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Sociotechnical Barriers to Circular Furniture Production: A Case Study of Swedish Regional Counties

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Abstract. The transition toward a Circular Economy (CE) demands a systemic transformation of production systems, requiring the simultaneous evolution of organizational structures and technology, often framed as socio-technical alignment. In Sweden, regional counties act as major public customers for the domestic furniture industry, and their procurement routines strongly influence how circular material flows are enabled—or constrained—in practice. Grounded in the Socio-Technical Systems Theory (STST) framework, this study investigates how sociotechnical misalignments limit the development of circular furniture production systems. A mixed-methods approach was employed, combining a quantitative survey administered to managers across Sweden's regional counties (47.6% response rate, N=10) with thematic analysis of expert focus group interviews. The results reveal persistent fragmentation across the socio-technical system. On the social side, responsibility for furniture strategy is often unclear or absent, with 40% of respondents reporting no assigned ownership. On the technical side, existing digital procurement systems remain poorly suited to circular practices, lacking basic functionality for asset tracking, reuse coordination, and reverse logistics. The study concludes that industrial-scale circularity cannot be achieved through isolated interventions. Instead, it requires joint optimization of procurement governance, digital infrastructure, and manufacturing systems. Particular attention must be given to the everyday user journey of ordering furniture, where circular options currently remain difficult to identify, evaluate, and choose in practice.

1 Introduction

Shifting to a Circular Economy (CE) requires a change in how we produce and consume, not just through new technologies, but through broad sociotechnical changes (Davis et al., 2014). This change is rooted in the Socio-Technical Systems Theory (STST), which analyses a complex system based on the interrelatedness of its social system (e.g., people, culture, goals) and its technical system (e.g., technology, infrastructure, processes/procedures) (Davis et al., 2014, Gembali et al.,



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2024). Research shows that in CE initiatives, especially those focused on higher circularity strategies (R0–R7), socio-institutional change, involving shifts in regulations, customs, standards, and behaviour, plays a more dominant role than radical technological innovation (Potting et al., 2017).

In the Swedish context, regional counties and public authorities function as key customers for the domestic furniture industry (Öhgren et al., 2019). These public bodies constitute a fundamental part of the socio-technical system for circular furniture production and use, as their organizational structures, digital tools, and user preferences shape resource flows and influence how effectively circular productions systems can be implemented (Gembali et al., 2024). Despite the fact that many office furniture pieces have a potential technical lifespan of up to 30 years (Besch, 2005), they are frequently replaced in the public sector after only a few years, often for aesthetic reasons, resulting in substantial resource wastage and significant environmental impact (Besch, 2005). While public procurement is recognized as a powerful lever to increase sustainability and circularity, particularly for furniture, studies on implemented Circular Public Procurement (CPP) strategies for furniture are scarce. Consequently, existing studies rarely address the mechanisms needed to extend product lifespans or reduce premature disposal, leaving a critical gap in understanding how procurement strategies can better align with circular production goals (Potting et al., 2017, Besch, 2005, Öhgren et al., 2019).

This study examines how socio-technical conditions shape the everyday implementation of circular furniture management in Swedish regional counties. Rather than treating circularity as a purely strategic ambition, the study focuses on how procurement routines, governance structures, and digital tools interact in daily practice. These interactions either enable or obstruct circular production systems. The study further increases understanding of the conditions that enable producers to adopt circular practices within Sweden's furniture sector. This addresses a critical research gap regarding the user journey of ordering circular furniture and how governance and digital tools can routinize circular practices (Greene et al., 2024).

Building on this aim, the study contributes by clarifying where and how sociotechnical misalignments emerge in public furniture procurement. First, it develops a sociotechnical map of barriers that hinder the integration of circular practices highlighting the need for joint optimization (Davis et al., 2014) of procurement governance, digital infrastructure, and manufacturing systems. Second, it emphasizes the role of user experience, spanning material quality, regulatory compliance, and design expectations in shaping whether circular options become routine or remain exceptional. By looking at how systems align with the needs and practices of users, the study shows how circular strategies can be both technically feasible and attractive to those who use and manage furniture. This approach highlights the conditions needed for circular production to scale in Sweden's furniture industry.

