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Strategies for Circular Supplier Selection: A Case Study from The Netherlands

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Abstract

Developing and validating circular supplier selection criteria within sustainable supply chain management is crucial for integrating circular economy principles. By addressing a significant gap in empirical research, our study emphasizes the necessity of incorporating circular economy principles into supplier selection criteria to enhance sustainability and competitiveness in an international context. Our research identifies and validates key criteria essential for selecting suppliers aligned with circular economy objectives by recognizing the increasing importance of circular economy principles. The identified gap prompted our research, aiming to bridge the divide by providing practical insights and empirical evidence. We employed a mixed-methods approach to define the supplier selection criteria framework, ensuring its relevance and applicability across different contexts. We validated eight supplier selection criteria, including material type, collaboration, sustainability incentives, and eco-friendly practices, highlighting their alignment with economic, environmental, and social dimensions. Our findings stress the necessity of integrating circular principles into supplier selection criteria, emphasizing environmental certifications, compliance with standards, and support for closed-loop processes. Our study reveals that effective circular practices can utilize unique resources such as recycled materials and innovative technologies, offering firms a competitive edge. Additionally, the research highlights the importance of collaboration and stakeholder engagement in advancing circular economy practices, encouraging mutual growth and sustainable supply chains. The validated supplier selection criteria framework provides a strategic tool for businesses to enhance their supplier selection process, ensuring transparency and collaboration while promoting long-term sustainability.

Keywords: Circular Economy, Circular Supplier Selection Criteria, Sustainable Supplier Selection, Supplier Selection Criteria, Supply Chain Management, Green Supplier Selection

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1. Introduction

The increasing complexity of supplier selection in today's globalized economy necessitates the development of thoughtful and comprehensive Supplier Selection Criteria (SSC). This complexity is further compounded when incorporating circular economy principles, which aim to minimize waste and maximize the reuse of materials (Prosman & Sacchi, 2016; Tushar et al., 2022). Despite the growing importance of these principles, there remains a significant gap in the literature regarding the development of SSC that integrates circular economy objectives into the supplier selection process and in international contexts.

Current literature has extensively explored various supplier selection methodologies and the inclusion of sustainability aspects (Govindan et al., 2015; Taherdoost & Brard, 2019). However, there is a notable absence of empirical studies that validate these criteria within real-world business contexts, particularly concerning circular supplier selection (El Barky et al., 2022; Tushar et al., 2022). There is a need to understand the conditions that encourage or impede engagement in circular economy (CE) practices by identifying the enabling and hindering factors among the actors in the supply chain. This includes overcoming collaboration barriers and enhancing collective incentives for advancing CE practices. Although stakeholder engagement is recognized as vital for the successful implementation of CE, there is a gap in effectively aligning interests, fostering a shared vision, and building trust-based relationships that facilitate knowledge and information exchange (Farooque et al., 2022; Govindan & Hasanagic, 2018). Moreover, international business research has thoroughly examined the standardization and adaptation of business strategies across borders but has rarely considered these aspects concerning sustainability and circularity criteria (Dow, 2006; Zou & Cavusgil, 2002). These gaps highlight the need for research that develops and validates SSC with empirical findings, integrating circular economy objectives, specifically within international markets.

In addressing these research gaps, our study focuses on an illustrative case study from the Netherlands. It specifically analyses a company known for its innovative approach to utilizing waste materials in the furniture industry. The choice of this company, Eco Company, is motivated by its unique circular business model that transforms waste into valuable products, thereby representing the principles of the circular economy. Eco Company stands out for its innovative methods of refurbishing and revitalizing waste materials, including textiles, leather, and cork, through a patented grinder and binder system. This makes Eco Company suitable for examining the application and validation of circular SSC.

The main research question (MRQ) guiding this study is: "What strategic circular SSC can be empirically validated to address the gap in integrating circular economy principles within international supplier selection frameworks?" By answering this question, our study aims to develop a strategic framework that can be utilized by companies looking to expand their circular practices internationally.

We studied the MRQ in two research questions (RQs) and two sub-research questions (SRQs) as follows:

RQ1: Which SSC can be derived from the producer's and supplier's internal requirements?

RQ2: Which SSC can be validated in terms of suppliers' ability to provide information respectively?

SRQ1. Which SSC facilitate the acquisition of relevant information from suppliers?

SRQ2: What challenges need consideration to enhance suppliers' ability to provide information for producer's supplier selection in the target market country?"

Our research has both theoretical and practical implications. Theoretically, we contribute to the existing literature by providing empirical validation of circular SSC, which is currently underrepresented (Govindan et al., 2020; Münch et al., 2022). One way of contributing to theory is to improve it through "incremental, interesting contribution", where "new insights are gained through empirical studies or new conceptualizations" (Reay & Whetten, 2011). We integrate circular economy principles with

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established theories such as the Resource-Based View (RBV) (Barney, 1991), Dynamic Capabilities Theory (Teece et al., 1997), and Internationalization Theories demonstrating how companies can support their unique resources and capabilities to achieve competitive advantage through sustainable practices in an international context. Click or tap here to enter text. By incorporating SSC that aligns with circular economy principles, companies can better meet the expectations of various stakeholders, including customers, regulators, and the community, thus enhancing their overall sustainability performance. Additionally, we address the gaps in empirical research by substantiating the practicality and effectiveness of these criteria in real-world settings (El Barky et al., 2022; Tushar et al., 2022).

Practically, the study offers a strategic framework and a practical tool, the Supplier Selection Fill Out Form (SSFoF), for businesses aiming to implement circular economy principles in their supply chains. This tool facilitates efficient and effective supplier evaluations, reducing the time-intensive communication typically required in the supplier selection process. The study also highlights the importance of collaboration and transparency between suppliers and buyers, promoting stronger partnerships that can lead to more innovative and sustainable solutions in supply chain management (SCM) internationally.

The remainder of this paper is organized as follows. The next section provides a literature review based on the theoretical background of our research, the evolution of the supplier selection criteria, and the widely used approaches for supplier selection. This is followed by our methodology and research design, a description of the case study we used, and the findings. Our paper concludes with a discussion of the implications of our research on circular supplier selection for theory and practice, as well as limitations and recommendations for future research.

2. Literature Review

2.1 Theoretical Background

The theoretical grounding for studying circular supplier selection criteria internationally is rooted in several key theories.

In recent years, the Circular Economy (CE) concept has gathered significant attention in both theoretical and practical settings (Geissdoerfer et al., 2018). CE is defined as an economic system where resources are utilized for as long as possible to maximize their value, highlighting the advantages of recycling waste materials and by-products (Geissdoerfer et al., 2018; Jacobsen et al., 2018). However, due to its interdisciplinary nature, there is no single, universally accepted definition of CE (Kirchherr et al., 2017; Tecchio et al., 2017). According to the Ellen MacArthur Foundation (2017), CE is “an industrial system that is restorative or regenerative by intention and design.” Driven by the rising demand from customers and stakeholders, companies are increasingly compelled to adopt sustainable practices throughout their supply chains (Mena et al., 2013; Vachon & Klassen, 2006). This increased pressure means that producers must ensure sustainable outcomes even after selling their products, extending their responsibility to the consumption and post-consumption phases.

Consequently, this responsibility shifts from a linear supply chain model to a circular one (Taghikhah et al., 2019). Integrating CE into supply chain management (SCM) becomes essential to implement this shift, leading to the concept of Circular Supply Chain (CSC) management. This approach involves both forward and reverse logistics and waste management, aiming for zero waste by reintroducing resources into the supply chain through various “R” strategies, such as refusing, reducing, reusing,

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repairing, refurbishing, remanufacturing, repurposing, recycling, and recovering (Farooque et al., 2022; Kirchherr et al., 2017). Described as "the integration of circular thinking into the management of the supply chain and its surrounding industrial and natural ecosystems" (Farooque et al., 2022), CSC ensures the continuous use of resources without them becoming waste, emphasizing the crucial role of supplier collaboration (Bundgaard et al., 2017; Nasir et al., 2017). Thus, supplier selection becomes an important aspect of reaching circularity goals.

Building on this framework, companies can achieve competitive advantage by developing capabilities based on valuable, rare, inimitable, and non-substitutable resources. The Resource-Based View (RBV) highlights the importance of internal, non-transferable organizational resources such as assets, capabilities, processes, information, and knowledge (Barney, 1991; Eisenhardt & Martin, 2000; Grant, 1991; Peteraf, 1993). Extending RBV, the Natural RBV (NRBV) integrates the firm's interaction with its natural environment, identifying key strategic capabilities: pollution prevention, product stewardship, and sustainable development (Hart, 1995; Hart & Dowell, 2010). Pollution prevention focuses on reducing waste and emissions through continuous improvement, which directly links to cost reduction and enhanced economic performance. Meanwhile, product stewardship considers the entire product lifecycle, involving multiple stakeholders to minimize environmental costs and gain competitive advantage (Hart, 1995; Pinheiro et al., 2023). Sustainable development, particularly significant in developing countries, aims to create products that deliver long-term environmental, economic, and social benefits (Hart, 1995; Hart & Dowell, 2010; Kumar et al., 2021). Incorporating these strategic capabilities into circular supplier selection emphasizes environmental certifications, compliance with standards, clean technologies, and eco-friendly practices in production and logistics. Firms effectively integrating circular practices can leverage unique resources like recycled materials and innovative technologies to gain a competitive edge (Bodhanwala & Bodhanwala, 2020).

