, the Swedish context provides a theoretically relevant case for studying early-stage circular transitions under advanced regulatory conditions.

A comprehensive representation of the value chain of furniture sector was a guiding principle in the selection of the sample. The focus in this study is actors in the B2B furniture value chain that are also partly described by Brege et al. (2022) and Kans (2024). To understand the perspectives of the different actors, customers, original manufacturers, retailers, remanufacturers, and customers were selected as samples in the study. The primary customers in this study are public sector organizations, which procure furniture in accordance with the Swedish Public Procurement Act based on the Swedish Law of Procurement. The original manufacturers were identified using SNI codes. The organizations in the public sector were first selected based on convenience sampling. When the original manufacturers and organizations in public sectors were interviewed, they were asked if there were other relevant organizations in the value chain that we should interview. Following the initial selection of organizations based on convenience sampling, a snowball sampling approach was applied to identify additional relevant actors in the furniture value chain. This approach helped capture perspectives from interconnected actors that are difficult to identify through formal sampling, though it may bias the sample toward sustainability-engaged organizations. To reduce this risk, organizations of varying sizes, roles, and levels of remanufacturing experience, including those with limited or no involvement, were included.

Upon initial contact, organizations were asked to designate a representative knowledgeable about remanufacturing. This resulted in interviews with 10 respondents from small, medium, and large producers (between 14 and 1700 employees) comprised of 6 CEOs, 1 product development manager, 1 R&D manager, 1 sustainability expert and 1 environmental, social and governance manager. Three CEOs from remanufacturing companies were also interviewed as well as two representatives from retailers. 6 representatives from the public sector that represented the customers were also interviewed. The organizations included counties and municipalities. Here, 5 of 6 representatives worked with sustainability or environmental issues, and one had the position of business developer. The prevalence of environmental sustainability experts and those responsible in the public sector likely suggests that within the selected organizations, remanufacturing is closely connected to sustainability.

### 2.3. Data collection

The main methods of collecting empirical data were semi-structured interviews and workshops.

#### 2.3.1. Semi-structured interviews

Before the semi-structured interviews were carried out, a semi-structured interview guide was designed by the researchers. The guide comprised questions regarding knowledge and adoption of remanufacturing with specific questions to the different actors in the value chain. Several of the questions were open-ended questions, chosen as they open for follow-up questions and deeper investigations in the field (Yin, 2018). During data collection, no single predefined definition of remanufacturing was imposed on the respondents. Instead, participants were encouraged to describe their understanding and practices using their own terminology. Divergent interpretations of remanufacturing were therefore not treated as inconsistencies, but as empirical findings reflecting industry-level ambiguity.

In total, 21 interviews were conducted between October 2022 and January 2023 with representatives from different parts of the furniture value chain see Table 1. All interviews were conducted online, and at least two researchers participated in each interview. The interview lasted between 15 and 60 min. The interviews were recorded and transcribed.

#### 2.3.2. Workshops

Two workshops were conducted to further develop knowledge about factors influencing the circular transition towards the adoption of remanufacturing. The first workshop aimed at the customer perspective, and the other workshop aimed at the original manufacturer perspective. Participants were researchers from the research group, representatives from an intermediate organization, an industry association, two organizations from the public sector, and one company. The approach of both workshops was inspired by the strategic development map (Löfving et al., 2023) as well as the method “Stop, Start, Continue” (see for example Pearlson and Saunders, 2009; Hoon et al., 2015).

### 2.4. Empirical data analysis

The empirical data collected through interviews and workshops were initially analyzed independently using the theoretical framework and proposed factors, presented in Table 1. A deductive thematic analysis was applied, following the approach of Braun and Clarke (2006), wherein the factors from the theoretical framework were used as the predetermined themes. Thereafter, a cross-case analysis was conducted to synthesize insights across the two empirical data sets. This comparative approach, inspired by the cross-case analysis by Miles and Huberman (1994), facilitated a deeper understanding of the findings. The analysis process enabled a structured analysis of how the empirical data was aligned with the theoretical findings.

In addition, a content analysis was performed to explore how the identified factors were distributed across various actors in the value chain. This step aimed to uncover which actors in the value chain were most associated with specific key factors of the adoption of remanufacturing. The integration of content analysis provided a deeper understanding of actor-specific influences, and due to this, enriched the overall interpretation of the empirical findings.

During the data analysis, reported practices were interpreted both according to respondents’ own descriptions and in relation to

established circular R-strategies (e.g., reuse, refurbishment, and remanufacturing). This approach allowed comparison across cases while acknowledging differences in interpretation.

### 2.5. Visual data analysis using Sankey diagram

To complement the thematic and content analyses of the interview and workshop data, a Sankey diagram was developed to visualize the multi-level framework of factors influencing the adoption of remanufacturing in the furniture sector. The Sankey diagram was chosen for its ability to represent complex systems of interconnected elements through weighted flows, making it particularly suitable for illustrating the relationships between macro, meso, and micro-level factors and their influence on key actors in the value chain.

The flow logic of the diagram begins with the three levels, macro, meso, and micro, which serve as the origin nodes. Each level connects to its respective influencing factors, identified through the structured literature review and empirical data. These factors include, for example, government regulations and customer attitudes at the macro level, collaboration and sectoral transformation at the meso level, and business models, design strategies, and operational practices at the micro level.

From these factors, flows extend to the actors most affected by or responsible for implementing remanufacturing strategies: original manufacturers, remanufacturers, and public sector organizations. In this paper, the Sankey diagram serves both as an analytical tool and an illustration of the results, and helped the authors to identify convergence points, which are influenced by multiple upstream factors. The Sankey diagram was generated based on coded empirical data indicating the presence of specific factors across actors and system levels. Flow thickness reflects the frequency of factor occurrence across interviews and workshops. Copilot was used solely as a visualization tool; factor selection, coding, and interpretation were performed by the authors.

