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Behind the Seams

Investigating the Balance of Cost and Sustainability in the Sourcing of Renewable Textile Materials

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Abstract:
The textile industry is a significant contributor to environmental pollution, with a substantial portion of this impact stemming from the upstream supply chain. Despite the growing recognition of renewable materials as a viable solution for achieving sustainability and circularity goals outlined by European legislators, existing literature has largely overlooked the relationship between buying firms and renewable textile material suppliers. This master's thesis aims to bridge this gap by examining both parties' perspectives on cost and sustainability, focusing on the potential for collaboration to ameliorate the trade-off between these factors.
Utilising semi-structured interviews with nine material innovators and twelve employees from a multinational buyer company, alongside a group interview, this study investigates the challenges and opportunities in balancing cost and sustainability in the renewable textile material sourcing process. The findings reveal that collaboration between material innovators and buying firms is critical for achieving a better balance between cost and sustainability, suggesting that working more closely can yield mutually beneficial outcomes. Additionally, both the innovators and the buying firm support the need for a harmonised system of sustainability measurement and assessment tools that can improve the sourcing process from both cost and sustainability perspectives.
The findings can serve as a valuable tool for industry stakeholders, policymakers, and as a base for future research in the field of renewable textile materials sourcing. For future research, it is recommended to incorporate the perspectives of tier-one suppliers and other supply chain actors, providing a comprehensive understanding of the dynamics and decision-making processes involved in renewable textile material sourcing. Additionally, further investigation could explore the experiences of a more diversified sample of buying companies to validate and refine the insights.

Supervisor: Sven-Anders Stegare

Keywords: Renewable Textile Materials, Sustainable Sourcing, Circular Economy

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Table of Contents

Definitions

Key Word	Description
Biodegradable	Materials with a gradual deterioration of their properties proportional to the improvement of soil conditions (Mwasha, 2009)
Carbon Footprint	The amount of greenhouse gases, represented as CO2 equivalents, released into the atmosphere by a person, organisation, product, process, or event within a defined boundary (Pandey, Agrawal, & Pandey, 2011)
Circular Economy	A framework built on the principles of waste elimination, circulating resources, and regenerating nature (Ellen MacArthur Foundation, n.db.)
Environmental impacts, burdens, or pressures	The consequences that may be caused by emissions, discharges and releases to the environment plus the resources consumed over a product's life cycle. Categories of environmental impacts to consider: impacts on the climate from greenhouse gas emissions (GHG); contributions to pressures on aquatic ecosystems from chemical emissions; and the availability of natural resources both now and for future generations (European Commission et al., 2010)
Life Cycle Assessment (LCA)	The process of quantitatively evaluating the environmental impacts of a product over its entire life period (European Commission et al., 2010)
Renewable material	A material that is capable of natural replenishment at its source at a rate equal to or greater than its consumption (Ellen MacArthur Foundation, n.d.a)
Sustainable	Items that are produced through processes where resources are not depleted or damaged permanently (Walter, 2009)

1. Introduction

The introduction of this thesis outlines (1.1) the background of the subject, (1.2) the purpose of the study and the research questions being explored, and (1.3) the expected contribution. The ending of this section (1.4) identifies the delimitations of the thesis.

1.1 Background

Textiles rank second among the most substantial necessities for human life (Madhav et al., 2018) yet they are as polluting as they are omnipresent. The textile industry faces numerous environmental concerns including energy use in production and pollutants emitted through water, fuel, and chemical usage (Harsanto et al., 2023). It is estimated that the textile industry generates more than 35% of chemicals released into the environment (Desore & Narula, 2018). The stretching of planetary boundaries resulting from textile production places the industry in a predicament caused by rising systemic risks (Cornell et al., 2021).

The European Commission (EC) has decided to create a more sustainable textile industry, where sustainable development is defined as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (Brundtland, 1987). Through the launch of the 2030 Vision for Textiles, the EC has prioritised the improvement of textiles' durability, recyclability, and repairability. This is included along with a wider use of recycled fibres, elimination of toxic substances across the supply chain; and protection of the environment and human rights (European Commission, 2022b). Developing supporting measures pave the way toward achieving the EU's 2050 climate neutrality goal as outlined in the EU Circular Economy Action Plan (European Commission, n.d.). This includes the proposed extension for textiles of the Ecodesign for Sustainable Products Regulation that encourages designing products with in-built circularity (European Commission, 2022a). Additionally, both the anticipated revision of the Waste Framework Directive 2008/98/EC to harmonise the EU extended producer responsibility covering rules for textiles (European Union, 2018) and Harmonised EU rules on extended producer responsibility for textiles (European Commission, 2022c) are crucial in achieving this goal.

There are many ways where companies might adhere to mounting regulations and participate in the transition toward a circular textile industry. Circularity, according to the Ellen MacArthur Foundation (2017), targets the elimination of waste and pollution via product and material usage loops considered already at the design phase, alongside the restoration of natural systems. Possible strategies include using more sustainable materials, reducing the environmental impact of production processes through lower water and/or energy consumption, complying with industry standards imposed by various certifications (UN Environment Programme, 2020), and adopting circular business models (European Commission, 2022c).

Regardless of the route that companies choose to take in the green transition, it is evident that considerable research, innovation, and investments must come from parties across the industry (European Commission, 2022c). In addition to implementing sustainable practices independently, it has been suggested that companies ought to collaborate with actors within their supply chain, as such joint efforts have been identified as critical for improving the sustainability performance of businesses in the textile industry. This is because textile supply chains are spread globally and involve many parties, which makes it challenging to implement sustainable practices throughout their entirety without a coordination of efforts (Ho et al., 2017). A majority of the negative environmental impacts stem from the very cultivation and creation of materials, followed by the textile manufacturing processes. Therefore, one of the biggest disruption opportunities lies at the upstream end of the supply chain, where material sourcing decisions take place (Bush & Chui, 2022). Consequently, to address the issue of sustainability, companies need to innovate both in the product design and in the materials sourcing phase (Braungart et al., 2007; Todeschini et al., 2017).

Triggered by the changing business-as-usual landscape, the growing body of academic research focused on integrating sustainability within the supply chain management business functions, such as sourcing, has given rise to a new field – sustainable supply chain management (SSCM). According to Carter and Rogers (2008, p. 9), SSCM requires “a transparent integration and achievement of an organisation’s social, environmental, and economic goals in the systemic coordination of key inter-organizational business processes.” This thesis focuses on the initial

stage of the SSCM, namely, sourcing; thereby adopting the view that SSCM covers all phases from design and sourcing of raw materials to manufacturing and end-of-life-management (Mentzer et al., 2001; Srivastava, 2007).

Despite the rapid expansion of theoretical knowledge surrounding this topic, the implementation of SSCM practices among organisations is not straightforward, nor is it well documented in the context of real company practice (Morali & Searcy, 2013). Additionally, most of the research about SSCM explores the relationships between companies and their tier-one suppliers, defined as direct suppliers to the buyer. Multinational companies have only recently actively engaged lower-tier suppliers in sustainability issues knowing that the predominance of negative environmental and social impacts is higher at lower tiers (Villena & Gioia, 2018).

One of the critical aspects of implementing SSCM is that while it can lead to improved environmental management, it does not always result in economic benefits. Making a trade-off between sustainability and effective cost performance is seen as a requirement by numerous researchers (Esfahbodi et al., 2016; Morrison-Saunders & Pope, 2013). The findings of Esfahbodi et al. (2016) suggest that while improving a company's environmental aspects, SSCM may not have a positive impact on cost performance, pointing to the existence of a trade-off between these aspects. Additionally, the analysis conducted by Morrison-Saunders and Pope (2013) emphasise that trade-off consideration must begin in advance of approved decision-making. This includes taking into account the nature and type of alternatives in a sustainability assessment.

Moreover, Winn et al. (2012) emphasise the managerial challenges that come as a result of the additional environmental and social factors that must be included in standard business thinking. This complexity derives from an understanding of the varied nature of sustainability concerns, such as the need to meet consumer expectations while being cost-effective. The authors argue that while seeking win-win outcomes, like reduced costs enabled by more efficient use of resources or improved brand image, organisations should not neglect the inherent presence of trade-offs and make sure they are capable of making both short and long-term decisions in this context.

1.2 Purpose and Research Questions

As a result of the background discussed in the previous section, there is a need to expand the understanding of SSCM implementation by real multinational companies within the textile industry and to broaden the current investigative work to explore initial stages of the supply chain, where material selection takes place. It is also crucial to consider the emerging innovations from tier-two suppliers being selected and how they are developed, given their significant impact on the sustainability of the final product. Moreover, to accelerate the transition towards a circular textile industry, the trade-off between cost and sustainability needs to be examined more closely, as it represents a potential barrier to organisations' willingness and ability to partake in the transition. To address this research gap and inspect the current decision-making process from the perspective of companies and their tier-two suppliers, taking into consideration the issue of cost and sustainability, the following research questions are presented:

1. How is the trade-off between cost and sustainability being addressed in the context of renewable material sourcing within the textile industry?
    - 1.1. How are renewable textile materials innovators integrating cost-effectiveness and sustainability into their material development process?
    - 1.2. How do firms balance cost-effectiveness and sustainability while sourcing emerging renewable textile materials?

1.3 Contributions

By delving deep into sustainable sourcing strategies, this paper aims to provide robust and valuable insights for both researchers and practitioners. Specifically, the goal is to contribute to the literature by (1) analysing sustainable sourcing in the context of the textile industry, (2) shedding light on the critical trade-off between cost and sustainability, and (3) contextualising it under the Circular Economy which aims to minimise waste and maximise the use of resources for a long as possible.

For practitioner contribution, the paper aims to (4) enhance firms' understanding of innovators' decision-making processes and considerations concerning cost and sustainability during the development phase, facilitate dialogue between buyers and tier two suppliers, uncover new opportunities for collaboration, and, ultimately, enable firms to adopt renewable textiles in their sourcing practices. Additionally, (5) innovators can create more compelling value propositions for buyer companies by becoming more aware of the factors that these firms consider when sourcing new materials, thereby driving sustainable sourcing practices.

1.4 Delimitations

The scope of this thesis is delimited to emerging innovations that are produced within Europe. First, sustainable innovation within the textile industry has most predominantly been done within a European context, which provides a larger background of research for this phenomenon (Harsanto et al., 2023). Moreover, the textile supply chain has been identified as a critical component in Europe’s Circular Economy Plan (European Environment Agency, 2022).

To narrow focus, research has been delimited to earlier-stage innovations that have yet to enter the market. Innovations are defined as emerging because they are fast-growing, novel technologies with the potential to have an impact (Rotolo et al., 2015). This focus was chosen as the early stages of development provide the highest opportunity to influence the environmental performance of the technology (Luttropp & Lagerstedt, 2006). Yet, they also have unique challenges that provide interesting aspects to explore (Oakey, 2003).

To gain a deeper understanding of the factors and context influencing the selection of sustainable innovations, this study will be limited to one case company to represent the buying firm and nine cases that represent the renewable innovators. By focusing on a specific company and multiple innovators, the research can provide a more comprehensive understanding of the factors and context influencing renewable materials sourcing and the challenges and opportunities for sustainable innovation in the textile industry. This will be further explained in section 4.2.1.

2. Literature Review

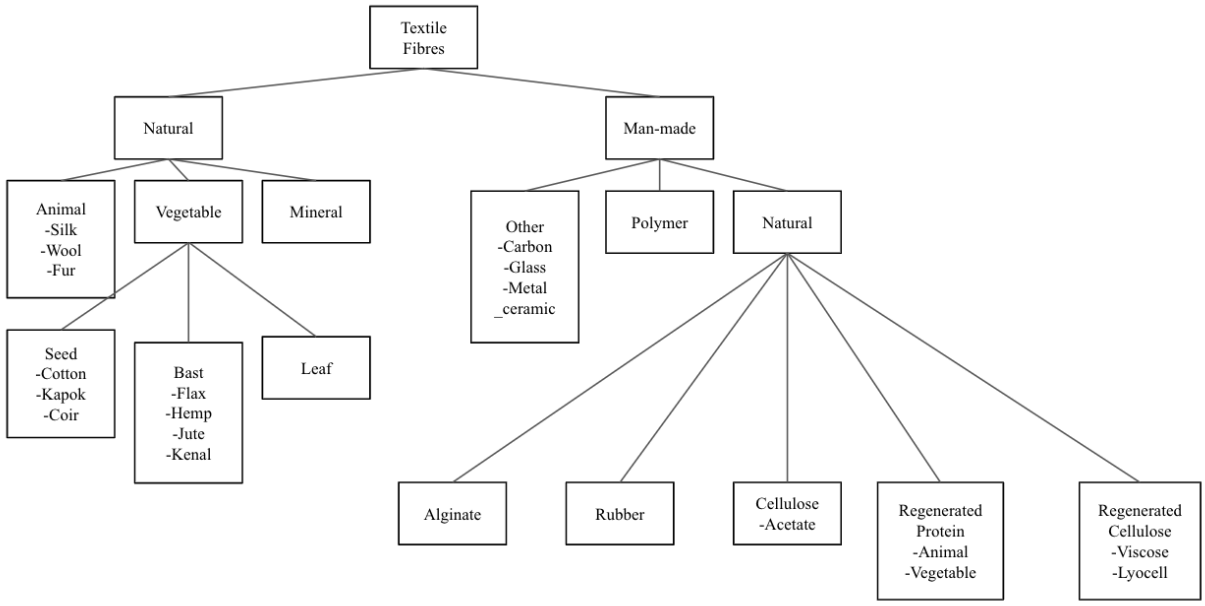
In order to answer the research questions, this section illustrates the background of (2.1) the textile industry (2.2), sustainability (2.3), cost and sustainability trade-off, and (2.4) sustainable sourcing.

2.1 Textile Industry

Textiles are defined as flexible materials made up of networks of fibres, created by weaving or knitting yarn into fabric. However, textiles can also be nonwoven if bonded by chemical, mechanical or heat treatments (UN Environment Programme, 2020). Textiles can be produced from many materials and are categorised according to the fibres they can produce. Historically, textiles were produced from natural fibres like plant, animal and minerals. However the standard today uses petroleum-based synthetic fibres as the leading source (Okafor et al., 2021). Figure 1 shows the significant textile fibres and their classifications.

Figure 1

Textile Fibre Types and Their Classifications



Note. Adapted from *Textile Handbook* (1st ed., p. 3), 2001, The Hong Kong Spinners Association. Copyright 2001 by The Hong Kong Cotton Spinners Association.

In 2021, the EU-27 textile industry reached a turnover of €78.3 billion, with 143,000 companies employing a workforce of 1.3 million people (The European Technology Platform, 2022). Given the size of the industry, it is not surprising that it exerts tremendous pressure on the environment —polluting and depleting water and land resources by using hazardous dyes and chemicals from fibre production to their disposal. According to the European Environment Agency (2023), textile consumption ranks fourth in environmental impact, and accounts for the fifth highest raw materials usage. Further, the production of textiles involves sourcing materials from all over the world. China is the largest exporter of textiles, followed by the European Union, India, the US, and Korea (Ghaly et al., 2014). The global journey of textiles adds a significant layer of complexity and risks to supply chains. Notably, sustainability issues can arise due to the differences in operations between markets, as well as the CO^2 emissions and costs of transportation. As awareness of the environmentally destructive nature of the textile industry spreads across various stakeholder groups, companies are no longer only facing scrutiny from consumers, media and NGOs (Warasthe et al., 2020), but also need to comply with new regulations calling for transparency and sustainable practices across the whole textile lifecycle and supply chain (European Commission, 2022b).