Further complementing RBV and NRBV, Dynamic Capabilities Theory highlights the necessity for firms to adapt and reconfigure their resources in response to changing environments, maintaining resilience and sustainability (Teece et al., 1997). Within circular supply chains, dynamic capabilities facilitate continuous innovation and process improvement. Importantly, collaboration emerges as critical for implementing CE principles, facilitating material recovery, and ensuring social welfare among value-chain actors (Batista et al., 2018; Mwaijande, 2024; Scarpellini, 2021). Economic challenges such as limited production capacity and high raw material costs highlight the importance of developing integrated and local supply chains. (Foschi, 2023). Effective collaboration necessitates understanding conditions that encourage or impede engagement in CE practices by identifying enabling and hindering factors among SC actors (Touboulic & Walker, 2015). This understanding is vital for grasping the relational and business dynamics in cross-sectoral collaboration advancing CE practices. Dynamic capabilities play a significant role in overcoming collaboration barriers and enhancing collective incentives, promoting CE principles and maintaining long-term competitive advantages in dynamic network environments (Borland & Lindgreen, 2013; Teece, 2007).

Aligned with these theoretical perspectives, Stakeholder Theory emphasizes considering the interests and expectations of various stakeholders, including customers, regulators, and the community (Freeman, 1984). Stakeholder engagement involves practices to identify and manage stakeholder needs, develop interaction methods, and create mutual learning opportunities

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through education and training (Freeman et al., 2018; Greenwood, 2007). Samant & Sangle (2016) recognize a shift in organizational sustainability literature, where stakeholders are seen as essential for value co-creation rather than inhibitors. Engaging stakeholders is crucial for aligning interests, fostering a shared vision, and building trust-based relationships that facilitate knowledge and information exchange in the context of CE (Bertassini et al., 2021; Calicchio Berardi & Peregrino de Brito, 2021). Furthermore, responsible sourcing of raw materials stimulates stewardship and certification programs that enable sustainability and circularity internationally (Mazzarano, 2021). Effective stakeholder engagement is, therefore, vital for the successful implementation of CE, as integrating CE principles within SCM relies heavily on it (Baah et al., 2023; Farooque et al., 2022; Govindan & Hasanagic, 2018). By adopting innovative, sustainable business models and incorporating CE principles into supplier selection, firms can better meet stakeholder demands for sustainability and transparency, enhancing their reputation and long-term success (Piontek et al., 2021).

Finally, addressing sustainability challenges requires companies to develop innovative business models domestically and adapt them internationally, considering the business's value chain may span beyond domestic boundaries (Tallman et al., 2018; Yurdaanik Eskiyerli & Ewertz, 2024). Although substantial research has focused on sustainable business model innovations locally and the internationalization of these innovations, there remains a gap in exploring sustainable business model innovation in an international context (Foss & Saebi, 2017; Geissdoerfer et al., 2018; Gölgeci et al., 2021; Josephson et al., 2016; Ostrom et al., 2010; Shakeel et al., 2020; von Delft et al., 2019). Integrating sustainability into international business strategies, particularly through collaboration with global supply chain partners, is essential (Dow, 2006; Yurdaanik Eskiyerli & Ewertz, 2024; Zou & Cavusgil, 2002). In this regard, the Uppsala Model suggests that firms should expand their international activities progressively, developing deeper relationships with international suppliers over time to align with sustainability goals (Johanson & Vahlne, 1977, 2009; Vahlne & Johanson, 2017). Dunning's Eclectic Paradigm emphasizes leveraging unique capabilities and selecting regions that support sustainability initiatives (Dunning, 1977, 1988). The Network Theory of Internationalization highlights the importance of building strong relationships with international suppliers to drive sustainable practices and share knowledge (Johanson & Mattsson, 2015).

In synthesizing these theoretical perspectives, it becomes evident that designing effective circular supplier selection criteria hinges on a multidimensional approach that incorporates sustainability, resource optimization, adaptability, and stakeholder collaboration. By adopting a circular economy framework, companies can extend their responsibility beyond the traditional supply chain, ensuring that resources are continuously reused and regenerated. This approach not only uses valuable and unique organizational capabilities to gain a competitive advantage but also emphasizes the need for continuous adaptation and innovation to maintain resilience in a changing environment. Engaging stakeholders across the supply chain fosters trust and collaboration, which are crucial for implementing sustainable practices and achieving long-term goals. Furthermore, expanding these sustainable business models internationally requires strategic partnerships and a deep understanding of different market dynamics to align global supply chain activities with sustainability objectives. Ultimately, integrating these concepts leads to a robust and adaptable circular supply chain that supports environmental sustainability, economic efficiency, and social responsibility.

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2.2 Evolution of the Supplier Selection Criteria

The supplier selection process involves evaluating and choosing suppliers for goods and services based on a set of predefined criteria that align with the company's strategic objectives (Choi & Hartley, 1996). Developing SSC dates way back (Dickson, 1966). In the more "traditional" supplier selection criteria, aspects such as "price", "quality", "on-time delivery", "performance history of the supplier", and "warranty used by the supplier" were considered to be of high importance (Dickson, 1966; Ding et al., 2008; Govindan et al., 2013). As global awareness of environmental issues and sustainability grew, organizations faced the imperative to address sustainability concerns in business, driven by government regulations and heightened community knowledge (Govindan et al., 2013; Idil Gaziulusoy, 2015). A main decision to enhance business performance and gain competitiveness in industrial supply chains led to the selection of green and sustainability-focused suppliers (Govindan et al., 2013; Grimm et al., 2014). The sustainability-focused supply chain, an extension of the green supply chain, incorporates social criteria alongside economic and green considerations within a supply chain context (Mangla et al., 2014). Green or sustainable practices have become integral to the planning processes of modern manufacturing organizations, aiming to improve overall supply chain performance (Rostamzadeh et al., 2015). Suppliers play a vital role in implementing sustainable supply chain initiatives and achieving gains in social, environmental, and economic dimensions (Govindan et al., 2013; Shen et al., 2013).

In a similar vein, the concept of circular economy aims to mitigate environmental impacts by incorporating circular principles in the supplier selection process (Govindan et al., 2020; Lahane et al., 2020). Circular supply chain management differs from sustainable supply chain management. While sustainable supply chains focus on minimizing environmental impact and enhancing social responsibility through practices such as reducing carbon emissions and ensuring fair labour practices, circular supply chains go further by emphasizing the regeneration of resources and the elimination of waste. In traditional economic supply chains, products are considered waste at the end of their lifecycle. In contrast, circular or closed-loop supply chains aim to maintain end-of-life products in the production cycle through self-sustaining production by continuously using and regenerating materials (Shooshtarian et al., 2022; Tushar et al., 2022). This approach involves rethinking product design, manufacturing, and consumption to support multiple lifecycles (Ellen Macarthur Foundation, 2017). By implementing strategies such as remanufacturing, refurbishing, and repurposing, circular supply chains reduce the need for virgin materials and contribute to the circulation of resources, requiring more complex coordination and collaboration (Farooque et al., 2022; Kirchherr et al., 2017). Embedding circular principles enables firms to achieve long-term sustainability, economic resilience, and competitive advantage through a regenerative system that prioritizes resource efficiency and material longevity over traditional waste management practices (Bundgaard et al., 2017; Nasir et al., 2017). This shift necessitates the development of new supplier selection criteria that account for circular principles, such as the ability to provide recycled materials, support for closed-loop processes, and compliance with circular economy standards (Govindan et al., 2020; Münch et al., 2022). The connection between these concepts highlights the need for specific criteria addressing the unique requirements of circular supply chains, such as providing secondary raw materials and supporting remanufacturing and recycling processes (Münch et al., 2022).

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In the literature, there is an abundance of studies providing comparative lists of SSC from various perspectives, including traditional and sustainable perspectives. The work of Taherdoost & Brard (2019) studies the critical aspects of the SCM and supplier selection within the context of modern business dynamics. They highlight the transformative role of SCM in the global economy, emphasizing its integral nature to business success by enhancing customer service, reducing costs, and fostering longer relationships between buyers and suppliers. Their work also categorizes and discusses a multitude of supplier selection methods, emphasizing the absence of a standard approach and the need for flexibility based on product, expectations, and industry. They emphasize the importance of understanding these methods and their appropriateness in diverse situations, providing a comprehensive and insightful overview of the complex landscape of SCM and supplier selection.

The study by Luthra et al. (2017) conducts a comprehensive review of relevant literature on supplier selection and evaluation in the context of supply chain sustainability. The chosen criteria for the review include the adoption of environmental, ecological, and social sustainability. In their study, a total of 22 SSCs are identified and categorized into three dimensions of sustainability (economic, environmental and social). They emphasize the significance of supplier selection in sustainability-focused supply chains and the complexity introduced when sustainability criteria are added to conventional qualities.

Recent research, such as the study of Münch et al. (2022), explores the shift from a linear to a circular paradigm in supply chain management and reviews the research on supplier selection within circular supply chains, highlighting the significance of circular supply chains for companies' competitiveness. Ten relevant articles from the previous two years are identified, with a focus on criteria formulation, supplier selection, and network design. They categorize circular supplier selection criteria based on key strategic capabilities: pollution prevention, product stewardship, and sustainable development. Criteria include environmental certifications, compliance with standards, clean technologies, clean transportation, emissions and pollution control, waste management, resource consumption, research and development, eco-friendly packaging, material selection, product design, and sustainability-oriented supplier practices.