## 3. Literature review and theoretical framework

### 3.1. Remanufacturing as a circular strategy

Remanufacturing is one of several circular strategies aimed at extending product lifecycles and retaining value within material flows. Circular strategies are often conceptualized using the 10R framework, which ranges from strategies such as *Refuse* and *Rethink* at the most preventive level, to *Repair*, *Reuse*, *Refurbish*, and *Remanufacture*, and finally *Recycle* and *Recover* at the lowest level of value retention (Potting et al., 2017; Reike et al., 2018; Kirchherr et al., 2017). Within this hierarchy, remanufacturing represents a comparatively high-value strategy, as it aims to restore used products or components to a condition comparable to new products in terms of functionality and performance, while preserving much of the embedded material, labor, and energy.

Remanufacturing is commonly defined as an industrial process in which used products are systematically disassembled, cleaned, inspected, repaired or upgraded, and reassembled to meet predefined quality standards (Sundin, 2019). Unlike repair or refurbishment, which typically address specific defects or aesthetic degradation, remanufacturing involves a more comprehensive and standardized process and often includes warranty conditions similar to those of new products. As emphasized by Kans and Löfving (2024), the practical interpretation of remanufacturing may vary across industries and actors, but its defining characteristic lies in its ambition to extend product lifecycles while retaining both functional value and brand integrity.

From a sustainability perspective, remanufacturing offers several advantages compared to linear production. By reusing existing components and materials, remanufacturing can substantially reduce the demand for virgin resources, lower waste generation, and decrease environmental impacts across the product lifecycle. These benefits are particularly relevant in manufacturing sectors where products are material-intensive and designed for long use phases, such as the furniture industry (Kans and Löfving, 2024). In addition to material efficiency, remanufacturing has been associated with significant reductions in energy use and emissions compared to new production, making it an important strategy for improving environmental and energy performance—an aspect further elaborated in the following subsection

Remanufacturing is widely recognized for its environmental benefits, with several studies demonstrating reductions in material and energy use. For example, Wang et al. (2023), (2023) present a case study on TV disassembly, using a deep reinforcement learning approach to optimize disassembly sequences and improve energy recovery from end-of-life products. Life-cycle assessments show that remanufactured products can significantly lower environmental impacts compared to new production, as illustrated by loading machines (Xiao et al., 2018) and mining machinery (Kanazawa et al., 2022). Sectoral shifts such as automotive electrification further influence the environmental potential of remanufacturing (Casper and Sundin, 2021). In addition, design approaches that support automated remanufacturing can enhance resource efficiency (Shahbazi et al., 2021).

### 3.2. Open innovation in the context of circularity and remanufacturing

Open innovation refers to the purposeful management of cross-boundary knowledge flows to enhance learning, competitiveness, and innovation in production and market development (Annamalah et al., 2022; Zhang et al., 2023). This is enabled through outside-in, inside-out, and coupled processes. Audretsch and Belitski (2023) further highlight open innovation as an interactive process of collaborative knowledge exchange involving partnerships with customers, suppliers, competitors, and universities. Open innovation is not automatically beneficial; its outcomes depend on industry context, the costs and risks associated with collaboration (Audretsch and Belitski, 2023), and on firms' internal learning and knowledge-management capabilities (Zhang et al., 2023). Zhang et al. (2023) show that openness leads to competitive advantage only when firms possess the absorptive and transformative capacities required to exploit external knowledge. Unlike closed innovation, which relies exclusively on internally generated knowledge, open innovation encourages firms to leverage external expertise and share internal resources, thus expanding their opportunities for value creation (Annamalah et al., 2022).

In the context of circular economy transitions, open innovation is particularly relevant for enabling inter-firm collaboration, shared infrastructures, knowledge exchange, and the co-development of new value propositions. It also provides mechanisms through which firms can interact, share information, and jointly shape innovation processes. Collaborative networks formed to pursue circular strategies can be understood as open-innovation ecosystems that reshape business-model elements and support industry-level transitions toward circularity (Krmela et al., 2022). Hadi and Khan (2025) further position open innovation as a foundational precondition for adopting circular business models rather than a discretionary, nice-to-have enabler. Circular open innovation supports data sharing, cross-sector collaboration, and co-creation needed for circular transitions, particularly when combined with Industry 4.0 technologies that enable transparency and digital traceability along product lifecycles (Hadi, Almessabi and Khan, 2025). It also facilitates the cross-organizational transparency and product-lifecycle information required to enable circular strategies such as repair, reuse, and remanufacturing (Mohammadian et al., 2025). Ipaki and Heydarie (2025) highlight how open-innovation mechanisms, such as shared patents, open-source design, remanufacturability labels, and Digital Product Passports, can drive circular strategies by directly supporting design for disassembly, repairability, and remanufacturing. Moreover, consumer-level open innovation strengthens circular supply chains by increasing engagement in end-of-life return programs through shared knowledge, cooperation, and inclusive policies, thereby improving product availability for repair, reuse, and remanufacturing

(Srisathan et al., 2025).

### 3.3. Theoretical framework applied in this study

At the macro level, the focus is on national and governmental levels (see for example Ghisellini et al., 2016; Mayer et al., 2019) that shape the broader system and governmental conditions for CE practices, including remanufacturing. In total, seven macro-level factors were identified in the literature review, see Table 2, with Government regulations, policies, and laws emerging as the most frequently emphasized in previous research studies. This factor includes legal frameworks, policies, and economic incentives that influence the feasibility, scalability, and attractiveness of remanufacturing. Closely following the factor Government in prevalence is Customer attitude and acceptance, which captures the public's perception and willingness to purchase remanufactured products.

The meso level involves interactions within industrial clusters and eco-industrial parks (Ghisellini et al., 2016; Kirchherr et al., 2017). Additionally, Blomsma et al. (2019) incorporate sectors, materials, and business types at the meso level. In this article, the meso level factors cover the value chain, sector, and industry specific context. Four meso-level factors were identified in the literature review. Relations and collaboration in the value chain and sector's ability to transform gained most attention in previous research studies. Relations and collaboration in the value chain address partnerships and coordination among stakeholders in the remanufacturing ecosystem while the sector's ability to transform refers to the capacity to adapt to remanufacturing through innovation and restructuring.