It is becoming increasingly evident that there is a need for more sustainable textiles that do not create permanent resource depletion or harm natural resources (Walter, 2009). Yet, it remains a challenging endeavour for material developers and buying companies alike. To achieve sustainability, a full assessment needs to be done, taking into account the environmental impact of production, maintenance, and disposal. In the fibre production phase, this means optimising resource use by leveraging recycled or renewable sources and minimising water, land, energy, and chemicals input. Then, the textile material should be designed to stay in use as long as possible to finally either be recycled or biodegraded (European Environment Agency, 2022). Given the current lack of industry-wide standards, the search for well-performing, sustainable materials remains a challenge (Ahi & Searcy, 2015; Chen & Burns, 2006). Therefore, the next section focuses on the different tools and frameworks that are currently used to assess sustainability in the textile industry, highlighting their advantages and disadvantages.

2.2 Sustainability

The lack of a common definition for sustainability and a comprehensive framework for retrieving and assessing data has hindered the adoption of sustainable practices. This has been identified as a key obstacle in the development of sustainable assessment methodologies, from production to end-of-life (Maier et al., 2016). In the next subsections, the most commonly used measurement tools and frameworks are showcased in the following order: (2.21) impact measurements commonly used to assess sustainability performance, (2.2.2) certifications administered by third parties that provide specific criteria, and (2.2.3) frameworks that are used as a structure to ensure sustainable business practices.

2.2.1 Impact Measurements

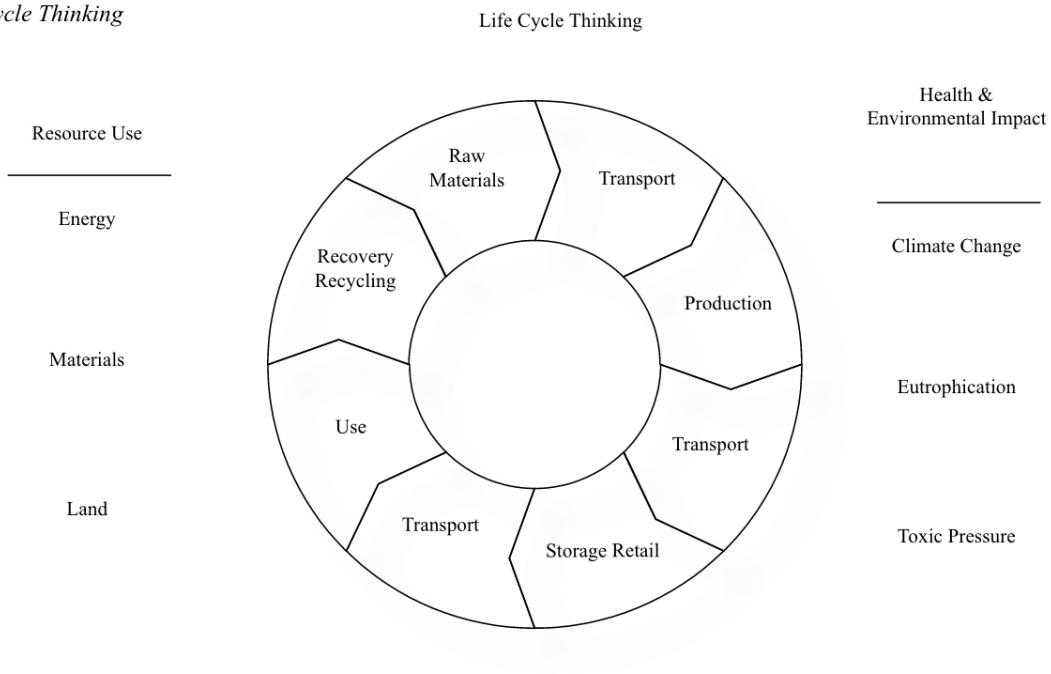
To cope with the negative effects of the industry and improve the sustainability of products, tools such as Ecodesign have been developed to act as the forefront of boosting the systemic shift towards a more circular economy (Salo et al., 2020). The concept of Ecodesign involves integrating environmental considerations into the product development process (Bovea & Pérez-Belis, 2012), while the use of Ecodesign tools can assist organisations in evaluating their environmental performance (Baumann et al., 2002).

One of the most prominent Ecodesign tools is the Life Cycle Assessment (LCA), which identifies environmental and health effects (Luo et al., 2021). The ecological implications of products in the lifecycle process include four main points: energy use; water and chemical consumption; solid and liquid waste; and direct CO^2 emissions (Okafor et al., 2021). The LCA can also track the endpoint levels, which include three damage categories: resources, ecosystem, and human health (Goedkoop et al., 2009). One major benefit of the adoption of Life Cycle Thinking (LCT) is the balanced view it takes from the beginning to the end of the innovation (Maier et al., 2016). By taking a holistic view from raw material choice to product disposal to reduce resource use and environmental impacts, LCA encourages the implementation of leaner processes, hence creating economic gains. Additionally, this methodology promotes the identification of alternative natural resources that lead to improving products' sustainability performance (European Commission et al., 2010). In contrast, the calculation process is intensive

and requires extensive data accumulated through databases, in-field, and literature (Wiedemann et al., 2020). To achieve the best estimation and enhance economic gains, policy developers, product designers and sustainability managers have to think outside their bank of data and knowledge, cooperating with actors in the upstream and downstream supply chain (European Commission et al., 2010).

Figure 2

Life Cycle Thinking



Note. Adapted from "Making sustainable consumption and production a reality: A guide for business and policy makers to Life Cycle Thinking and Assessment" by the European Commission, Directorate-General for Environment, & Joint Research Centre, 2010, Publications Office of the European Union, p. 6. Copyright 2010 by European Union.

Another prominent measurement tool is the Higg Index—a suite of scoring tools developed by the Sustainable Apparel Coalition for clothing and footwear companies (Radhakrishnan, 2015). Two versions of the Higg Index (1.0 and 2.0) were developed, with the former focusing on environmental sustainability and the latter taking social and labour factors into account (Luo et al., 2021). This method has three levels: product, facility, and brand; assessed on a numeric index from 0 to 100. The Higg Index uses quantitative and qualitative data, with the Higg Material Sustainability Index being an LCA-based metric calculated by weighting and normalising quantitative data and one semi-quantitative indicator (*Higg Index-Overview.* n.d.). Although the Higg Index is multidimensional, in June 2022, reports surfaced claiming that the Higg Index is

only a complex version of greenwashing that favours synthetic fabrics derived from fossil fuels over natural textiles (Tabuchi, 2022). The Norway Consumer Authority has since banned its use in marketing to consumers as the full life cycle is not assessed (Forbrukertilsynet, 2023).

2.2.2 Certifications

As consumers have become more concerned about the environmental impact of and the sourcing location of textiles (Caniato et al., 2012), they are placing greater emphasis on transparency and favouring brands that have a positive impact. 42% of millennials prioritise understanding the parts and manufacturing process of products before making a purchase (Amed et al., 2023). A way that brands can communicate the sustainability of their products to customers—and which has become one of the most prominent methods used by companies (Lakhal et al., 2008)—is by acquiring green certifications. Certified labels can be used to show that the product was produced with environmentally friendly materials, produced in regard to the health of workers, and produced within various human rights criteria. In many cases, fibre-specific criteria are employed. To illustrate the variety of existing certifications, Table 1 below summarises some of the most prominent ones that are presently used in the textile industry.

Table 1

Certification	**Purpose**
Oeko-TEX 100	Shows that the textile contains no chemicals that are potentially harmful to human health (Almeida, 2015).
Global Organic Textile Standard and the Organic Cotton Standard	Guarantees the organic origin of textiles, from the initial harvesting of raw materials to environmentally and socially responsible production (Almeida, 2015).
Bluesign	Analyses the manufacturing process, energy inputs, and air emissions to assess the ecotoxicological issues within textile production and waste processing (Almeida, 2015).
The Forest Stewardship	Guarantees that the product was made from a sustainably

Council (FSC)	managed forest (Marx, 2011).
Country-specific chemical certifications	Controls the use of per- and polyfluorinated compounds (PFCs) (Posner et al., 2013), where PFCs are artificially produced chemicals that are water, dirt, grease and oil repellent.
Cradle to Cradle	Considers the end of life of the material and is used to categorise eco-effectiveness to achieve zero waste emissions, zero resource use, and zero toxicity (Llorach-Massana et al., 2015). It focuses on five categories: material, health, material reutilization, renewable energy, water stewardship, and social fairness (Toxopeus et al., 2015); and exists in four levels: 1. Basic—assessment of environmental effects 2. Silver—production takes environmental effects into account 3. Gold—cycle closed for recycling/composting 4. Platinum—all social and environmental problems solved. Due to the qualitative characteristics of the certification, it can be difficult to calculate. Additionally, to achieve Cradle to Cradle Platinum, would require involvement of all parties which would make this process extremely complex (McDonough & Braungart, 2002).

2.2.3 Frameworks

Alongside certifications and impact measurement tools, companies in the textile industry can develop their sustainability strategies according to frameworks such as The 17 UN Sustainable Development Goals (UNSDGs) and The Triple Bottom Line (TBL), both of which aim to balance economic, social, and environmental considerations.

The UNSDGs were adopted by all member states of the UN in 2015 as a universal call to action “End poverty, protect the planet and ensure that all people enjoy peace and prosperity” (UN

Development Programme, 2023). The UNSDGs provide a way for organisations to measure and track their progress towards sustainability by focusing on specific goals and targets (Khaled et al., 2021). However, the limitations of SDGs are similar to those of the LCA and Higg Index, including difficulty in acquiring data for newer or non-built innovations (Maier et al., 2016).

The TBL was introduced in 1994 as a way to measure sustainability and corporate social responsibility. It takes into account social justice, environmental quality, and economic prosperity (Elkington, 1998). It has previously been suggested that to develop a sustainable textile supply chain, the TBL framework must be implemented (Shen et al., 2017). However, the TBL is rather broad and does not provide clear guidelines on how a firm could measure social and environmental performance (Gray, 2006), which leads many firms to overemphasise economic factors (Srivastava et al., 2022).

In the pursuit of improving sustainability, however, companies in the textile industry cannot one-sidedly follow sustainability goals. A critical challenge lies in balancing the trade-off between economic factors and sustainability. As organisations strive to adopt sustainable sourcing practices, they must carefully navigate financial constraints and operational efficiency, ensuring that sustainable initiatives do not compromise their competitiveness and ability to meet customer demands, which will be explored in the next section.

2.3 Cost and Sustainability Trade-Off

The textile industry is concerned with both sustainability and cost implications of materials and production processes. Understanding what drives cost in the industry, including raw material, labour, energy, and processing, is crucial for companies striving to maintain cost leadership while balancing environmental and economic performance (Rabai et al., 2022). At the same time, there is often a perceived tension between sustainability goals and cost considerations, with some arguing that sustainable practices are inherently more expensive (Margolis, 2009; Walley & Whitehead, 1994). Yet, academia is divided on this, and numerous studies indicate that businesses can accomplish their cost objectives while also minimising their environmental footprint (Christmann, 2000; Russo & Fouts, 1997).

Given the interconnected nature of environmental and social concerns, stakeholders who were previously excluded from supply chain decisions are now actively involved, including consumers, employees, and NGOs. The close scrutiny of the public and NGOs has prompted organisations to take environmental issues into consideration. Moreover, dedicated employees who are internally driven by their organisation's values and goals often play a crucial role in driving firms towards sustainability (Wu & Pagell, 2011). However, consumers attribute different importance to sustainability, as their attitudes and behaviours towards products can vary. On the one hand, Chekima et al. (2016) have identified that there is a growing demand for sustainable products as consumers become more informed and have greater access to information. Studies have confirmed that consumers are willing to pay extra for eco-friendly and sustainable products (Tully & Winer, 2014; Wei et al., 2018). On the other hand, Han et al. (2017) identified a gap between consumers' concerns about sustainability and their actual purchasing behaviour when it comes to sustainable textile fashion products. In addition to this, when it comes to circular products, consumers are less willing to pay for recycled goods, because they perceive them as of lower quality (Guide & Li, 2010; Michaud & Llerena, 2011). Due to the diversity of values and issue saliency among stakeholders, including consumers (Donaldson & Preston, 1995), organisations frequently encounter the need to make trade-offs between environmental areas (Hertwich et al., 2000) and profitability (Wu & Pagell, 2011). On top of this, organisations are increasingly facing global competition for resources (King & Lennox, 2002) and stricter environmental regulations (Florida, 1996).

Thus, not all stakeholders can be satisfied all the time, and sustainability-focused businesses must navigate complex trade-offs and balance competing priorities to achieve their goals (Walley & Whitehead, 1994). Moreover, sustainability-focused enterprises must consider the expectations of external stakeholders (Freeman, 2010) as even when being exposed to the same information, stakeholders may have different views on the optimal actions (Hertwich et al., 2000). Therefore, organisations that aim to balance cost and sustainability must consider which stakeholders to prioritise (Wu & Pagell, 2011).

Further, since environmental actions must be financially feasible, organisations take a cautious approach to environmental action. However, cost and other resource limitations do not always

prevent sustainable innovation. In reality, these businesses may gain a new perspective on their supply chain operations as a result of environmental concerns. Additionally, managers must think about short-term growth and long-term competitiveness in addition to profits and sustainability due to the costs and resource constraints associated with environmental challenges(Wu & Pagell, 2011).

To reduce the trade-off between cost-effective performance and sustainability, organisations can incorporate new management concepts and innovative technologies (Bourlakis et al., 2014). One approach to achieving sustainability goals is to adopt sustainable sourcing practices – the initial component of the sustainable supply chain (Pagell et al., 2010). This can involve sourcing materials from sustainable suppliers, reducing waste and pollution, and prioritising social responsibility in the supply chain (Pagell & Wu, 2009). Further, according to Touboulic and Walker (2015), the relationship between financial performance and sustainability could be reliant on intermediary factors —for example, the cooperation between supply chain partners with a view to improve both cost and environmental aspects (Vachon & Klassen, 2008) or organisational learning, as proposed by Carter (2005). However, the implementation of this strategy demands significant resources such as a dependable supply chain for raw materials, cost-effective distribution channels, and access to financing to optimise operational efficiency (Hart, 1995)

Hence, academia is divided with respect to the implications of pursuing sustainability on firms' financial performance, which creates opportunities for further empirical research in this area targeting companies that aim to combine a low-cost strategy with sustainable practices. Therefore, as sustainable sourcing practices can be a viable solution for firms seeking to balance cost and sustainability, this idea will be explored in the following section.

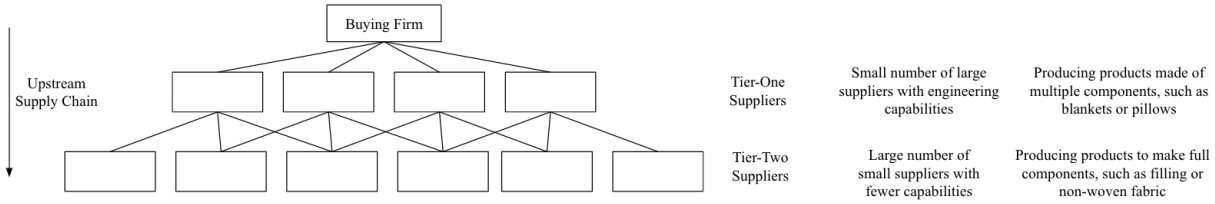
2.4 Sustainable Sourcing

Sustainable sourcing practices are essential components of modern supply chain management that focus on incorporating environmental and social considerations into the purchasing process. This function plays a critical role in a company's sustainability efforts. A company is not only as sustainable as the suppliers that they purchase from, as argued by Krause et al. (2009), but also

their suppliers, and so on upstream (Villena & Gioia, 2018). These suppliers make up the different tiers where sourcing takes place. Figure 3 illustrates the relationship between tier-one and tier-two suppliers and the buying firm.

Figure 3

Tiered Supply Structure



Note. Adapted from "Product development performance: Strategy, organization, and management in the world auto industry" by Clark, K. & Fujimoto, T., 1991, Harvard Business School Press, p. 139. Copyright 1991 by Harvard Business School Press.