Similarly, El Barky et al. (2022) developed a list of 23 supplier selection criteria towards sustainability performance in the context of circularity with four dimensions (Economic, Environment, Social, and Circular). Münch et al. (2022) developed supplier selection criteria in a circular supply chain, classified under pollution prevention, product stewardship and sustainable development. These four studies by Luthra et al. (2017), Taherdoost & Brard (2019), Münch et al. (2022) and El Barky et al. (2022) comprehensively reviewed and categorized SSC and therefore are selected as the literature pillar for our study.

Despite the abundance of studies on supplier selection, there are fewer empirical studies than conceptual ones, especially in terms of circularity aspects and international contexts. Empirical studies, such as those by El Barky et al. (2022), Tushar et al. (2022), Kusi-Sarpong et al. (2023), and Ali et al. (2023), have started exploring the practical applications of circular principles in supplier selection. These studies, while insightful, are limited in number and vary in scope. This gap signifies an opportunity for conducting more empirical research, such as case studies, which could provide valuable insights into the practical challenges and successes of implementing circular supplier selection criteria in various industries. Our case study involves a circular business model utilizing secondary raw materials or by-products as inputs. Therefore, suppliers need to be identified in terms of their ability to provide such raw materials. The data will be collected initially to understand the internal specifications of

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both parties (supplier-producer) involved. Existing criteria presented in the current literature will allow us to complement the internal requirements of the companies. Solely focusing on one company's internal standards and requirements of its international joint venture partners would cause a limited and biased perspective. Therefore, using standards from the literature as a benchmark will allow us to develop a scalable and adaptable list of criteria.

2.3 Supplier Selection and Widely Used Approaches for Supplier Selection

Supplier selection involves a comprehensive process where businesses aim to identify, evaluate, scrutinize, analyze, and form agreements with suppliers (Chai & Ngai, 2020). The supplier selection process can be portrayed as one of the most comprehensive challenges to be managed by the procurement department (Taherdoost & Brard, 2019). The procedure intends to establish a final list of suppliers with respect to a firm's objectives. A review of the literature on supplier selection reveals that a wide array of quantitative multicriteria decision-making criteria have been formulated over time, including the analytic hierarchy process (AHP), analytic network process (ANP), fuzzy-based approach and data mining (Chai et al., 2013; Fahimnia et al., 2015; Wetzstein et al., 2016; Zimmer et al., 2016). Regarding literature reviews based on sustainable supplier selection criteria, these quantitative multicriteria decision-making criteria still prevail with the addition of Data Envelopment Analysis, Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) Decision Making Trial and Evaluation Laboratory (DEMATEL) and Multi-Attribute Utility Theory (MAUT) (Govindan et al., 2015).

Among these, AHP has been praised for its ability to break down decision criteria and offer a straightforward, defensible approach including qualitative and quantitative parameters, making it highly accessible for practitioners, whilst also been criticized for having been used by researchers for its convenience than theoretical rigour (Govindan et al., 2015). Govindan et al. (2015) also warn against integrating multiple methods in an effort to reach a more comprehensive decision-making tool since the complexity of using multiple methods can deter practitioner acceptance, suggesting a need for research into simplifying these approaches for better usability. Behind all these analyses for supplier selection lies the fundamental structure which can be summarized in four steps: (1) problem formulation, which refers to the understanding of the incentive for supplier selection; (2) formulation of criteria, which addresses the process in which criteria and related importance weights should be selected with respect to a firm's objectives, (3) qualification, which incorporates the selection of qualified suppliers based on their performance, (4) final selection, which refers to establishing a final list of suppliers (De Boer et al., 2001). In our study, we aim to provide a set of selection criteria based on in-depth qualitative analysis where the data is collected based on circularity criteria through an empirical study. Our study does not intend to provide a final list of suppliers but aims to identify a set of criteria that allows our case study company, as well as their joint venture partners, to identify and validate foreign suppliers that can supply suitable waste materials. Therefore, only steps 1 and 2 of the above criteria will be carried out. The determination of applicable SSC enables the identification of suitable suppliers.

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3. Methodology

3.1 Design of the Conceptual Model

We incorporated relevant principles and SSC from existing literature into our Conceptual Model (CM). In developing our CM, three determinants guided our selection: (1) repetitiveness of criteria and principles, (2) relevance to the business problems of case study companies selected for our study (Eco Company and Eco Design), and (3) alignment with the research objective.

To identify overarching principles, a comparison of literature reviews made by Taherdoost & Brard (2019), Luthra et al. (2017), El Barky et al. (2022), and Münch et al. (2022) was carried out. Notably, literature since 2017 emphasizes linking SSC with economic, environmental, and social dimensions, highlighting the contemporary importance of sustainability in the supplier selection process. Considering the relevance of circularity, a categorization system that includes economic, environmental, social, and circular dimensions is proposed. This also aligns with the current literature.

Economic Dimension Criteria: For the economic dimension, the criteria "Quality," "Price," and "Delivery" were identified through a comparative analysis of (Taherdoost & Brard, 2019), Luthra et al. (2017) and El Barky et al. (2022). These criteria, consistently highlighted across all three studies, provide a solid foundation for the CM. Specific definitions from each study were carefully chosen to ensure clarity and practicality.

Social Dimension Criteria: Within the social dimension, "Occupational Health & Safety Systems," "Interest & Rights of Employees," and "Information Disclosure" were selected based on their relevance in both the studies of Luthra et al. (2017) and El Barky et al. (2022). The criteria "Interests & Rights of Employees" effectively combines and represents the former two, streamlining the SSC.

Environmental & Circular Dimension Criteria: In our CM, environmental and circularity criteria are specifically focused on keeping resources within the supply chain loop for as long as possible, thereby minimizing waste and promoting resource efficiency. While some of the studied literature for comparison places circularity concepts under the heading of "environmental" criteria (El Barky et al., 2022; Luthra et al., 2017), others place them under the heading of "circularity" criteria (Münch et al., 2022). Therefore, we used the heading "environmental and circular" in our CM. For the environmental and circular dimensions, similarities between studies by Luthra et al. (2017), El Barky et al. (2022) and Münch et al. (2022) were identified. "Environmental Management Systems" (El Barky et al., 2022; Luthra et al., 2017) and "Environmental Certifications" (Münch et al., 2022) were considered, with the latter used in our CM, providing a more practical and insightful representation as it indicates if a company has been able to establish environmental management systems. Additionally, the criteria "Eco-friendly raw material for packaging and in producing the product" and "Eco-friendly Transportation" are chosen for their specificity and relevance across multiple studies. The connections of these criteria to circularity are described below:

Environmental Certifications: Certifications like ISO 14001 demonstrate a supplier's commitment to environmental management, aligning with sustainable supply chain practices by reducing negative environmental impacts. In terms of circularity, possessing an environmental certificate serves as an initial step towards identifying and implementing CE initiatives (Marrucci et al., 2022). Research has demonstrated a positive correlation between the adoption of CE practices and the presence

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of an environmental management system (Fonseca et al., 2018). Consequently, environmental certifications are recognized as a key enabler for the implementation of circular supply chains (Bodova, 2017).

Eco-friendly Raw Materials and Packaging: This criterion emphasizes the use of materials that are environmentally friendly throughout their lifecycle, including sourcing, production, and disposal. The significance of packaging in achieving a closed-loop system is especially emphasized by several factors: the critical role of packaging waste management (Niero et al., 2017) and the reuse of packaging to promote circularity (Silva & Pålsson, 2022).

Eco-friendly Transportation: Sustainable transportation methods aim to reduce carbon emissions and other pollutants, contributing to a lower overall environmental footprint (Luthra et al., 2017).

Our initial Conceptual Model derived from the aforementioned literature review consists of the criteria shown in Table 1.

Table I: Initial Conceptual Model

Economic	Environmental& Circular	Social
Quality	Environmental Certifications	Interests & Rights of Employees
Price	Eco-friendly Raw Materials&Packaging	Information Disclosure
Delivery	Eco-friendly Transportation	

Source: Authors' Own Elaboration

Throughout the study, circularity criteria are comprehensively integrated into the supplier selection form. Initially, the conceptual model sets the foundation by including key environmental and circularity criteria such as environmental certifications, the use of recyclable raw materials for packaging and products, and eco-friendly transportation. Subsequently, empirical findings through supplier interviews validate these criteria and highlight additional practical considerations. The practical problem requires a strategic tool facilitating supplier selection. The emphasis is on creating a set of SSCs that will aid in the effective gathering of pertinent information. The establishment of an SSC is supposed to enable the design of an SSFoF in which internal requirements and external challenges will be considered, making the SSFoF mutually beneficial. The SSFoF should be a handy tool that eases the exchange and knowledge-sharing processes. By offering support in the upstream supply chain, this study contributes to the producer's desire to expand its circular business model to the target market country in Northern Europe. The following research questions allow the researcher to realize the objective of this research.

Our MRQ for this study is:

"What strategic circular SSC can be empirically validated to address the gap in integrating circular economy principles within international supplier selection frameworks?"