At the micro level, the focus is on the specific processes and practices within an individual company or for a particular product, or a consumer (Ghisellini et al., 2016; Kirchherr et al., 2017; Blomsma et al., 2019). The micro level in this study concerns company specific factors and nine micro-level factors were identified in the literature review. Several of these micro-level factors are frequently highlighted in previous research studies. The micro-level factors that gained less attention are Procurement and purchasing strategy, The organization's ability to transform and Sales and market share. 42 of the 47 identified articles in the literature review highlight Technological and operational factors as critical for remanufacturing. Technological and operational factors cover tools, processes, and systems that enable efficient remanufacturing. Design and materials are also revealed as essential for remanufacturing as 32 articles mention this factor. Product design and material choices that facilitate remanufacturing are covered in this factor.

#### 3.3.1. Furniture-industry-specific characteristics included in the framework

Research on remanufacturing in the furniture industry remains limited; for example, Kans and Löfving (2024) identify only around 20 prior studies addressing this topic. The furniture industry exhibits several characteristics that influence remanufacturing factors across system levels. Furniture products have long lifespans and slow replacement cycles, which reduce the predictability and volume of returned products (Vanacore et al., 2021; Kurilova-Palisaitiene et al., 2023; Kans and Löfving, 2024). Demand is strongly influenced by design, aesthetics, and brand identity, affecting customer acceptance of remanufactured furniture (Kans and Löfving, 2024; Pei et al., 2024). The sector is dominated by SMEs operating in intermediary-driven B2B value chains, where retailers and designers act as key decision-makers, limiting direct manufacturer–end-user interaction (Brege et al., 2022; Blomsma et al., 2019). At the micro level, heterogeneous materials, undocumented legacy products, and low-volume project-based operations constrain the scalability of remanufacturing (Kans and Löfving, 2024; Lahrour et al., 2019).

## 4. Empirical findings

In this section, the empirical findings are presented based on the

**Table 2**
Theoretical framework including proposed factors for remanufacturing.

| Proposed factors on Macro level | Main sources |
|---|---|
| Government regulations, policies, and laws | Chong et al. (2024); Misran, Roslin (2018); Ngu et al. (2020); Wang et al. (2023), (2023); Ayati et al. (2022); Chen and Huang (2021); Moroni-Cutovoi (2021); Kerin and Pham (2020); Okorie et al. (2021); Golinska-Dawson et al. (2025); Yuan et al. (2025); Mejía-Moncayo et al. (2023); Dong et al. (2023); ElMenshawy et al. (2024) |
| Customer attitude and acceptance | Chong et al. (2024); Misran, Roslin (2018); Ngu et al. (2020); Wang et al. (2023), (2023); Ayati et al. (2022); Kerin and Pham (2020); Okorie et al. (2021); Golinska-Dawson et al. (2025); Mejía-Moncayo et al. (2023); ElMenshawy et al. (2024) |
| Waste and energy infrastructre | Rahito et al. (2019); Dong et al. (2023); ElMenshawy et al. (2024) |
| Standardization and certification frameworks | Chong et al. (2024); Misran, Roslin (2018); Yang et al. (2023); Kim et al. (2024); Dong et al. (2023); Forcael et al. (2025); ElMenshawy et al. (2024) |
| Information Infrastructure, Digital Platforms and security | Ngu et al. (2020); Wang et al. (2023), (2023); Chen and Huang (2021); Kerin and Pham (2020); Yang et al. (2023); Teixeira et al. (2022); Kim et al. (2024); Mejía-Moncayo et al. (2023) |
| Public education and awareness | Ayati et al. (2022); Kerin and Pham (2020); Okorie et al. (2021); Mejía-Moncayo et al. (2023) |
| Enterprise demand and willingness | Chen and Huang (2021); Okorie et al. (2021); Golinska-Dawson et al. (2025); Mejía-Moncayo et al. (2023) |
| **Proposed factors on Meso level** | **Main sources** |
| Relations and collaboration in the value chain | Chong et al. (2024); Misran, Roslin (2018); Ngu et al. (2020); Wang et al. (2023), (2023); Chen and Huang (2021); Moroni-Cutovoi (2021); Kerin and Pham (2020); Okorie et al. (2021); Golinska-Dawson et al. (2025); Yuan et al. (2025); Mejía-Moncayo et al. (2023); ElMenshawy et al. (2024) |
| The sector's ability to transform | Chong et al. (2024); Misran, Roslin (2018); Ngu et al. (2020); Wang et al. (2023), (2023); Chen and Huang (2021); Moroni-Cutovoi (2021); Kerin and Pham (2020); Kahhal et al. (2024); Okorie et al. (2021); Golinska-Dawson et al. (2025); Dong et al. (2023); Forcael et al. (2025); ElMenshawy et al. (2024) |
| Competence needs | Misran, Roslin (2018); Ngu et al. (2020); Kerin and Pham (2020); Caterino et al. (2025); Matsumoto et al. (2016); Kanishka and Acherjee (2023); Hjorth and Chrysostomou (2022); Di Pasquale et al. (2024) |
| Research and innovation | Chong et al. (2024); Kerin and Pham (2020); Kahhal et al. (2024); Okorie et al. (2021); Matsumoto et al. (2016); Teixeira et al. (2022); Du et al. (2023); ElMenshawy et al. (2024) |
| **Proposed factors on Micro level** | **Main sources** |
| Value offer and business models | Ayati et al. (2022); Chen and Huang (2021); Di Gerlando et al. (2024); Hofmeester, Eyers (2023); Psarommatis et al. (2025); Kerin and Pham (2020); Okorie et al. (2021); Golinska-Dawson et al. (2025); Matsumoto et al. (2016); Yang et al. (2023); Mejía-Moncayo et al. (2023); Dong et al. (2023); Kumar and Ramachandran (2016) |
| Technological and operational factors | Chong et al. (2024); Misran, Roslin (2018); Wang et al. (2023), (2023); Ayati et al. (2022); Ngu et al. (2020); Chen and Huang (2021); Moroni-Cutovoi (2021); Chau et al. (2021); Di Gerlando et al. (2024); Hofmeester, Eyers (2023); Kaarlela et al. (2024); Lee et al. (2024); Shrivastava et al. (2021); Yang et al. (2022); Psarommatis et al. (2025); Liu et al. (2024); Kerin and Pham (2020); Kahhal et al. (2024); |