Sustainable sourcing involves selecting suppliers based on their environmental and social performance, in addition to the traditional factors of cost, delivery lead time, and quality (Dai & Blackhurst, 2012; Gold et al., 2010). Practices of sustainable sourcing emerged as a result of increasing pressure from government regulations, customer needs, and the demands of non-governmental organisations and other stakeholders for organisations to adopt sustainability in their products and business processes (Igarashi et al., 2013; Krause et al., 2009). Initially, these practices were adopted reactively in response to government policies and market pressures. However, over the past decade, firms have proactively incorporated sustainability into their sourcing activities to gain a competitive advantage (Dai and Blackhurst, 2011).

Companies engage in sustainable sourcing for several reasons, including stakeholder pressures, compliance with regulations, consumer demand, and competitive advantage (Ambekar et al., 2019). Moreover, cost reduction and image building also drive firms to adopt these practices. By embracing sustainable sourcing, organisations can achieve various benefits, such as improved competitive advantage (Markley & Davis, 2007), enhanced image in society (Ghosh & Shah, 2012), reduced supply costs by minimising waste and scrap (Mann et al., 2014), increased market share (Formentini & Taticchi, 2016), and reduced supply risks (Frostenson & Prenkert, 2015).

Companies can adopt a range of sustainable sourcing processes, such as supplier relationship management, the development of new specifications and evaluation methods for supplier selection, the design of sustainable purchasing policies and strategies, supplier monitoring,

auditing and inspection. Additional measures that firms implement include: trust-building, communication, restricting purchases to sustainable products and suppliers, adopting a code of conduct, conducting LCAs and engaging in stakeholder collaboration such as new product and process development (Ambekar et al., 2019).

In recent years, there has been an increase in collaborative practices involving suppliers and other external organisations, as well as training and development activities, transparency, and support from within organisations (Ambekar et al., 2019). These collaborative efforts contribute to the success of sustainable sourcing initiatives by fostering open dialogue, encouraging innovation, and promoting the adoption of best practices among supply chain partners. Further, collaboration facilitates the sharing of knowledge, information, profits, and risk among supply chain companies, enabling organisations to work together more effectively to achieve sustainability goals (Mentzer et al., 2001).

Additionally, collaboration can help organisations address the inherent complexity of sustainability issues that often span multiple tiers of the supply chain and involve a diverse range of stakeholders. For example, engaging in collaborative efforts with suppliers can help buyers identify and address the root causes of environmental and social problems, rather than merely addressing the symptoms through individual purchasing decisions (Walton et al., 1998). With the suppliers' side, they can achieve greater success by having convenient access to the technology and processes companies use, as well as fostering strong relationships with their customers (Lee & Kim, 2011).

2.5 Research Gap

Existing research on renewable material sourcing in the textile industry has largely focused on the environmental benefits of using bio-based and biodegradable materials, such as organic cotton, lyocell, and bio-based polymers (Zamani et al., 2015). While these materials can contribute to a reduction in waste, pollution, and resource depletion, their adoption has been hindered by the perception of higher production costs and the need for significant upfront investments in new technologies and processes (Beton et al., 2014). Some studies have explored the potential cost savings and benefits associated with implementing circular economy principles

in textile production, such as closed-loop recycling systems, product design for disassembly, and service-based business models (Lieder & Rashid, 2016; Tukker, 2015). However, there is a limited understanding of how firms navigate the trade-offs between cost and sustainability in the context of renewable material sourcing and material development (Gružauskas et al., 2018).

While academia acknowledges the growing need for collaboration between companies and their lower-tier suppliers, most of the research has focused on relationships with tier-one suppliers, as the incidence of the former is still sparse among global companies (Villena & Gioia, 2018). Additionally, sustainable sourcing has been addressed in extant literature with a primary focus on buyer companies, leaving out the perspective of suppliers (Foerstl et al., 2015), which is central to facilitating collaborative rapport.

Based on the identified research gaps, this study aims to provide insights into the decision-making processes and strategies employed by both material innovators and buyer firms concerning cost and sustainability considerations, thus extending the academic knowledge base in sustainable textile sourcing, and surfacing practical implications in renewable textile material adoption for multinational companies.

3. Theory and Framework

This section provides the theoretical framework that is used as a lens to understand the research questions. The first part (3.1) introduces the Circular Economy Framework while the second (3.2) provides the Resource-Based View and Natural Resource-Based View, and the last (3.3) shows the Stakeholder Theory. This is concluded with (3.4) a theoretical framework that combines these theories to offer a multiperspective lens to answer the stated research questions.

3.1 Circular Economy Framework

The Circular Economy (CE) paradigm originates from ecological economist Kenneth Boulding's (1966) essay "The Economics of the Coming Spaceship Earth", whereby the sustainability of human life on earth is seen as dependent on a circular economy system. Later in 1989, Pearce and Turner extended this idea by formulating it as a framework for the transition from a

linear—take-make-use-destroy—model, to a circular model focused on minimising waste and maximising resource efficiency (Ghisellini et al., 2016; Stahel, 1982). The CE aims to keep products and materials in use for as long as possible and minimise the need for new ones, through the means of reuse, repair, and recycling (Stahel, 1982). This involves creating longer life cycles for products; guaranteeing reuse of goods and restitution of waste through systemic approaches in supply chain management (World Economic Forum, 2014).

William McDonough and Michael Braungart are considered the modern-day "fathers" of the circular economy. In their book *Cradle to Cradle* (McDonough & Braungart, 2002), the authors propose a new school of thought with a titular name. Their main thesis is that waste should be regarded as a resource and be returned into its biological, or technical environment, with their respective "metabolisms" (p.104). When waste is brought back into the cycle, then the cost of raw materials and negative waste externalities could both decrease (Bompan & Brambilla, 2021). According to the Ellen MacArthur Foundation (2017), the technical cycle is most commonly explored in the textile industry, through mechanical and chemical recycling processes. Nevertheless, McDonough and Braungart (2002) highlight that products need to first be designed in a way that allows for their reintegration as a resource in the biological or technical cycle, whereby the materials used play a central role. Therefore, innovation, long-term and systems thinking are prerequisites of creating circular products, as the cost and impact of materials needs to be considered from the beginning to the end of the product life cycle.

The CE can be defined as a condition for sustainability where companies and regulators act as the main actors (Geissdoerfer et al., 2017). According to this, CE is not a goal in itself, but a way to achieve sustainable development (Wiebe et al., 2023). Moreover, CE emphasises value creation and the economic gains that companies are to experience via more efficient use of resources; reduction in environmental pollution; while society is assumed to benefit as a result (Geissdoerfer et al., 2017). Numerous researchers have used the CE framework over the last years to understand the implications of this transition in various industries, business models, and organisation functions, including circular product design (Bakker et al., 2014), supply chains (Govindan & Hasanagic, 2018) and textiles (Franco, 2017).

3.2 Resource-Based View

Resource-Based view (RBV) is a theoretical framework that is used to explain the competitive advantage of firms. It proposes that competitive advantage is derived from a firm's unique resources and capabilities that are difficult for other firms to imitate. This view suggests that a firm's resources and capabilities are the primary sources of competitive advantage rather than the external environment. The RBV posits that a firm's resources must be valuable, rare, inimitable, and non-substitutable to enable a sustainable competitive advantage (Barney, 1991). Resources that have been defined as giving stronger competitive advantage are financial, physical, human, organisational (Barney & Hesterly, 2019; Grant, 1991), technology, and reputation (Grant, 1991). The role of capabilities is to stack resources and create particular value-added tasks, such as technology, design, production, and distribution (Hart, 1995).

Theorists using RBV argue that a firm's resources and capabilities can be used to adapt to changes in the external environment, creating a sustainable competitive advantage. This is seen as a strength as it allows the company to take a more proactive approach, rather than a reactive one (Madhani, 2010).

Previous studies that applied the RBV to environmental issues found that firms can create a sustainable competitive advantage when they are closer to the natural environment. For example, firms can minimise the lifecycle cost of products to preempt competitors and reduce their environmental burden to strengthen their future position (Hart, 1995). Research has also found that proactive policies on environmentalism can translate into a firm's internal competitive advantage (Russo & Fouts, 1997) and that a firm's investment in eco-innovation is positively related to the firm's competitive advantage. These findings show that by investing in environmental innovation, firms may be better positioned to achieve superior performance in the long term (Albino et al., 2009). Simultaneously, in the environmental management context, firms competing in the same industry follow different environmental strategies despite facing the same environmental threats and opportunities. According to Hart (1995), a reason for this could be due to their available resources and capabilities.

RBV has been widely regarded as one of the best-suited theories to link sustainability performance in supply chains and firms' economic, market and operational performance (Ghadge et al., 2019; Vachon & Klassen, 2008). However, RBV has been criticised for not considering the natural environment and resource constraints that impact a firm's innovation capabilities (Lillis et al., 2015). Alternatively, the Natural Resource-Based View (NRBV) suggests that firms should focus on their relationship with the environment to ensure there is sustainable development while simultaneously pursuing sustainable competitive advantage through three interconnected strategies: pollution prevention, sustainable product stewardship, and sustainable development. Pollution prevention can be a challenging process, but it can also help companies reduce costs in a way that sets them apart from competitors. Product stewardship allows companies to reduce the economic and social costs associated with their products. By actively engaging with external stakeholders, these programs can help companies demonstrate their commitment to responsible business practices. Finally, sustainable development minimises environmental impact and engages with external stakeholders (Hart, 1995).

As SSCM practises directly impact the natural environment, the NRBV allows one to see environmental issues as an opportunity to develop new firm capabilities, or by developing a shared vision for sustainable development, companies can generate opportunities for long-term growth and competitiveness; therefore, building their capabilities and staying relevant in a rapidly changing business landscape (Hart, 1995). Moreover, environmental innovation can thrive despite cost and resource limitations, as such challenges can prompt companies to view their supply chain operations in a new light (Wu and Pagell, 2011). For example, by identifying ways to minimise waste, companies can minimise their environmental impact and lower costs associated with waste discharge or treatment, hence improving their financial performance (Green, et al., 2012; Young & Tilley, 2006) and generate superior competitive advantage based on cost (Singh et al., 2020). Alternatively, Paulraj (2011) views SSCM practices as a standalone source of competitive advantage, fuelled by superior purchasing capabilities.

3.3 Stakeholder Theory

Stakeholder theory was first introduced in *Strategic Management-A Stakeholder Approach* (Freeman, 2010), where considering the interests of all stakeholders, including customers,

investors, suppliers, and employees were emphasised. Within this theory, firms have the responsibility to meet the needs and expectations of the stakeholders, while also balancing the interests of the firm (Donaldson & Preston, 1995).

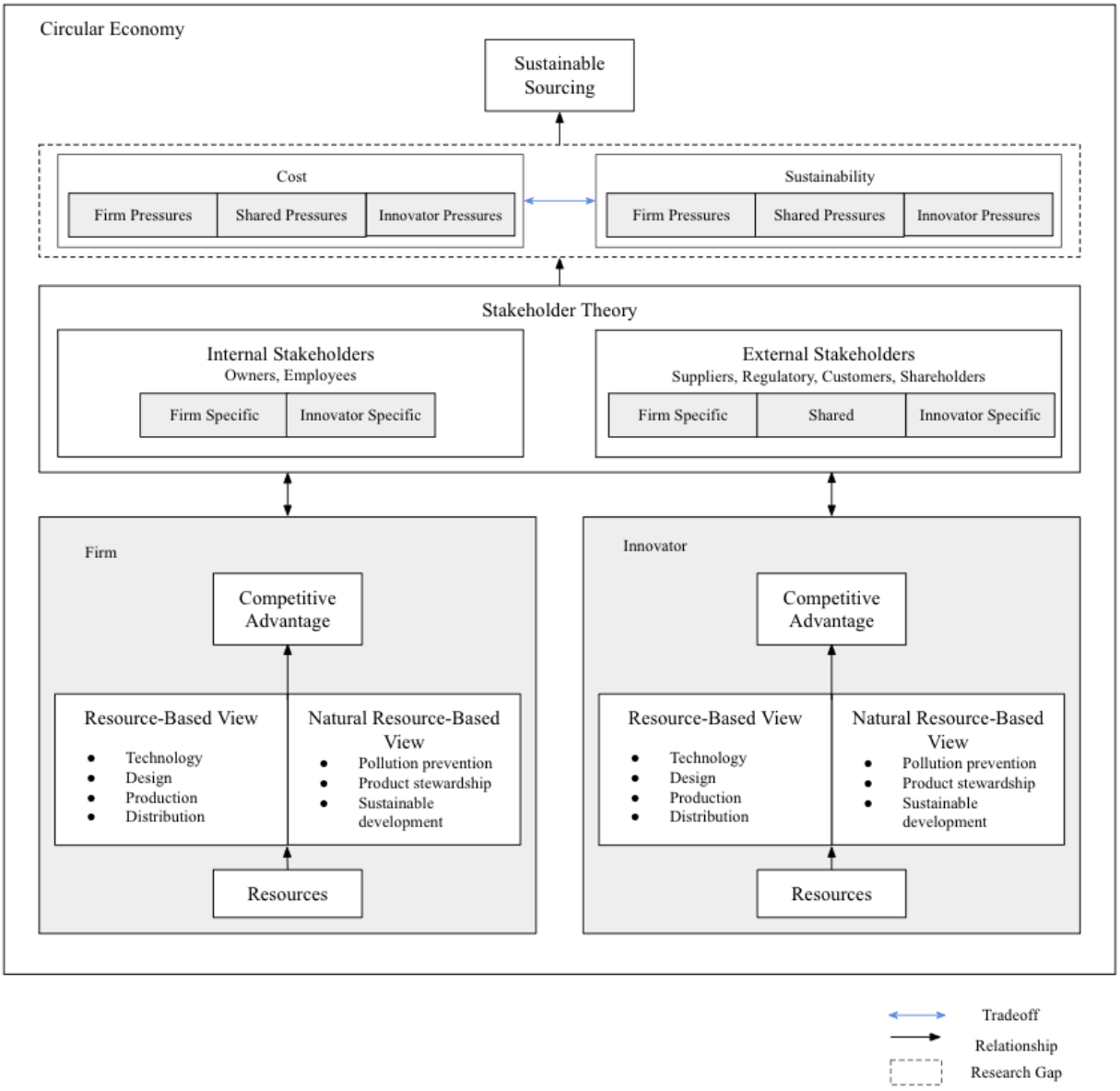
The stakeholder approach implies that firms are actors of the environment that they are placed in and thus have to respond to stakeholder demands to reach strategic objectives. This leads to a broader focus on social and environmental impacts of the organisational activities of firms (Linnenluecke & Griffiths, 2013). There is a growing interest in corporate social responsibility, as stakeholders are placing more focus on the environment (Sweeney & Coughlan, 2008). Researchers have worked to incorporate corporate social responsibility into stakeholder studies (Zhao et al., 2012), which can influence how firms incorporate and report their environmental performance (Clarkson, 1995).

In numerous studies examining the drivers, enablers, and challenges of SSCM, the stakeholder theory emerges as a prevalent theoretical lens. This theory encapsulates the interconnectedness of a diverse range of actors within supply chains that frequently span across the globe. Stakeholder theory emphasises that the evolution of sustainable supply chain management is driven by the influence of different parties that are affected by the operations of businesses (Touboulic & Walker, 2015). Moreover, the stakeholder theory lends itself to SSCM research especially well, as companies might adopt SSCM practices that are unprofitable in the short term due to pressure from various stakeholder groups (Sarkis et al., 2011).

3.4 Conceptual Framework

Figure 4

Theoretical Framework



Note. Adapted from "Achieving Shared Triple Bottom Line (TBL) Value Creation: Toward a Social Resource-Based View (SRBV) of the Firm" by Tate, W.L. & Bals, L., 2018, Journal of Business 152(3), p. 46. Copyright 2018 by Journal of Business which was further adapted from "A natural-resource-based view of the firm" by Hart, S.L., 1995, Academy of Management Review 20(4), p. 988 and "A natural-resource-based view of the firm: Fifteen years after" by Hart, S.L. & Dowell, G., Journal of Management 37(5), p. 1472

The proposed theoretical framework combines the above-mentioned theories to provide a comprehensive base for analysing the trade-off between cost and sustainability in the context of renewable material sourcing within the textile industry.