We broke down the MRQ into research questions (RQs) and sub-research questions (SRQs) as follows:

RQ1: Which SSC can be derived from the producer's and supplier's internal requirements?

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Understanding the producer's and supplier's internal requirements is vital for shaping relevant SSC. Semi-structured interviews allow us to uncover factors which influence purchasing decisions. This ensures that derived SSCs are tailored to internal needs. In conducting a thematic analysis, an initial set of SSC will be derived. This will serve as a foundational step in consideration for the SSFoF, enabling us to create an SSC that aids in the acquisition of information in line with internal requirements.

RQ2: Which SSC can be validated in terms of suppliers' ability to provide information respectively?

This question focuses on testing and approving criteria viability. Expert interviews with Eco Company's experienced and inexperienced suppliers assess if these criteria enable suppliers to provide the necessary information. Furthermore, it allows the SSC to be tested and identifies potential challenges suppliers face in information provision. Ensuring the criteria's practical validation is vital for the incorporation into the SSFoF. The goal is to finalize criteria that align with internal requirements while considering the supplier's practical challenges.

SRQ1: Which SSC facilitate the acquisition of relevant information from suppliers?

SRQ2: What challenges need consideration to enhance suppliers' ability to provide information for producer's supplier selection in the target market country?".

These SRQs evaluate criteria that can be validated due to the supplier's ability to provide information leading to immediate application in the SSFoF. The aim is to conclude that SSC won't need further consideration.

This study involves two distinct phases employing a two-phased iterative process for validation and supplementation. Phase 1 focuses on answering RQ1. It begins with a comprehensive exploration of the supplier's and producer's internal SSS to compile relevant SSC using a CM. This CM serves as a benchmark for comparing and contrasting primary data against validated SSC from four authors, facilitating triangulation for validation (Verhoeven, 2022).

The second phase addresses RQ2 by answering two SRQs. The first explores how SSC facilitates the acquisition of relevant information from suppliers, while the second investigates challenges requiring consideration to enhance suppliers' ability to provide information in the target market country (Figure 1).

3.2 Research Design

A substantial number of studies have been carried out on the supplier selection problem with various evaluation criteria and methods for traditional, green, and sustainable supply chains. We initially reviewed such research on supplier selection, which also included a review of the prior work in these fields. Afterwards, we used a longitudinal single case study methodology (Edmondson & McManus, 2007; Yin, 2013). This approach has been shown to facilitate a more detailed description of a phenomenon (Siggelkow, 2007), a deeper exploration of the subject (Dyer & Wilkins, 1991), and a reassessment of old theoretical relationships (Yin, 2013), which are in line with the objectives of this study. Our study spans one year. In the duration of one year, the following aspects of the research have been carried out:

Multi-Phased Approach: Our study is divided into two distinct phases, each requiring sufficient time to thoroughly explore and validate the supplier selection criteria. Phase 1 involves an initial exploration of internal requirements through semi-structured

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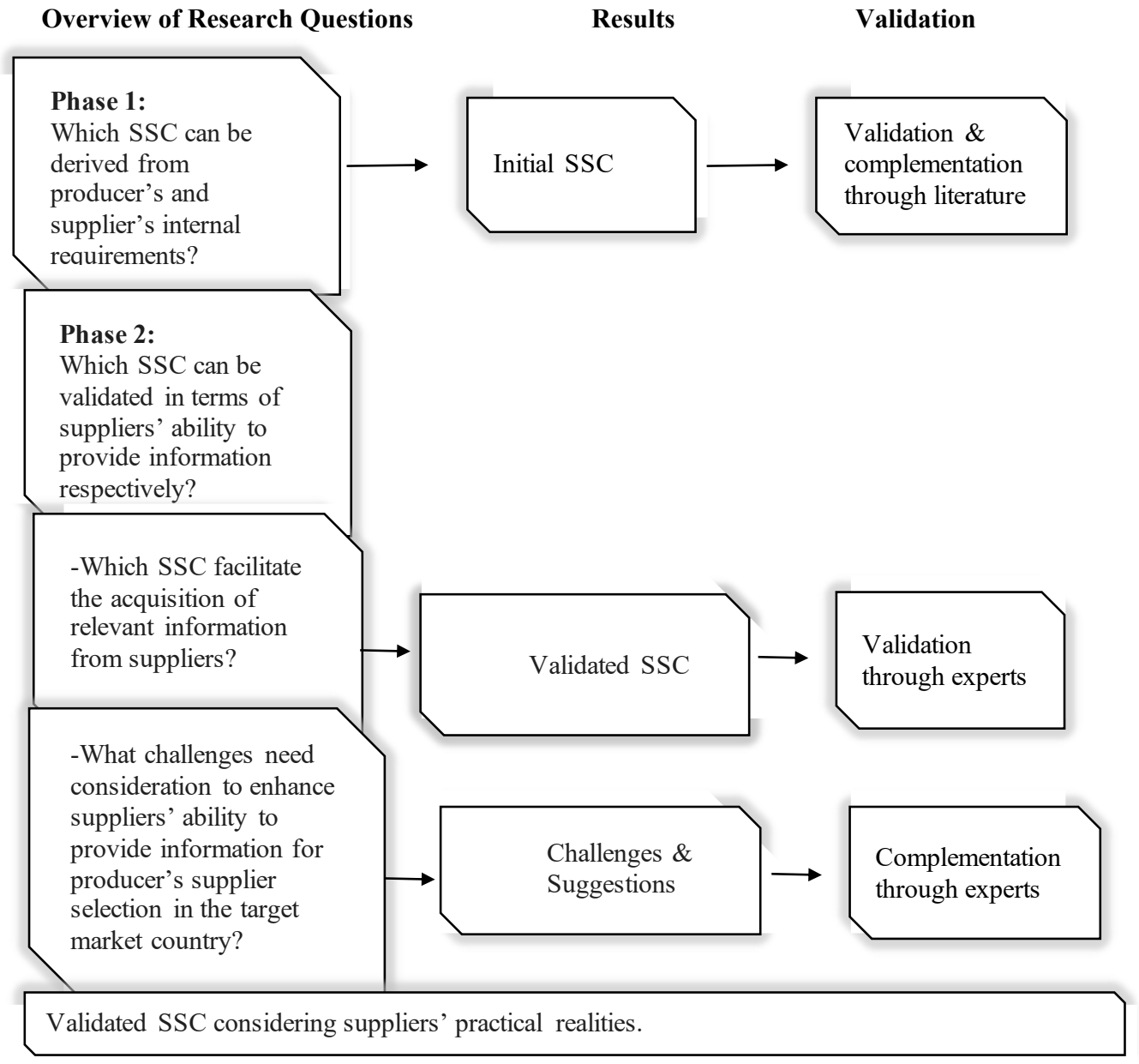
interviews, while Phase 2 focuses on validating these criteria with industry experts and suppliers. This iterative process ensures that the criteria are suitable and applicable in real-world scenarios.

Figure 1: Research Methodology



Source: Authors' Own Elaboration

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Data Collection: A one-year period allowed for data collection through multiple rounds of interviews and interactions with key stakeholders. This duration was used to capture detailed insights and make necessary adjustments to the criteria based on feedback and practical challenges encountered during implementation.

Validation and Refinement: The longitudinal aspect of the study provided ample time for the validation and refinement of the supplier selection criteria. It allowed for observing the practical application of these criteria in the business operations of Eco Company and its joint venture partners, ensuring that the criteria are not only theoretically sound but also practically viable.

We also used a collaborative research design, incorporating business perspectives while contributing to a theory (Freytag & Young, 2017) in a mixed-approach framework. The case study benefits from previous theoretical findings and aims to expand them with empirical findings from the business.

Our case study is an "illustrative" case study. An illustrative case study is a research approach used to describe and explain a specific instance of a phenomenon, often to highlight its key characteristics, context, and implications. An illustrative case study offers a thorough and detailed description of the case, capturing essential details that help illuminate the broader phenomenon being studied (Yin, 2013). It situates the case within its broader context, allowing researchers to explore how specific factors and conditions influence the observed outcomes (Stake, 1995). By providing concrete examples, illustrative case studies help explain theoretical concepts, making them more accessible and understandable to readers (Merriam, 2009). They often focus on real-world applications and implications, demonstrating how theoretical principles are implemented in practice and highlighting best practices and lessons learned (Eisenhardt & Graebner, 2007).

In the context of this research, Eco Company serves as an illustrative case study to explore and validate circular supplier selection criteria. By focusing on Eco Company's innovative circular economy practices and strategic goals for international expansion, the study provides a detailed and practical example of how circular principles can be integrated into supplier selection processes. This approach helps to clarify the theoretical concepts and demonstrate their practical application, offering insights for both researchers and practitioners in the field of sustainable supply chain management.

3.3 Description of the Company used for the Case Study

The case study company (referred to as Eco Company) is a company established in 2015 in the Netherlands. The company aims to eradicate wasteful production processes, products, and materials to challenge traditional norms in the furniture industry. The company stands out for its innovative approach to reusing and revitalizing waste materials and residual flows. By embodying a pioneer in transforming wasteful upholstery processes, the company envisions a future where design and industrial solutions align with the principles of a circular economy.