(continued on next page)

**Table 2** (*continued*)

| Proposed factors on Macro level | Main sources |
|---|---|
| | Sitcharangsie et al. (2019); Okorie et al. (2021); Caterino et al. (2025); Matsumoto et al. (2016); Rahito et al. (2019); Teixeira et al. (2022); Zhang et al. (2021); Du et al. (2023); Kanishka and Acherjee (2023); Habeeb et al. (2023); Hjorth and Chrysostomou (2022); Yuan et al. (2025); Kim et al. (2024); Zhao et al. (2024); Abd Aziz et al. (2021); Mejía-Moncayo et al. (2023); Abuzied et al. (2020); De Simone et al. (2025); Di Pasquale et al. (2024); Dong et al. (2023); Forcael et al. (2025); Zhao et al. (2024), (2024); Yan et al. (2018); Jing et al. (2023); Kumar and Ramachandran (2016) |
| Procurement and purchasing strategy | Chen and Huang (2021); Moroni-Cutovoi (2021); Kaarlela et al. (2024); Zhang et al. (2021) |
| The organization's ability to transform | Ayati et al. (2022); Moroni-Cutovoi (2021); Di Geraldo et al. (2024); Hofmeester and Eyers, (2023); Lee et al. (2024); Psarommatis et al. (2025); Chau et al. (2021); Kaarlela et al. (2024); De Simone et al. (2025); Di Pasquale et al. (2024) |
| Design and materials | Chong et al. (2024); Misran, Roslin (2018); Ayati et al. (2022); Ngu et al. (2020); Chen and Huang (2021); Chau et al. (2021); Di Gerlando et al. (2024); Kaarlela et al. (2024); Lee et al. (2024); Shrivastava et al. (2021); Yang et al. (2022); Psarommatis et al. (2025); Hofmeester, Eyers (2023); Liu et al. (2024); Kahhal et al. (2024); Caterino et al. (2025); Golinska-Dawson et al. (2025); Matsumoto et al. (2016); Rahito et al. (2019); Yang et al. (2023); Zhang et al. (2021): Du et al. (2023); Kanishka and Acherjee (2023); Habeeb et al. (2023); Yuan et al. (2025); Zhao et al. (2024); Abd Aziz et al. (2021); Abuzied et al. (2020); Forcael et al. (2025); Zhao et al. (2024), (2024); Jing et al. (2023); Kumar and Ramachandran (2016) |
| Reverse logistics and collection strategy | Chong et al. (2024); Wang et al. (2023), (2023); Kaarlela et al. (2024); Psarommatis et al. (2025); Hofmeester, Eyers (2023); Kerin and Pham (2020); Sitcharangsie et al. (2019); Golinska-Dawson et al. (2025); Matsumoto et al. (2016); Kim et al. (2024); Zhao et al. (2023); Mejía-Moncayo et al. (2023); Dong et al. (2023); ElMenshawy et al. (2024) |
| Sales and market share | Chen and Huang (2021); Di Geraldo et al. (2024); Okorie et al. (2021); ElMenshawy et al. (2024); Kumar and Ramachandran (2016) |
| Traceability, quality assurance and product information | Chong et al. (2024); Wang et al. (2023), (2023); Ayati et al. (2022); Ngu et al. (2020); Moroni-Cutovoi (2021); Chau et al. (2021); Hofmeester, Eyers (2023); Di Gerlando et al. (2024); Kaarlela et al. (2024); Shrivastava et al. (2021); Psarommatis et al. (2025); Liu et al. (2024); Kerin and Pham (2020); Sitcharangsie et al. (2019); Okorie et al. (2021); Golinska-Dawson et al. (2025); Zhang et al. (2021); Du et al. (2023); Kanishka and Acherjee (2023); Kim et al. (2024); Zhao et al. (2024); Abd Aziz et al. (2021); Dong et al. (2023); Yan et al. (2018); Jing et al. (2023); ElMenshawy et al. (2024) |
| Digitalization and intelligent process control | Shrivastava et al. (2021); Kaarlela et al. (2024); Lee et al. (2024); Psarommatis et al. (2025); Chau et al. (2021); Hofmeester, Eyers (2023); Di Gerlando et al. (2024); Yang et al. (2022); Liu et al. (2024); Kerin and Pham (2020); Kahhal et al. (2024); Caterino et al. (2025); Rahito et al. (2019); Yang et al. (2023); Teixeira et al. (2022); Du et al. (2023); Kanishka and Acherjee (2023); Habeeb et al. (2023); Yuan et al. (2025); Kim et al. (2024); Abd Aziz et al. (2021); Mejía-Moncayo et al. (2023); De Simone et al. (2025); ElMenshawy et al. (2024); Sitcharangsie et al. (2019) |

theoretical framework. The findings are compared with literature in the discussion section.

### 4.1. Empirical descriptions of remanufacturing

The initial insight from the interviews revealed a lack of consensus on the definition of remanufacturing. This lack of a standardized definition led to varied interpretations of remanufacturing among the representatives in the study. Some firms interpret remanufacturing as a process of restoring used products to their original condition, while others see remanufacturing as washing and polishing a product, see Figure 1 with citations from the representatives from interviewed organizations regarding their descriptions of remanufacturing.

### 4.2. Factors for circular transition towards adoption of remanufacturing

The analysis of the empirical data against the proposed factors in the theoretical framework revealed distinct patterns across the three system levels depending on the data collection technique employed. A total of eight factors were not identified in either the interviews or the workshops, indicating potential gaps in awareness of remanufacturing or that some topics were not emphasized by the representatives. Furthermore, several factors were identified in either the interviews or at the workshops. One reason might be that during interviews one representative answered the questions, while the participants at the workshop consisted of actors from different organizations in the value chain. This interplay between actors in the value chain might lead to new discussions as well as new insights for the participants.

