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RESEARCH ARTICLE

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A dynamic view of strategic innovation for sustainability: A longitudinal case study of a luxury fashion engineering company

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In this article, we study how a luxury fashion engineering company strategically introduced sustainability-oriented innovations (SOIs) over time through an in-depth longitudinal analysis of a leading Italian business-to-business (B2B) firm. We apply a strategic management perspective to this first-tier engineering manufacturer to bring new insights into how upstream firms deploy SOIs and to what effect, thus determining long-term technological choices in the industry. We observe that such innovations evolved dynamically from the process dimension to the supply chain and, lastly, to the product dimension, thereby spanning explorational, procedural and communicational practices. We find that the company sustained significant growth over a decade while implementing its sustainability transition, thanks to three elements: a broad and wide-ranging experimentation in all areas of the company, a continuous dynamic process of learning-by-doing and a commitment of the top management to prioritize new sustainable practices. The propositions developed from this case study can inform future strategic analysis and management of SOIs in other firms/industrial sectors.

KEYWORDS
circular economy, dynamic innovation, ESG strategy, fashion supply chains, innovation strategy, luxury apparel, sustainability-oriented innovation

1 | INTRODUCTION

The fashion and textile industry has been widely criticized for its damaging environmental footprint: the industry's greenhouse gas emissions are expected to rise to 2.7 billion tons per year by 2030, and global textile waste will reach 134 million tons per year (Ellen MacArthur Foundation, 2021; Islam, 2021). Concerns about the industry's environmental impacts have led to a growing interest in innovations to achieve corporate sustainability because, despite an increasing number of initiatives, the pressure of the fashion industry on the planet is still rising (Moretto et al., 2018; Palm et al., 2021). Sustainability-oriented innovations (SOIs) could be particularly relevant for the luxury segment of the apparel industry, where the high price margins enable lots of innovative experimentation. Thus, innovations can play a strategic role in ensuring a synergistic interaction between luxury and sustainability (Amatulli et al., 2017). However, examples and research based on primary data on sustainable innovations in luxury businesses are still scant (Grigorescu & Ion, 2021).[1]

Many significant environmental impacts of the fashion industry are due to the activities upstream in the supply chain. Because raw material and fibre suppliers have limited scope for SOIs, as they typically do not control product innovations (Brun & Ciccullo, 2022; Khairul Akter et al., 2022), it is, therefore, crucial to understand how SOIs are deployed strategically by first tier garment manufacturers. More specifically, upstream manufacturers handling the product 'engineering'[2] play a pivotal role in sustainability innovation, as they determine long-term technological choices in the industry and can be the fulcrum of product, process and supply-chain innovation (Wilhelm & Villena, 2021). Therefore, exploring how sustainable innovation activities are strategically layered inside such engineering companies and in

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their supply chain is essential to understand how to establish a sustainable competitive advantage and promote a more sustainable and responsible fashion ecosystem (Afeltra et al., 2021). Furthermore, SOIs play a crucial role in enhancing transparency throughout the supply chain, also mitigating risks associated with supply chain disruptions, regulatory challenges and reputational damage stemming from unsustainable practices. Consequently, they can engender long-term cost savings and operational efficiency, strengthening the resilience of the supply chain in an ever-evolving environment (Cohen et al., 2022).

While the sustainability initiatives of luxury retail brands have been studied extensively in the literature, there is still a significant research gap regarding the analysis of companies upstream in the supply chain. There is especially a lack of evidence beyond the study of single initiatives that demonstrates a strategic change in entire production structures, that is, introducing SOIs in both processes and products, not only within individual companies but also along their supply chains (Caniato et al., 2012). The literature still falls short in illustrating how these activities should be integrated within the overarching long-term strategy of an upstream company and how they contribute to shaping their activities. It is crucial, therefore, to understand their long-term vision—combining strategy and expertise—and recognize how their pivotal role in the supply chain empowers them to implement more sophisticated and impactful SOI strategies. The challenges of this implementation extend beyond the mere financial constraints, encompassing a comprehensive strategic and operational vision, among others.