First, as renewable materials are seen as an important way to reach circularity in the textile industry, it becomes necessary to investigate the extent to which innovators and companies focus on circular principles to define their approach to sustainability in the development and sourcing process respectively, with the corresponding impact on cost, sustainability, and the trade-off between them. This framework becomes all-encompassing in theoretical development.

Secondly, given the two distinct types of organisations under research, the RBV theory and NRBV theory extension allow for the potential uncovering of unique resources and capabilities that play an important role in how innovators and companies approach their significant stakeholders and how they address their identified trade-off.

Finally, the transition towards a circular economy requires that organisations take into account all the stakeholders that might be affected by a firm's activities. This includes stakeholders that are unique to each organisation and shared stakeholders. Therefore, it is necessary to understand which stakeholders innovators and companies are focusing on and how these weigh on the cost and sustainability trade-off.

These combined steps create pressures and influence the decisions the organisations make when working to balance cost and sustainability in the sourcing phase of the supply chain.

4. Methodology

The following section will explain (4.1) how the pre-study was conducted, (4.2) the design of the study, and (4.3) how the quality of the study was ensured.

4.1 Pre-Study

We conducted a study in order to gain a better understanding of the latest trends, developments, challenges and prospects in the textile industry. Five scholars and three industry consultants were interviewed, resulting in important findings that informed further interviews with innovators and IKEA employees. A summary of the main learnings, alongside rationales for choosing specific experts, is found in Appendix A and B, while the interview guide can be found in Appendix C.

The most frequently occurring theme in the interviews was the present lack of a commonly used definition of sustainability and assessment tools**,** which creates room for multiple interpretations of sustainability on both companies' and innovators' sides. Nevertheless, the experts shared possible assessment tools such as the LCA tool, based on assumptions about a material's longevity; the Higg Index, plus sustainability criteria such as transparency and traceability, carbon emissions, sourcing location, end-of-life, recyclability, land use, wastewater and water use. As a result, it became clear that both parties would be required to share their working definition of sustainability, alongside employed methods of measuring it.

Further, the experts pointed out that a full LCA cannot be performed until the technology has been scaled; and the same is required for a proof of concept. The aspect of scalability cascades into another major barrier for new material developers—cost. While most companies seek fast solutions, the full deployment of a new material technology can take up to 15 years, a time during which innovators need significant financial input. According to the experts, in the current absence of effective government support, these investments can be undertaken by big companies such as H&M and IKEA, which are motivated by early access to the technology, and whose involvement in the co-creation of novel materials can lead to win-win scenarios. These insights served as a foundation for exploring the **co-creation** aspect as a potential mediator of the cost-sustainability trade-off previously identified in literature via subsequent interviews.

Another important takeaway from the research was the experts' **shortlisting of promising emerging materials**, which complemented the initial desktop research performed and refined the further search for relevant technologies. The suggestions included specific cellulose materials of different origins such as mycelium, algae fibres, and fibres from agro-waste; plus descriptive

criteria including potential to drive scale, ability to combine the fibre with other virgin materials, locally sourced, and tactile properties similar to cotton and polyester—currently the most used materials in the textile industry.

Finally, the experts assisted in the choice of a suitable **framework for assessing the readiness of emerging technologies**. Suggested proxies included compatibility of fibre with existing suppliers' machinery, secured financing and speed of industrialisation, plus the most frequently quoted European Framework Horizon 2020, which represents the Technology Readiness Level (TRL) scale shown below (European Commission, 2017).

Table 2

TRL Level	**Definition**
TRL 1	Basic principle observed
TRL 2	Technological concept formulated
TRL 3	Experimental proof of concept
TRL 4	Technology validated in lab
TRL 5	Technology validated in relevant environment
TRL 6	Technology demonstrated in relevant environment
TRL 7	System prototype demonstration in operational environment
TRL 8	System complete and qualified
TRL 9	Actual system proven in operational environment

Technological readiness is an element of the RBV (Richey et al., 2007). One study has found that higher TRL positively influenced a firm's collaboration strategies, which meant that they were more likely to engage in inter-firm collaboration (Richey & Autry, 2009). As a result, the latter has been chosen to classify identified novel renewable materials.

4.2 Research Design & Approach

The following section will explain (4.2.1) the rationale for choosing a qualitative case design (4.2.2) the scientific research design, and (4.2.3) the use of the abductive approach.

4.2.1 Qualitative Case Design

The purpose of this study is to create a greater understanding of the renewable textile industry, what emerging technologies exist, and what are important cost and sustainability factors contributing to buyers' sourcing and second-tier suppliers' material development decisions. With this purpose in mind, this research aims to gain a deeper knowledge of the research area and not generalise the results (Bell & Bryman, 2011). We used a qualitative approach to gather the contextual knowledge that is needed in this novel research area, as there is limited research and theory. This study's contribution is to integrate new concepts into existing ones that have been developed in other industries and contexts (Gibson & Brown, 2009).

To create a contemporary investigation within real-world examples, we used a multiple-case design as a strategy to produce a revelatory outcome. This design also allows for the examination of similarities and differences across cases, which helped identify patterns, increase the generalisability of the findings, and provide a balanced perspective on the question (Yin, 2003). An inherent limitation of using a case study approach is that the generalisation of findings can be limited due to the small sample size. Even when examining multiple startup cases, it can be difficult to draw universal conclusions. (Chen et al., 2017).

The first case focuses on IKEA. IKEA is a multinational furniture giant present in sixty-two different markets (IKEA, 2023) with approximately two hundred thirty-one thousand employees (Statista Research Department, 2022). As one of the biggest players in the home furnishing industry globally, IKEA is influenced by the abovementioned increasing sustainability regulations, which target upholstery, bedding, and other home textiles to be sold in the EU (European Commission, 2022b). The company was founded by Ingvar Kamprad in 1943, where in 1948 furniture was first introduced in the IKEA range. IKEA originally started as a mail order company, but this changed in 1965 when the first store was opened in Älmhult which became the

model for all IKEA establishments (IKEA, n.d.d). The company has already made a public commitment to sustainability and set a goal to become 100% circular by 2030. In pursuit of this goal, IKEA leadership understands that materials are the "largest and most complex component" of its climate footprint. IKEA has identified renewable textiles as a way to reduce their environmental impact and hopes to reach 56% renewable materials by 2030 (IKEA, n.d.a). Given the multinational's cost-driven strategy and commitments toward sustainability, it was chosen as a case company to perform research in more depth due to the richness of the data and the access to information, making it more feasible than the other cases (Eisenhardt, 1989).

The second through tenth cases were conducted through various renewable materials innovators. The limited supply of companies that make renewable textiles in Europe implies a risk of selecting case companies opportunistically, thus it was important to only select companies that matched the requirements of the research questions (Benbasat et al., 1987). The companies were selected based on their focus on renewable textile materials, how far developed their products were (their TRL), and their commitments to sustainability.

4.2.2 Scientific research design

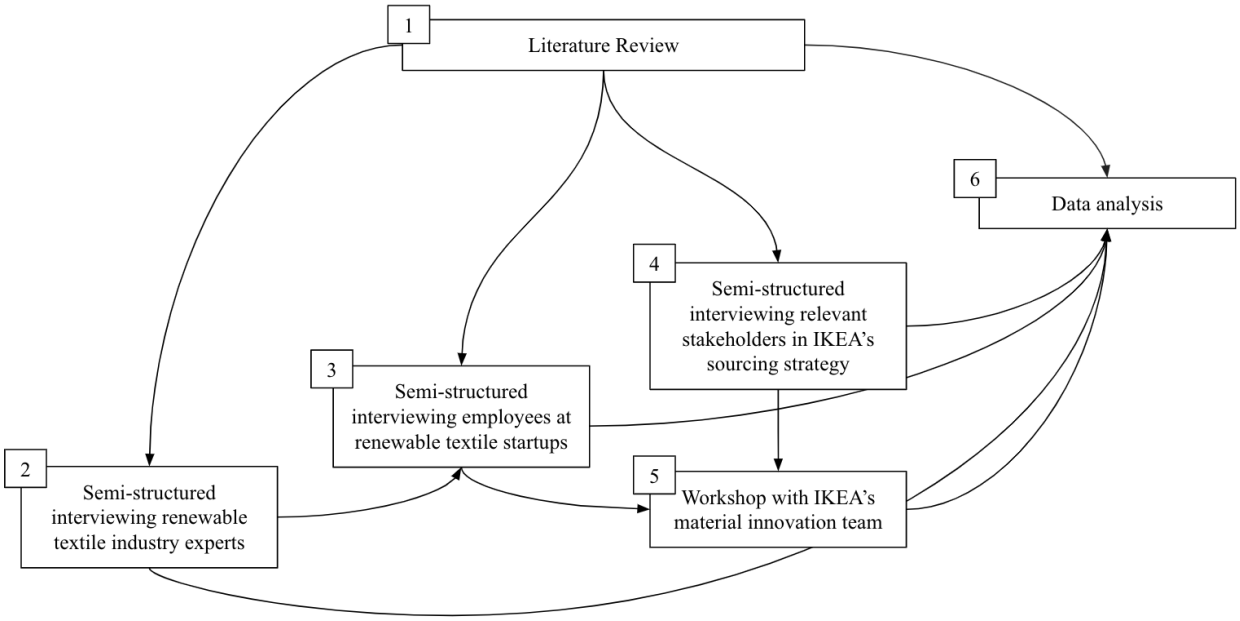
We selected semi-structured interviews as a way to gain a deeper sense of understanding of the renewable textile industry as a whole, how different materials perform against a variety of metrics, and IKEA's renewable materials' sourcing strategy, which is where open-ended questions provide great use. Semi-structured interviews are beneficial technique, as they are flexible around the interviewees' perspectives and provide a greater output of explanation and understanding in patterns and contexts. These guides were continuously updated throughout the study as new focus areas were identified while ensuring respondent flexibility and according to the abductive approach (Bell & Bryman, 2011). Additionally, this interview method provided interviewees with specific questions that allow for a consistent coverage of material, while also allowing them to freely elaborate when discussing their known industry, material, or way that they interact within IKEA's sourcing strategy (Harrell & Bradley, 2009). It is important to note the potential for interviewer bias, where the interviewer's personal biases or opinions may influence the way they ask questions or interpret responses as a limitation of this method (Bell & Bryman, 2011).

4.2.3 Abductive Approach

As a way to combine theories that are relevant to this industry, we used an abductive approach. Abductive approaches are a continuous interplay between empirical observation and theory; meaning that throughout the research process, the conceptual framework was modified as a result of the theoretical insights developed and empirical information found (Dubois & Gadde, 2002). The way that this was performed is outlined in Figure 4 below.

Figure 4

Abductive Approach Used



4.3 Data Collection

The following section will explain (4.3.1) the research design, (4.3.2) the research sample, and (4.3.3) the interview process.

4.3.1 Research Design

The data collection process consisted of four parts. First, semi-structured qualitative interviews were conducted, meeting with the innovators from the selected renewable textile innovation startups. Understanding the development of the emerging renewable technologies, along with

how cost, readiness, and sustainability were assessed by the innovators was the key goal of conducting interviews. These areas of interest provided depth for the case study examples (Yin, 2003).

The interviews were semi-structured with the aid of an interview guide (Appendix E). As new themes were found, the guide was revised in order to gain more information. Interview questions mostly focused on the innovation, how far it was in the development process, how easily it could be scaled, sustainability and cost aspects. Co-creation concepts were also explored in the interviews.

The second part consisted of gathering information from the companies' websites, investment websites, and news stories that were used to supplement the innovations discussed in the interviews. This approach helped to ensure construct validity and develop new insights while accumulating more robust evidence (Yin, 2003; Gibbert & Ruigrok, 2010; Eisenhardt, 1989).

The third part of the research included semi-structured qualitative interviews with employees at IKEA who are involved in the decision-making process about textile materials. The individuals were selected as key stakeholders and in diverse roles in order to provide in-depth information to help answer the research questions (Yin, 2003). These interviews were semi-structured and followed various interview guides depending on the role of the individual within the company (example: Appendix G). These interviews were also cross-checked with information hosted on IKEA's website to provide further context and understanding of their ways of working and requirements.

The fourth part of this research consisted of an in-person group interview with the Material & Innovation Team, Textile Furnishings at the IKEA office. This interview incorporated a presentation of preliminary findings, followed by semi-structured questions (Appendix H) to the IKEA employees, and concluded with key takeaways. A group interview was used in order to obtain information on multiple people simultaneously who operate as a team (Edmiston, 1944). This interview was used to help articulate and explore the difficult challenges in research

involving novel technology. By adding this additional research method, the case could be studied as in-depth as feasible (Eisenhardt, 1989).

4.3.2 Interview Sample

We employed purposive sampling to maximise the relevance of the interviewees, selecting participants based on their specific experiences, perspectives, and knowledge pertinent to the research questions (Bernard, 2018). Additionally, the availability and willingness of the interviewees to participate were considered (Etikan et al., 2016). This strategy aimed to optimise the use of available resources, especially given the limited number of innovators within the field of renewable textile materials (Patton, 2002). Moreover, according to Hennink and Kaiser (2022), qualitative research can reach empirical saturation at relatively small sample sizes if the objective of the study is narrowly defined as it is in this case study given the delimitations and research questions.

Therefore, to ensure the relevance of the study's findings, we selected material innovators and researchers based on their use of prototype-proven technology and renewable raw materials that had not yet been introduced to the mass market, meaning the materials held a TRL between 3 and 7. These respondents varied in roles from cofounders, CEOs, lead researchers, head of product development, communications manager and product managers. 29 emerging renewable material innovators were contacted with a total of forty-seven outreaches. This led to a total of nine interviews, three of which involved two interviewees, and six that held one interviewee.

We selected IKEA employees based on their involvement with renewable textile materials sourcing, sustainability and cost assessment, and textile product management. The contact person at the company provided liaison to the interviewees, and a total of twelve semi-structured interviews were carried out within this category (Appendix F). The respondents varied in roles within Range and Category Management, Material Creation, Material and Innovation, Research and Development, and Sustainability.

4.3.3 Interview Process

We conducted eight online interviews ranging from 26 to 38 minutes in length, with representatives of renewable material innovations. Due to time constraints, one interviewee was unable to participate in a semi-structured interview but agreed to respond via email. The interview guide was sent, and the interviewee addressed all questions in a single email. Previous research indicates that email interviews can still yield rich data (Costello et al., 2017; Illingworth, 2006). We conducted ten online interviews with IKEA employees, while two interviews took place in person. Each interview lasted between 21 and 50 minutes.

Online interviews were deemed appropriate in order to accommodate the widespread geographic locations of the interviewees and were conducted using Microsoft Teams. As a mode of data collection when comparing online and in-person interviews, online interviews have been determined to not affect data quality (Shapka et al., 2016). A further advantage of the online format was the reduced likelihood of interviewees being influenced by the interviewers, resulting in decreased interview bias (Bell & Bryman, 2011).

At the beginning of each interview, confidentiality, anonymity, and GDPR-compliant data handling practices were confirmed to encourage transparent responses. With the respondents' approval, all interviews were recorded and transcribed to enable a comprehensive analysis of the discussions and to support the notes taken during the interviews, ensuring the minimization of interviewer bias (Heritage, 2008). Initial transcriptions were generated using transcription software, but due to inaccuracies, the interviews were listened to and corrected manually before analysis. Additionally, the transcribed quotes were shared with respondents for their approval, allowing them to correct any misunderstandings.