Overall, the data reveals that interviews tended to emphasize more context-specific and infrastructural factors, particularly at the macro level, while the findings from the workshops focused more on identifying sectoral transformation and innovation themes at the meso level. The macro level showed the greatest overlap, reflecting a common view regarding societal factors among the participants.

Below, we present the main findings based on the factors that were identified in both interviews and workshops.

Several factors identified in the literature review, such as digitalization and intelligent process control, were not mentioned in interviews or workshops. This absence does not indicate that these factors are irrelevant, but rather reflects the current stage of remanufacturing adoption in the furniture sector. At present, remanufacturing activities are largely low-volume, manual, and project-based, which reduces the immediate relevance of advanced digital and automated solutions. As a result, practitioners tend to focus on more immediate challenges related to demand, reverse logistics, procurement, and collaboration. These findings suggest a gap between technologically oriented research and current industry practice, particularly in early-stage circular transitions.

#### 4.2.1. Factors on macro level

**Government regulations, policies, and laws** were viewed as both hindering and enabling transition towards adoption of remanufacturing. Several respondents mentioned that the new regulations could lead to a larger amount of administration and were not sure how to for example collect and store all needed data for example Digital product passports. Moreover, the participants at the workshop agreed that the introduction of digital product passports would facilitate the tracking of products throughout their lifecycle, thereby supporting circular economy practices. However, they also noted that this transition would require new competencies and the need for employee training to navigate the new

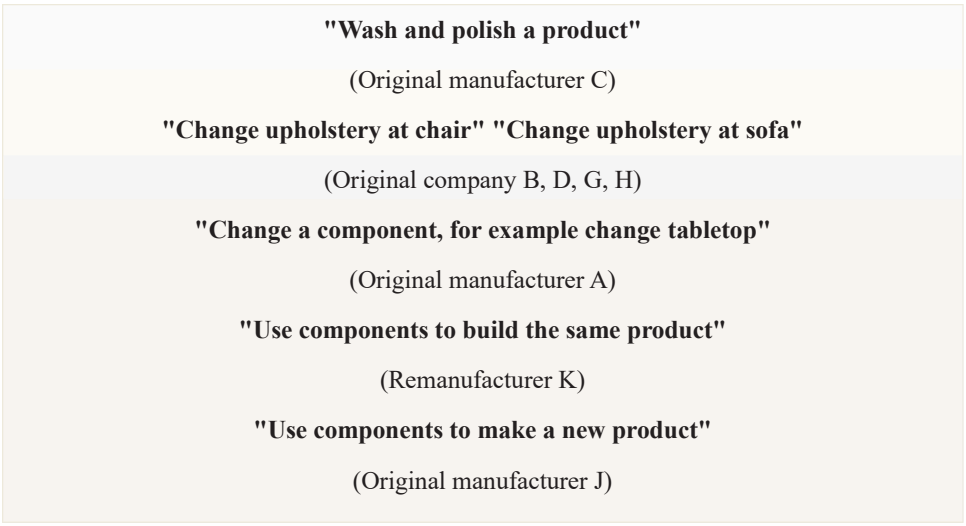


**Fig. 1.** Empirical descriptions of remanufacturing.

**Table 3**
Factors identified in the empirical study.

| Factors on Macro level | Identified factors from the interviews | Identified factors from the workshops |
|---|---|---|
| Government regulations, policies, and laws | x | x |
| Customer attitude and acceptance | x | x |
| Waste and energy infrastructure | x | |
| Standardization and certification frameworks | x | x |
| Information infrastructure, digital platforms and security | | |
| Public education and awareness | | |
| Enterprise demand and willingness | x | |
| Factors on Meso level | | |
| Relations and collaboration in the value chain | x | x |
| The sector's ability to transform | | x |
| Competence needs | | |
| Research and innovation | | x |
| Factors on Micro level | | |
| Value offer and business models | x | x |
| Technological and operational factors | x | x |
| Procurement- and purchasing strategy | x | x |
| The organization's ability to transform | | |
| Design and materials | x | x |
| Reverse logistics and collection strategy | x | x |
| Sales and market share | x | |
| Traceability, quality assurance and product information | x | x |
| Digitalization and intelligent process control | | |

regulatory landscape.

**Customer attitude and acceptance** was seen as a hindrance for the adoption of remanufacturing for customers in the public sector. Price and design sensitivity were viewed by the respondents in the interviews as primary customer-related obstacles. Moreover, the respondents from original manufacturers and retailers unanimously reported that customers were generally unwilling to pay a premium for circulated products. The customers from the public sector's reluctance to pay a premium for remanufactured furniture is not driven by negative attitudes toward sustainability. Instead, it is largely explained by public procurement laws and policies that emphasize lowest purchase price, and limited use of lifecycle costing. Several respondents noted that even when sustainability ambitions exist, procurement rules constrain purchasing decisions.

However, the interviews revealed an increasing trend towards circulated and remanufactured products from customers from private organizations. Sometimes these projects were used for marketing purposes by both retailers, original producers, and customers.

**Standardization and certification frameworks** were described by both the representatives at the interview as well as at the workshop as essential for adoption of remanufacturing. During interviews and workshops, participants highlighted that the absence of clear standards creates uncertainty for both original manufacturers and customers that can also be related to the factor Government regulations.

#### *4.2.2. Factors on meso level*

On the meso level, the empirical findings show that **relations and collaboration in the value chain** are the key factors for the adoption of remanufacturing. The first finding here was that the original manufacturers have no direct contact with end customers and vice versa, as the retailer acts as an intermediary organization. The original manufacturer also mentioned that there are some influential actors in the value chain they need to create a relationship with, such as the few large retailers on the market, designers, and architects that design offices.

#### *4.2.3. Factors on micro level*

**Circular business models** were seen as important for the original manufacturers, being emphasized at the workshops. At the time of the interviews, none of the participating manufacturers had implemented dedicated circular business models. However, several expressed a clear interest in enhancing their knowledge and competence in this area. Many original manufacturers had already experimented with circular activities, including repair services, take-back schemes, secondhand sales, and remanufacturing of both their own and other brands' products. These initiatives were generally small in scale, ranging from a few items to 50 chairs. One company stood out by offering renovation and remanufacturing services for public environments such as churches, lecture halls, and theatres. The low scale of remanufacturing activities can be explained by uncertain and irregular demand, concerns about cannibalization of new product sales, and the reliance on manual, project-based operations. Together, these factors make it difficult for manufacturers to justify investments in more standardized and scalable remanufacturing systems.