1.1 Socio-Technical Systems Theory (STST): Foundations and Principles

STST serves as a foundation for analyzing complex systems, emphasizing the interconnectedness of social and technical elements (Davis et al., 2014, Gembali et al., 2024). The central argument is that organizational success in achieving complex goals requires joint optimization (or joint design) of both systems; optimizing the social or technical system in isolation will not lead to success (Baxter and Sommerville, 2011). STST has evolved over 60 years, shifting its emphasis from heavy industry to advanced manufacturing and office-based work, consistently focusing on the introduction of new technologies (Davis et al., 2014).

1.2 Sociotechnical Alignment for Circular Economy Transitions

STST is primarily utilized in the CE context to evaluate the complexity of transitions by examining the necessary co-evolution between social structures (governance, culture, people) and technical requirements (technology, infrastructure processes) (Gembali et al., 2024, Walker et al., 2008). High-value strategies such as remanufacturing is often jeopardized by the 'stochastic' or unpredictable nature of material returns, a systemic challenge that requires tight coordination between users and producers (Kurilova-Palisaitiene et al., 2018). In CE transitions, social and institutional changes often pose the greatest challenge, especially for achieving high-level circularity strategies (Potting et al., 2017).

2 Literature Review: Circular Furniture Flows and the Regional Context

2.1 Circular Furniture Material Flows and Environmental Impact

Office furniture is a high-relevance product category for the circular economy due to its durability, high initial cost, and stable technology, with over one million pieces discarded annually in Europe (Öhgren et al., 2019). Although many items have a technical lifespan of 20–40 years, they are often replaced within 10–12 years because of aesthetic wear, fashion trends, or organizational changes rather than functional failure (Besch, 2005). This early replacement contributes to material flows that are far from circular.

2.2 Environmental Urgency and Potential of Circular Business Models

The urgency for a circular transition in Sweden's furniture production stems from the industry's significant environmental footprint. Transitioning to circular business models, which replace linear models where furniture is manufactured, used, and discarded, could reduce primary raw material consumption by approximately 50% and decrease climate impact by 20–40%, with potential annual savings of 45,000 tons of CO₂ equivalents if the entire Swedish office furniture market adopted circular practices (Bolin et al., 2017).

2.3 The Swedish "Circularity Paradox" and Regional County Role

Despite their central procurement role, Swedish public entities and regional counties frequently replace office furniture after only a few years, even though many pieces can last up to 20 years (Røyne, 2019). This "circularity paradox" shows that the environmental benefit of high-quality furniture is lost if actual use periods are short (Bolin et al., 2017; Røyne, 2019).

Regional counties are key to this transition, acting as "gatekeepers" of large-scale furniture contracts (Öhgren et al., 2019). If procurement prioritizes new goods over circular options, manufacturers lack incentives to invest in Design for Remanufacturing or Reverse Logistics. Surveys indicate that 45% of Swedish public procurers express interest in second-hand furniture and 20% in leasing, yet reconditioned items account for only a small fraction of purchases (Öhgren et al., 2019).

3 Methodology

This study employed a mixed-methods approach, combining a structured quantitative survey with qualitative focus group interviews to achieve a comprehensive understanding of the challenges facing circular furniture management in Swedish public entities. The investigation was structured according to the dimensions of STST (Davis et al., 2014, Gembali et al., 2024).