Finally, one hour-long group interview was completed with eight members of the Material & Innovation Team, Textile Furnishings, where seven were in person and one was online. This consisted of the entirety of the team within this area of the company and was used as a way to ethnographically study how the team would make decisions around specific cases of emerging renewable materials and the factors that would be highlighted when considering adoption or

further important questions about the technology, along with understanding how the team operated.

4.4 Data Analysis

The process of data collection involved gathering semi-structured data, resulting in a semi-structured output that required careful and consistent handling to ensure the reliability of the conclusions drawn (Bell & Bryman, 2011).

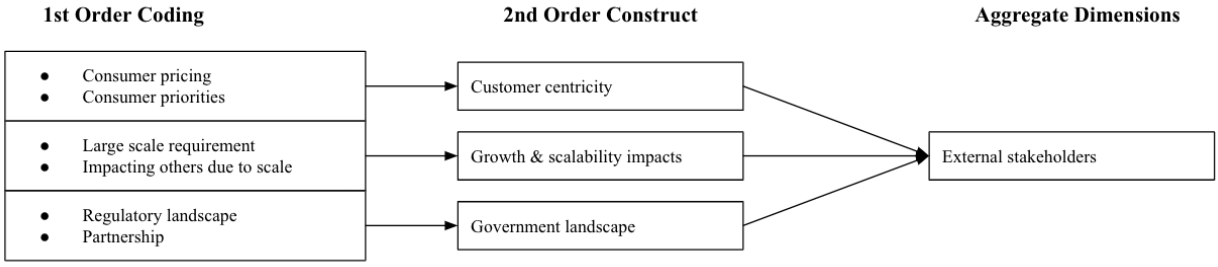
Grounded theory involves systematically collecting data and using it to develop a theory (Strauss & Corbin, 1994). We used Gioia Methodology, beginning with open coding to conceptualise the data, and labelling it with terms used by the respondents (Gioia et al., 2013). Relevant quotes were marked with comments, where both researchers independently read and coded the recorded transcripts to ensure quality (Barratt et al., 2011). Then they were compiled to identify first-order codes which were narrowed from 67 to 22 for the innovators and from 69 to 26 for the firm.

Inductive and deductive thinking was used to identify constructs aligned with the CE, stakeholder theory, and the RBV (Strauss & Corbin, 1994), resulting in nine second-order constructs for the innovators and 13 for the firm. These were then condensed further into four aggregate dimensions for the innovator and five for the firm. For the innovators: cost, environment and social sustainability, development and efficiency, and collaborative partnerships. For the firm: strategic decisions and values, external stakeholder considerations, cost and volume, sustainability, and the balance between cost and sustainability.

A partial extraction of the methodological approach is shown in Figure 5 with a complete overview provided in Appendix K and L. Transcriptions were matched with the first-order coding to assess the cohesiveness of each concept (Appendix I, J) (Gioia et al., 2013).

Figure 5

Partial Extraction of Methodological Approach



4.5 Quality of Study

It is important to assess a study based on trustworthiness, where qualitative data can be based on four criteria: credibility, transferability, dependability, and confirmability (Bell & Bryman, 2011).

4.5.1 Credibility

It is significant to note that within qualitative research, credibility is about identifying the truth value to the extent to which conclusions of the research are a reflection of reality (Yin, 2003). It is also important to ensure that insights from the interviewees correspond correctly to the results. In this case, the use of different resources supported credibility (Guba & Lincoln, 1994). Additionally, transparently showing how data was collected and analysed ensures that how decisions were made is understood. IKEA and the material innovators read over interpretations of their interviews, to ensure that information was interpreted correctly. This was beneficial because reviewing and validating can significantly enhance the validity of research (Goffin et al., 2019).

4.5.2 Transferability

Transferability has been characterized as a way for a study to reach wide audiences, where findings can be applied in additional contexts (Guba & Lincoln, 1994). While the findings of this particular study were limited to the specific cases of one buying firm and nine supplying firms and may not be directly transferable, transferability may nevertheless be seen as a way to allow future research to apply findings in additional scenarios.

Given that this sample was focused on a few particular case companies, other case-company examples could warrant transferability; and this case had the ambition to include enough details to warrant transferability (Guba & Lincoln, 1994). While different companies may use different strategies to adopt innovative renewable materials, detailed explanations could help the reader understand when this case can be applicable to others (Bell & Bryman, 2011).

4.5.3 Dependability

In order to maintain dependability, it is critical to guarantee that others can see and verify that the study design was carried out correctly (Guba & Lincoln, 1994). In this case, records of interviews were detailed, as was the research procedure, and the data analysis methodologies.

4.5.4 Confirmability

Confirmability ensures that researchers have acted in good faith and that the interpretations of the data were appropriate. As personal values and theoretical preferences should not affect the research or findings (Bell & Bryman, 2011), confirmability was maintained by ensuring questions were open, transcribed, and double-checked by each researcher during the research process.

4.5.5 Ethical Considerations

The Swedish Research Council holds four ethical research principles to ensure that research has been carried out ethically. The four principles consist of information requirement, consent requirement, confidentiality requirement, and user requirement (Vetenskapsrådets, 2002). We took these into account during the interview process.

Within the information requirement, interviewees were informed of the purpose of the study and how their answers would be used in the study. To meet the consent requirement, all respondents gave their approval to participate in the interviews and gave their permission to record the interviews. Additionally, all respondents were allowed to refuse to answer questions if they felt that the information was confidential or they were uncomfortable sharing that information. Within confidentiality, at the beginning of the interview, they were assured that their information would be confidential and this confidentiality was restated in emails following the initial interviews. Finally, with the user requirement, the data of interviewees was only utilised for the

paper and no other purpose. Each respondent filled out a consent form to ensure they understood these requirements and consented, along with verbally consenting at the beginning of the interview.

5. Empirical Findings

The empirical findings will be presented in two parts: (5.1) the analysis of the decisions the innovators and startups make when balancing cost-effectiveness and sustainability in their development process and (5.2) an analysis of how the firm (IKEA) addresses cost-effectiveness and sustainability when sourcing innovative renewable materials.

5.1 Empirical Findings from Innovators

The following empirics were obtained via semi-structured interviews with nine material innovators. A summary of the interviewees' roles, raw materials used in textile manufacturing, TRL levels and indicative information on cost and end-of-life can be found in Appendix D.

This part covers four main dimensions that have been identified within the exploration of the trade-off between cost and sustainability from the innovators' perspective: environmental and social sustainability, production development and efficiency, cost, and customer relationships.

5.1.1 Material Sustainability: Balancing Environmental and Social Impacts

When prompted with questions about the sustainability of materials, innovators' responses fell into five themes: environmental impact, raw material sourcing, end-of-life, social responsibility, and sustainability certification.

The interviewed innovators are actively pursuing environmentally sustainable materials and practices. They highlighted the potential of their materials to contribute to global CO2 reduction and the importance of developing cleaner production methods by minimising water use and waste and avoiding harmful chemicals to reduce their **environmental impact.**

> CO2 reduction is a very important part of it because of course with our material . . . we could actually save the world from 113 million metric tons of CO2. . . . We don't use any harmful chemicals. Our focus is to ensure that during the dying and during the purifying of the material, we can stay sustainable. – CEO of company 3

> We chose to blend our PALF with fibres from LENZING™ because of the sustainable credentials that they hold. Their processes use less water, less harmful chemicals than conventional viscose processing and the characteristics of the fibre is complementary to our Pineapple Leaf Fibre. – Product Manager of company 5

Further, efficient and sustainable **raw material sourcing** was also emphasised by the innovators. Several companies focused on using agricultural waste or regenerative agricultural practices to reduce land and water use, which can contribute to more sustainable material sourcing. This approach not only minimises the environmental impact of their products but also supports a more circular economy by utilising waste materials.

> After the fruit harvest, you would be surprised by how much waste is on that field. The farmers often burn the leaves to quickly clear the field for the next harvest of the fruit. Instead, we then purchase them. And with that, we then save CO2 emissions being released into the atmosphere. . . . On the pineapple leaf fibre part of the composition we use no extra land or water due to it being agricultural waste. – Product Manager of company 5

> Nettle is planted with regenerative methods, the soil recovers with nettles on it. Plant rotation on a nettle field is after 5-8 Years, as nettle does not have to be replanted every year, it is a perennial crop. It actually fits in quite well in the whole program (EU future requirements). – Strategic Director of company 7

The interviewees also stressed the importance of considering materials' **end-of-life** in their sustainability assessment. Biodegradability and recyclability were commonly mentioned, but some interviewees acknowledged the challenges in achieving these properties due to the need for

additional coatings or dyes. This highlights the need for companies to balance material performance with end-of-life considerations to ensure overall sustainability. The Product Manager of company 5 mentioned, “Due to the yarn being 100% cellulose based, with no additional harmful chemicals or plastics used, means the end of life of the yarn can biodegrade, be composted, and chemically and mechanically recycled.” While the Lead Researcher of company 4 pointed out “It can be biodegradable because the only fibre is hemp. But we want to really blend it with biodegradable and bio source materials to improve certain properties.”

> In the textile field we are working with the membrane itself—it's always laminated to the face and back fabric. So when it comes to end of life, you have to think about the face fabric, then the glue, then the membrane, glue again, and then the back. When it comes to biodegradability,all the materials have to be biodegradable under the same circumstances; and when it comes to circularity, all of the material has to be out of the same polymer because you need a mono material in all three layers—the glue has to be the same—to melt it and produce something else, so the raw material stays in the supply chain. – Head of Development of company 2

Additionally, the innovators acknowledged the **social impacts** of their materials and production processes, focusing on job preservation and creation and safer production practices. This emphasis on social responsibility demonstrates the importance of considering not only the environmental impact of materials but also the broader societal implications.

> We're in direct contact with our farmers. We give them a second stream of income . . . and so with the second stream of income, we also create more jobs in the rural communities and we work with those rural communities to help train them on how to process these leaves into fibres for us to then purchase them. So we don't simply buy fibres from anywhere; we have quite close connections to those farming communities. – Product Manager of company 5

Despite honing in on various sustainability characteristics of their materials and production processes, the interviewees shared challenges associated with obtaining standardised **sustainability certifications** for their materials. Some mentioned that their technology was too early in development to qualify for certification, while others expressed concerns about the financial burden and subpar requirements of certain standards. This highlights the need for more robust and transparent certification processes that can accommodate innovative materials and startups.

> We also look into what standards we should use because some brands require their suppliers to have these certifications (e.g., bluesign). Otherwise it is not possible to supply these brands. Certification to these standards is costly, especially for a startup. And when you look into the details . . . we just have the feeling the standards should be higher; and our main focus is chemical—not using forever chemicals . . . And then we just see eco standards which still allow using PFCs [per- and polyfluorinated compounds], and in our mind with our knowledge, this is just not acceptable. – Head of Development of company 2

Life Cycle Assessment (LCA) was commonly mentioned as a method for measuring sustainability, but many interviewees found it difficult to apply. The lack of standardised models and the reliance on self-reporting makes it challenging to compare LCAs across different materials and companies. This suggests that more consistent and comparable metrics are needed to effectively evaluate material sustainability.

> The main challenge in assessing the impact, it's that there's no standard model for doing so. This entire system essentially works off self-reporting. If you use a third party, you can still kind of sculpt that third party into building whatever kind of life cycle that you want. . . . Trying to then compare that against another life cycle analysis is almost impossible as it's done by someone else. They won't be compared against the same metrics. They might use different data sets and might make different assumptions so I think it is very challenging to make that an effective baselining use case in the industry. It's hard enough for carbon, let alone

> for all of the other associated benefits which you might pick up in the life cycle analysis. – CEO of company 9

On top of the sustainability assessment tools and certifications most commonly employed by innovators, frameworks such as the UNSDGs and the TBL, alongside the downfall of the Higg Index have been sparsely mentioned by the interviewees. Overall, the innovators communicated a lack of clear sustainability guidelines and accurate measurement tools, which makes it difficult to align the development of new renewable materials with ambiguous sustainability benchmarks.

5.1.2 Production Development and Efficiency

The empirical results highlight the role of production efficiency and development in the context of sustainable material innovation. The interviewees emphasised the influence of economies of scale, production location, and integration with existing manufacturing processes on the cost and sustainability of their materials.

First, the results suggest that **economies of scale** can positively impact development costs and, consequently, lower the price of materials. As companies scale up their production, they can achieve cost reductions and make their products more accessible to a wider market. However, it is important to note that economies of scale may not play a significant role for all materials, as evidenced by the example of bacterial cellulose-based material.

> If there wouldn't be food waste available then we can actually use additives to just add the sugar that our bacteria requires. But because there is actually a lot of food waste available everywhere—then we are talking about microbes, so as you can imagine, they don't need much food per microbe. Because of this, we don't require much food waste either, so it's not limiting us in that sense. In terms of the production, only the energy price would be the factor that is the cost. – CEO of company 3

Alternatively, **production location** was identified as a more influential factor on cost than economies of scale for some companies. Factors such as labour and electricity costs can vary

significantly depending on the production location. Producing in regions with lower costs, like Asia, may help companies reduce their overall expenses. Additionally, producing materials in close proximity to the textile industry's supply chain can also contribute to sustainability by reducing transportation and associated emissions.

> Economies of scale at the moment is not the biggest driver, I would say it's more where you produce, so labour costs and electricity costs. It's very important, as we're still producing in Europe. For sure we look into Asia, as the whole textile industry is there. And also when it comes to sustainability, you have the fabric supplier, all the factories, which then produce the final product, everything is near to each other. It's also more sustainable. – Head of Development of company 2

Several innovators mentioned the possibility of developing their materials in existing factories, **leveraging current infrastructure** and machinery, as the Head of Development in company 2 stated, “We don't have our own facilities, but the production works on machines which are already used in the industry. So I guess to scale that up is not really a big thing for us.” This approach can help companies scale up their production more efficiently, without the need for significant investments in new facilities. By integrating their materials into existing manufacturing processes, companies can potentially reduce the barriers to entry for sustainable materials in the market.

Some companies focused on developing a holistic approach to production, incorporating **zero-waste principles** and generating additional revenue streams from side products, as indicated by the Strategic Director of company 8, “We ensure quite lean production and zero waste principles because we can also sell the side streams for other purposes . . . so that also brings us some more financial security and cost effectiveness.” This approach can contribute to increased financial security and cost-effectiveness for the company while also promoting sustainability throughout the production process.

5.1.3 Cost: Striking a Balance Between Affordability and Sustainability

The empirical results reveal the diverse strategies that innovators employ when it comes to pricing their materials, whereby the trade-off between affordability and sustainability plays a crucial role in determining their approach. While some companies aim to maintain competitive pricing to drive market adoption, others focus on premium pricing or prioritise research and development over cost considerations. Overall, innovators' perspectives on pricing their materials vary across three primary themes: comparable pricing, premium pricing, and no focus on pricing due to early development stages.

Among the companies that aim for **comparable pricing** are innovators working with cellulose-based materials that emphasise the importance of keeping prices corresponding to those of similar fibres in the market. The Lead Researcher of company 1 stated, “In any case, it must be comparable to the cost of classic Lyocell fibres.” While the CEO of company 6 mentioned,“(The price) It's equal to the current viscose production. This fibre has a chance to really be in the same price level and achieve success.”

In contrast, some innovators acknowledge that their materials may command a **higher price**. One reason for this is the expectation that consumers are willing to pay a premium for sustainable products and a compelling startup story. Another reason is the absence of direct competitors in the market and the potentially higher costs of production, as revealed by Head of Development at company 2,“Our customers or potential customers which are brands, for sure are willing to pay a little bit more for sustainability, and for a good startup story . . . so it will always be premium.”

> [Yarn-brand name] is more expensive if compared to conventional yarns such as virgin cotton and polyester, but competitive in price to other pineapple leaf fibre yarns on the market and incomparable in sustainable credentials and quality to other pineapple leaf fibre yarns. – Product Manager of company 5

For innovators in the early stages of development, **pricing** is **not a primary concern**. Instead, they focus on determining the feasibility of their materials and processes. Researcher of company

4 shared,“We care at the end, but at this point of research, we don't care about the costs. We see if it's feasible or not.”