Our study addresses this research gap by exploring a B2B fashion engineering company's long-term strategy to serve numerous multinational luxury retail brands (such as Armani, Burberry and Prada). The company was one of the first movers in the context of sustainability, obtaining the international SA8000 Social Accountability certification in 2012 and publishing Sustainability Reports since 2015. In recent years, it has experimented with advanced sustainability innovations of increasing complexity (such as 3D technologies for dress pattern dematerialization). Meanwhile, the company has expanded, acquiring 11 other companies, and its revenues grew by 730% in 10 years. We map through a longitudinal case study the SOIs implemented by this company over a decade, examining how they helped achieve some sustainability improvements.

To structure our exploration, we draw upon two theories from the sustainability literature: the Three-Dimensional Concurrent Engineering (3DCE) framework, which identifies products, processes and supply chains as core strategic dimensions (Ellram et al., 2008), and models of organizational, operational and communicational levels of practices (González-Benito & González-Benito, 2006). We categorize different SOIs in the focal company through the lenses of these two theoretical approaches. However, existing theories do not explicitly characterize *how* these innovations are implemented dynamically and evolve over time. This leads to our overarching research question: *how does a luxury fashion engineering company deploy SOIs strategically over time?* To answer this, we apply an inductive approach to identify the building blocks and their iterative stratification by conducting an in-depth analysis of our case study through a strategic management lens.

Our main contribution is a detailed characterization of the breadth, depth and time dynamics of the innovative practices in the case study. We observe that strategic transversal and incremental improvements in technologies and know-how are central to this process. We find that experimentation occurred across all company areas rather than concentrating on a few specific issues. Second, we show that innovative actions were more basic in earlier stages, setting the foundations for more substantial and ambitious innovations over time when the company has achieved higher levels of 'sustainability maturity'. Third, we note that the CEO's commitment and vision are essential to support the entire strategy and prioritize new solutions. We critically assess the effectiveness of this dynamic sustainability strategy in terms of sustainability and financial performance in the past few years.

The paper is structured as follows. Section 2 provides the theoretical background. Section 3 presents our data and methodology. Section 4 illustrates the case study and results. Section 5 develops three theoretical propositions and discusses limitations. Section 6 concludes.

2 | THEORETICAL BACKGROUND AND RESEARCH FRAMEWORK DEVELOPMENT

To interpret the breadth and depth of the innovations in our case study and how different sustainable innovations were implemented dynamically by the company over time, we refer to two streams of the business strategy literature concerning SOIs and knowledge accumulation. Detailed evidence on the role of fashion engineering companies is scant in both areas. Moreover, previous literature on SOIs mainly focuses on the characteristics of SOIs (Jarmai, 2020; Khurana et al., 2021), their drivers and outcomes (Kiron et al., 2013; Maletic et al., 2015), innovation capabilities (Inigo & Albareda, 2019) and the role of stakeholders in the innovation process (Goodman et al., 2017), leaving a significant gap regarding strategic management.

2.1 | Sustainability-oriented innovations and business strategies

Corporate SOIs[3] encompass a variety of innovative endeavours, ranging from technical innovations—new products, machinery and productive processes—to non-technical ones—business model innovations, corporate practices and intangible value creation in marketing or management (Mariadoss et al., 2011). Although some of the classic elements of strategic business innovation apply, the focus on environmental, social and governance (ESG) value creation adds specific challenges and opportunities for developing a coherent innovation strategy.

Previous research on innovation and sustainability has been mainly in science and engineering, focusing on environmental technologies in the manufacturing context, technical processes and product development, thus lacking a broad strategic management perspective that

critically links innovation with sustainable value creation (Adams et al., 2016; Hansen et al., 2009). Our research is meant to inform previous work in the field of SOIs from this strategic perspective and contribute to it, thus addressing a significant gap identified by several studies.

For instance, Brook and Pagnanelli (2014), building on various research streams in sustainability, innovation, strategy and portfolio management, point out the need to strategically manage the innovation project portfolio about sustainability during the development phase of projects. They highlight how the strategic side of innovation portfolio management is generally poorly addressed. Similarly, the importance of a strategic innovation viewpoint has been emphasized by Palmié et al. (2023), who note how decisions concerning the acquisition, development and deployment of innovations require competencies at the intersection of strategic management and technology and innovation management. However, in their study, sustainability is not considered.

