INTEGRATING SUPPLY CHAIN PRACTICESTO MITIGATE CIRCULAR ECONOMY RISKS: A QUALITATIVE STUDY OF THE GREEK FURNITURE SECTOR

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Abstract
This study explores the intersection of Supply Chain Integration (SCI) and Circular Economy (CE), aiming to assess how integrating SCI practices within CE frameworks influences organizational performance. The purpose of this study is to provide businesses with insights to facilitate a smoother transition to CE models. By leveraging integrative practices, organizations can better manage CE-related risks, optimize resource utilization, and enhance operational efficiency. As organizations increasingly transition toward circular and sustainable business models, they encounter novel challenges and heightened risks, particularly within the context of CE practices. SCI implementations are essential for managing such risks and uncertainties. Furthermore, there is limited empirical evidence regarding the effectiveness of SCI in mitigating the specific risks associated with CE adoption. Utilizing a qualitative research approach, this study focuses on selected companies within the Greek furniture sector, analyzing how these organizations implement and benefit from SCI-CE operational efficiencies. Notably, this integration enables companies to achieve cost savings and environmental gains by effectively recycling and repurposing waste materials, ultimately contributing to a more resilient and sustainable supply chain.

Keywords: *Circular Economy (CE), Supply Chain Integration (SCI), Sustainable Business Models, Risk Management, Resource Optimization*

1. Introduction

The European manufacturing sector faces both environmental and economic regulations. The increased global competition, the development of new manufacturing markets, logistic implementations, and reduced tariffs on imported products challenge European-based companies. Moreover, given the worrying rate at which global consumption is increasing, the traditional linear economy model is proving to be an unsustainable manufacturing practice (European Environmental Bureau, 2017). On the other hand, increased demand for low-cost items and high labor, energy, and raw material costs within the internal market put intense pressure on European furniture organizations. To cope with these threats, new techniques and

innovative strategies are required to renew the sector and make it more sustainable (Suzanne et al., 2020). Supply chain management adapts the circular economy's principles as a solution to significant global challenges such as climate change and resource depletion.

The circular supply chain emerges as a key factor in addressing resource scarcity and the issues of consumer-added value and profitability. The perspective of a world in which nothing is squandering, what is often seen as "waste" is valued and actively reclaimed. All products are gathered after their initial use for purposes such as reuse, remanufacturing, or recycling over generations. The dream of a circular economy (CE) is not only ambitious but essential (Šimelytė, 2025).

Moreover, supply chain integration and implementation of reverse logistics are crucial factors for supply chain management efficiency. Those functions involve practices such as the collection, sorting, and processing of products and all kinds of materials that have reached the end of their lifespan, so they cannot re-enter the production process. This integration reduces waste, enhances resource efficiency and aligns with the circular supply chain's goals. Despite the increased prominence of the CE approach in academic, practitioner and policy circles, its implementation subsists limited and fragile (Gregson et al., 2015). Driven on a CE, based on circular design and production, circular business strategies encompass the retrieval of products, by-products, waste and cross-sector collaborations extending beyond traditional supply chain boundaries (Dervojeda et al., 2014; WEF, 2014). The technological infrastructure necessary for success remains to be developed.

Summarizing, this study examines the relationship between circular supply chain management and SCI and related CE risks in the Greek furniture sector. Specifically, this paper aims to:

- Identify the main challenges and risks of Greek furniture manufacturers that face in switching to circular business models.
- Assess the role of SCI in strengthening supply chain resilience and reducing disruptions related to CE adoption.
- Examine the best practices and strategies followed by companies in the Greek furniture sector in integrating SCI and CE principles.
- Formulate successful strategies and research approaches for policymakers to facilitate the transition toward sustainable and circular supply chains.

2. Literature Review

Within the realm of Circular Economy (CE), the focus is on moving beyond the traditional linear model of the economy based on a "take-make-dispose" mentality to a closed-loop system prioritizing resource efficiency and recycling (Geissdoerfer et al., 2017). The usage of practices related to CE, including recycling, remanufacturing, and eco-design, is gaining momentum within the furniture industry as firms seek to comply with environmental regulations and align with consumer demand for sustainable products (Bocken et al., 2016).