5.1.4 Customer Relationships: A Key Strategy for Renewable Material Innovators

The empirical findings highlight the importance of partnering with brands for many of the interviewed companies. These partnerships serve various purposes, including acquiring financial resources, accessing consumer insights, and aligning values, which are crucial for successful material development and market adoption. However, some challenges exist when working with larger brands, which may necessitate tailored strategies to ensure successful collaboration.

For many innovators, **securing financial resources** through partnerships is critical, especially during the early stages of material development. As the Head of Development at company 2 mentioned, “We try to get brands on board . . . to have some joint developments. So it's not that we just provide them with a finished product, but get them on board early, also that they kind of financially support the development.”

Moreover, strategic brand partners can sponsor **quality tests** to assess the material's performance across different categories. As one of the interviewees explained,

> Most of our certified third party lab tests come from our strategic brand partners. This way they get comparable results to previously tested materials. Different categories require different qualities (e.g., different material thickness), so in this way we get an accurate picture of all the different categories, which helps us navigate better in terms of the next steps in the material development. – CEO of company 3

In addition to financial support, partnerships with customers provide innovators with valuable insights into **market needs** and **consumer preferences**.

> As soon as you have a promising technology, this is the latest point where you should try to partner up with the industry. Otherwise you think you developed the

> product for the future, but you don't have the contact to your future customers and it could be dangerous that you kind of develop in the wrong direction. – Head of Development of company 2

Nevertheless, partnerships are not solely driven by financial considerations or market access. Companies must collaborate with brands that share their commitment to sustainability and innovation. **Aligning values** ensures a common goal and fosters a successful long-term relationship, as Head of Development at company 2 exemplified: "It's basically the brands that have a strong sustainability commitment and a strong innovative commitment that we're looking for."

Furthermore, even when products are developed independently, collaboration with customers can ensure the **effective use of materials**. As the Product Manager of company 5 mentioned, they provide education and support to their customers, helping them maximise the potential of their material.

> We are very collaborative in helping our customers develop products using our material. Some customers are happy to buy [material] and with their own ideas develop materials/products. Other times they really value the fact that we're there for more of a support and hands-on approach with the development. – Product Manager of company 5

The findings also indicate that some innovators face challenges when working with **larger brands**, as these may require more mature products that can supply their volumes.

> In our experience, it's easier to work with smaller companies. . . . They are more interested in our MVP and want to launch it with us. . . . The bigger companies require a bit more ready feeling, so the MVP wouldn't necessarily suit their production volumes. – Strategic Director of company 8

5.2 Empirical Findings from the Sourcing Firm

This section presents the findings obtained through the interviews at IKEA and public source information about the company. The following empirics were obtained via semi-structured interviews with twelve IKEA employees and one group interview consisting of eight employees within the material innovation team. These empirical findings provide valuable insights into the interplay between cost and sustainability in the context of renewable textile material sourcing at IKEA by examining the company's background strategic decisions and values, external stakeholder considerations, cost and volume, sustainability, and the balancing act between the latter.

5.2.1 IKEA's Background, Strategic Decisions, and Values

In order to better understand IKEA's decisions and strategy, it is important to first note the context in which IKEA is operating. For this reason, the context is presented in a narrative style to provide additional information and increase understanding (Bell & Bryman, 2011).

In order to understand and analyse the sustainability activities of IKEA, it is important to note the values and vision instilled in IKEA from the inception of the company, which shaped the company culture. From the beginning, Ingvar Kamprad stated, "IKEA is not the work of one person alone. It is the result of many minds and many souls working together through many years of joy and hard work" (IKEA, 2023). This philosophy of "the many" later translated into IKEA's current mission "to create a better everyday life for the many people," (IKEA, n.d.b) and to have a beneficial influence in all markets. This vision hones in on the product range and price philosophy being the basis for the firm's work (Kamprad, 1976) in alignment with the "cost-consciousness" value (IKEA, n.d.a). This inclusive approach is exemplified by the Range and Product Design Leader's quote, "Each product is not meeting the many, but the many should find something they love, trust and can afford in our product range offer."

Furthermore, IKEA states that they are committed to having a positive impact on the world through the value of "lead by example" (IKEA, n.d.a), and as indicated by the Material and Innovation Manager's statement, "We need to move the industry. . . . Someone has to start and create the pull effect and then others will follow. Then when it's the majority, there's a shift." This demonstrates the company's ambition to be a catalyst for change in the industry and its

focus on driving sustainable practices.

An example of how IKEA is moving the industry is its involvement in TreeToTextile—a pioneering joint venture between H&M Group, Inter IKEA group, Stora Enso, and LSCS Invest. TreeToTextile developed an innovative cellulosic fibre technology "that will provide textile fibres with good sustainability performance at an attractive cost-level." The project's aim is to inspire new game-changing innovations and collaborations. By pursuing this mission, TreeToTextile hopes to inspire others in the industry to prioritise sustainability and prioritise innovative partnerships (TreeToTextile, n.d.).

5.2.2 External Stakeholders

IKEA's sustainability efforts are also influenced by **government regulations**. The company seeks to stay ahead of the legislative curve by ensuring compliance with current and working to comply with future regulations, as expressed by the Global Cotton Manager, "We need to be compliant with the legislations and when we talk about sustainability, traceability and transparency is kind of included in our sustainability agenda."

One of the biggest challenges for IKEA when combining its vision "for the many" with ambitious sustainability goals is maintaining low costs, as the company aims to make sustainable products accessible and affordable to its **customers**. As the one Range and Product Design Leader mentioned, "Everything stands on the low price, price is what you pay and value is what you get." This is in line with the company's understanding that customers are not willing to pay more for sustainable products, but rather prioritise design and aesthetics. Nevertheless, there is optimism that new materials will enable IKEA to deliver on both low price and sustainability.

> IKEA is a company "for the many" people with thin wallets. We would like to have good and sustainable fibres available for the many people with thin wallets. So we believe in a new technology that can deliver low cost. – Category Manager 1

The primary goal of seeking new solutions is to cater to a broad customer base interested in home furnishing products. IKEA has already made significant strides in working with and identifying more renewable materials.

> In textiles in general, we are leading the agenda quite a lot. . . . When we are looking at new materials, Tree To Textiles and so on. We're looking into possibilities of our own as well. . . . We have a plan for that by 2030 . . . So there is a constant search, I feel, and development in regards to how we find alternative materials, better recycled materials, recycling our own materials, and so on. – Category Manager 2

Innovation and range teams also rely on **external networks**, **experts**, **consultants**, and **suppliers** to make informed decisions. They proactively ask questions and gather information from these knowledgeable sources to identify relevant materials. A Material and Innovation Manager said, "We need to be the ones asking. Because they are so well connected and knowledgeable, they will have something somewhere in a drawer or they will know someone."

Once a material is identified as relevant, IKEA consults their suppliers to see if they can integrate it into their processes.

> We purchase the finished product, not the raw materials, but in some cases we will nominate the raw material resource which we think is good for the IKEA business. Either we can lower the cost or secure the sustainability and the social responsibility. But in most cases, we give the freedom to our supplier to purchase the raw material as long as they meet IKEA requirements like traceability, social responsibility, worker safety. – Material Creator 2

This relationship with suppliers is highly important and valued by the company given the energy they place in creating the partnership and the shared values that they develop, as Category Manager 1 said, "Many of our suppliers have been with us for decades and we are a company that stays with our partners, supplying partners for a very, very long time."

5.2.3 Cost and Volume Considerations

The company looks for new materials and solutions that are cost-effective or have the potential to be scaled up, as it can help bring down costs and make sustainable products more accessible to a larger customer base. As the Sustainability Manager expressed, “Volumes are our best friends that enable us to limit the cost.”

However, it is essential to note that IKEA's cost considerations extend beyond the price of raw materials to include the total cost of production.

> We don't want to add too much cost when we implement the new solution or new materials. But we won’t only consider the cost of the raw material, but also the total cost in the supply chain for the final product. – Material Creator 2

Moreover, material availability plays a critical role in IKEA's decision-making process, as the company must secure sufficient quantities of renewable materials to meet its production needs. The Material & Innovation Developer acknowledged this aspect, stating, “If the company is working with very small volumes, then maybe it won’t be an IKEA fit.”

5.2.4 Sustainability

The empirical findings on IKEA's sustainability practices can be broken down into five themes: internal standards, social responsibility, environmental impact, circularity, and certifications

Internal standards

> In IKEA, we have different strategies and one of them is called People & Planet Positive. That is our sustainability strategy. And sustainability is also part of our business direction, which is called Three Roads Forward. So it is integrated in our vision, in our business direction and also a strategy for delivering the goods. – Sustainability Manager

The former focuses on the balance between environmental, economic, and social impact, while the latter aims to achieve circular and climate-positive goals by 2030.

Additionally, IWAY, the IKEA way of sourcing materials responsibly, is also a key component of the company's sustainability efforts alongside various performance indicators related to climate change, energy consumption, recycling, and water usage.

> We have a code of conduct which suppliers need to follow which we call IWAY. It defines how a supplier should be in compliance with the environmental and social requirements. . . . All suppliers need to have 100% compliance. Then there are different sustainability impacts. Whether it's the GHG footprints, the consumption of energy, the amount of renewable energy, the recycling of material or recycling of waste that is generated, the amount of water that is used and recycled by suppliers, these are some of the performance indicators on sustainability. – Sustainability Manager

Feedstock availability and sourcing are also crucial factors to IKEA in terms of sustainability, as the Global Cotton Manager mentioned, “We have a team which is called Responsible Sourcing which works to understand if we are sourcing in a responsible way the feedstock that we use in our material for our range.”

IKEA also follows a specific definition for renewable materials: “Materials composed of biomass from a living source which can be continually replenished. When virgin materials are claimed to be renewable, they shall be from sources that are replenished at a rate equal to or greater than the rate of depletion” (IKEA, n.d.c).

Certifications

IKEA uses certifications to ensure the sustainability of their materials.

> When we source wood for our materials and IKEA, we use FSC. Then we source cotton, so we have the Better Cotton Initiative. . . . Only recycled polyester is

> used, and for that we use . . . the Global Recycling Standard. For conventional wool . . . the Responsible Wool Standard. – Sustainability Manager

When dealing with innovative materials, sometimes certifications do not always exist.

> If there is no standard available anywhere . . . we do create ways of working and then we try to align with the external partners to find out what are the requirements that should be set for that material from the quality point of view, from the sourcing point of view. But IWAY requirements are applicable from day zero. – Sustainability Manager

Environmental Impacts

Environmental sustainability is a crucial factor within sourcing at IKEA. Category Manager 1 emphasised, "If we could have new fibre that would come at the cost of more greenhouse gases we would not engage in that." The Global Cotton Manager added, "*We are looking at recyclability. We're looking at water usage. We're looking at greenhouse gases."*

The company focuses on various aspects, such as reducing greenhouse gas emissions, promoting water stewardship, enhancing soil health, and promoting biodiversity. The Global Cotton Manager elaborated, "We are talking about climate change, carbon resilience, carbon sequestration." Additionally, the Range Strategist mentioned, "Every single product that we have in our range is assessed . . . to get the CO2 footprint. Also putting in everything connected to circularity."

Circularity principles

Circularity is a driving factor within IKEA, and especially in product development.

> Because the circular product is different from circular raw material and in the end it ends up in a product. So that's the important part because the product will be the one that gets thrown away or reused or not. So for us it's about the circular product much more than circular raw material. - Material & Innovation Manager

Additionally, products are assessed based on criteria like durability, separability, and the availability of recycling technologies. However, to enable circular lifecycles, the importance of collaboration was noted,

> It comes to the whole supply chain. How to build the infrastructure to give a second life for such products?. . . But that needs the effort from different partners, not just from our company, but also from the local government which needs to build up such a system to support the collection of such waste. – Material Creator 2

The company uses the cradle-to-gate approach to measure the sustainability of their products. While commonly used, many employees acknowledge that this method presents some challenges. The Material & Innovation Manager said, "Cradle-to-gate is until our supplier's gate. It's not telling you very much, to be honest, because then there's a huge process coming after that."

> One of the biggest challenges that we are facing as a business ... is that we are missing good quality, credible primary data. What we are working with is secondary data, tertiary data, whatever is available online and whatever has been reported. – Global Cotton Manager

Social Sustainability

Last but not least, social sustainability is another key decision factor within IKEA's material sourcing strategy.

> We have assessed the social responsibility risk to avoid child labour. So we map the regions with the different levels of risk. There is higher risk for some countries and in others it's low risk. We have traceability requirements for all these materials. - Material Creator 2

5.2.5 Balancing Sustainability and Cost

The empirical findings show that IKEA's approach to sustainability and cost in renewable textile materials sourcing is a complex interplay between various factors. Still, a common narrative among employees and expressed by Category Manager 1 is that "Sustainability and cost are right from the beginning."

The way that cost and sustainability are integrated in the product design and development process is defined by the Democratic Design (DD) Framework, which is "at the heart of every product", as expressed by the Range and Product Design Leader. This framework was first launched in 1995 at a furniture fair in Milan (IKEA, n.d.b) and it helps the company balance various dimensions, including function, form, quality, sustainability, and low price. DD serves as a guiding tool for ensuring that IKEA products cater to a broad range of customers while maintaining sustainability and affordability. As further explained by Category Manager 1, "Of course we have to recognize that things come with a cost, but we also try to find the way forward that's available here and now and that can give the greatest total benefit from a democratic design perspective."

The empirical findings also suggest that while there can be trade-offs between sustainability and cost, in some cases, the raw material cost does not have to impact the cost of the end product. For example, when IKEA introduced recycled polyester, it was initially more expensive than virgin polyester.

> When we introduced recycled polyester, it was actually quite more expensive than virgin polyester, and everyone was like, why are you doing that? And in the end the product is the same, but you want to use a more expensive material. . . . We think this is the right thing and we need to move the industry. And today recycled polyester is the same price as virgin polyester. – Material & Innovation Manager

Therefore, evidence suggests that, over time, the prices of both materials became equal, indicating that sustainable solutions can be cost-effective as well.

This example also highlights the importance of a long-term perspective and the willingness to invest in sustainable materials, even if the initial costs are higher. By pushing for sustainable materials and taking the lead in moving the industry towards greener practices, IKEA can eventually achieve cost parity and make sustainable products more affordable.

6. Discussion

The following section will discuss the empirical findings in relation to the relevant literature. The first part (6.1) will look at how innovators balance cost and sustainability when developing renewable textiles; the second (6.2) will analyse how the case firm is balancing cost and sustainability when sourcing emerging renewable textiles; and the third (6.3) will bridge the two perspectives.

6.1 Balancing Cost-Effectiveness and Sustainability: Renewable Textile Innovators' Perspective

When looking at how renewable textile materials innovators are integrating cost-effectiveness and sustainability into their material development process, the present study confirms the existing literature on the internal values that drive innovators towards producing sustainable products and addressing market gaps, as highlighted by Salo et al. (2020). The results demonstrate that innovators place significant importance on reducing carbon emissions, water and land use, and avoiding harmful chemicals in the textile industry, which aligns with key capabilities in NRBV, such as pollution prevention and sustainable development. Sustainability practices were recognized as valuable resources that provide a competitive advantage to innovations.

Nevertheless, the sustainability impact of the materials has been found difficult to assess due to the lack of standardised models for calculating it, as well as incompleteness of existing certifications vis-a-vis new renewable materials, or each innovation displays its own unique sustainability characteristics, and requires unique certifications. This makes the process of complying with any given buyer firm's sustainability requirements and desired certifications difficult and often costly. As a result, innovators strive to collaborate with buyer firms early on in

the development process, as this allows them to tailor the materials' sustainability characteristics to their preferences. However, as lower TRL undermines inter-firm collaboration (Richey & Autry, 2009), innovators also find that such collaboration is more readily achieved with smaller brands that favour experimentation.