Other recent works underlined how a successful sustainability-oriented strategy requires going beyond isolated and technology-oriented innovations, thereby demanding a more systemic perspective (Brown et al., 2021; de Vasconcelos Gomes et al., 2023; Iacovidou et al., 2021). While there is abundant literature on specific processes, products or technologies for sustainable innovations (Aka, 2019; Castellacci & Lie, 2017) and few recent studies on the managerial selection of SOIs in organizations (e.g. Chen et al., 2023), the current scholarship offers limited evidence on how firms strategically handle different SOIs over time.

Therefore, our study offers three main contributions to fill this gap in the strategic management of SOIs.

First, the theory of SOIs has reached the 'what' phase of theory-building, only recently entering the 'how' phase concerning their implementation, organization and management (Adams et al., 2016). Thus, a guiding principle of our analysis is to identify *how* SOIs are specifically deployed. Given the transversality, complexity and uncertainty in outcomes of SOIs, both in terms of financial and sustainability results, the literature has argued that an integrated approach is necessary for their strategic use in business (Hansen et al., 2009). SOIs seem to require deep organizational engagement with stakeholders (Juntunen et al., 2019; van Lieshout et al., 2021), together with a commitment to sustainability from the top management to establish new organizational structures (Kiron et al., 2013).

Second, sustainable innovations generally require an integrated view that brings together economic, environmental and social concerns as a basis for change at all levels. Although sustainability may have previously appeared to business leaders as an additional cost (Metz et al., 2016), today, it is perceived as a potential driver of value creation (Van Holt et al., 2020). Hence, our contribution is examining SOIs in the high-end fashion industry, encompassing all types of strategic business innovations. In this sense, SOIs include changes 'internal to a single company (i.e., operational optimization), but also organizational transformation, through buyer-supplier collaborations, as well as more extensive collaboration with not proximate stakeholders for building new systems' (Brun & Ciccullo, 2022, p. 307). The strategic goal of SOIs is to achieve economic improvements, environmental upgrading and social progress, simultaneously creating value in these three concurrent dimensions (Lohmeyer et al., 2022).

Third, previous work has treated sustainability statically and dichotomously (sustainable/not sustainable) rather than considering SOIs a multi-layered process developing over time (Adams et al., 2016). The question of strategic improvements in sustainability implies organizational change, a dynamic process with different steps of innovative activity. Therefore, we combine the insights of the cumulative innovation literature with the different SOI dimensions and practices to provide novel insights into luxury supply chains from a dynamic strategic perspective. Existing research on sustainability in the fashion industry has not yet examined SOIs through these conceptual lenses. Given the key role of B2B companies in sustainable fashion supply chains and their innovative potential, we aimed to fill the gap on these pivotal players by exploring these different areas for SOIs, adding a dynamic time dimension. This dynamic perspective is discussed in the following section.

2.2 | Frameworks for dynamic innovation strategies

To investigate how a fashion engineering company can achieve sustainability dynamically over time, we build on the idea that 'the key to progress is innovation' (Nidumolu et al., 2009, p. 2), and we draw on key results of the SOI literature, which show that sustainability can be a long-term driver of innovation for new products, services, business models and processes (Geradts & Bocken, 2019; Karimi Taklo et al., 2021; Metz et al., 2016; Pedersen et al., 2018). This literature is dominated by quantitative surveys, with few qualitative in-depth case studies, and the development of novel theories is still lacking (Oduro et al., 2022). Thus, we use our case study to build upon existing theoretical frameworks from the innovation literature and to combine and expand their insights.

A suitable innovation framework that simultaneously captures multiple sustainability issues is the 3DCE framework, which identifies three core SOI dimensions: product, process and supply chain (Ellram et al., 2008). In this framework, the traditional focus on products and processes is augmented by an additional supply chain dimension (Mombeshora et al., 2014). The 3DCE framework has been applied to manufacturing to demonstrate how companies can satisfy the apparently conflicting sustainability and profitability goals while highlighting the synergies of tackling these three dimensions jointly. However, the framework does not distinguish between different types of management practices within the three dimensions.

Therefore, we combine the 3DCE framework with other theoretical approaches that capture different groups of practices, for instance, with a distinction among operational, organizational and communicational practices (González-Benito & González-Benito, 2006). With a similar categorization, we distinguish:

- Explorational practices: mainly at the operational level, including developing and implementing more sustainable manufacturing

techniques: 'sustainability exploration is concerned with challenging existing sustainability solutions with innovative concepts' (Maletič et al., 2014, p. 183).