Through a patented grinder, the Eco Company can grind waste materials, including textiles, leather, and cork, into a versatile coating. The ground powder can be sprayed on top of a patented binder, which allows refurbishing any object within seconds. To ensure an efficient grinding process and compatibility, Eco Company's binder waste materials need to fulfil Eco Company's internal requirements.

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In addition to Eco Company's initiatives in refurbishing end-of-life items, they have procured furniture foam from tennis balls to create furniture from scratch. This development led to a broad spectrum of projects, including interior and exterior furniture design projects, industrial projects, and customized offers. To build up on its circularity promise, Eco Company has made its furniture available as a leasing option for seasonal use.

The company advocates for local sourcing to maintain a tight connection between suppliers and production. Eco Company aims to expand internationally through a joint venture model. The company desires to extend the benefit of its technology internationally. In this regard, the North European company "Eco Design" emerged as a fitting joint venture partner for Eco Company's endeavours. Eco Design, specifically focused on design, seeks out small waste particle sizes to refine and explore the diverse attributes of particles within materials. This involves examining shapes and forms that can be applied in various ways. They are dedicated to investigating the effective utilization of different forms, particles, and structures of waste, making Eco Company's technology a supporting facilitator.

The choice of Eco Company as the case study subject is based on several reasons:

Alignment with Research Objectives: Eco Company's business model is inherently circular, aiming to transform waste materials into valuable products. This alignment with circular economy principles provides a rich context for exploring and validating circular supplier selection criteria, directly addressing the research question of how to enable international expansion through new supplier selection based on circular principles.

Innovative Practices: Eco Company employs a patented technology for grinding waste materials, including textiles, leather, and cork, into a versatile coating. This coating can be applied to refurbish objects within seconds, displaying a practical and scalable application of circular economy concepts. The company's innovative approach to material reuse and its potential for broader industrial applications make it an illustrative example of circular economy practices in action.

Strategic Fit for International Expansion: Eco Company is prepared for international expansion through a joint venture with Eco Design, a North European company. Eco Design is focused on refining and exploring the diverse attributes of waste particles, aiming to utilize various waste forms in innovative ways. This partnership underlines the practical relevance of developing supplier selection criteria that can support Eco Company's expansion into new markets, highlighting the need for a strategic framework that considers international regulatory, cultural, and environmental contexts.

Local Sourcing and Environmental Impact: Eco Company advocates for local sourcing to maintain a tight connection between suppliers and production, ensuring that waste materials meet their stringent internal requirements. This local sourcing strategy not only supports the regional economy but also minimizes the environmental impact associated with transportation. The company's dedication to sourcing materials locally while preparing for international expansion presents a unique opportunity to study the practicalities and challenges of implementing circular supply chain practices on a global scale.

Comprehensive Circular Business Model: Beyond refurbishing end-of-life items, Eco Company has developed furniture foam from tennis balls, demonstrating its ability to create new products from waste. This broad spectrum of projects, including interior and exterior furniture design, industrial projects, and customized offers, illustrates the versatility and potential of their

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circular business model. Additionally, their leasing option for furniture underscores their commitment to circularity by promoting reuse and extending product life cycles.

3.4 Data Collection and Analysis Method

Data collection is carried out in two phases. For each phase, interviews have been carried out using purposive sampling criteria. For all purposive sampling procedures, the focus is less on the number of participants to be selected and more on which specific participants should be chosen to provide saturation to the data to be collected (Hammersley, 2015). A case study methodology often employs one or two case studies to deeply investigate a specific phenomenon or institution (Saunders et al., 2015). Therefore, data are subsequently collected from either all participants or a selected sample of participants within these case studies. The interviewees have been selected according to the following criteria, based also on the study of Knott et al. (2022) :

Relevance to the Research Question: The interviewees were selected based on their relevance to the study's focus on circular supplier selection within the context of sustainable supply chain management. This aligns with the research objective of identifying and validating key criteria for selecting suppliers who align with circular economy objectives.

Expertise and Experience: Eco Company's Chief Commercial Officer (CCO) and senior representatives are chosen for their strategic roles and in-depth knowledge of the company's supplier selection processes and criteria. Their expertise is crucial for understanding the company's objectives and the details of its material acquisition for circular economy practices. Eco Design representatives are selected for their specialized knowledge in local waste material sourcing and their analytical approach to material utilization. Their perspective complements the commercial focus of Eco Company and provides a deeper understanding of experimental approaches to waste material utilization.

Diverse Perspectives: Three suppliers were included to provide practical insights and validate the criteria from the perspective of those involved in recycling and sustainability practices. This diversity in interviewees ensures that the study captures a broad range of experiences and perspectives.

Purposive Sampling: A purposive sampling method was employed to select information-rich cases relevant to the study's scope. This approach ensures that the selected interviewees can provide in-depth and specific insights, enhancing the reliability of the data collected.

Empirical and Practical Relevance: The interviewees were chosen for their direct involvement in material sourcing, supplier selection, or waste management processes relevant to the circular economy. This empirical relevance ensures that the data collected is pertinent to the study's objectives, thus enhancing the validity of the findings.

Inclusion and Exclusion Criteria: The inclusion criteria were based on the interviewees' roles, expertise in sustainable and circular practices, and their involvement in strategic sourcing and supplier selection. Exclusion criteria likely included individuals without direct involvement or expertise in these areas, ensuring that the interview data was relevant and valuable for the study.

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Phase One: In addressing RQ 1, primary data was collected through semi-structured interviews. The exploratory nature of this phase made semi-structured interviews suitable, allowing for flexible exploration and qualitative in-depth insights. A thematic framework (Figure 2) guided the conversation. Interviews involved Eco Company's CCO, and two senior representatives of Eco Company, and two representatives from Eco Design who are experts in local waste materials sourcing. Open-ended questions were employed to gain a comprehensive understanding of the companies' operating context and supplier specifications.

Table II: Thematic framework semi-structured interviews

Themes	**Explanation**
Understanding the business context.	Getting an understanding of the business context allows the researcher to have a better contextual understanding, prolonging the researcher's engagement in the research process.
Current requirements for suppliers.	Getting an understanding of current requirements allows to uncover intrinsic SSCs that are crucial for the aim of this research.
The additional value of the SSFoF	Understanding the purpose and the value of the SSFoF allows to indicate further requirements for the SSFoF and uncovers preferred features that the SSFoF should have.
The value that suppliers can bring to the business operations.	Understanding the values that suppliers can bring to producers and suppliers triggers a better understanding of what kind of information they need to get in the SSFoF.

Source: Authors' Own Elaboration

Thematic analysis, applying both deductive and inductive approaches, was utilized to analyse the primary data set. The deductive approach, initiated by the predetermined themes and codes from the literature review and thematic framework, provided a structured baseline for analysis. However, an inductive approach allowed for the emergence of unexpected themes during the analysis, maximizing depth (Dawadi, 2020). A six-phased thematic analysis approach was applied, involving familiarizing with data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the report (Nowell et al., 2017). This reflexive process maintained alignment with research objectives and client-centricity, resulting in a refined set of SSC derived from the producer's and supplier's internal requirements.

Combining a deductive approach with an inductive approach enabled a dynamic interplay between pre-established themes and those emerging from interviews. The adjustment aimed to maintain alignment with research objectives and client-centricity, resulting in a comprehensive and tailored thematic analysis based on the refined thematic framework.

Phase Two: In the second phase, we address RQ2 and two SRQs. The examination of the initial set of SSC is accomplished through expert interviews, wherein industry experts provide insights to verify SSC feasibility and reliability or highlight areas requiring considerations to align SSC with practical supplier realities. This phase introduces the international aspects of SSC and circularity.

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Structured interviews were employed to gain insights into supplier practical realities concerning SSC. These interviews, designed for the extraction of specific responses, promote standardization to facilitate meaningful analysis (Rashidi et al., 2014). This approach proves suitable for validating SSC while allowing flexibility for deeper insights into suppliers' practical realities. The target group for these structured interviews was identified using a non-probability sampling method, specifically the purposive sampling method, chosen to optimize data sources for qualitative research in information-rich cases related to the study's scope (Palinkas et al., 2015). The sample size, determined based on data saturation rather than statistical power analysis, included two Dutch suppliers with experience working with Eco Company and one supplier in the target market country in Northern Europe. This selection aimed to provide unbiased and critical perspectives on practical realities faced by suppliers in Northern Europe, enhancing the applicability of SSC for the target market.

Supplier 1 is a multinational company operating in the athletic footwear and apparel industry. They are located in Belgium and have experience in working with Eco Company. The interviewee was part of the sustainability/recycling department and was in charge of the recycling operations for both footwear and apparel. Within the scope of its mandate, it is important to identify matching partners who are able to work with the company's recycled materials to put them back into new products or back into the company's ecosystem. Supplier 2 is a multinational company operating in the footwear industry, and they do have experience working with Eco Company. The interviewees were part of the Global Sourcing Team, which is responsible for strategic sourcing, supplier selection, contracting, and negotiating on behalf of different technical factors. Supplier 3 is a waste management company located in the target market country in Northern Europe. The company collects waste materials of companies from various industries. Two representatives of the company participated in the meeting. They are part of the development department.

For data analysis, a second thematic analysis, focused on suppliers' ability to provide information, has been executed. This deductive approach utilized the initial SSC as an overarching theme. Responses from suppliers were assessed not only based on fulfilling criteria but also on their ability to provide information. This facilitated the addressing of SRQs 1 and 2. Challenges in providing information were considered opportunities either to exclude a specific SSC or to frame questions in a way that would enable suppliers to address these challenges.