The innovators also emphasised the social impacts of their materials and production processes, focusing on job preservation and creation and safer production practices, where they viewed their own suppliers as key stakeholders in their production (companies 4, 5, 6, 7 and 9). By prioritising the interests of their suppliers as key stakeholders, the companies focus on job preservation and creation and supplier relationships contribute to building a good reputation—a resource that is potent in creating competitive advantage (Grant, 1991).

The greatest variation in innovators' perspectives was noticed in the relationship between sustainability practices and cost. These were aligned with the different priorities of the buying firms, which innovators valued as a key stakeholder. Three innovators (companies 2, 3, and 7) hypothesised that customers would be willing to pay more for sustainable and differentiated items, following Tully & Winer (2014) and Wei et al. (2018)'s findings. This implies that they viewed sustainability as a competitive advantage among alternative materials, showing that they believed a more sustainable product was of enough competitive advantage that consumers would be willing to pay more for it. Alternatively, two innovators (companies 5 and 7) noted that sustainable design had a negative and significant impact on cost performance and, consequently, price. This is in line with Esfahbodi et al. (2016)'s and Walley & Whitehead's (1994) findings. Another innovator (company 6) believed that the implemented differentiation strategy may lead to a low-cost position, which aligns with Hill's (1998) findings and can result in the realisation of economies of scale and scope. Three innovators (companies 1, 3, 9) believed that low cost was required because that is what consumers wanted, following Han et al.'s (2017) conclusion on consumers' attitude-behaviour gap. Ultimately, these findings provide support for contrasting perspectives that have been documented in earlier research.

Although none of the innovators mentioned circularity goals, it was evident that they aimed to keep products and materials in use for as long as possible with all adopting the biodegradability

and recycling approach. Five of the innovators mentioned their use of waste materials in production (companies 1, 3, 4, 5, and 6), and three innovators (companies 2, 4, and 5) highlighted considerations regarding materials' end-of-life that need to be accounted for when enhancing the performance of the materials. This aligns with the CE framework and demonstrates that it is a guiding principle in material development that helps them achieve sustainability (Wiebe et al., 2023).

6.2 Balancing Cost-Effectiveness and Sustainability: Firm's Perspective

The empirical findings demonstrate that IKEA acknowledges the potential trade-offs between cost and sustainability in renewable material sourcing and profitability (Hertwich et al., 2000; Wu & Pagell, 2011). The company is nevertheless committed to delivering sustainable and cost-effective products "for the many," while driving innovation at the same time.

One of the key aspects of IKEA's strategy is its cost leadership approach. This approach is aimed at reducing prices in order to appease consumers' cost aware behaviour, as offered by Han et al. (2017). IKEA's mission to create a better everyday life "for the many" people shows that they view cost as a key capability and competitive advantage. The low price point goes hand in hand with the consumer-centric design that is enabled by the DD Framework. One could argue that this framework is a key to balancing sustainability and affordability, as it considers function, form, quality, sustainability, and low price throughout the product development process. The findings align with the NRBV theory, which emphasises the importance of integrating environmental concerns into the corporate strategy to generate competitive advantage (Hart, 1995). IKEA's adoption of the DD Framework supports the NRBV by ensuring that environmental sustainability is integrated into the company's product development process. Additionally, taking a long-term approach, IKEA adopted recycled polyester and eventually reduced the trade-off between cost-effective performance and sustainability (Bourlakis et al., 2014), demonstrating NRBV's sustainable product stewardship.

Further, IKEA demonstrates that its approach to integrating cost-effectiveness and sustainability into its product development process is multifaceted and tightly interconnected with its material sourcing strategy. The company leverages internal standards, sustainable business strategies like

People & Planet Positive and Three Roads Forwards Strategy, and certifications to ensure that its suppliers' practices and expectations regarding cost, environmental and social sustainability (Shen et al., 2017) are aligned with the company's values and goals. Sustainable supply chain management practices, such as supplier selection (Carter & Jennings, 2004), monitoring (Emmelhainz & Adams, 1999), and joint development (Mamic, 2005) (in the case of TreeToTextile), are also employed by IKEA to support their sustainability commitments.

However, in addition to helping IKEA develop sustainable products, the open communication, collaboration, and transparency in the relationships with partners across the supply chain, assist IKEA in fulfilling its low-cost strategy. This is in line with earlier findings by Ambekar et al. (2019), who documented an increase in the prevalence of collaborative practices involving suppliers. First, the company relies on suppliers for knowledge sharing and innovation, as collaboration facilitates the exchange of ideas and expertise that could lead to new cost-efficient technology or material discovery. Second, collaborative relationships with suppliers enable IKEA to optimise its supply chain by identifying areas for improvement, reducing waste, and increasing efficiency. Third, IKEA supports suppliers to secure higher volumes, lowering the unit cost of raw materials as a result. Finally, IKEA has collaborated with suppliers and material creators on joint development projects aimed at creating new, cost-effective, and sustainable materials or technologies. By pooling their resources, expertise, and capabilities, both parties can achieve better results and reduce development costs, which ultimately leads to lower costs for IKEA. These findings confirm anterior research that has elucidated the benefits of collaboration with suppliers (Ambekar et al., 2019; Mann et al., 2014; Mentzer et al., 2001) and shows that cost efficiencies can occur as a result (Vachon & Klassen, 2008).

Overall, the identified strong relationships with external partners and actors across the supply chain, coupled with a product development strategy that combines customer-centric design and sustainability, are consistent with stakeholder management theory, which emphasises the importance of considering various stakeholder interests in corporate decision-making (Freeman, 2010). While the findings complement the identified growing pressure that legislators (Salo et al., 2020) exert on companies to adopt sustainable practices, companies such as IKEA experience difficulties due to the lack of supporting infrastructure for activities such as recycling —a

contribution that firms expect from governments. IKEA's case also shows that for its customers sustainability is not a top priority (Han et al., 2017), which adds to the tension between maintaining low cost and being fast in implementing sustainable materials in their products. Further, similar to what has been suggested by Villena and Gioia (2018), IKEA mainly collaborates with tier-one suppliers, who are consulted on material recommendations and is more likely to engage in inter-firm collaboration with material innovators at later stages in the development process (Richey & Autry, 2009), which could mean that opportunities for achieving a better balance between cost and sustainability are forgone.

Circularity was identified as a driving factor in the firm's sustainability strategy and its role has been highlighted as significant in the company's product development process. This focus on circularity aligns with the principles of the CE, which emphasises the importance of designing products and systems that maximise the utilisation of resources, minimise waste generation, and facilitate recycling and reuse (McDonough & Braungart, 2002; Stahel, 1982). In line with the suggested systemic approach in supply chain management (World Economic Forum, 2014), IKEA has been found to focus on developing circular products rather than just focusing on circular raw materials. However, it lacks reliable primary data to assess the full impact of products, which is further compromised by the current lack of take-back and recycling infrastructure. Therefore, due to the early stage of the CE, companies such as IKEA cannot accurately assess the sustainability of their products, nor can they assess the costs of circulating renewable materials back into the resource loop, adding further unknowns to the cost and sustainability equation.

6.3 Balancing Cost-Effectiveness and Sustainability: Bridging Viewpoints

When combining the perspectives above, important parallels can be drawn. One significant challenge that emerged and was faced by both the buying firm and innovators is the need for scale. While IKEA seeks innovative renewable materials to stay ahead of external pressures, it also requires large volumes to maintain cost efficiency. In contrast, material innovators often struggle to achieve the necessary scale without receiving financial support from buying firms in the pre-scale phase. Collaboration between these parties can help overcome this issue by pooling resources, sharing risks, and leveraging the buying firm's financial capabilities to support

material innovators in scaling their operations (Mentzer et al., 2001). This collaboration not only promotes the development of sustainable materials that meet the buying firm's requirements, but also fosters cost-effectiveness, ensuring that both parties benefit and gain key resources from the partnership.

Another common challenge lies in the need for data to assess sustainability on the buying firm's part and the lack of standardised certifications or appropriate ones that material innovators may require, as emphasised by Maier et al. (2016) and Wiedemann et al. (2020). Collaborative efforts can facilitate the development of shared sustainability metrics, allowing both parties to better understand and track their progress toward achieving environmental goals. Furthermore, collaboration can help promote the establishment of standardised certifications and industry benchmarks that reflect the unique requirements of renewable textile materials, ultimately fostering greater transparency and credibility in the market, which solidifies a recommendation made by European Commission et al. (2010).

Both IKEA and material innovators acknowledge the importance of partnerships with supply chain actors who share the same values and are open to collaboration. By aligning their sustainability goals and fostering open communication, these actors can better understand each other's needs and constraints, ultimately enabling them to develop mutually beneficial solutions. This collaborative approach not only strengthens the relationships between buying firms and material innovators but also drives the development of innovative and sustainable textile materials that can cater to the market's and society's demands (Ambekar et al., 2019). Overall, this approach recognizes the importance of stakeholder management, which involves identifying and responding to the needs and expectations of different stakeholder groups to achieve long-term success (Freeman, 2010).

Moreover, both parties recognise the critical role of government regulation and infrastructure in enabling them to close the loop and control the end-of-life of materials and products, highlighting the role of regulators as the main actors in the CE alongside companies (Geissdoerfer et al., 2017). Collaboration between buying firms, material innovators, and policymakers can facilitate the development of supportive regulations and policies that

encourage the adoption of sustainable materials and practices across the textile industry. Additionally, the establishment of robust infrastructure for recycling and waste management can help ensure that renewable materials are effectively integrated into a circular economy, further minimising the industry's environmental impact (McDonough & Braungart, 2002).

Finally, while the differences between IKEA's and the innovators' strategy towards balancing cost and sustainability for the end-customers are apparent, they both share a similar objective of creating value for this stakeholder group. Quality remained an objective that many innovators (companies 2, 3, 6, 7, 9) and IKEA, through the DD, aimed to provide in order to ensure competitiveness of materials and products on the market. This is consistent with the findings of other studies, such as Guide & Li (2010) and Michaud & Llerena (2011) and can help the buying and supplying firm find a common ground in what they hope to provide for the final customers.

In summary, these findings highlight the importance of collaboration between buying firms and material innovators in addressing the trade-off between cost and sustainability in the renewable textile material sourcing process. By working together to overcome common challenges such as the need for scale, data, and supportive regulations, these actors can drive the development of sustainable and cost-effective textile materials that align with the industry's long-term goals.

7. Conclusion and Outlook

This portion of the thesis outlines (7.1) concluding remarks of the study, along with both (7.2) the theoretical and (7.3) practical contributions of the thesis, while also exploring (7.4)limitations and future research opportunities.

7.1 Conclusion

The objective of this thesis was to offer a systematic account of how cost and sustainability considerations are reconciled in the sourcing of innovative renewable materials in the textile industry. The study illuminates the perspectives of both material innovators and the buying firm with the help of a theoretical framework that uses the CE as an overarching concept, followed by the RBV and its NRBV extension, and the stakeholder theory. The empirical findings shed light

on the disparities and commonalities in evaluating materials' sustainability and cost among the various innovators and the buying firm, with resulting effects on the balance between cost and sustainability.

The common issues faced by buying firms and material innovators in their efforts to achieve both sustainability and cost-effectiveness are rooted in the newness of the renewable textiles industry as a whole. Both parties share a hope for more standardised ways of acquiring and sharing sustainability data to be able to accurately assess and communicate the impact of materials even if they are unique. Material innovators are particularly burdened by the cost of acquiring certifications, as buying firms' requirements may vary; while buying firms wish for more transparency in environmental impact data sharing from the material innovators' side. Further, both groups cannot fully assess the cost or sustainability impact of materials due to the underdeveloped processes for material reintegration in the resource loop, highlighting that the CE is still in its early stages.

Having contextualised the findings under the RBV and NRBV, sustainability emerged as a standalone competitive advantage for innovators, but as an enabler of cost-effectiveness for the buying firm in the long term. In the same vein, the results showed that the ability to maintain low costs was emphasised more as a competitive advantage by the buying company, focusing on maintaining the low price value proposition to the final consumer; while innovators' put less emphasis on cost due to the impending need to achieve sustainability first.

In support of the extant literature on sustainable sourcing, we have identified the necessity for collaboration in overcoming the trade-off between cost and sustainability. From the previously documented benefits of collaboration, both innovators and the buying firm would benefit from sharing knowledge, sustainability information, costs, and risks. This would accelerate renewable material development and shape the renewable textile industry according to both innovators' and buying firms' needs.

7.2 Theoretical Contribution

This paper makes several theoretical contributions that align with those outlined in Section 1.3. The study (1) expands the literature on sustainable sourcing in the textile industry. This paper carefully examined multiple cases from the upstream sourcing processes of materials in the early stages of development. A deeper understanding of how different ideas about the role of sustainable sourcing impact both the buyer and supplier in the sourcing process was gained. The study (2) sheds light on the critical trade-off between cost and sustainability within the context previously stated. This paper offers a fresh and innovative perspective by exploring the interplay between the two, a more nuanced understanding of how companies can effectively integrate cost and sustainability was provided. (3) This was contextualised under CE and allowed an exploration of how different aspects of CE shaped the renewable textile development and choice of renewable materials. The connection between economic and environmental problems was evaluated under this framework. (4) Finally, this thesis contributes to the literature on CE, stakeholder theory, and RBV with its NRBV extension by examining how these frameworks can be applied to understand the complexities of renewable textile material sourcing and the integration of cost-effectiveness and sustainability in textile material development.

7.3 Practical Contribution

The findings illuminated the importance of moving to CE through collaborations within the supply chain. By identifying the strategies and practices that firms employ to balance cost and sustainability in renewable material sourcing, the study can inform the development of best practices and guidelines that support the transition towards a more sustainable textile industry.

The paper’s outcome helps (5) firms adopt a circular economy approach that emphasises the use of renewable materials, as well as collaborate with suppliers to optimise the supply chain and reduce waste. Additionally, (6) the insights gained from the analysis of renewable textile materials innovators' development process can inform regulators to better develop policies and incentives that promote innovation and investment in sustainable technologies and processes.

7.4 Limitations and Further Research

While this study did not have the aim of producing statistical generalisability, it is still significant to note the small sample included within the study, both in the innovators interviewed, but also with the limitation of analysing one firm as a case company. Nevertheless, this study still aspires to promote this generalisability by encouraging further research with additional case companies, along with innovators in other geographical regions.

Additionally, this study may lack information from tier-one suppliers, which opens a window for future research to integrate the entire upstream supply chain in the analysis of renewable materials sourcing. A further study that analyses the role they play in connecting tier-two suppliers and buyers could produce interesting findings related to the cost and sustainability trade-off in the sourcing process under the CE framework.

The research field of supply chain sustainability is recognising the need to broaden the range of collaborative partners when relating to environmental issues (Ambekar et al., 2019; Mentzer et al., 2001). However, most studies have tended to focus on tier-one partners in the supply chain, rather than the entire system (Villena & Gioia, 2018). There is still a gap that needs to be filled that analyses the value chain as a whole, including non-traditional stakeholders, such as non-governmental organisations, government agencies, and academia in order to see the role that they play in creating pressure, co-creating, and interacting with the system.

Moreover, a content analysis of research on supply chain collaboration for sustainability reveals that the majority of studies focus on upstream entities, such as suppliers, while downstream entities like customers, universities, research institutes, and competitors are overlooked. However, these entities also play significant roles in promoting sustainable practices. To fill this gap, there is a need for research that examines the entire input-output sequence from raw materials to final products used by customers, including upstream supply chain collaboration with suppliers, and downstream collaboration with universities, and research institutes. Such research can provide insights that contribute to the development of sustainable practices via supplier collaboration from the input perspective (Chen, L. et al., 2017).