- Procedural practices: mainly at the organization level, encompassing the planning and implementation of coordinated management systems, developing policies and procedures to select and achieve environmental objectives and assess their outcomes (Boström, 2012).
- Communicational practices: conveying to stakeholders the priorities and actions taken in favour of the natural and human environment and enhancing their engagement with the sustainability strategy.

Thus, a company can explore new sustainable solutions through a trial-and-error approach, settle procedures intended as routines, certifications and rules to replicate sustainable behaviours, and finally, communicate such actions internally and externally. These types of practices can be applied to any product, process or supply chain dimension.

However, existing studies on sustainability in the luxury apparel industry have mainly approached sustainable innovations, resorting to a static framework without analysing the cumulative, step-by-step implementation of new activities (Caniato et al., 2012; Karaosman et al., 2020). The few studies that consider a dynamic dimension refer to roadmaps but do not unpack the specific SOIs required throughout the process (Arena & Chiaroni, 2014; Moretto et al., 2018) or focus narrowly on the development of one sustainable or circular innovation, thereby lacking a broader strategic view (Brydges, 2021; Saha et al., 2021).

Nonetheless, long-standing innovation literature has highlighted the importance of building cumulative knowledge through such principles as path dependence ('standing on the shoulders of giants') and innovation persistence (Thrane et al., 2010).

We argue that to sustain socio-environmental responsibility and a leadership role in their sector over time, companies need to deploy interlinked innovations, which progressively build up know-how inside the company and along its value chains.

Therefore, we break down our overarching research question (*How does a luxury fashion engineering company deploy SOIs strategically over time?*) into three issues.

First, building on the dimensions of the 3DCE framework, we analyse the breadth of SOI:

- Research Question 1 (RQ1). How can a luxury fashion engineering company implement SOIs within the product, process and supply chain dimensions?

Next, we distinguish types of practices within each of the innovation dimensions of RQ1 to explore the depth of such SOIs:

- Research Question 2 (RQ2). How are SOIs implemented within each product, process and supply chain dimension as different explorational, procedural and communicational practices?

Finally, we consider a dynamic framework that evolves over time:

- Research Question 3 (RQ3). How does the company combine these 'building blocks' over time to dynamically achieve its environmental, social and economic strategy?

In short, we propose a research framework (Figure 1) built on the main conceptual features that emerged from the literature and theoretical background. The role of this framework is to clarify the relationship between conceptual constructs and research questions to guide our inductive analysis. The SOI dimensions (y-axis) indicate the breadth of

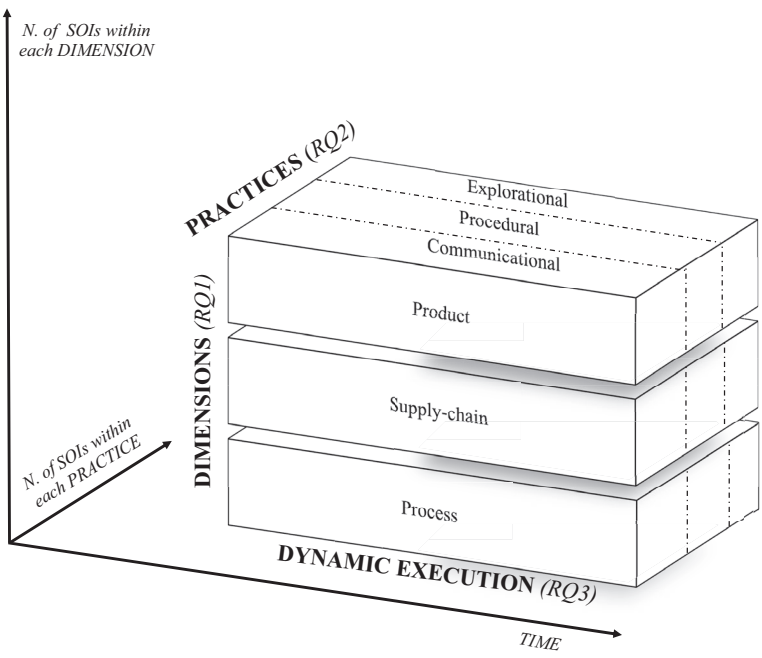


FIGURE 1 Research framework and specific research questions. We categorize sustainability-oriented innovations (SOIs) in three dimensions (product, process and supply chain) and, within each, in the three possible types of practices (explorational, procedural and communicational). Lastly, we map the SOIs over time.

