

Supplier-customer relationships for sustainability-led innovation in the textile industry

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Abstract

Purpose – This paper aims to investigate sustainability-led innovation, focusing on the interplay between product and process innovation for sustainability goals and the underlying supplier–customer relationships. Thus, the paper delves into sustainability-led innovation and how it affects supplier–customer relationships, and vice versa, thus providing a twofold perspective.

Design/methodology/approach – The textile industry is the empirical context of this study, which is exploratory research based on in-depth, semi-structured interviews with entrepreneurs, managers and experts in the textile industry.

Findings – In the textile industry, sustainability-led product innovation concerns mainly product durability and performance, product recyclability and the use of waste for new product development. Process innovation deals with circular economy, traceability and water and chemical use minimization. The paper also shows how sustainability-led innovation is implemented in more technical terms and regarding supplier–customer relationships.

Originality/value – The paper adopts an original perspective on how processes take place in the relationships between suppliers and customers, where there is no dominance of one actor, but innovation emerges from interdependence and interaction. Such perspective allows to provide an in-depth analysis of the supplier–customer relationships and underlying dynamics that affect sustainability-led innovation; moreover, the authors study how such innovation impacts supplier–customer relationships and the underlying relational dynamics. The value of the paper also stands in delivering a real representation of the innovation processes grounded in the textile industry.

Keywords Supplier–customer relationship, Innovation, Sustainability, Case analysis, Textile industry

Paper type Research paper

1. Introduction

The aim of the paper is to investigate sustainability-led innovation, focusing on the interplay between product and process innovation for sustainability goals and the underlying supplier–customer relationships. More specifically, the paper delves into sustainability-led innovation and how it affects supplier–customer relationships, and vice versa, thus providing a twofold perspective.

Innovation has always been an underlying principle of the market context, and nowadays, with increasingly uncertain and volatile markets, innovation is fundamental to support the continuous process of generating value and competitive advantage (Petricevic and Teece, 2019). The innovation process has been generally and extensively studied to outline the motivations that drive innovation, the activities that

implement it and how it can be managed at the company level (Lee and Qualls, 2010; Chesbrough, 2006). More recently, it has also been acknowledged that innovation is strongly linked to and positively affects sustainability (Kuzma *et al.*, 2020). The latter is considered another major driver of business growth and change, with companies developing approaches to innovation management required to face the growing pressures and emerging opportunities linked to sustainability issues (Seebode *et al.*, 2012). Sustainability and innovation turn out to be two aspects that nowadays go hand in hand, so innovation is often pursued to achieve sustainability-related goals (Keränen *et al.*, 2023). Thus,

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the choice of linking the concept of innovation with that of sustainability in the present study seems even more appropriate at a time when there is a greater focus on and call for sustainability than ever before (Du *et al.*, 2022).

Another relevant issue related to innovation is the role played by the supplier–customer relationships that can be a strategic source of innovation. In the past decades, extant business marketing and innovation literature has underlined how innovation is connected to interactive processes and networking (Fliaster and Kolloch, 2017; Chesbrough, 2006; Andersson and Mattsson, 2015; Håkansson, 1987).

There has already been a sharp increase in publications in the business marketing literature reflecting on sustainability in business-to-business (B2B) markets (Huang and Rust, 2022), and there is an open discussion on how sustainability, understood according to the triple bottom line principle – referring to environmental, social and economic sustainability – can be embedded in various business-to-business activities to achieve efficiency and, at the same time, sustainable goals (Melander and Arvidsson, 2021). However, there is still a need to explore at a micro level and in a grounded and empirical way how sustainability-led innovation occurs and the role of supplier–customer relationships. Starting from this background, this paper develops a micro-processes analysis entering into a detailed study of the link between customer–supplier relationships and innovation. We adopt the Industrial Marketing and Purchasing (IMP) perspective to investigate the relational dynamics affecting (and affected by) sustainability-led innovation. Relational dynamics have been widely investigated by IMP scholars and can be defined as “all the changes that originate on a relationship level between counterparts, which, in turn, can influence the larger business network in which at least one counterpart is embedded” (Runfola *et al.*, 2023, p. 146). The paper addresses the following research questions:

- RQ1. How does sustainability-led innovation affect supplier–customer relationships in terms of emerging relational dynamics?
- RQ2. How do supplier–customer relationships generate sustainability-led innovation?

For this study, we consider the textile industry as the empirical context. The textile industry has been a rapidly evolving industry in the past decades and, after years of traditional production methods, has faced a profoundly changed market in which previous norms have given way to new market dynamics and innovation processes (Dissanayake and Sinha, 2015). In a rapidly changing environment, the traditional nature of the textile industry seems to be experiencing a moment of weakness in which companies must question boundaries, practices and market strategies. The craftsmanship of the product, typical of Italy, can no longer withstand competition from other textile industries, such as those of excellence in Germany, where the focus is on technological innovation and technical textiles, or from low-cost Eastern countries (Fromhold-Eisebith *et al.*, 2021). Innovation appears to be an essential element for this industry, aimed at balancing craftsmanship with innovative products and processes that meet customers’ needs for more sustainable and adaptable solutions (de Oliveira Neto *et al.*, 2019). The increasing demand for sustainability in the textile

industry (Guercini and Ranfagni, 2013) is due to its highly polluting nature (Roy *et al.*, 2020), with large quantities of water and chemical components used during the production phases. Moreover, in the textile industry, companies are linked together by a dense network of relationships, which represent a fertile ground where to investigate the relational dynamics put in place to develop sustainability-led innovation activities (Runfola *et al.*, 2021).