3.1 Structured Survey (Quantitative Analysis)

A structured survey was administered to managers responsible for furniture strategies across Sweden's 21 regional counties. The survey targeted the entire population of primary decision-makers overseeing public furniture management, resulting in 10 responses (a 47.6% response rate). The survey instrument comprised 23 questions utilizing closed-ended formats for quantification and open-ended text fields for qualitative insights. Questions covered three thematic areas:

1. Organizational and Governance Status (Social System): Assessment of fragmentation, resource availability, and clarity of responsibility (Gembali et al., 2024).
2. Procurement Practices and Infrastructure (Technical System): Evaluation of criteria, use of agreements for reused furniture, and digital tool functionality for asset tracking.
3. Circularity Preferences: Measurement of preferences for repairability, certified materials, and environmental requirements.

This structure supported the clarified analysis of People Barriers (PB) and Technological/Infrastructural Barriers (TB/IB) (Gembali et al., 2024).

3.2 Focus Group Interviews (Qualitative Analysis)

To provide depth to the quantitative indicators, focus group interviews were conducted with procurement and sustainability professionals.

Participants were chosen through purposive sampling (Öhgren et al., 2019), ensuring representation from public procurement organizations, regional county management, and researchers specializing in circular production. The interviews followed a thematic structure centered on the furniture lifecycle—covering procurement, use, maintenance, and end-of-life—to explore operational complexities such as framework agreement rigidity and the cultural "user journey" of furniture acquisition (Greene et al., 2024).

All sessions were recorded and transcribed for qualitative content analysis. Empirical data were subsequently mapped onto STST dimensions to identify intersections between social barriers, such as a lack of leadership, and technical barriers, including storage deficits. To ensure the credibility of these findings, the study employed data triangulation by cross-verifying survey results with focus group transcripts and open-ended survey responses. This approach ensured that the identified sociotechnical factors were grounded in both broad organizational data and specific professional experiences.

3.3 Analysis and Framework

The analysis focused on how customer-side governance (Social System) and procurement infrastructure (Technical System) interact to constrain circular production outcomes (Davis et al., 2014, Gembali et al., 2024). By mapping data onto STST dimensions, the study identified Social System Barriers (PB and Cultural Barriers, CB) and Technical System Barriers (TB and IB). This framework provides a rigorous methodological link between the research questions and the ultimate call for joint optimization.

4 Results

The empirical material, gathered from the structured survey administered to managers across Sweden's 21 regional counties (achieving a 47.6% response rate, N=10) and subsequent focus group interviews, reveals the operational disconnects hindering circular furniture management. The findings are categorized according to the systemic barriers identified within the social and

technical systems that govern public procurement, alongside the stated circular ambitions of these organizations.

4.1 Social System Barriers (Organizational and Cultural)

Organizational structures and prevailing workplace cultures pose significant constraints on the effective implementation of circular furniture strategies. A foundational issue identified through the structured survey is organizational fragmentation; 40% of respondents reported that no department within their organization has assigned overall responsibility for furniture management. This lack of centralized leadership creates a systemic "responsibility gap," where no single entity oversees the full product lifecycle.

This absence of leadership is closely tied to critical resource and knowledge gaps. Qualitative data identified the issue of responsibility as "unsolvable" due to the near-total absence of dedicated personnel and budget. Furthermore, a recurring theme was the lack of knowledge and education among staff, decision-makers, and users, which was consistently cited as a major barrier to routinizing circular practices. These institutional hurdles are compounded by cultural resistance to reuse. Results show that disposal criteria often prioritize aesthetic factors over technical lifespans, driven by "user wishes" and a demand for novelty. Focus group interviews reinforced this, highlighting the pervasive perception that users inherently prefer "new, fresh furniture" over functional, pre-owned assets.

4.2 Technical System Barriers (Infrastructural and Procedural)

Existing digital tools and standardized processes remain optimized for a linear economy, creating significant technological barriers (TB) that actively obstruct circular flows. A critical deficit lies in the failure of digital procurement systems to support basic circularity functions, such as asset tracking. Respondents explicitly noted a lack of digital tools to visualize surplus furniture within warehouses, a gap that prevents internal reuse and hinders the traceability necessary for planning industrial remanufacturing volumes.