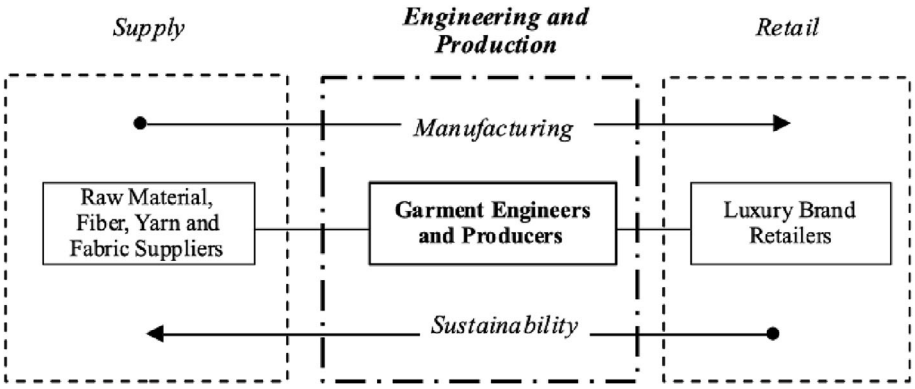


FIGURE 2 Fashion supply chains: engineering companies are the loci of multiple potential innovations because they control the manufacturing process. They also receive sustainability requests 'cascaded up' from final retailers. Authors' own elaboration from Wilhelm and Villena (2021).

the SOIs implemented, answering RQ1; the practices within each dimension (z-axis) indicate the depth of such SOIs, answering RQ2; and time (x-axis) captures their dynamic evolution, answering RQ3. These three axes represent a general 'scaffolding' to organize the numerous innovations identified but still grant us the flexibility to identify inductively patterns in the data on how SOIs were implemented in the context of the case study.

3 | METHODOLOGY

3.1 | Research approach and case reasoning

We conducted an exploratory longitudinal case study to investigate how a B2B fashion engineering company can deploy SOIs strategically over time. A case study approach is an appropriate empirical research method to examine this phenomenon in its natural setting, answer 'how' questions and characterize new phenomena (Yin, 2017). Our choice of a longitudinal case study is essential to study the company's evolution, from the initial implementation of its sustainability strategy to a more consolidated phase. Finally, single case studies can be projected toward analytical generalization, thus supporting the development of theoretical propositions to be tested statistically in future studies (Yin, 2017).

Identifying a suitable company with a long-term sustainability strategy in this sector is crucial for an in-depth case study (Siggelkow, 2007). Still, it was not easy because most B2B firms have only recently addressed ESG issues. We chose a leading Italian company—'PG'—with a relevant long-term sustainability strategy and a trajectory of economic success over the past years. PG was founded in 2000 and rapidly became one of the most innovative fashion engineering companies in luxury apparel, serving major brands in Europe, offering a paradigmatic example of continuous sustainable innovation. We argue this is a 'revelatory case' (Eisenhardt & Graebner, 2007) because, as a manufacturing company that controls the prototyping and production of luxury clothing, PG plays a pivotal role in sustainable innovations within an increasingly complex global fashion supply chain.

Over the past decades, most famous multinational fashion groups have committed to principles of carbon neutrality, revaluing waste, resource efficiency and social responsibility, creating a demand for SOIs in the sector. However, supply chain sustainability remains challenging (Simpliciano et al., 2022), and the sustainability strategy of suppliers still largely remains a black box. First-tier companies control product manufacturing, innovation and design, being the fulcrum of the engineering of new garments, and also select and monitor their own suppliers according to sustainability criteria, enforcing appropriate requirements up in the supply chain. Therefore, we considered PG a perfect example illustrating how a fashion engineering company can be a new locus of sustainable innovation with SOIs for new products, processes and supply chain actions (Figure 2).