The paper is exploratory in nature and reports on the results of in-depth, semi-structured interviews with entrepreneurs, managers and experts in the textile industry. The paper is structured as follows: Section 2 reports on the literature background; Section 3 is dedicated to introducing the method adopted in the study and the empirical context of the analysis, the textile industry; Section 4 is devoted to the outcomes of the research; the paper ends with the conclusions reached in this study, implications and suggestions for further research.

2. Literature background

2.1 Innovation in supplier–customer relationships

In this study, our primary focus is on the role played by supplier–customer relationships as a strategic source of innovation. When addressing the issue of innovation within the realm of business activities, various perspectives have emerged. Among these perspectives, industrial economics offers insights into different industries based on their approach to innovation. Specifically, Pavitt (1984) distinguishes between supplier-dominated, production-intensive and science-based industries. Supplier-dominated industries are those in which innovation within companies is primarily driven by suppliers or other actors higher up in the value chain. Von Hippel (1986) examines cases of lead users steering innovation and considers suppliers as potential sources of innovation for companies. Teece (1986) underscores how the success of an innovator hinges on complementary resources that a company can access through its inter-organizational relationships with other actors, including both suppliers and customers.

Another significant contribution arises from the open innovation approach, which marks a definitive shift away from viewing innovation as solely an internal process within a company (Chesbrough, 2006). Open innovation represents the convergence point for new innovative ideas that occur at an ecosystem level, transcending the confines of a company’s internal processes (West *et al.*, 2014). Within the realm of managerial literature, the involvement of customers and suppliers in innovation is widely acknowledged. Notable examples include research in new product development and supply chain management, which has significantly contributed to the analysis of the conditions under which suppliers and consumers can effectively and efficiently participate in a company’s innovation process (Keränen *et al.*, 2023; Vesal *et al.*, 2022). This extensive body of literature spans several decades, with its focus on elements such as knowledge sharing, power dynamics and collaboration (Desouza *et al.*, 2008; Mahr *et al.*, 2014; Petersen *et al.*, 2005; Pihlajamaa *et al.*, 2019; Wagner, 2012). Scholars underline how inter-firm relationships are a critical element of success for the appropriate development and implementation of innovation (Noordhoff *et al.*, 2011; Uzzi, 1997). As Inkpen and Tsang (2005) point out, inter-organizational collaboration offers

companies the opportunity to facilitate knowledge-sharing and learning processes among actors.

The literature deals extensively with product-related innovation, that is, the generation of a new type of product with new features and applications (Badrinarayanan and Arnett, 2008). Such innovations, for most authors, are based on the sharing of resources and expertise by actors involved in the same interaction context (Cantù *et al.*, 2012; Kaartemo and Nyström, 2021). However, relatively limited attention is given to process innovation. It is important to recognize that process innovation is an essential variable in the context of product innovation (Aliasghar *et al.*, 2019; Pihlajamaa *et al.*, 2019; Pieroni *et al.*, 2019). Very often, alongside product innovation, there necessarily occurs process innovation that enables the realization of the final product (Aliasghar *et al.*, 2019; Shamsuddoha and Woodside, 2022). We define process innovation using the words of the Organization for Economic Co-operation and Development, whereby “process innovation consists of the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software”.

From an inter-organizational perspective, process innovation results from the collaboration between actors who constantly interface in the activities implemented daily (Athaide *et al.*, 2018; Brown *et al.*, 2019; Choi *et al.*, 2010; Cantù *et al.*, 2012). A fundamental micro-founded approach and analysis of the dynamics of supplier–customer relationships for innovation are given by scholars in the field of business marketing. Håkansson (1987) offered a sound empirical set of studies proving how industrial technological development is founded on supplier–customer relationships. IMP literature has been developing interpretive models and conceptualizations for decades; these developments may be relevant to our purpose (Håkansson and Snehota, 2017; Snehota and Hakansson, 1995; Waluszewski *et al.*, 2004). For instance, research has shown how companies cooperate to build innovation (Håkansson, 1987), and more recently, studies have concentrated on the development of interactive resources in many contexts (Håkansson and Waluszewski, 2002; Lind, 2015; Prenekert *et al.*, 2022).