A recurring theme was the perception that circular offerings could compete with the production of new items. Nevertheless, manufacturers indicated that, should demand increase, they would be prepared to integrate circular offerings into their product and service portfolios without significant operational efforts. Importantly, all original manufacturers viewed themselves as original manufacturers firsthand, and not as circular actors.

In contrast, remanufacturers had developed more mature circular business models but faced persistent challenges related to high variability of returns, particularly with respect to the volume and quality of returned products and cores, necessitating extensive inventory capacity. From the customer side, a lack of awareness regarding available circular options and the absence of supportive public procurement frameworks were identified as key barriers. This suggests untapped market potential for circular offerings, while also highlighting the complexity and regulatory challenges associated with public procurement processes.

**Technological and operational factors** were discussed as a factor related to the adoption of remanufacturing. The original producer's production system aimed at flexibility as the new products were manufactured at low volumes, but with high variety. The remanufacturing projects at the time of the interviews were managed and planned as a typical project. Moreover, the inspection and disassembly of returned products were conducted manually by experienced operators.

A notable empirical finding concerns the **procurement** from public sector customers. Respondents from the public sector described how they procured furniture based on the Swedish Law of Public Procurement. According to the respondents, this sets limitations on how to manage already procured furniture at the end of life. The procurement strategy was extensively discussed during the workshops, where participants emphasized the need to shift focus from initial purchase price to total lifecycle cost and environmental impact.

Respondents described that **design and material choices** significantly influence the adoption of remanufacturing. Design as well as quality are the main competitive factors for the furniture produced by the companies in this study. Design as a competitive factor was also emphasized by the retailers in the study. During the workshops, two different paths related to design and materials were identified and discussed. The first path relates to existing furniture. The respondents here highlighted that if the furniture with a unique design and material are taken back and renovated, or refurbished by another organization, the design feature and in the end the brand can be affected. Hence, if the furniture is returned to the original producers, they are aware of the design feature and keep the design features in the remanufacturing. However, the companies said that taking back their own furniture might not be such a large problem as they usually keep the drawing, and have experienced employes, however, if they receive furniture from another brand, they cannot be sure about the materials. Due to this, some companies prefer to only take back their own furniture. Organizational knowledge, particularly regarding historical product specifications, emerged as a critical enabler of remanufacturing. Employees with long-standing experience and familiarity with historical furniture have a key role in the adoption of remanufacturing. A key challenge is the material that was used in the original production as it is sometimes not clear of what chemicals were used in the production of materials such as textiles and plastics.

The other path focuses on the design of new products. Here, the respondents from the companies said that principles of extending the lifespan and lifecycles of a product can be included in the design of new products. The primary barrier is the interest from customers, especially related to procurement from public sectors.

**Reverse logistics and collection strategy and traceability and product information** were identified as critical in both the interview study and at the workshops. The main challenge was to trace the used products as there was no direct contact between original manufacturers and customers in the public sector. However, here the companies mentioned that Digital product passports can be a support to trace products in the future. However, there will still be challenges to trace products that were produced before this regulation was implemented. The challenges related to reverse logistics are mainly caused by the lack of direct contact between original manufacturers and end users, and fragmented ownership of furniture over time. As furniture is typically procured and replaced through intermediaries, manufacturers often lack information about product location and condition at end of use.

Furthermore, the workshops conducted as part of the study emphasized the need for a collaborative approach to reverse logistics. Participants discussed the importance of building strong relationships with logistics providers and other stakeholders in the value chain to enable product returns.

## 5. Discussion

This study explored the factors influencing the circular transition towards the adoption of remanufacturing in the furniture sector, with a particular focus on original manufacturers in the furniture industry operating in B2B contexts. By comparing insights from the structured literature review with empirical data collected through interviews and workshops, several key factors and themes emerged across macro, meso, and micro system levels.

### *5.1. Lack of standard definition of remanufacturing amongst the actors in the furniture sector*

While the theoretical definition of remanufacturing focuses on restoring products to a "like-new" condition (Sundin, 2019), the empirical findings revealed that the practical understanding of remanufacturing among the respondents in the interview study varied widely. The respondents did not have a homogenous definition of remanufacturing, and the broader interpretation of remanufacturing includes activities such as cleaning, component replacement, and even repurpose components for new products. If relating this to the 10R framework that exemplifies 10 different circular strategies from recovery to rethink (Potting et al., 2017; Reike et al., 2018; Kirchherr et al., 2017), the practical interpretation of remanufacturing also includes reuse and restoration, see Figure 2.

This divergence between academic definitions and practical interpretations of remanufacturing can create significant challenges for communication and collaboration, both between academia and industry, and among actors across the value chain. It may result in inconsistent practices and outcomes, making it difficult to establish industry-wide benchmarks and ultimately hindering the adoption of remanufacturing. The lack of a shared understanding of remanufacturing among actors in the furniture sector should therefore be understood not only as a conceptual issue, but also as a practical barrier that complicates communication, standardization, and collaboration across the value chain. Achieving a shared understanding requires deliberate efforts in communication and the exchange of practical experiences. This divergence underscores the need for clearer communication and education about the specific processes and benefits of remanufacturing within industry.

### *5.2. Influencing factors*

This study highlights the multi-level complexity of factors influencing the adoption of remanufacturing in the furniture sector. The Sankey diagram in Figure 2 visually synthesizes how macro, meso, and micro-level factors interact and shape the practices of key actors; original manufacturers, remanufacturers, and public sector organizations.