3.2 | Description of the case study

PG was founded by two former top-line fashion patternmaking and engineering workers with a long-term vision of creating an Italian Hub of Luxury Fashion Engineering. Today, PG consists of 12 companies throughout the country, covering different luxury sectors: menswear, womenswear, knitwear and leather goods. The business is highly verticalized, as PG carries out the entire production cycle, from the development of the garments to the prototyping and realization of samples to the production and sales to retail brands. In 2022, it recorded a turnover of € 100+M (growing 43% from 2021) and employed around 1.000 people.

3.3 | Data collection

We conduct a retrospective case analysis using multiple data sources and with multiple actors through a holistic approach (Blasco-Arcas et al., 2020; Halinen & Törnroos, 2005). To gain a deep understanding of the dynamics under examination, we diversify and triangulate information sources to reduce biases and strengthen the reliability of our findings (Patton, 2014). The data collection was developed in two steps.

First, we gathered data from secondary sources using publicly available information and internal documents from 2012 to 2022, with more than 1800 pages of secondary material (Table S0.1 in Appendix S0).

Second, from June 2019 to December 2022, we collected primary data through interviews with PG employees and third parties with

whom PG collaborates over various sustainability areas. We started conducting semi-structured, face-to-face interviews in Italian at PG's headquarters until the COVID-19 pandemic, then the remaining rounds through online meetings, for a total of 13 interviews lasting 60–120 min each. Because employees and managers might have an imperfect recollection of past sustainability activities, we cross-checked information from different sources. We interviewed top and middle managers to ensure a variety of points of view on the same phenomenon and the granularity necessary for its analysis (Table S0.2 in Appendix S0).

The interview method was chosen 'to obtain both retrospective and real-time accounts from those people experiencing the phenomenon of theoretical interest' (Gioia et al., 2013). Whenever possible, the interviews were complemented with shop-floor visits. A predetermined interview outline was used to increase the comparability of responses. The questions covered corporate sustainability strategy, SOI projects, supply chain relationships, difficulties faced and benefits achieved (interview protocol available in Appendix S1). After each meeting, interviewers edited and checked the field notes for accuracy. All the interviews were tape-recorded, transcribed verbatim and translated into English for a total of 120 pages.

We cross-checked the information provided by PG employees through further interviews with five external companies collaborating with PG in various sustainability areas. The interviews were conducted during December 2022 through online meetings, for a total of six interviews, each lasting 1 h (Table S0.3 in Appendix S0). The questions covered the sustainability strategy of PG, its strengths and weaknesses, the financial and human resources commitment in its sustainability path, a general assessment of the luxury apparel industry and a characterization of the competitive positioning of PG, for a total of 45 pages.

3.4 | Data analysis

To address our research questions, we use the dimensions and practices of our theoretical framework (Figure 1), derived from the analysis of the literature, as a grid to organize our data and categorize innovations, with the aim to identify inductively patterns that associate similar innovations. We analyse our primary and secondary data in three steps, according to established recommendations for qualitative data analysis (Gehman et al., 2018). Following the prescriptions for case studies, we performed multiple rounds of data coding, line-by-line, supported by NVivo12 software. We followed a thematic analysis approach, which identifies patterns in a large and complex dataset and identifies links within analytical themes (Braun & Clarke, 2006). First, we coded for the SOIs of the product, process and supply chain dimensions (following RQ1). Then, within each SOI dimension, we coded for the explorational, procedural and communicational practices (second-order practices) to investigate how they had been implemented (RQ2). In other words, after extracting all the SOIs we could identify in the raw data, we organized them into the nine categories defined by the research framework (three dimensions, each subdivided into three types of practices). This way, we group similar innovations together and avoid comparing SOIs applied to different areas of the company. While all these innovations can bring improvements in sustainability, to disentangle their cumulative effects, we prefer to organize them according to the general matrix depicted in Figure 1 and only then work inductively to identify new patterns.