The literature on innovation within networks has extensively explored the innovation process, seeking to identify the driving forces behind it, the activities that facilitate its execution, and methods for controlling it at the business level (Lee and Qualls, 2010; Woodside and Biemans, 2005; Dahlquist, 2021). In the context of innovation within business networks, this body of work reveals that relationships encompass more than just the exchange of goods and services; they serve as prerequisites for the exchange of capabilities and competencies that enhance a business's capacity to create additional value (Håkansson and Snehota, 2017). It is crucial to acknowledge that for these exchanges of resources and skills to effectively yield innovation, they must be carefully managed, especially within complex network contexts. Networks, by their very nature, comprise diverse individuals with varying positions and influences, which can make management a challenging endeavour (Aarikka-Stenroos *et al.*, 2017). Despite the multitude of studies mentioned earlier, there remains a pressing need for a more comprehensive exploration of the knowledge associated with customer–supplier relationships, particularly within the realm of sustainability-led innovation. Furthermore, it is essential to

recognize that as supplier–customer relationships drive innovation, innovation itself can significantly impact these very relationships.

2.2 Sustainability-led product and process innovation

When reflecting on sustainability, it is recognized now that it represents a strong market need that inevitably influences the decision-making process and strategic choices of companies. Sustainable strategies shape the company's approach to innovation and the innovation process by making them the means of achieving corporate goals (Melandar and Arvidsson, 2022). Indeed, sustainability has become an imperative for a company's marketing strategy (Jones *et al.*, 2008) with a positive impact on a company's performance and competitiveness, so much so that sustainability awareness has generally increased (Ferro *et al.*, 2019). The innovative process that companies implement seems to be increasingly oriented towards a focus on environmental, social and governance principles and the triple bottom line (Ormazabal *et al.*, 2018).

In a production setting, the economic and environmental factors might specifically converge in circularity (Keränen *et al.*, 2023). In particular, three major activities should be understood about this latter concept: reuse, reduce and recycle (Goyal *et al.*, 2018).

Reusing and reducing can decrease waste. However, they are sometimes more challenging than merely using recycled materials because they require more energy and resources (Ranta *et al.*, 2020). Recycling is significantly simpler and uses fewer resources and energy because the majority of recyclable objects can be easily disassembled into their parts. Both justify the means to waste reduction by preventing valuable materials from being wasted or from ending up in landfills, where they will require a long time to decompose naturally (Sohal and De Vass, 2022). As a result, sustainability and circular economy are often discussed together in the literature (Melandar and Arvidsson, 2022).

Integrating circular economy principles into manufacturing operations has emerged as a viable approach for achieving sustainability objectives (Aguar and Jugend, 2022; Alonso-Muñoz *et al.*, 2021). This realization underscores the importance of adopting an innovative process, especially within the manufacturing context, to shift away from traditional production paradigms. This transition involves moving from a linear approach to a circular one, where the product not only embodies sustainability but also results from an innovative, sustainable production process (Homrich *et al.*, 2018; Alonso-Muñoz *et al.*, 2021). However, ensuring a product's sustainability should extend beyond its end-use and final outcome. It is crucial to consider a comprehensive set of activities that encompass the entire lifecycle of the product, commencing as early as the product design phase, ideally in the most environmentally responsible scenarios (Aarikka-Stenroos *et al.*, 2017). At this initial stage, it becomes evident that the interaction between sustainability and innovation concepts throughout the production process holds paramount importance.

2.3 Sustainability-led innovation in business marketing

Considering the preceding discussions, a company aiming to optimize its operations for efficiency and modernize manufacturing techniques in pursuit of sustainability goals

must contemplate the role and potential of its resources (Nguyen *et al.*, 2022). It is essential to evaluate the competencies and capabilities of these companies and gauge their adaptability to new market and environmental demands (Fraj *et al.*, 2015). To attain these objectives, these resources should be amenable to a process of amalgamation and reconfiguration to ensure their capacity for innovation. While companies may possess resources suitable for adapting to sustainability-led innovation in the short term, establishing a long-term competitive advantage rooted in sustainability-led innovation necessitates looking beyond their own confines for such capabilities (Keränen *et al.*, 2023; Cheng *et al.*, 2023). Indeed, as noted by Melander and Pazirandeh (2019), relationships with stakeholders beyond the typical contractual arrangements carry greater significance in the context of sustainable innovation compared to traditional innovation processes.

Thus, developing relationships with actors positioned within a company's network is likely to be a necessity. Moreover, it might be imperative to create new interaction linkages if specific skills and competencies are required that are currently absent within the relevant network. (Brown *et al.*, 2019; Du *et al.*, 2022; Makkonen and Johnston, 2014). In this perspective, the sustainability-led innovation process promoted by an actor must scale the supply chain by also involving other actors (Li *et al.*, 2021; Melander and Tell, 2019). Indeed, innovation can be successfully achieved through the collaboration of actors linked by continuous exchanges. Therefore, by orienting business choices towards sustainability, even relationships must take the same direction (Athaide *et al.*, 2018; Lo *et al.*, 2018; Wang *et al.*, 2020). As pointed out by Brown *et al.* (2019), customer–supplier relationships assume a relevant role when companies move towards innovation. This is because these interaction fosters trust and a predisposition for collaboration, leading to a privileged exchange of information that proves invaluable during the innovation process (Waluszewski *et al.*, 2004; Snehota and Hakansson, 1995; Jaakkola and Hakanen, 2013). Additionally, it is worth noting that as the demand for sustainability gains increasing prominence in the business landscape, sustainability becomes a prerequisite for entering certain relationships and for cultivating collaborative efforts on sustainability projects geared towards creating sustainable products (Bocken and Konietzko, 2022; Fraj *et al.*, 2013; Dahlquist, 2021). In the context of sustainability, adhering to conventional production paradigms and a linear economy approach can lead to the erosion of relationships and, consequently, a loss of competitive advantage (Melander and Pazirandeh, 2019; Charterina *et al.*, 2016). Investing in relationships, especially when multiple actors are involved, as is often the case in manufacturing industries (Keränen *et al.*, 2023), proves advantageous. This holds true whether an actor wields significant influence and holds a leading market position or if the company does not directly champion innovation (Cantù *et al.*, 2015).