Analysing data regarding suppliers' ability to provide information inherently involves the researcher's judgment, impacting the objectivity of the analysis. To enhance objectivity, the majority of "positive" or "negative" responses were considered. Two positive responses (indicating suppliers' ability to provide information) outweighed one negative response (indicating challenges), leading to the validation of the SSC. Conversely, two negative responses outweighed one positive response, prompting the identification of challenges and providing suggestions for the SSFoF. In cases where suppliers were unable to suggest ways to address their limitations, the SSC would be excluded from the SSFoF.

4. Analysis and Results

In order to understand which SSC can be derived from the producer's and supplier's internal requirements, semi-structured interviews have been carried out with the respective company representatives of Eco Company and Eco Design. The topic

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guide for the interview with Eco Company included material requirements, supplier assessment, grinding process, market expansion, collaboration and marketing, supplier information form, colour specifications, waste material definitions, economic dimension, location and waste materials. The interviews spanned a period of 1 year, and a series of 5 interviews were carried out ranging from 60-90 minutes.

The semi-structured interviews with Eco Company revealed key insights into the company's requirements and criteria for selecting suppliers of waste materials. In the interviews, the interviewees conveyed a comprehensive approach to supplier selection and material acquisition for circular economy practices. Emphasizing the importance of particle size and structure, he highlighted the efficiency gained from using pre-processed materials while acknowledging the challenges associated with larger materials. Sustainability was a main criterion, with a preference for organic materials and a clear aversion to plastics. The interviewees expressed strategic interest in the target market in Northern Europe, citing its abundance of various waste materials. Collaborative aspects of supplier relationships were underscored, emphasizing mutual promotion and the creation of marketing value. The interviewees concluded by highlighting the need to understand the locations of production facilities, providing insights into the geographical distribution of waste materials crucial for Eco Company's strategic decision-making.

The topic guide for the interviews with Eco Design included the company approach, utilization of waste as an analytical tool, design methodology contribution, global utilization of waste, investigation criteria and experimental stage tools for material categorization. There were a series of 7 interviews, each ranging from 60-90 minutes.

In the interviews with representatives of Eco Design, a company involved in waste stream utilization, they shared insights into their experimental approach compared to Eco Company's commercial venture. They explained that their work is more analytical and experimental, aiming to refine materials through complex processes for application. They illustrated this with an example of using accumulated dust from a mining company as a colouring agent. They emphasized their role in contributing design methodology to Eco Company's technology and outlined their interest in utilizing diverse waste materials globally. The discussion also touched on criteria for investigating waste streams, such as particle size and purity, and the challenge of determining substances in recycled materials. The interview highlighted their experimental stage and the need for tools to categorize materials for better communication with waste management companies.

In the iterative phase of coding the interviews, the following process was followed:

Step 1: Data Familiarization: The initial step involves familiarizing with the data, wherein predefined themes and codes are recognized, understood and coloured during the review and engagement with interview data.

Step 2: Generation of Initial Codes: The emphasis is placed on selective quotes. Repetitively mentioned quotes are coded to develop inductive codes representing internal SSS. These codes are cross-referenced with codes and themes from the concept model. Through this process, the following observations emerged:

1. Identification of Matching Codes: From the primary data set, codes such as "Pricing" and "Certification have been identified to align with CM codes. While the remaining CM codes complement the internal SSS, the criterion "Quality" is excluded due to Eco Company’s and Eco Design’s inductive codes providing more tailored quality specifications, aiming to maintain simplicity and utility for suppliers.

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2. Terms Mentioned by Stakeholders: Certain terms, including "Quantity," "Collaboration," "Supplier Engagement," and "Sustainability Incentive," mentioned by Eco Company or Eco Design representatives, align with CM themes.
3. Inductive Codes: Five terms – "Type of Material," "Size & Structure," "Purity," "Colors," and "Material Categorization" – emerged as inductive codes. Although unmatched with CM codes or themes, these inductive codes enhance the existing set of SSC, proving relevant for Eco Company and Eco Design.

Table III: Revised Themes and Codes

Theme	**Economic & Material Details**	**Environment & Circular**	**Social**
Codes	Type of Material Material Categorization Size & Structure Supplier Engagement Purity Colours Price Quantity Delivery Collaboration	Sustainability Incentive Environmental Certifications Eco-friendly Raw Materials and Packaging Eco-friendly Transportation	Interests & Right of Employees Information Disclosure

Source: Authors' Own Elaboration

Steps 3, 4, and 5: Theme Confirmation, Review, and Naming: In the subsequent steps (3), (4), and (5), the process involves searching for, reviewing, and naming themes. The confirmation of pre-defined themes is initiated by aligning matching inductive codes. Key observations during this process are detailed below:

1. Allocation of Inductive Codes: Inductive codes such as "Pricing" and "Certification" align seamlessly with pre-determined themes such as "Economic" and "Environmental & Circular" due to their correlation with deductive codes. Additionally, inductive codes "Quantity," "Collaboration," and "Supplier Engagement" find alignment under the theme "Economic."
2. Social Theme Consideration: No direct inductive codes align with the "Social" theme. However, the persistence of the theme and its associated codes is warranted based on their relevance, as emphasized by (Luthra et al., 2017) and (El Barky et al., 2022).
3. Emerging Themes: The examination of inductive codes that don't match with the CM leads to the identification of new themes. Codes like "Type of Material," "Size & Structure," "Purity," "Colors," and "Material Categorization" point towards a thematic focus on assessing materials based on their features. Consequently, the introduction of the theme "Material Details" is justified, providing comprehensive information about the materials.

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4. Integration of Economic and Material Details: The interview emphasizes the paramount importance of materials in the SSFoF. The economic details related to materials, as crucial determinants, warrant a thematic amalgamation. Thus, the theme "Economic & Material Details" is proposed to combine these dimensions, enhancing clarity and utility for Eco Company in utilizing the information.

Step 6: Report Production: The final step involves producing the thematic analysis report. The adjusted CM, incorporating the refined themes, has been integrated into the report. This revised model encapsulates the comprehensive understanding derived from the thematic analysis, providing a qualitative structure tailored to Eco Company's specific needs. The clarity achieved through the "Economic & Material Details" theme enhances the utility of the SSFoF, Eco Company interviewee's emphasis on a clear overview.

Table IV: Initial Draft of SSC

SSC	Definition
Economic & Material Details	
Type of Material	Information about the type of materials.
Material Categorization	The ability to categorize the material according to by-product, post-consumer, post-industrial, or finished-product waste.
Size & Structure	Information about the particle sizes and ability to provide smaller waste particles.
Supplier Engagement	Suppliers have the ability to commit to Eco Company's concept to the extent that they find suitable waste streams for Eco Company without having previous specifications.
Purity	The ability to provide information about the substances contained in a material.
Colours	Providing information about the availability of colours.
Quantity	An understanding of how much a company can supply on a monthly, quarterly, or yearly basis.
Delivery	The ability of suppliers to meet specified delivery schedules, including the lead time (Taherdoost & Brard, 2019)
Collaboration	Existing interest for mutual collaboration in terms of projects/solutions enhancing the marketing value.
Environmental & Circular	
Sustainability Incentive	A company's sustainability mission, targets, or initiatives.
Environmental Certifications	Possession of environment-related certifications, e.g., ISO 14001, EMAS, and Carbon Trust Standard (Münch et al., 2022).
Eco-friendly Raw Materials and Packaging	Using recyclable materials for packaging and producing the product (El Barky et al., 2022)
Eco-friendly Transportation	Use of clean and suitable vehicles to distribute and collect the products for recycling (Münch et al., 2022)
Social	
Interests & Right of Employees	The suppliers' respect for its workers' rights, employment insurance, standard working hours, and employment compensations (El Barky et al., 2022)

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Information Disclosure	Providing information to the suppliers, customers and stakeholders regarding material used, carbon emissions and toxins released during production (Luthra et al., 2017)

Source: Authors' Own Elaboration

The semi-structured interviews with representatives of Eco Company and Eco Design provided important insights into their supplier selection criteria for waste materials, emphasizing the importance of material characteristics, geographical considerations, collaborative relationships, experimental approaches, and material categorization. Using pre-processed materials, particularly smaller, consistent particle sizes, improves production quality and aligns with Eco Company's sustainability goals by favouring organic over plastic materials. Strategic interest in Northern Europe supports production needs while optimizing logistics and reducing carbon footprints. Collaborative relationships advance innovation and shared growth, enhancing the company's circular economy goals. Eco Design's experimental focus on refining and repurposing diverse waste streams complements Eco Company's operations, offering new market opportunities. Accurate material categorization streamlines procurement processes, ensuring a consistent supply of high-quality waste materials, thus supporting operational efficiency and sustainability.

After this initial stage, the following section examines the second phase by testing and approving the viability of SSC. The second phase determines SSC that can be validated and challenges which need to be considered in the SSFoF.

First, we studied which SSC enable the acquisition of relevant information from suppliers. This section undertakes an analysis to promptly validate specific SSCs based on suppliers' ability to provide information, facilitating their immediate application in the SSFoF. We interviewed three suppliers for this analysis. The conclusion of this section will present the successfully validated SSC.