The furniture industry aligns closely with CE principles, because it uses durable materials such as wood, metal and textiles that can be repurposed or recycled (Jawahir & Bradley, 2016). However, it should be noted that the complex nature of furniture design and composite materials often make CE methods very difficult to adopt (Nasir et al., 2017). Bright contrast with this approach represents the nailing and gluing in furniture manufacturing, which makes it difficult to separate the portions for recycling, and this can create significant technical barriers bank (Merli et al., 2018).

As far as the implementation of CE practices is concerned with various technical and financial risks, as well organizational and administration issues arise (Nasir et al., 2017). In

the furniture industry, technical risks are significantly due to the nature of product design and the challenges associated with material recovery (Jawahir & Bradley, 2016). For instance, incorporating composite materials in furniture manufacturing complicates the separation of components for recycling, which presents significant obstacles to CE adoption (Merli et al., 2018).

Moreover, financial risks arise from the elevated costs linked to recycled materials and the necessary investments in CE infrastructure (Kalmykova et al., 2018). Companies frequently navigate a dilemma between the increased expenses of sustainable materials and the necessity to remain competitive within the market (Lieder & Rashid, 2016). Organizational risks are related to cultural transformation, and ensuring supply chain partners are aligned with CE objectives (Tukker, 2015). For example, businesses must invest in training programs to cultivate a sustainability-oriented culture and ensure all employees are on board with CE goals (Bocken et al., 2016).

The embedding of digital technologies in supply chains supports the implementation of reverse logistics, which allows organizations to recover and reintegrate products at the end of their life cycle (Akinade & Oyedele, 2019). However, the implementation of digital technologies requires capital investment and technical expertise, posing a challenge for small and medium-sized furniture businesses (Kingsberg, 2014).

Government policies and some standards by the industry are significant factors for adopting practices of CE (Andrews, 2015). An example of a supportive policy framework is the EU's Circular Economy Action Plan "*for a cleaner and more competitive Europe",* which sets targets for waste reduction and resource efficiency, in order to guide society to CE (Kalmykova et al., 2018). However, this is delayed by the absence of supportive policies and incentives in some regions towards CE practices, especially in developing countries (De Jesus & Mendonca, 2018).

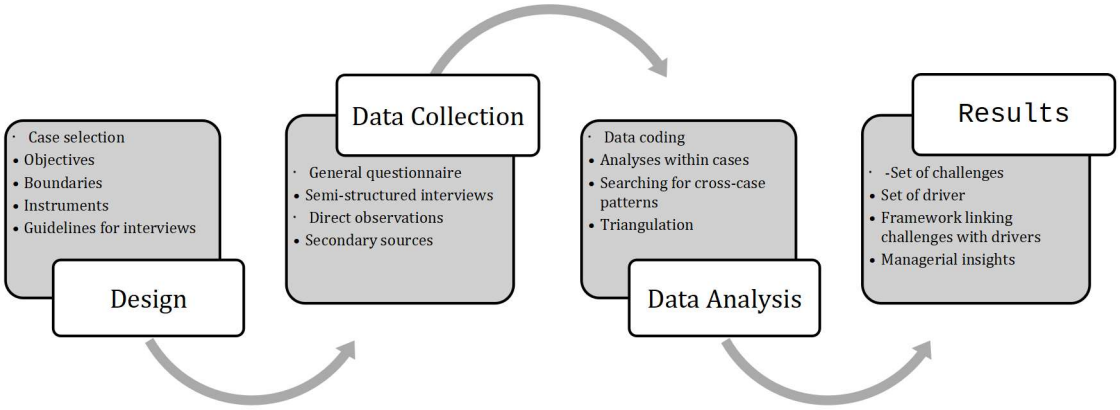
3. Methodology

A multiple case study methodology is adopted for this research. A qualitative research method involving the in-depth examination of multiple cases has been chosen in this study (Yin, 1984; Eisenhardt, 1989; Miles & Huberman, 1994). Specifically, the major aim of the present research is to investigate how circular economy is related to SCI practices in the Greek furniture industry.