Despite the existing body of literature on sustainability and the role of supplier–customer relationships, relational dynamics within the context of sustainability-led innovation have been relatively neglected within the realm of business marketing studies.

3. Research method

As sustainability-led innovation and the related relational dynamics are a complex and evolving issue, and the actors involved are closely linked to the dynamics of the context in which they operate, our study is exploratory and relies on in-depth interviews as the main method for data collection (Eisenhardt and Graebner, 2007). This methodological choice made it possible to understand directly from the target industry what it means to pursue sustainability-led innovation goals for textile companies and how these companies implement the dictates of sustainability in process and product innovation. Through the analysis of these two aspects, we were able to detect the relational dynamics between customers and suppliers for the achievement of sustainability goals through innovation, and those generated by sustainability-led innovation.

As the first step of our study, we selected the empirical context, namely, the textile industry. The reasons behind this choice are threefold: firstly, the textile industry is distinguished by the complex structure of buyer–supplier relationships that shape the business network, which represents a fertile ground to investigate the various dynamics put in place to carry out sustainability-led innovation (Guercini and Milanesi, 2019). Secondly, the industry has been progressively moving towards the pursuit of sustainability goals that now appear to be an acquired and imperative priority to successfully compete in global markets (Shen and Li, 2017; Shen *et al.*, 2017; Akrou and Guercini, 2022). Thirdly, it is an industry that is hardly impacted by changes at the global level, and this can be relevant for companies that are constantly exposed to any change and trends at the international level (Barnes, 2013).

3.1 Selection of the respondents

After the selection of the empirical context for our study, we selected the experts to be included in the study. Experts were purposely selected (convenience sampling), with each respondent who had actively participated in sustainability-led innovation projects, thus providing an insider perspective and useful insights for this study (see Table 1 for details about the experts). The selection of respondents was conducted by targeting business representatives and industry experts in the context of traditional textiles, technical textiles and institutional organizations. Regarding the latter, we specifically considered the industry associations that group the actors operating in the textile industry, to obtain cross-company information, since their activity is carried out at the whole industry level and not only at the company level. Regarding industry experts, they were targeted to obtain insight into the sustainability-led innovation projects implemented. The experts were selected from the technical textile industry and the traditional textile industry; within the former, we considered experts belonging to companies that develop products – historically having an industrial application – for which the focus is placed on the performance of the fabric rather than on its aesthetic content. Within the latter, we considered the production of fabrics in which the aesthetic component leads the way over the technical performance-related function. This dual focus within the industry has served to emphasize points of intersection and potential best practices in the strategies and activities of these

Table 1 Respondents and interviews

Industry and number of companies	Type of companies	Role of respondent/number of respondents	Number of interviews	Duration (/min)
Institutional associations (3)	- Textile association - Consortium	- President (1) - Director (2)	3	194
Traditional textile (9)	- Manufacturer of wool yarns - Manufacturer of fabrics - Manufacturer of furnishing fabrics	- CEO (6), - Director (1), Sustainability Manager (2)	9	587
Technical textile (7)	- Certification agency - Manufacturer of high-tech fibres/yarns/fabrics - R&D and services - Textile machinery	- CEO (2), - Director (1), - Product director (2) - Manager (2)	7	411
TOTAL			19	1,192 (20 hrs.)

Source: Authors' own work

two industries (technical textile and traditional textile), both of which are directed towards achieving process and product innovation aligned with sustainability objectives. In addition, we have chosen respondents from companies at various levels of the textile chain (e.g. producers of yarns and fabrics) to take into account supplier–customer relationships.

3.2 Data collection and analysis

We then proceeded with data collection using in-depth interviews (Legard *et al.*, 2003). Specifically, the experts were asked questions on different levels of depth. The interview guide was composed of three parts. In the first part of the interview, the experts were asked to highlight trends that are and will be characterizing the textile industry, with a strong focus on sustainability issues. Specifically, respondents were asked to explain how sustainability has changed the behaviour and activities of textile companies, and the main dimensions of sustainability most addressed by companies. The second part of the interview concerned the propensity to innovation and innovative activities of companies operating in the industry. In particular, the experts presented and discussed in detail specific product and/or process innovation projects – in which they have taken part – that have been developed to achieve sustainability goals. Finally, the third part of the interview raised the question of understanding the relational dynamics enacted in the network that contributed to the effective achievement of sustainability-led innovations. The experts were asked about the main suppliers/customers involved in the abovementioned product and/or process innovation projects, not only how the existing relationships affected/stimulated sustainability-led innovation projects but also how the latter generated changes in the company's relationships.