These digital shortcomings are compounded by physical constraints in the reverse logistics (RL) infrastructure. Regional county facilities frequently lack the necessary storage capacity to manage furniture returns, with respondents identifying the triad of storage, transport, and tracking as significant daily obstacles to reuse. Furthermore, contractual and procedural rigidity within procurement processes further constrains the system. Current framework agreements are typically structured for one-way flows and often lack mandatory take-back clauses or resale provisions. This prevents manufacturers from establishing the predictable material streams required for industrial-scale production.

Finally, economic feasibility remains a substantial hurdle. While environmental motivation for adopting reconditioned items are high, respondents observed that restoration costs often exceed the price of new purchases. This price disparity makes it difficult to secure organizational buy-in, as sustainable options are frequently perceived as less cost-effective than linear alternatives.

4.3 Circularity Preferences

Despite the identified systemic barriers, the data reveals significant formalized organizational ambition to pursue circularity. Commitment to circular practices is high, with 80% of respondents confirming the existence of initiatives aimed at promoting furniture reuse, such as internal reuse programs and the utilization of central warehouses. The most significant outcomes cited from these initiatives include measurable cost savings and a reduced environmental impact.

Furthermore, there is a clear preference for material attributes that support lifespan extension, with reparability identified as a primary requirement.

Regarding material preferences, high-quality materials such as solid wood are valued for their aesthetic appeal, tactile warmth, and inherent durability. While there is a strong preference for certified wood (e.g., FSC or PEFC), the specific geographic origin of the timber, such as Swedish-grown wood, was not prioritized by the majority of respondents. These findings suggest that while the organizational "will" and material preferences align with circular goals, they are currently constrained by the structural misalignments detailed in previous sections.

5 Discussion

The findings reveal a deep sociotechnical misalignment that creates significant constraints on the design and operation of circular production systems. Fragmented governance and digital incapacity on the customer side prevent producers from receiving the predictable material and information flows required for high-value circular strategies.

5.1 Social System Implications: Governance Fragmentation

The organizational barriers identified in Section 4.1 translate directly into unpredictable material flows (Öhgren et al., 2019, Gembali et al., 2024). Fragmented governance structures create a market environment of risk for producers, who require stable "stochastic" returns to justify investments in industrial remanufacturing (Öhgren et al., 2019, Kurilova-Palisaitiene et al., 2018). Without a designated department to manage the furniture lifecycle, high-value material returns remain accidental rather than systematic.

5.2 Technical System Implications: Enabling Remanufacturing

Remanufacturing (R4–R6) offers significant economic and environmental advantages over lower-value strategies like material recycling (R8) (Potting et al., 2017, Besch, 2005). However, remanufacturing is not just a technical challenge but a systemic coordination issue (Jensen et al., 2019, Kurilova-Palisaitiene et al., 2018). Manufacturers require reliable information to implement Design for Remanufacturing (DfR). The reported missing digital tools generate stochastic return patterns, preventing the establishment of stable "core" streams essential for scaling (Kurilova-Palisaitiene et al., 2018).

5.3 Socio-Institutional Transformation and Policy Alignment

The results demonstrate that fragmented governance and cultural resistance create institutional "lock-ins" (Unruh, 2000, as cited in Potting et al. (2017)) that prevent circular systems from scaling. Transitioning to a Circular Economy (CE) requires dismantling these lock-ins through joint optimization of procurement and production (Davis et al., 2014). Public procurement acts as the most effective lever; framework contracts must integrate both new and reconditioned furniture while training staff to prioritize lifespan extension (Öhgren et al., 2019).

5.4 Digitalization and the User Journey

To overcome technological barriers, Digital Product Passports (DPPs) can provide the documentation required for asset tracking and reuse. However, a critical research gap remains regarding the user journey of ordering circular furniture (Greene et al., 2024). Little is known about how public sector users interact with procurement systems and make decisions when choosing circular options over new products.