8. References

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9. Appendices

Appendix A. Scholar Interviews

Title	Rationale for Pre-Study Selection	Learnings
1 Interviewee - Saxion University of Applied Sciences	Eminent researcher in the textile industry. Provided theoretical knowledge, overview of the field, and potential case examples.	Knowledge about the current industry workings and future industry expectations. Raw material recommendations for further research. The use of the EU TRL.
1 Interviewee - Aalto University	Eminent researcher in the textile industry. Provided theoretical knowledge, overview of the field, and potential case examples.	Knowledge about the current industry workings and legislative expectations. Raw material recommendations for further research. The use of the EU TRL.
1 Interviewee - Borås University	Eminent researcher and practitioner in the textile industry. Provided industry knowledge, overview of the field, and potential case examples.	Knowledge about the current industry workings and future industry expectations.
1 Interviewee - L'École nationale supérieure des Arts Décoratifs	Eminent research in the textile industry. Provided theoretical knowledge, overview of the field, and potential case examples.	Knowledge about the current industry workings and future industry expectations. Bacteria based innovations as raw material recommendations.
1 Interviewee - York University	Eminent research in the textile industry. Provided theoretical knowledge, overview of the field, and potential case examples.	Knowledge about current industry workings and future industry expectations. Bacteria and cellulose based innovations. Raw material recommendations for further research.

		The use of LCA.

Appendix B. Practitioner Interviews

Practitioner Title	Rationale for Pre-Study Selection	Learnings
1 Interviewee - Sustainable Textile Consultant	Eminent practitioner in the industry. Provided industry knowledge, overview of the field, and potential case examples.	Knowledge about the current industry workings and future industry expectations. Raw material recommendations for further research. The use of LCA Relevance of tenacity in new materials.
1 Interviewee - Circular Economy Consultant	Eminent practitioner in the industry. Provided industry knowledge, overview of the field, and potential case examples.	Knowledge about the current industry workings and future industry expectations. Raw material recommendations for further research. The lack of uniform definitions in the industry.
1 Interviewee - Renewable Textile Consultant	Eminent practitioner in the industry. Provided industry knowledge, overview of the field, and potential case examples.	Knowledge about the past and current industry workings, along with future industry expectations. Incubator recommendations for further research. The use of the Higg Index for internal metrics.

Appendix C. Pre-Study Interview Guide

Intro:

- Introduction to master's thesis
- All answers will be confidential
- The thesis will later be published on the Stockholm School of Economics website
- We will handle data processing
- Approval for recording

Interview

1. Please tell us about yourself and your job
2. What are the current trends and developments in the renewable textile industry within the last year or two?
3. What are the most promising emerging technologies in this field?
4. What do you see as the future of renewable textiles, within the next five years?
5. How is the renewable textile industry addressing issues of sustainability and cost competitiveness with conventional textiles?
6. What metrics and indicators are being used to evaluate the readiness of renewable textiles for widespread adoption and implementation?
7. How is the sustainability and environmental impact of renewable textiles being measured and assessed?
8. Where do you see these technologies coming from?

Concluding

- Is there anything that we have missed that you want to add?
- Do you have any questions for us?
- Thanking for time

Appendix D. Innovator Cases

Case Number	Material	Textile	TRL	End of life	Cost	Interviewee/s	Date	Location	Format	Length
1	Ionic liquid dissolved cellulose	Nonwoven textile	6	Recyclable 2-4 times	On-par with traditional counterparts	Lead Researcher	2023-02-16	Finland	Email	-
2	Biobased Polymer Membranes	Membrane fabric	6	Biodegradable	Premium Prices	Head of Development	2023-02-16	Switzerland	Microsoft Teams	30 minutes
3	Bacterial Nano-cellulose and food waste	Leather	5	Biodegradable	On-par with traditional counterparts	CEO	2023-02-17	Hungary	Microsoft Teams	26 minutes
4	Finola Hemp fibre	Nonwoven Textile	4	Recyclable, Biodegradable	On-par with traditional counterparts	Lead Researcher	2023-02-27	Sweden	Microsoft Teams	35 minutes
5	Pineapple Leaf	Yarn	7	Recyclable, Biodegradable	Premium Prices	Product Manager & Communications Manager	2023-02-28	UK	Microsoft Teams	28 minutes
6	Wood cellulose	Nonwoven Textile	5	Recyclable	On-par with traditional counterparts	Lead Researcher & CEO	2023-03-07	Finland	Microsoft Teams	26 minutes
7	Nettle Fiber	Nonwoven Textile	4	Biodegradable	Premium Prices	Strategic Director & CEO	2023-03-14	Switzerland	Microsoft Teams	38 minutes
8	Cattails	Down	3	Biodegradable	Premium Prices	Strategist	2023-03-16	Finland	Microsoft Teams	31 minutes
9	Cattails	Down	4	Biodegradable	Competitive Prices	CEO	2023-03-20	UK	Microsoft Teams	32 minutes

Appendix E. Innovator Interview Guide

Intro:

- Introduction to master's thesis
- All answers will be confidential
- The thesis will later be published on the Stockholm School of Economics website
- We will handle data processing
- Approval for recording

Theme 1: Introductory Phase

1. Can you tell us about yourself?
2. Can you tell us about your material innovation?

Theme 2: Raw Material

3. What raw materials go into the textile/material that you are developing?
    a. How much of this material is available?
4. What does end-of-life for this material look like?

Theme 3: Sustainability

5. Why is this material sustainable?
6. How do you assess sustainability? Tools/frameworks/certifications

Theme 4: Technology Readiness

7. At what stage of development is your material?
8. Where do you see this material in five years?

Theme 5: Cost Effectiveness

9. Compared to other renewable materials that you are aware of, how would you position your product in terms of cost?
    a. How do you see this developing with economies of scale?
10. In an ideal world given this specific material, to what extent can it be scaled?

Theme 6: Co-Creation

11. To what extent is co-creation integrated in your development process

Concluding

- Is there anything that we have missed that you want to add?

- Do you have any questions for us?
- Thanking for time

Appendix F. IKEA Interviews

Job Title	Team	Date	Location	Format	Length
Cotton Development Manager	Cotton Development	2023-02-22	Sweden	Microsoft Teams	25 minutes
Range and Product Design Leader	Range Design Team	2023-02-24	Sweden	Microsoft Teams	50 minutes
Research & Development Project Manager	Innovation Ventures	2023-02-27	Sweden	Microsoft Teams	31 minutes
Category Manager (Tree to Textile Board Member)	Textile Products	2023-03-01	Sweden	Microsoft Teams	25 minutes
Range Strategist	Colour, Materials, and Finishes	2023-03-09	Sweden	Microsoft Teams	25 minutes
Material and Innovation Manager	Material and Innovation Team	2023-03-09	Sweden	In Person	27 minutes
Category Manager	Fabrics and Covers	2023-03-09	Sweden	In Person	21 minutes
Material Creator	Leather & Skins	2023-03-17	China	Microsoft Teams	45 minutes
Material & Innovation Developer	Material and Innovation Team	2023-03-17	Sweden	Microsoft Teams	45 minutes
Material Creator	Down & Recycled Polyester	2023-03-17	China	Microsoft Teams	37 minutes
Category Manager	Filling Products	2023-03-22	Sweden	Microsoft Teams	30 minutes

Sustainability Manager	Textile Furnishing Category Area	2023-03-27	Sweden	Microsoft Teams	24 minutes

Appendix G. IKEA Individual Interview Guide Example

Intro:

- Introduction to master's thesis
- All answers will be confidential
- The thesis will later be published on the Stockholm School of Economics website
- We will handle data processing
- Approval for recording

Theme 1: Introductory Phase

1. Can you tell us about yourself?
2. Can you tell us about your role at IKEA?

Theme 2: Material

3. What is IKEA's long-term strategy for your material?
4. How is the sustainability and environmental **impact** of this material being **measured** and assessed?
5. What do you view as the end of life for products in this range?
6. What materials could replace this material in the future?
7. How do you address the issues of cost competitiveness with emerging solutions?

Theme : Supplier and Material Selection

8. What role do you play in the process of selecting new materials?
9. Could you describe the process of selecting new material suppliers?
10. How are strategic partnerships developed with suppliers, particularly early stage innovations?

Theme : Balancing Cost Effectiveness and Sustainability

11. Could you describe IKEA's take on the balance between cost-effectiveness and sustainability?
12. What are the difficulties faced with this balance and how are they tackled?
13. What are your expectations with suppliers to maintain this balance?
14. How could the relationship with suppliers/innovators be improved to reduce the trade-off?

Concluding

- Is there anything that we have missed that you want to add?

- Do you have any questions for us?
- Thanking for time

Appendix H. IKEA Group Interview Outline

Intro:

- Introduction to master's thesis and research questions
- All answers will be confidential
- The thesis will later be published on the Stockholm School of Economics website
- We will handle data processing

Presentation:

- Nine emerging renewable materials presented
- Nine points displayed for each material (raw material, environmental impact, social responsibility, sustainability certification, end of life, TRL level, production efficiency, cost and pricing, stakeholder engagement)

Questions for Each Slide:

1. Is this a material you would be interested in?
2. What are your initial thoughts when you see the information presented on this slide?
3. What are the challenges you see with integrating this material?
4. How significant is the price of this material to your decision to source it?
5. Do you see these sustainability metrics aligning with your own?

Concluding Questions:

1. Can you describe your role in the process of sourcing innovative renewable materials?
2. What metrics and indicators are you using to research emerging materials?
3. What challenges do you encounter in this process?
4. What are important criteria for you when sourcing new materials?
5. How are you collaborating with other stakeholders in the textile industry to address the trade-off between cost and sustainability in renewable material sourcing, and what opportunities exist for further collaboration?
6. To what extent can cost be driven down with your scale?
7. Is there anything else you would like to add?

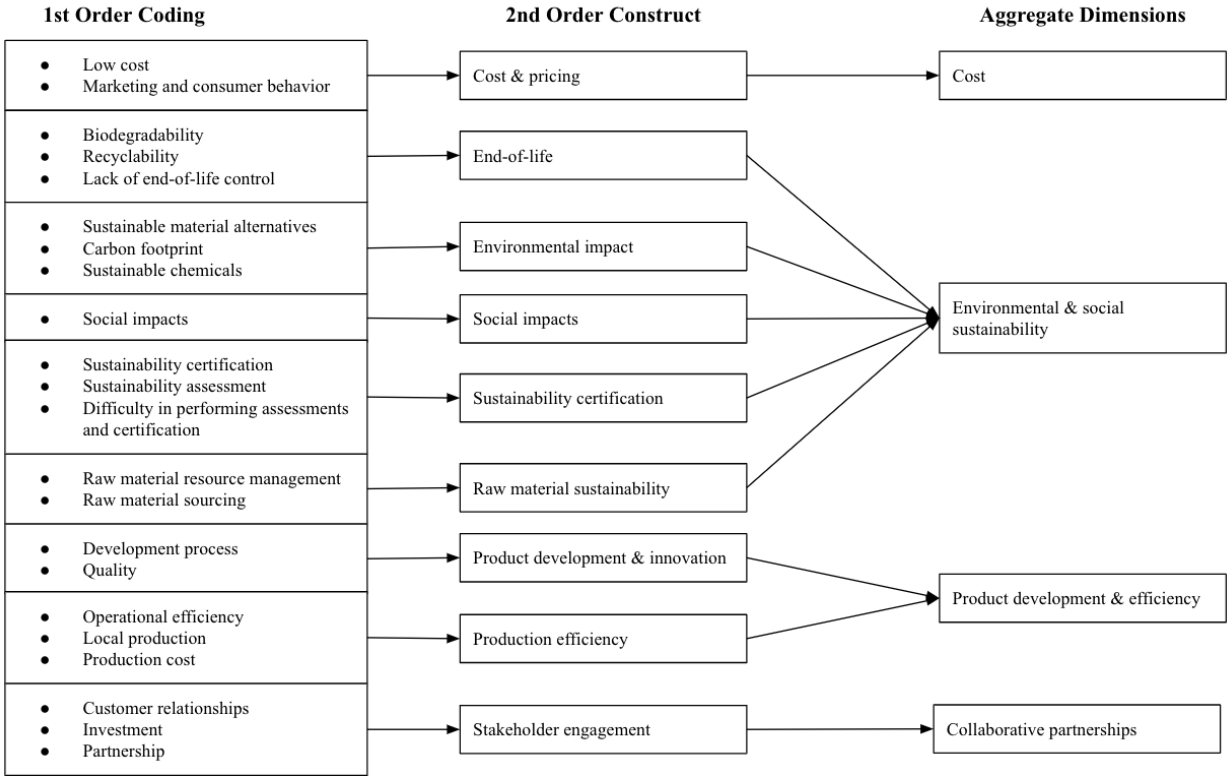
Appendix I. Innovator Construct Mapping

1st Order Coding	Company 1	Company 2	Company 3	Company 4	Company 5	Company 6	Company 7	Company 8	Company 9	
Low cost	x		x			x			x	4
Marketing & consumer behaviour		x	x		x		x			5
Biodegradability		x	x	x	x	x		x	x	7
Recyclability	x	x		x	x				x	5
Lack of end-of-life control		x			x	x			x	4
Sustainable material alternatives	x	x	x	x	x	x	x	x	x	9
Carbon footprint	x	x	x	x	x	x	x	x	x	9
Sustainable chemicals		x	x	x	x	x				5
Social sustainability				x	x	x	x		x	5
Sustainability certification					x		x		x	3
Sustainability assessment			x		x	x		x	x	5
Difficulty in performing assessments & certification		x				x			x	3
Raw material resource management	x		x	x	x	x	x	x	x	8
Raw material sourcing	x		x	x	x	x	x	x	x	8
Development process		x	x	x	x		x	x	x	7
Quality		x	x			x	x		x	5
Operational efficiency		x	x	x		x			x	5
Local production		x		x		x	x			4
Production cost		x	x	x		x	x	x	x	7
Customer relationships		x			x		x	x	x	5
Investment	x	x	x				x		x	5
Partnership		x	x	x		x	x	x	x	7
	6	16	15	13	14	16	14	10	19	

Appendix J. Firm Construct Mapping

1st Order Coding	Cotton Development Manager	Range and Product Design Leader	Research & Development Project Manager 3	Category Manager 1	Range Strategist	Material and Innovation Manager	Category Manager 2	Material Creator 1	Material & Innovation Developer	Material Creator 2	Category Manager 3	Sustainability Manager	
"For the many"		x		x		x			x			x	5
Industry Leader				x		x	x	x	x		x		6
Strategic direction			x		x			x			x	x	5
Solution diversity			x	x			x		x			x	5
Consumer priorities		x	x		x	x			x	x	x	x	8
Consumer budget		x		x		x			x		x		5
Regulatory landscape	x				x	x				x	x		5
External network support	x		x	x		x				x	x	x	7
Supplier values	x		x	x				x	x				5
Supplier partnership on material innovation and development	x	x	x	x		x	x		x	x	x	x	10
Value supplier relationship	x	x	x	x		x	x	x		x	x	x	10
Traceability from supplier	x	x					x	x		x			5
Pilot at small level then scale	x		x	x		x					x		5
Large scale requirement	x		x	x	x	x			x	x	x	x	9
Company scale is an advantage			x			x	x				x	x	5
Cost-conscious	x	x		x					x	x	x	x	7
Social sustainability	x						x	x		x		x	5
Sustainable certifications	x					x				x		x	4
Environmental indicators	x			x	x		x	x	x	x	x	x	9
Internal standards	x	x	x	x	x	x	x			x		x	9
Product circularity	x			x	x	x		x			x		6
Renewable materials					x		x	x		x	x	x	6
Recyclable materials	x	x		x	x	x	x	x		x	x	x	10
Challenges in balancing cost and sustainability		x		x	x	x				x			5
Adapt material development to lower costs if more sustainable				x	x	x	x			x	x		6
Democratic design		x		x	x	x	x	x	x	x	x		9
	15	11	11	18	12	18	13	11	11	17	18	16	

Appendix K. Innovator Dimension Aggregation



Appendix L. Firm Dimension Aggregation