The interviews started in December 2021 and continued until June 2022. The interviews lasted from 50 to 90 min, for a total of almost 20h, and were recorded and transcribed in a Word file of about 20,000 words of transcripts for content analysis, conducted by all the research team members. The transcripts were analysed without the use of software, using the qualitative content analysis method (Forman and Damschroder, 2007). Data analysis followed a subjective interpretation of transcripts with written synthesis and systematizations of recurrent topics. The analysis was carried

out individually by each member of the research team, results were then compared through a discussion of the individual views, aimed at verifying that the interpretations were consistent with the words of the respondents, without distortion. During the discussion, we verified the degree of convergence on the main topics emerging from the interviews. This interpretative endeavour led to the creation of shared categories (recurring topics) and the related relevant quotes concerning sustainable thinking in the textile industry according to the respondents and their experience in the implementation of sustainability-led product and process innovation, and what happened at the relational level.

4. Findings

We now report the findings emerging from the interviews. Firstly, we outline sustainability-led innovation in the textile industry, with a focus on both product and process innovation; secondly, we present how sustainability-led innovation is implemented, discussing in more technical terms how this occurs to get more sustainable products and processes and the underlying supplier–customer relationships. In the final section, we will discuss the implications that such findings have on supplier–customer relationships.

4.1 Sustainable thinking among respondents

In this section, the focus is on sustainability-led innovation in the textile industry from the perspective of the respondents (R1...R20 from now on) that consider sustainability as a relevant principle to be part of product and process innovation. The respondents generally agree with the assumption that sustainability in the textile context is an important variable in defining company choices and strategies. Indeed, many respondents think that, as clearly stated by R5:

[...] textile industry is a highly polluting sector, hence, in responding to the increased need from business customers to use more sustainable fabrics, textile companies must develop new products and new production process that includes sustainability principles in them as circular processes and new fully sustainable fabrics.

Furthermore, sustainability has become a manifestation of the growing importance placed by consumers on the impacts of production activities. In addition to evaluating product quality when making choices, today's consumers also exhibit a keen

concern for environmental considerations and the sustainability practices and behaviour of companies. These factors are fundamental pillars of a company's reputation.

Sustainability has to do with both product and process innovation, which often cannot be separated. Indeed, R12, during the interview, stated that: "you can no longer produce a sustainable product if the production processes are sustainable managed" meaning that developing sustainable processes is a prerequisite for developing new and sustainable products. Regarding product innovation, as revealed through interviews with respondents, reimagining products for sustainability involves addressing three key facets: product durability and performance, product recyclability, and the creation of new products derived from waste materials. The respondents demonstrated a consensus on these aspects of product innovation.

In the context of durability, sustainability is achieved by developing products that simultaneously extend the fabric's lifespan while delivering performance tailored to the needs of customers. Traditionally, the market trend favoured the creation of exceptionally robust fabrics, often at the expense of yarn lightness and flexibility. However, the current challenge is to produce enduring products that also exhibit performance attributes that enhance fabric flexibility and reduce overall weight. In this sense, R1 said: "Changing lifestyles, climate and work habits are making the need prevail for manufacturing brands to use lighter fibers but at the same time maintain comfort, durability and sustainability characteristics". As a matter of fact, finding lighter fabrics that nonetheless have comfort, durability and sustainability features is becoming a greater issue for manufacturers. To match the demands of contemporary consumers, brands have been driven to modify their production processes due to shifting lifestyles, climatic conditions and work habits. In this sense, R2 proposed an objection that found agreement from several interviewed managers:

[...] an increasing amount of people no longer go to work during winter by foot, they rather use transports which protect them from the rigid weather. Moreover, they wear them more casually and the silks ties – as an example – are no longer used in many business contexts, meaning that products must be tailored according to new customer needs, and textiles should be lighter and performant rather than complexly woven.

Manufacturers must embrace innovative technologies such as advanced weaving techniques and synthetic materials to strike the delicate balance between lightweight design and product longevity. These technologies enable the creation of products that are both lightweight and durable, meeting the demands of consumers for comfort and environmental friendliness. By investing in these cutting-edge materials, brands can align themselves with consumer preferences and maintain their competitiveness in an ever-evolving industry.

Regarding product recyclability, product innovation for sustainability means intervening in product characteristics so that they can be the input for circular economies. As pointed out by R6: "Our goal is the development of a product whose waste can be reused in the production process, thus giving rise to circular economy processes and the treatment of waste". From this perspective, the integration of sustainability into yarns and textiles entails a reimagining of the product, beginning with its design, to incorporate sustainability principles aligned with the concept of circular economies. This approach necessitates that

the product, apart from featuring traceable raw materials upstream, which are linked to production quality and transparency, should also be reconceptualized in terms of its weaving, blending of materials and overall composition. By prioritizing high-quality raw materials and meticulous attention to fibre composition, the resulting fabric can be repurposed into other products with new characteristics, thereby contributing to a sustainable cycle of reuse and reducing waste.