At the macro level, government regulations and policies emerged as both enablers and barriers. Digital product passports were highlighted as a promising tool for traceability and with previous research emphasizing regulatory frameworks as critical drivers of circular practices (Chong et al., 2024; Mejía-Moncayo et al., 2023). However, the original

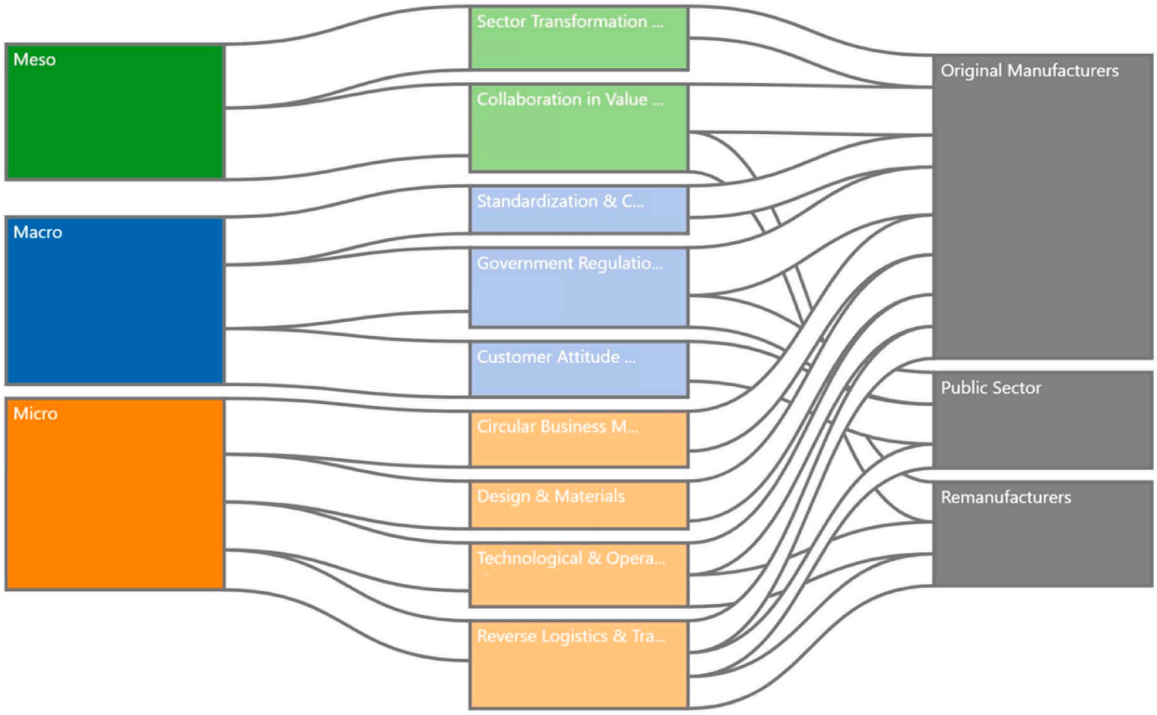


**Fig. 2.** The Sankey diagram illustrates the factors influencing the adoption of remanufacturing in the furniture sector, based on the macro, meso, and micro-level framework. NOTE: This diagram was generated by Copilot, but analysis was conducted by the authors.

manufacturers, mainly SMEs, expressed concern about administrative burdens and competence gaps, also emphasized by Golinska-Dawson et al. (2025) and Ayati et al. (2022). Customer attitudes and procurement practices were equally decisive. Public sector customers prioritize price and design over lifecycle value, limiting uptake of remanufactured products. This finding aligns with Güngördü Belbağ and Belbağ (2025), who report consumer reluctance toward reused goods, and Kurilova-Palisaitiene et al. (2023), who identify procurement legislation as a barrier. Interestingly, the empirical data revealed growing interest from private organizations, suggesting an emerging market for remanufactured furniture when positioned as a sustainability and branding opportunity.

At the meso level, collaboration across the value chain was essential. In this specific sector, it was found that the original manufacturers lack direct contact with end-users, complicating reverse logistics and traceability. The workshops revealed that intermediary actors, such as retailers and designers, play a strategic role in enabling circular flows as the for example design the interior of new offices. This supports Blomsma et al. (2019) and Kirchherr et al. (2017), who emphasize the importance of relational structures, but the findings extend this by showing that intermediaries can act as innovation brokers and facilitating cross-actor dialogue. This aligns with research showing that collaborative arrangements in circular supply chains function as open-innovation ecosystems, where shared knowledge, joint problem-solving, and cross-boundary coordination enable circular strategies to emerge and scale (Krmela et al., 2022).

At the micro level, the business model emerged as the central factor. While original manufacturers had not yet implemented circular business models, many had initiated small-scale activities such as take-back schemes and remanufacturing projects. These fragmented efforts reflect the uncertainty described by Linder and Williander (2017) and the risk of cannibalization noted by Okorie et al. (2021). Technological and operational factors were discussed in both literature and practice. While Kerin and Pham (2020) and Psarommatis et al. (2025) emphasize automation, empirical findings showed that remanufacturing activities were largely manual and project-based, reflecting low volumes and limited investment. Design and material choices were also decisive, particularly regarding brand integrity and chemical content in older components (Golinska-Dawson et al., 2025; Kaarlela et al., 2024). The absence of some factors identified in literature but not mentioned by the original manufacturers, such as digitalization-related factors, further highlights the early-stage and exploratory nature of remanufacturing in the furniture sector, in contrast to more mature remanufacturing industries.

Open innovation plays a critical role in enabling circular transitions in the furniture sector. This study demonstrates how collaboration, information sharing, and co-creation among original manufacturers, public sector organizations, retailers, and remanufacturers are essential for overcoming barriers such as reverse logistics and traceability. These findings align with Psarommatis et al. (2025), who emphasize that successful reuse and remanufacturing depend on flexible supply chains and shared design strategies, that are described as keys in open innovation environments, and Mohammadian et al. (2025), who highlight the importance of improved information flows and shared product-lifecycle data for enabling repair, reuse, and remanufacturing in practice. Similarly, Prado et al. (2025) argue that open innovation enhances sustainability by fostering cross-sector collaboration, engaging stakeholders, and leveraging external knowledge through mechanisms like crowdsourcing. Workshops in this study further support the value of open innovation platforms, where diverse actors co-develop standards, business models, and operational practices. Public procurement is also identified as a potential driver of innovation, highlighting the importance of institutional openness and regulatory support. Overall, these patterns reflect what Hadi and Khan (2025) identify as the 'necessary-only' role of circular open innovation, indicating that a minimum level of cross-boundary knowledge sharing is essential for circular business models and remanufacturing to take root.