A comprehensive research protocol is developed to ensure methodological rigor, covering study design, data collection, analysis procedures and results documentation (Voss, et al, 2002; Yin, 2009; Murray et al., 2017).

The selection of case study followed by purposive sampling is based on two key criteria: First, companies must have implemented CE initiatives involving value chain or supply chain redesign, and second the participating companies were strategically chosen to represent diverse supply chain echelons and value-creation stages. Figure 1 illustrates the empirical methodology of this study.

Figure 1: The empirical methodology



Source: (Sekaran, 2003)

The data-collecting process aims to guarantee a thorough awareness of the possibilities and difficulties related to CE methods applied in the furniture industry.

Semi-structured interviews have been selected for data collection. Initially, a pilot interview has been conducted to test and refine the interview protocol. The insights gained from this pilot study have been used to clarify and improve the questions for the subsequent interviews. Specifically, three in-depth interviews have been conducted with managers or operational staff to ensure a comprehensive understanding of the company's experiences with CE and SCI practices, while direct observations have been made during visits to the companies' facilities. In order to enhance the validity of the findings, triangulation has been conducted with secondary sources, including company documentation, websites, and industry reports. This approach aims to affirm the collected data through interviews and observations.

The data analysis process entangled several steps to ensure the reliability and validity of the results:

- Data Coding: The interview reports were encrypted to identify key factors and hidden patterns related to CE challenges and SCI impact to CE.
- Triangulation: The interview findings also were triangulated with secondary data to enhance the validity of the study (Vos et al., 2002).
- Framework Development: A conceptual framework is developed from analysis that links the identified challenges with potential levers to overcome them.

The interview transcripts have been sent back to the respondents for validation, and the final case results have been reviewed and confirmed by the informants to minimize observer bias (Yin, 1984). The usage of multiple data sources and the triangulation of findings further enhance the validity of this study.

In conclusion, the data collection methodology aims to provide a comprehensive understanding of the challenges and opportunities associated with CE and SCI practices in the Greek furniture sector. The usage of semi-structured interviews, direct observations and secondary sources combined with a data analysis process ensure the reliability of the findings.

4. Empirical results

In this empirical research, three companies active in the Greek furniture sector were selected, being at different levels and phases of the supply chain, the companies, named Alpha, Beta, and Gamma, provide a diverse range of perceptions about CE practices and the associated risks.

Alpha Company is a raw material supplier of binders & additives used in the furniture industry. Beta Company is a wholesaler that manufactures wooden frames, energy and thermo panels, shutters, and exterior-interior wooden constructions. Finally, Gamma Company is a retailer that is involved in the design and production of kitchen furniture, wardrobes and wooden frames (Table 1).

Table 1: Case study companies

	Alpha Company	**Beta Company**	**Gamma Company**
Founded	1977	2005	1970
Location	Thessaloniki, Greece	Karditsa, Greece	Kozani, Greece
Product/service	Development & Application of Industrial Technology for Binders & Additives, Production of Amino & Phenolic Resins	Manufacturing wooden frames, energy and thermo panes, shutters, exterior-interior construction	Design and production of kitchen furniture, wardrobes and wooden frames.
Role in supply chain	Supplier of raw materials	Manufacturer, Wholesaler	Manufacturer, retailer
Interviewees	Researcher- Technologist	Production Manager	Production Manager

Alpha Company has implemented Circular Economy (CE) practices for the past three to five years focusing on strategies such as using recycled materials, eco-design, and minimizing waste through reuse and recycling. These initiatives have not significantly increased costs, but they present operational challenges, including a lack of specialized knowledge, difficulty in modifying production processes, and inconsistent quality of recycled materials. The company faces financial constraints and quality management issues, but CE adoption has led to product differentiation and a reduced environmental footprint. However, consumer demand for sustainable furniture remains very low, limiting its competitive advantage.

Supply Chain Integration is crucial for Circular Economy success. Alpha Company collaborates with universities and research institutions and uses Enterprise Resource Planning (ERP) and Artificial Intelligence (AI) for supply chain management. However, integration remains moderate due to a lack of transparency and limited real-time information sharing. While technology has improved efficiency, its potential in optimizing CE processes is yet to be fully realized.