As for the issue of waste, respondents underline that textile production is generally characterized by a lot of production waste – examples are residuals fabrics and leftover filaments in spools – which used to be only a negative item on companies' balance sheets; hence, the companies' goal is to create new target markets to which they can resell the waste that would have to be disposed of. Indeed, R15 stated that:

[...] waste handling is a great opportunity for the textile sector in terms of revenues, new business relationships and sustainable practices. It is not an easy task, but by leveraging on new relationships with actors in other production fields, such as the automotive industry, we are now able to prepare our wastes for other uses that before this sustainability trend were impossible to think of.

Recycling and reuse emerge as significant considerations even within the realm of process innovation. Once again, there is a unanimous consensus among the respondents regarding key facets of sustainability-led process innovation: the importance of circular processes, stringent traceability requirements and the minimization of the use of environmentally harmful resources and water. It is imperative to develop processes that enable companies to establish production cycles that are as circular as possible. The market needs to shift away from the traditional linear economic model towards a circular one, where the impact of production is minimized, especially concerning the reuse of production waste, either by reintegrating it into production steps or preparing it for use in other supply chains.

Furthermore, there is an escalating emphasis on traceability concerning the raw materials used in production, which has become a pivotal factor in acquiring product certifications. For companies in the textile supply chain, traceability translates to the ability to readily access comprehensive product information, and it has become a critical factor in the product selection process. As stated by R5, traceability requires:

[...] skills from the IT and engineering that have to be developed with specialized suppliers, and it is possible to identify the fabric through special machines that scan the fabric with inside microparticles of pigment different from the colour of the fabric, so that it is possible to understand who the product of the fabric is. It's interesting also for the supplier-customer relationship to have not only a traceability of the product but also a higher level of transparency.

Companies are progressively seeking detailed information about various stages of the production process, particularly those tied to the sourcing of raw materials. These raw materials must originate from certified companies that meet rigorous sustainability standards. Consequently, traceability serves as a fundamental principle, serving the interests of both companies within the textile supply chain and as a means of fostering customer trust. Concerning raw material consumption, sustainability mandates a production system that minimizes the utilization of scarce resources and the application of polluting compounds, such as chemical additives used in yarn dyeing processes.

4.2 Implementing sustainability-led innovation

The respondents delved into the practical implementation – and underlying relationships – of sustainability principles. In line with these principles, companies commit to innovation to translate them into tangible aspects of both products and production processes. Regarding the product dimension, companies undertake the development of novel types of yarns, aiming to create innovative fabrics with prolonged durability and sustained high performance. The realization of these products stems from robust collaborations with companies operating in the chemical industry. This is the case told by R2, that works in a company whose main business is the production of woollen fibre fabrics such as cashmere:

We have undertaken a development project with a supplier from the chemistry industry, whereby the fabric is made lighter, but combined, to increase durability, with sustainable fibers, which therefore do not go to the detriment of the recyclability of the product to increase the performance that would be reduced due to the lighter fibers used.

These novel blends and fibres sometimes serve as direct substitutes for traditional fabric types. In other instances, the collaboration between these two industries yields new weaving techniques that enhance fabric or filament performance. Through partnerships with the chemical industry, new methods are developed to replace synthetic polymers with natural polymers. These alternatives offer equivalent fabric performance without the use of chemical materials derived from the synthesis of fossil resources.

From the perspective of creating products that can be seamlessly reintegrated into upstream production processes, companies use strategies to redefine their offerings from the outset. This involves developing durable products that can be recycled with minimal economic effort, allowing the fibres to be reintroduced into the production cycle in accordance with circular economy principles. In some cases, companies intentionally redesign the compositions of their fabrics or yarns to favour mono-fibre configurations. This approach ensures that the fibres can be reintegrated into the production process without impurities resulting from the combination of chemical and natural components. An example provided by the respondents pertains to synthetic textiles, which are composed of a single type of polymer, facilitating their reintegration into earlier production stages. A relevant case in this sense was provided by R11, who works in a company focused on the recycling of polyester fibres:

[...] my company has initiated a business line that deals with the recycling of textile fibers only, by developing a collaboration with other companies that use such fibers, to incentivize the use of only one type of fiber in their textiles, so that the recycling process can take place more easily.

The goal is that the company can act as a customer, in that it buys waste or recovered fibres, and as a supplier of the same companies, thus creating a true circularity of the supplier–customer relationship.

In terms of waste management, companies are actively engaged in activities geared towards transforming waste into valuable raw materials for other industries, such as the automotive sector. In some instances, waste can even be reintegrated into the initial stages of the production process. This approach opens new market opportunities for companies, extending their reach to non-traditional customers who find value in these reclaimed raw materials.

Regarding innovations in the production process, particularly in highly progressive companies, there is a meticulous re-evaluation of individual processes and production steps. The primary objectives are to achieve process circularity, enhance traceability, and minimize the use of water and chemical compounds for fabric treatment. In pursuit of these goals, companies establish relationships with new partners who assist in various aspects, such as the treatment of production inventories. Some companies opt to outsource certain waste re-processing functions through these partnerships, allowing waste to be restored to its original state and subsequently reintegrated into production stages. Conversely, there are instances where companies internalize the recycling process, ensuring that waste from fabric inventories and production surplus is promptly reincorporated into the production cycle in the form of fibre.