Compared to sectors such as automotive and electronics, where remanufacturing benefits from standardized products, established reverse logistics systems, and relatively high return volumes, the furniture sector faces distinct challenges. Furniture products are heterogeneous in terms of design, materials, and volumes. Moreover, return

volumes are typically low and irregular. In addition, strong design identities and brand sensitivity increase concerns related to quality perception and reputational risk. These sector-specific characteristics help explain why remanufacturing adoption in the furniture industry remains at an early stage despite its circular potential.

## 6. Conclusion

The purpose of this study was to explore factors that influence circular transition towards the adoption of remanufacturing in the furniture sector. To achieve this purpose, a literature review and qualitative study, including interviews and workshops, were conducted. An analytical framework was developed based on a structured literature review and used to analyze empirical data from interviews and workshops. Factors influencing remanufacturing adoption across macro, meso, and micro level were analyzed with the analytical framework. In the study, we identified the main influencing factors on each level for the original manufacturer, public sector, and remanufacturers. On an overall level, the macro factors such as policies and regulations as well as customer attitude influence the adoption of remanufacturing for all actors in the study. At the meso level, collaboration across the value chain emerges as a critical factor. The B2B structure of the furniture industry, where manufacturers often lack direct contact with end-users, also complicates reverse logistics and product returns. At the micro level, business models, operational practices, and design strategies are central to remanufacturing adoption for the original manufacturers. While the manufacturers have initiated small-scale circular activities, scaling these efforts requires new and innovative and circular business models. As discussed in 5, the challenges identified in the furniture sector differ in important ways from those reported in more mature remanufacturing sectors such as automotive and electronics.

### 6.1. Theoretical and practical implications

From a theoretical perspective, this study contributes to the growing body of literature on CE transitions in general and remanufacturing in particular by showing how remanufacturing can be adopted in a specific sector, in this case the furniture sector. This study therefore expands existing literature about remanufacturing by identifying the factors on the three levels for the actors in this study. Instead of only focusing on one actor, this study takes a larger step to understand how remanufacturing factors influence both original manufacturers and customers in public sectors as well as remanufacturers.

For *original manufacturers*, the adoption of remanufacturing can be facilitated through small-scale, short-term initiatives rather than immediate large-scale transformation. In the short term, manufacturers can initiate pilot take-back collaborations with selected retailers or customers for specific product categories. These pilots can help clarify responsibilities related to collection, inspection, and refurbishment, while allowing firms to test demand and operational requirements with limited risk. Over time, such initiatives may be expanded and integrated into more formalized circular business models as experience and market acceptance increase.

*Retailers and designers* play a key intermediary role in the furniture value chain and can actively support remanufacturing by identifying furniture suitable for return at replacement stages and coordinating reverse logistics. In the short term, this may involve informal collaboration agreements with manufacturers or remanufacturers, while longer-term arrangements could include more standardized processes for product returns and information sharing.

*Public sector organizations* can support remanufacturing adoption by gradually incorporating lifecycle considerations into procurement practices. In the short term, this may include functional requirements that allow for remanufactured furniture, while in the longer term procurement criteria may increasingly emphasize lifecycle cost and environmental performance rather than lowest upfront price.

At the policy level, *regulators and industry associations* can facilitate remanufacturing by supporting the development of furniture-specific standards and guidelines. In the short term, this may involve clarifying definitions and quality expectations for remanufactured furniture, while longer-term efforts could focus on harmonized standards that support scalability and cross-actor collaboration.

### 6.2. Limitations and future research

This study provides insights into remanufacturing adoption in the furniture sector, but several limitations should be acknowledged. The primary limitation is the relatively small number of interview participants, which may affect the generalizability of the findings. Although efforts were made to include diverse actors across the value chain, future studies should involve a larger and more representative sample to strengthen empirical robustness.

Additionally, only one representative from each organization was interviewed, resulting in a single-perspective view of organizational remanufacturing practices. This limits the depth of insight into internal knowledge, decision-making processes, and operational challenges. Future research would benefit from including multiple respondents per organization to capture a more comprehensive organizational perspective.

The study also captured remanufacturing adoption at a single point in time. Longitudinal studies are therefore recommended to examine how remanufacturing practices, collaborations, and capabilities evolve over time. Such studies could be particularly valuable in understanding how relationships among value-chain actors develop, especially regarding product returns and coordination between customers, manufacturers, and remanufacturers.

Further research should also explore business model innovation in greater depth. Prior research highlights the importance of developing business models that create value for both manufacturers and customers to enable scalable and economically viable remanufacturing. Investigating alternative value propositions, incentive structures, and contractual arrangements could support broader adoption.

Finally, the scope of this study was limited to the Swedish B2B furniture sector with a focus on public-sector customers. As procurement is often mediated by retailers, the perspectives of private-sector customers and the role of retailers were not fully captured. Future research should expand the scope to include private organizations and examine retailers as key decision-makers. While the findings offer analytical insights relevant to similar institutional contexts, comparative studies across countries would further test and refine the framework.

## CRediT authorship contribution statement

**Malin Löfving:** Writing – original draft, Methodology, Investigation, Formal analysis, Data curation. **Mirka Kans:** Writing – original draft, Project administration, Methodology, Investigation, Formal analysis, Data curation.

## Ethical approval

Ethical approval is not applicable for this article

## Statement of informed consent

There are no human subjects in this article

## Statement of human and animal rights

This article does not contain any studies on human or animal subjects.

## Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of this work the authors used Copilot in order to improve the grammar and language of the manuscript. After using this tool, the authors reviewed and edited the content as needed and took full responsibility for the content of the publication.

The Sankey diagram in Figure 2 was generated by Copilot, but the analysis was conducted by the authors.

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## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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