The topic guide for this section included an overview of organization, types and categorization of materials, particle sizes of materials, recognition of smaller waste materials, purity of recycled materials, adaptation to client requirements, determining the pricing of materials, collaborations with customers, sustainability practices, environment-related certifications, circular practices in the supply chain, clean transportation initiatives, and employee safety and well-being. Five interviews have been carried out in total, each lasting 75-90 minutes,

Supplier 1 focused on recycling footwear and apparel, targeting post-consumer, post-industrial, and finished product waste. Their recycling processes yield specific material types, such as textiles, foams, rubber, and leather, with fixed particle sizes due to the limitations of their machinery. While they show flexibility in quantities supplied, they face challenges in altering material sizes and colours to meet specific client requirements. Their approach to sustainability is comprehensive, involving initiatives for environmental and social responsibility, including using recycled materials in new products. However, the company acknowledges gaps in awareness about smaller waste outputs and the potential value they hold. Supplier 2 emphasized the company's vertically integrated structure, enabling control over the quality and types of waste produced in-house. Their waste materials, primarily categorized as post-industrial waste, include leather and textiles. They have fixed particle sizes for their waste materials and face challenges in adjusting these sizes due to the need for additional machinery and investment. Their approach to sustainability includes rigorous auditing processes for suppliers, emphasizing corporate social responsibility and

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environmental impact. However, like Supplier 1, Supplier 2 also recognizes limitations in identifying and utilizing smaller, less obvious waste streams. Supplier 3 operates in a broader waste management context, dealing with various waste materials across the target market country. Their focus is on standardized waste fractions, with less emphasis on specific fibres or raw materials. They acknowledge the need for better strategies to identify valuable materials in waste streams and the challenges of adjusting their systems for new types of waste. Their approach involves exploring innovative ways to connect upstream suppliers with downstream demands and leveraging organizational shifts to focus more on sustainable practices. However, they, too, face challenges in effectively identifying and utilizing smaller waste streams and ensuring the purity and detailed classification of recycled materials. Across all three suppliers, a common theme emerges: while there is a commitment to recycling and sustainability, there are operational challenges in terms of machinery limitations, size and colour flexibility, and the identification of valuable smaller waste streams. These challenges highlight the need for innovation and more effective communication strategies in the recycling and waste management industry to fully utilize the potential of all waste materials, particularly smaller, less recognized streams.

Upon analysis of the interviews, the SSC "Material Type" and "Material Categorization" were promptly validated. First, suppliers' responses affirm their competence in providing information regarding material types. Second, the usage of terms such as "Post-consumer waste," "Post-industrial waste," "By-Product," and "Finished-product waste" has been substantiated as key in identifying waste streams.

Table V: Summary of the Validated SSC

Theme	Economic & Material Details	Environment & Circular	Social
SSC	Type of Materials Material Categorization Collaboration	Sustainability Incentive Environmental Certifications Eco-friendly Raw Materials and Packaging Eco-friendly Transportation	Interests & Right of Employees Information Disclosure

Source: Authors' Own Elaboration

Afterwards, we also validated the SSC "Collaboration." This was evident as all suppliers engaged in collaborations with other companies beyond mere material supply and recognised the value of close collaboration for mutual development.

Subsequently, we also validated the SSC "Sustainability Incentive" and "Environmental Certifications." Suppliers effectively provide information about their sustainability incentives and unanimously confirm the possession of environmental certifications by their respective companies. Continuing the validation process, we validated the SSC "Eco-friendly Raw Materials and Packaging". Suppliers demonstrate their ability to communicate internal initiatives by incorporating eco-friendly raw materials during the design and purchasing stages of product development and packaging. Furthermore, supplier 3, a waste management company, is seen as inherently supporting the incorporation of waste materials in their processes.

Afterwards, we validated the SSC "Eco-friendly Transportation". Suppliers underscore the use of clean and sustainable vehicles for the distribution and collection of products for recycling. Despite the lack of initiative from supplier 2, the SSC is validated

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due to the mature plans of suppliers 1 and 2 to accelerate the shift to eco-friendly transportation, outweighing the response of supplier 2.

Finally, we validated the SSC "Interests & Rights of Employees" and "Information Disclosure." All suppliers communicated their companies' initiatives regarding Corporate Social Responsibility (CSR), referencing reports that demonstrate efforts in both CSR and sustainability initiatives. In conclusion, the analysis affirms the immediate validation of the specified SSC, providing a robust foundation for their seamless integration into the SSFoF.

Through expert interviews with three suppliers, several SSCs were validated for their practical applicability and impact on operations. Knowing the type of materials that the suppliers can provide is fundamental for meeting production requirements, aiding Eco Company in making informed decisions and reducing supply chain disruptions. Collaboration with suppliers enables innovation and sustainable practices, enhancing product quality and sustainability. Suppliers' commitment to sustainability and possession of environmental certifications supports Eco Company's environmental goals and mitigates reputational risks. Using eco-friendly raw materials and packaging minimizes environmental impact, promoting recycling and supporting the circular economy model. Sustainable transportation practices reduce the logistics carbon footprint while respecting employee rights and ensuring safe working conditions, enhancing Eco Company's ethical standards. The analysis also identified challenges, such as fixed material sizes and limited awareness of smaller waste outputs, with suggestions to address these issues, including providing standard-size information, enhancing communication, and offering technical data sheets. Flexibility in quantity and delivery was noted, but pricing variability and colour availability depend on production factors, with suggestions to indicate available colours and lead times.

The following analyses focus on specific supplier challenges that require further consideration, particularly concerning the provision of information. Seven SSC challenges have been identified, and this section aims to present these challenges along with corresponding suggestions from suppliers to address the obstacles.

Initially, a common challenge was highlighted among suppliers, which was adjusting material sizes. (1) All suppliers mentioned having fixed sizes for supply. (2) However, they clarified their ability to provide information about these sizes. (3) Supplier three proposed using industry information, processes, and end-products as indicators to identify smaller waste streams.

Afterwards, we identified suppliers' difficulties in engaging with Eco Company’s concept by identifying smaller waste outputs. (1) Suppliers emphasized the general challenge of offering smaller waste outputs due to a lack of awareness regarding the value of these materials. (2) Recommendations include communicating Eco Company’s concept, emphasizing the value of these materials, and showcasing examples of use cases to encourage suppliers to support the initiative.

Then, we identified challenges that suppliers face in providing detailed information about substances contained in materials. (1) Suppliers noted their inability to furnish intricate details about material substances. (2) Suggestions were made to overcome this limitation, including the provision of technical data sheets or rough overviews of these materials.

We also identified the challenge of determining pricing, indicating variability depending on a case-by-case basis. (1) Suppliers did not provide specific suggestions on how to accommodate this challenge within the SSFoF.

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Finally, we illustrated suppliers' ability to adjust the quantity, delivery, and colours of waste materials. (1) Suppliers expressed flexibility regarding quantity. (2) Colors and delivery depend on production, with suggestions to provide indications on available colours and average lead-time or quantity.

Table VI: Challenges of Suppliers and Suggestions to Accommodate These Challenges

SSC	Challenges	Suggestions
Size & Structure	Fixed sizes.	Indications about the sizes can be provided. Knowledge about processes and end products can give indications of where unrecognized waste outputs might appear.
Supplier Engagement	Lacking knowledge about the value of smaller waste outputs.	Need to communicate knowledge and examples to foster suppliers' mentality
Purity	Limitations in determining the substances of materials.	They can provide either a technical data sheet or a rough overview can be provided
Price	Has to be decided upon request.	No suggestions have been made.
Colours	Depends on waste outputs.	They can tell what colours will be available.
Quantity	Depends on the waste outputs.	They are quite flexible. Mostly steady flow.
Delivery	Depends on inventory.	Lead times could be indicated.

Source: Authors' Own Elaboration

In general, the SSFoF does not eliminate communication to suppliers at all. Nor does it enable the identification of the ideal supplier. However, due to the guidance of relevant SSC, the SSFoF enable the collection of pertinent information, facilitating the identification of suppliers while reducing time-intensive back-and-forth communication. The SSFoF should be used as a starting point for negotiations with suppliers. This allows to pose more specified questions within the conversation without cherry-picking the necessary information. The SSFoF increases transparency for both entities, which allows for more efficient and straightforward communication, fostering a mutually beneficial partnership.

The validated SSC significantly impact Eco Company and Eco Design's operations and supply chain management, directly aligning with their circularity ambitions. Knowing the types of materials available ensures high product quality and supply chain resilience by diversifying the supplier base and reducing risks associated with supply chain disruptions. This is crucial for maintaining a steady flow of recycled materials, which supports the company's goal of minimizing reliance on virgin materials. Collaborative relationships with suppliers enable joint innovation in sustainable practices, leading to mutual benefits such as cost savings and increased market competitiveness. This collaboration enables the development of new products from waste materials, driving the circular economy model forward. Ensuring suppliers possess relevant environmental certifications and sustainability incentives helps Eco Company comply with international regulations, enhance brand reputation and attract eco-conscious consumers and investors, all of which are vital for sustaining their circular economy initiatives.