In this regard, the company's CEO (R14) maintained that:

[...] at the moment, the technologies allow advanced fibers to be reprocessed so that they can have a new life in another production process. Today it is particularly easy for synthetic fibers such as those derived from fossil sources, the challenge for the company of tomorrow, is to be able to get back with characteristics almost like the original fiber.

In some cases, particularly virtuous companies create special production lines with which to set up processes for reusing discarded fabrics and recycling materials. One of the respondents, R9, provided the example of one company that initiated a project centred on recycling the very same chemical components used in the process of fabricating fibre from natural source:

[...] this has represented a large investment, thanks to the collaboration with mechanical-textile manufacturing companies, and the company has developed a completely circular production process in which residual chemical components downstream are automatically put back into the production process, thus avoiding pollution and unnecessary waste of chemical materials.

This process innovation makes it possible to create a sustainable fibre, compared to competitors in the industry, which has enabled the company to gain a leading position in the field of sustainable fibres.

Regarding traceability, there is the scrupulous implementation of digitalization within processes, which, as stated by R14, “requires new suppliers able to manage new digital technologies and help us in the implementation. Sometimes ‘old’ suppliers are not able to deal with the digital world”.

Advanced techniques have been devised to enable product traceability at every stage of production. These methods use a material that, when combined with pigmentation during fabric dyeing, creates a distinct yet invisible pattern, functioning much like a QR code to identify the fabric manufacturer. Furthermore, in terms of water usage, companies are turning to process digitalization, particularly with the advent of new machinery developed from a 4.0 perspective. These machines not only synchronize seamlessly with one another across various fabric production stages through intricate efficiency-enhancing algorithms but are also capable of significantly reducing water consumption, by up to 60% compared to current practices. Additionally, thanks to these innovative calculation tools, it is now possible to precisely determine the amount of dyeing pigment required based on the yarn's absorbency capacity. This precision ensures that after the dyeing process, the water discharged from the system is potable

and free from pollutants. One of the respondents (R7) works for a company engaged in the production of high-quality wools and yarns and underlines the role of cooperation with a dyeing machine supplier, which has led to the development of a technology that enables to read the absorbing capacity of the fabric and put into the water the exact amount of pigment that during the dyeing process will be completely absorbed by the fibre, leaving the water perfectly impurity-proof. As R7 claimed that:

[...] when some customers come to visit the production site, I usually show them the workings of the machine and amaze them with the fact that from a tap I can take water and drink it since it is free of impurities and chemical elements.

Sustainable thinking and the implementation of sustainability-led innovation are shown in Table 2.

5. Discussion

The findings underscore that the textile industry faces mounting pressure to spearhead sustainability-led innovation, encompassing both sustainable products and eco-friendly production processes aimed at mitigating environmental impact. Product innovation entails the creation of new or enhanced products that offer superior performance, quality or value to customers. Concurrently, production process innovation entails the adoption of novel or improved manufacturing methods that enhance efficiency and productivity. As a result, these innovations, such as the development of new fibres derived from renewable or recyclable materials and the reduction of water and energy consumption during production, among other initiatives, enable the textile industry to meet the growing demand for sustainable products while simultaneously curtailing its environmental footprint. The crux of these challenges lies in the interplay between suppliers and customers, underscoring the pivotal role of these relationships in driving sustainability-led innovation within the industry (Melander, 2017).

We can thus now face our research question concerning how product and process innovation for sustainability goals affect supplier–customer relationships (RQ1: how does sustainability-

led innovation affect supplier–customer relationships in terms of emerging relational dynamics?).

Sustainability-led innovation leads companies to open to new relationships with both suppliers and customers specialized in different and varied technologies and belonging to different industrial settings; in other words, it is evident that there is a trend towards an enlargement of business relationships leading to a general expansion of the network to which the company belongs (Melander and Pazirandeh, 2019). In this sense, we discovered that many of the respondents leveraged existing business relationships whenever possible to facilitate sustainability-led innovation. When existing connections were not available, they actively sought out new business partners who possessed the necessary capabilities to collaborate on sustainability-led innovation initiatives. Additionally, in terms of the size of their customer base, companies have demonstrated a willingness to expand into new potential target markets (Keränen et al., 2023). For example, the development of a new business towards the marketing of production wastes. In these aspects, companies developed new business relationships with industries far away from the usual business clients' portfolio finding actors to collaborate with for the aim of handling the waste as much correctly as possible, to use it as an alternative new production process raw material. In addition, new suppliers enter companies' portfolios because they can respect traceability requirements and deliver, compliance with certification requirements. Traceability indeed is an important suitable tool. Developing product sustainably is not enough (Dahlquist, 2021). Companies are increasingly compelled to obtain sustainability certification, which necessitates a reconsideration of their business relationships. When other business actors are unable to meet the company's demand for traceability and sustainability standards, this often requires a reconfiguration of the relationship. Empirical data further demonstrate a discerning approach to the supply side of companies. Relationships with suppliers that fail to adhere to sustainability requirements are either weakened or terminated, while new partnerships are cultivated, or existing ones are reinforced as part of the company's sustainable strategy. This selective intervention reflects a commitment to upholding sustainability principles throughout the supply chain.