Alpha Company in order to gain CE advantages should strengthen supplier collaboration, enhance supply chain transparency and invest in recycling innovation. Greater government support, regulatory incentives, and training programs are also needed. Additionally, increasing consumer awareness of sustainable products could boost demand. Moreover, Alpha Company has made progress in CE adoption, but it should overcome supply chain challenges to fully realize its potential. A well-integrated circular supply chain will improve sustainability and competitiveness in an evolving market.

Beta Company has implemented CE practices for over six years, focusing on eco-design, waste minimization, and material recycling. These efforts have significantly reduced production costs and environmental impact. However, challenges such as a lack of expertise, difficulty in sourcing sustainable suppliers, and limited government incentives persist. Regarding SCI, the company faces low supply chain transparency and minimal digital integration. While it employs ERP and CRM tools, full integration is lacking. Collaboration with sustainable suppliers and energy reduction strategies support its sustainability goals, but further efforts are needed. The future includes adopting advanced digital technologies, such as AI, to optimize operations and improve both CE and SCI effectiveness. Strengthening

governmental support and investment in CE initiatives will be crucial for overcoming existing barriers.

Finally, Gamma Company applies CE practices to a limited extent. Some of the limited-scale practices include recycled or recyclable materials in production, eco-design focusing on sustainability, durability and the use of wood and fabrics from sustainable sources.

Although the company's management acknowledges the contribution of CE to sustainability and the reduction of environmental impact, they struggle to adopt CE strategies due to a lack of financial resources and insufficient governmental support. Additionally, while they recognize that integrating supply chain processes could positively contribute to CE development, its implementation is hindered by a lack of suitable infrastructure and technology. It is noted that the company does not use any supply chain management software or technology. According to the company, developing CE strategies requires access to expertise, infrastructure, and technology, which they lack due to insufficient funding and the absence of state support.

5. Conclusions

This study examines the integration of SCI practices within CE frameworks in the Greek furniture sector, focusing on how such integration minimizes CE-related risks and enhances operational efficiency. Drawing on a qualitative case study analysis of three companies, namely Alpha, Beta, and Gamma, this empirical research reveals the different levels of CE adoption and the challenges that businesses face in implementing sustainable initiatives.

There is evidence that companies actively involved in CE efforts, such as Alpha and Beta, have achieved cost savings, differentiation, and environmental benefits. However, these benefits come with issues such as budget constraints, lack of expertise, supply chain inefficiencies and lack of government incentives. Gamma Company with minimal CE activity struggles to incorporate sustainable practices due to constrained resources and a lack of incentives.

Supply chain integration affects significantly the supply chain resilience and the further adoption of circular economy practices. Companies leveraging digital tools such as ERP and AI demonstrate improved efficiency, but the full potential of digital transformation in circular supply chains remains untapped. Additionally, collaboration with suppliers and research institutions emerge as a key factor in overcoming operational challenges. However, transparency and real-time information sharing across supply chains remain areas of concern.

For Greek furniture manufacturers to successfully transition toward circular supply chains, a holistic approach is needed. This approach includes stronger supplier collaboration, investment in digitalization, and policy interventions that provide financial and government support. Increasing consumer awareness of sustainable furniture products is also essential to drive demand and incentivize businesses. To advance the relationship of SCI and CE, future research should focus on the following areas:

- Quantitative Analysis of SCI Impact: Large-scale empirical studies to measure the direct effects of SCI on CE performance metrics, such as waste reduction, resource efficiency, and cost savings.
- Cross-Industry Comparative Studies**:** Investigating how SCI and CE integration varies across different types of industries to identify sector-specific best practices.
- Technological Advancements in SCI for CE: Exploring the role of emerging technologies like AI, machine learning, and digital twins in optimizing circular supply chains.

Addressing these research gaps will provide deeper insights into how Supply Chain Integration can facilitate the transition to a Circular Economy and inform more robust policy and managerial strategies.

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