6 Conclusions

This study concludes that deep sociotechnical misalignments between public procurement and industrial capacity hinder Sweden's circular furniture transition. Progress is constrained by the inability to achieve joint optimization between social systems (governance/culture) and technical systems (infrastructure/procedures) (Davis et al., 2014, Gembali et al., 2024).

Key Findings:

1. Governance deficits (40% responsibility gap) and knowledge shortages prevent the coordination required for circular implementation.
2. Linear infrastructure lacks the digital tools (e.g., for asset tracking) necessary to establish the predictable material flows required for industrial remanufacturing (Kurilova-Palisaitiene et al., 2018).
3. Remanufacturing (R4–R6) is the most environmentally beneficial strategy for durable office furniture, yet it is stalled by stochastic returns and rigid framework agreements.

Recommendations for Policy and Practice: Strategic interventions must bridge institutional gaps by establishing dedicated governance units with the authority to manage the full furniture lifecycle. Investment in integrated digital systems and reverse logistics, including Digital Product Passports, is essential to support remanufacturing (Jensen et al., 2019). Procurement frameworks should mandate Reverse Logistics and DfR to generate stable demand for the industry (Öhgren et al., 2019).

Future Research: Scholars should investigate the routinization of circular furniture ordering within institutional daily life (Greene et al., 2024). Furthermore, there is a need to design resilient circular manufacturing systems capable of functioning efficiently despite fluctuating material inflows (Kurilova-Palisaitiene et al., 2018).

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Appendix A

"Survey: Obstacles and Opportunities for Circular Furniture Strategies in Sweden's Regions".

The survey instrument consisted of 23 questions, designed to gather numerical and unstructured data from managers responsible for furniture strategies across Sweden's 21 regional counties, focusing on circular strategies from procurement and maintenance to disposal.

Here are the specific questions, categorized by their thematic focus:

Part 1: Governance, Responsibility, and Existing Practices

These questions addressed the Social System Barriers (organizational issues) and the existing infrastructure for circularity:

1. Does your organization have a department with overall responsibility for furniture management?
2. Which department has the overall responsibility for furniture management?
3. What is your job title?
4. When purchasing new office furniture, which of the following criteria are currently used within the region?
5. Are there any agreements for reused furniture?
6. Which agreements do you have for reused furniture?
7. What is the reason you do not purchase reused furniture?
8. What is the primary criterion used to determine whether a used piece of furniture should be discarded/disposed of?

Part 2: Initiatives and Challenges (Mixed-Methods Component)

These questions sought qualitative data (open-ended responses) regarding specific initiatives, their effects, and the encountered Technical and Socio-institutional Barriers:

9. Is there an initiative within your region to promote a more circular handling of the region's office furniture by reusing furniture instead of throwing it away?
10. Briefly describe the initiatives.
11. Briefly describe the biggest effect you have achieved with this.
12. Briefly describe the biggest challenge you have encountered in this initiative.
13. Which of the following is the biggest obstacle to implementing circular furniture management principles?
14. Briefly describe the most important measures and solutions that may need to be implemented to overcome this obstacle.
15. Briefly describe the most important resources and collaborations that may be needed.

Part 3: Focus on Wood and Material Preferences

These questions focused on material choices and customer perception, particularly regarding wood furniture's potential role in enhancing circular strategies:

16. How do you define a wooden piece of furniture?
17. Which environmental aspect is most important to consider when purchasing wooden furniture?
18. Which type of wood do you prefer when purchasing wooden furniture?
19. What is the most important requirement you place on wooden furniture regarding material choices?
20. Is it important that the wood material in the wooden furniture comes from Sweden?

21. Is it important that the wood material in the wooden furniture is certified (FSC, PEFC, or similar)?
22. Is it important to be able to repair the wooden furniture?
23. Is there anything else you think is important for preferring a wooden piece of furniture over a piece of furniture made of another material?