Table 2 Sustainable product and process innovation in the textile industry

Sustainable thinking	Implementing sustainability
Product	
Product durability and performance	<i>Innovative fabrics</i>
Increase in durability and meet customer need of performances	Collaboration with chemical industry (new blends and new polymers)
Product recyclability	<i>Reconceptualization of the product</i>
Intervention in product characteristics to make product become input for CE	Monofibre textiles or use of only one polymer
New product development (waste)	<i>New market for production waste</i>
How wastes are handled	Becoming input for other businesses (automotive)
Process	
Circular economy	<i>Circular process development</i>
Transition from a linear to a circular process chain (waste)	Outsource reprocessing wastes or new production line with CE flows
Traceability requirements	<i>Monitoring inputs use</i>
Element of customer trust and monitoring product quality	Inventories digitalization and new monitoring tools of raw material use
Water and chemical use minimization	<i>Water and chemical use minimization</i>
	New IT tools to reduce water and pigments (clean water)

Source: Authors' own work

It is also possible to discuss how supplier–customer relationships generate sustainability-led innovation (*RQ2*). The empirical data show that sustainability-led innovation increasingly rarely develops within a single company but acquires relevance if developed by leveraging the main business relationships in which knowledge is shared and sustainable technologies and processes are implemented. Such supplier–customer relationships can foster innovation and create a supportive environment for sustainability initiatives. For instance, the respondents highlighted that in the development of sustainability-led innovation, particularly within the production process, their relationships with suppliers played a pivotal role in terms of collaboration and comprehension of the textile industry's specific requirements. One illustrative example involved a company seeking a novel textile colouring process. This company actively participated in all phases of the innovation journey, from conceptualization to testing, ultimately contributing to the creation of a new colouring tool that is now gaining widespread adoption in the market. This exemplifies how strong supplier collaborations can drive and shape sustainability-led innovations within the textile industry. Our findings also demonstrate that the content and dynamics of individual supplier–customer relationships change depending on the goals for achieving sustainability (Lind, 2015). If, in the past, the relationship was based on the exchange of information and competencies to make products that reflected the customer's needs, now the relationships take a step forward to the content. The dyadic supplier–customer relationship becomes stronger as both parties work together to achieve sustainability goals and develop innovation. On the product side, the two parties collaborate on the definition of innovative solutions that inductively trace market demands for performance and adoption of sustainability standards; then, on the process side, supplier and customer collaborate on the development of innovative processes without which the output of the production process would be only partially sustainable.

6. Conclusions

This study revealed how the textile industry conceives product and production process innovation from a sustainability perspective and proposed an overview of the activities carried on by companies to implement the principles of sustainability in the product and production processes. We show that sustainability-led innovation takes place and is developed in the textile industry within the interaction between suppliers and customers. The IMP perspective adopted in the paper allows us to discuss how innovation for sustainability goals takes place in the relationships between suppliers and customers, where there is no dominance of one actor, but innovation emerges from interdependence and interaction (Prencert et al., 2022; Melander and Arvidsson, 2021). Thus, the paper has provided an in-depth analysis of the supplier–customer relationships and underlying dynamics that affect sustainability-led innovation and, vice versa, how such innovation impacts supplier–customer relationships. The paper also contributes to delivering a representation based on the real world of the innovation processes grounded in the textile industry.

The findings of this study could be useful for managers and entrepreneurs of many Italian companies, not only in the textile

industry but that are also following processes of sustainability-led innovation. Even if they feel the pressure of the market to be innovative and develop sustainable products, managers and entrepreneurs should keep in mind that the answer is closer than it seems and lies in the interaction between suppliers and customers. Suppliers, such as the producers of yarns in the textile industry, still play a fundamental role in process innovation, but at the same time, the companies that are more in contact with the final consumer are more aware of what the market requires in terms of new sustainable products. The interaction between the two appears to be the trump card towards sustainability-led innovation. Thus, on the one hand, entrepreneurs and managers should consider the advantages that can be gained, in terms of innovation for sustainability goals, by the existing and consolidated interactions, especially when suppliers and customers work together in the same sustainable direction. On the other hand, entrepreneurs and managers should be open to considering new relational opportunities, since sustainability-led innovation might require new technologies or skills that could be even outside the industry, or do not be afraid to close the relationships with consolidated suppliers that are not able to achieve the sustainability standards and goals.

The paper has some limitations that we acknowledge and could be overcome with future research. The paper focuses on the textile industry only, but we are aware that sustainability-led innovation is a compelling issue for many industries, such as the automotive, food and paper industry, to cite a few. A comparative study could shed light on the different roles of supplier–customer relationships and the underlying relational dynamics. Moreover, the paper uses in-depth interviews with experts in the field. While this provides an overview of sustainability thinking and actions in terms of process and product innovation, each kind of product and process innovation (e.g. product durability/circular economy) can be unpacked as a relevant case. Thus, single, longitudinal case studies of companies implementing specific kinds of sustainability-led innovation could provide much more insight both into the technical aspects and the relational dynamics.

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