Using eco-friendly materials and packaging reduces waste, decreases the demand for virgin materials, and can lead to cost savings in waste management, supporting the company's circularity goals. Sustainable transportation practices lower the carbon footprint and improve operational efficiency through optimized routing and reduced fuel consumption, contributing to the

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company's environmental sustainability targets. Ensuring suppliers respect employee rights and maintain safe working conditions creates an ethical supply chain, which is essential for the company's social responsibility commitments within a circular economy. Addressing challenges related to fixed material sizes, limited awareness of smaller waste outputs, and difficulty in providing detailed material information enhances production flexibility and supports the efficient utilization of all available waste materials. Enhanced communication and standardized processes ensure that Eco Company can fully leverage its SSCs to promote innovation, regulatory compliance, and ethical practices, ultimately strengthening its position as a leader in the circular economy.

5. Discussion and Conclusions

Our study aimed to develop and validate circular SSC within the context of circular supply chain management. Our findings include insights into the practical application of these criteria, contributing to the literature and offering implications for both academics and industry. In our study, we have identified and addressed the following gaps: initially, our study addressed the lack of empirical evidence on the application of circular SSC by conducting semi-structured interviews providing real-world insights that are often missing in the literature. We developed a practical, scalable, and adaptable SSC framework for an SSFoF, validated through supplier interviews to ensure its applicability across different contexts. By integrating circular economy principles into the SSC, focusing on eco-friendly materials, packaging, and transportation, our research aligns supplier selection with the companies' circularity goals. Emphasizing supplier engagement and collaboration, our study highlights the benefits of strong supplier relationships for integrating circularity into the supply chain. Additionally, we identified specific material-related criteria such as particle size, categorization, and purity to meet stringent quality and sustainability standards. Finally, we addressed practical challenges in SSC implementation, such as fixed material sizes and communication about smaller waste outputs, providing solutions to facilitate effective and transparent communication between suppliers and producers. The validated SSC contributes to the literature on sustainable and circular supply chain management. By integrating economic, environmental, and social dimensions, these criteria help companies align their supplier selection processes with circular economy principles. This alignment is crucial for maintaining end-of-life products within the production cycle, reducing reliance on virgin materials, and promoting resource circulation. For business practitioners, the SSFoF developed in this study offers a practical tool for strategic supplier selection, facilitating efficient communication and collaboration with suppliers. This tool helps companies gather pertinent information, reducing the time-intensive process of back-and-forth communication and ensuring transparency and mutual understanding.

The literature mentions the gap in empirical studies concerning the practical application of circular principles in supplier selection (El Barky et al., 2022; Tushar et al., 2022). Our research not only addresses this gap by empirically validating SSC through supplier responses but also provides a practical framework (SSFoF) for incorporating these criteria into the supplier selection process. This contributes insights into overcoming the practical challenges of implementing circular and sustainable supplier selection criteria.

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The literature also stresses the importance of developing scalable and adaptable criteria (El Barky et al., 2022; Münch et al., 2022). Our approach to integrating both validated and challenging SSC into the SSFoF, based on supplier insights and practical realities, exemplifies the scalable and adaptable nature of the criteria developed. This approach ensures that the SSFoF can accommodate the variability in supplier capabilities and environmental considerations, thus enhancing the framework's applicability across different contexts and industries. The strategic importance of sourcing materials locally to optimize logistics and reduce transportation costs is highlighted. This geographical focus is unique and not typically emphasized in traditional SSC discussions. Our article identifies practical challenges faced by suppliers, such as fixed material sizes and limited awareness of smaller waste outputs, and offers solutions to address these issues. This practical focus on addressing operational challenges is a significant contribution. The emphasis on fostering strong collaborative relationships with suppliers to drive innovation and mutual growth aligns with Dynamic Capabilities Theory (Teece et al., 1997) and Stakeholder Theory (Freeman, 1984). This strategic adaptability and focus on collaboration are crucial for implementing sustainable and circular supply chains. On the other hand, RBV suggests that firms gain a competitive advantage by utilizing valuable, rare, inimitable, and non-substitutable resources (Barney, 1991). This theory is reflected in our study's emphasis on high-quality materials, eco-friendly resources, and strategic geographic advantages, which enhance the company's resource base and competitive edge. Dynamic Capabilities Theory, which emphasizes a firm's ability to adapt and reconfigure its resources in response to changing environments (Teece et al., 1997), is shown in the company's adaptability, innovation, and continuous improvement in supplier relationships and sustainability practices. This aligns with the company's dynamic capabilities, which are necessary for maintaining competitiveness in a rapidly changing market. Stakeholder Theory, which suggests that firms should create value for all stakeholders (Freeman, 1984), is evident in the company's commitment to social responsibility, transparency, and community impact. This approach ensures that the company's operations benefit all stakeholders involved.

The CE theory emphasizes the continuous use of resources by creating closed-loop systems where products, materials, and resources are reused, refurbished, remanufactured, and recycled (Geissdoerfer et al., 2018). Our study's criteria, such as the use of recycled materials and eco-friendly packaging, support these principles by minimizing waste and maximizing resource efficiency. The Internationalization Theory, including the Uppsala Model and Network Theory, emphasizes the gradual expansion into foreign markets and the importance of building relationships with international partners (Johanson & Mattsson, 2015; Johanson & Vahlne, 1977). Our findings highlight strategic sourcing and collaboration with international suppliers, aligning with these theories by leveraging local market conditions and fostering collaborative networks to implement circular economy principles globally. These connections emphasize the robustness of the study's findings and their significant contribution to advancing sustainable and circular supply chain management.

Our study also provides practical and managerial insights into the development and implementation of circular supplier selection criteria within the context of sustainable supply chain management. Firstly, it emphasizes the importance of material characteristics such as particle size, structure, and purity in enhancing production efficiency and maintaining high product quality. This level of detail is crucial for companies aiming to incorporate circular economy principles by ensuring that reclaimed materials can perform equivalently to virgin materials.

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Geographical considerations are highlighted as a strategic factor in supplier selection, with a particular focus on the availability of diverse waste materials. This approach not only supports production needs but also optimizes logistics, reducing transportation costs and the overall carbon footprint. These findings highlight the necessity for companies to strategically source materials from regions that offer both economic and environmental advantages.

Collaborative relationships with suppliers are identified as essential for fostering innovation and sustainable practices. The study reveals that such collaborations can lead to joint efforts in innovation and marketing, promoting mutual growth and the development of more sustainable supply chains. This insight is particularly valuable for managers seeking to enhance their company's circular economy initiatives by building stronger partnerships with their suppliers.

The experimental approach of companies, focusing on refining and utilizing diverse waste streams, complements the commercial operations of those companies. This synergy allows for the exploration of innovative uses for waste materials, such as using mining dust as a colouring agent, which can open new market opportunities and support the company's sustainability goals.

Material categorization is also emphasized as a critical factor for effective communication and utilization of waste materials. Accurate categorization helps streamline the procurement process, ensuring a consistent supply of high-quality waste materials that meet production needs. This practical insight can guide managers in developing more efficient and effective supplier selection processes.

Overall, the study offers a strategic framework and practical tool, the SSFoF, which facilitates efficient supplier evaluations and promotes transparency and collaboration between suppliers and buyers. This tool helps reduce the time-intensive communication typically required in the supplier selection process, making it easier for companies to implement circular economy principles in their supply chains. The emphasis on maintaining high purity standards, material categorization, and fostering collaborative relationships provides a comprehensive approach to enhancing both operational efficiency and sustainability performance.

6. Limitations and Directions for Future Research

Our article has several limitations that need to be acknowledged. Firstly, the study relies on a limited number of semi-structured interviews. This small sample size may not fully capture the diversity of perspectives and practices across different industries and geographical regions. Secondly, the research emphasizes Northern Europe for strategic sourcing of waste materials, which might limit the generalizability of the findings to other parts of the world where the availability of waste materials and regulatory environments differ significantly. Thirdly, the study is heavily focused on the specific context of companies involved in the recycling and utilization of waste materials, making the findings potentially less applicable to industries with different operational and sustainability challenges. Additionally, while the study validates the SSC through interviews, it does not provide quantitative data or case studies to support the effectiveness of these criteria in improving operational performance and sustainability outcomes. To address these limitations, future research should involve a larger and more diverse sample of companies across different industries and geographical regions, helping to understand the applicability and relevance of the

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SSC framework in various contexts. Conducting quantitative studies to measure the impact of implementing the validated SSC on operational performance, cost savings, and sustainability outcomes would provide more robust evidence of their effectiveness. Developing detailed case studies of companies that have successfully implemented the SSC framework could offer practical insights and best practices for other organizations. Additionally, investigating the role of digital technologies, such as blockchain and IoT, in enhancing the traceability, transparency, and efficiency of circular supply chains could provide valuable insights into the integration of technological solutions with SSC. Research should also explore the implementation of circular SSC in regions outside Northern Europe to understand how different regulatory environments, resource availability, and cultural factors influence the adoption of circular economy practices. Longitudinal studies tracking the long-term effects of implementing SSC on supply chain sustainability and business performance would provide deeper insights into the sustained impact of these practices. Lastly, further research should focus on identifying and addressing specific barriers to the implementation of circular SSC, such as financial constraints, lack of technical expertise, and resistance to change within organizations. By addressing these limitations and pursuing these suggestions for further research, future studies can build on the findings of this article to provide a more comprehensive understanding of sustainable and circular supply chain management.

Conflict of Interest

The authors have no conflict of interest related to this publication.

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