Second, after this broad classification, the SOIs were coded inductively into first-order categories within the typical tree-like structure of the Gioia methodology (Figure 3), thus allowing the development of a more fine-tuned empirically grounded framework (Gioia

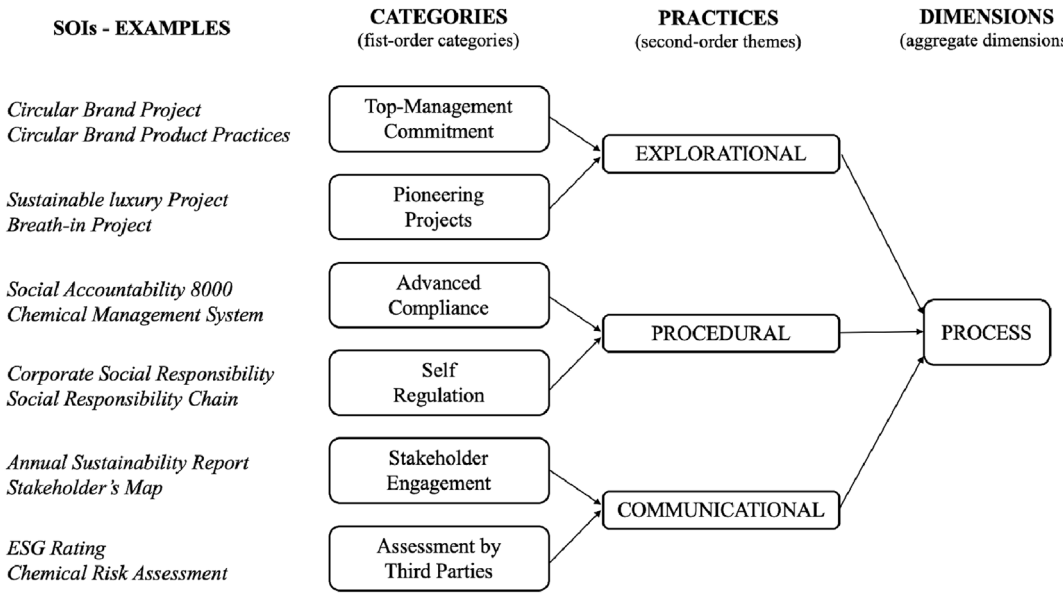


FIGURE 3 The structure of the data concerning Research Question 1 (RQ1) and Research Question 2 (RQ2) regarding the 'process' dimension. From individual innovations, we code the first-order categories inductively while organizing them according to our theoretical framework in the practices and then within dimensions. The same structure applies to the 'supply chain' and the 'product' dimensions.

et al., 2013). As SOIs come from the company and are the raw data of our analysis, we examine them to find recurring themes and new insights for theory building. The SOI patterns that emerge from this analysis are confined within the conceptual boundaries established by the theoretical framework, enabling a meaningful comparison of reasonably similar SOIs. With more than 40 SOIs identified, this is a necessary step to ensure that the insights drawn from the data remain coherent across various strategic intervention domains. We iterated back and forth between the empirical data and the emergent first-order categories to update our empirically-grounded framework based on evidence gathered in subsequent interviews (Burawoy et al., 1991).

More details on representative quotes and the development of the empirically grounded framework and first-order categories can be found in Appendix S2 and S3.

The first-order categories of SOIs that emerged inductively from the data are six:

1. *Top-Management Commitment* to new sustainability initiatives, projects and principles that reflect on corporate actions.
2. *Pioneering Projects*, which are driven by innovative ideas and technologies with a long-term vision of doing something that has not been tried before.
3. *Advanced Compliance* with external requirements defined by national and international voluntary frameworks over and beyond legal requirements.
4. *Self-Regulation*, based on a voluntary adherence to legal, ethical and/or safety standards defined internally to supplement external rules.
5. *Stakeholders' Engagement* at multiple levels and with multiple tools involving all the actors who may be affected and can affect the company's interests and actions.
6. *Assessment by Third Parties*, through external objective measures or evaluations concerning different issues and their related criteria.

The three categories of practices (explorational, procedural and communicational) are mainly intended to reflect the purpose of such activity. For instance, the Annual Sustainability Report is coded as a 'Communicational' practice because the company uses it chiefly to communicate information about its performance to the outside world every year. For this reason, we state that such SOI aims to communicate rather than explore or develop procedures.

Finally, as a third step, and in line with the purpose of the paper, we provide logical and supportive arguments to explain how the identified dimensions and practices (RQ1, RQ2) have been executed through an iterative stratification over time (RQ3), looking for the dynamic pattern of deployment of SOIs. Consistent with the theory-building process of exploratory case research (Eisenhardt, 1989; Grodal et al., 2021), our analysis allows us to conceptualize some key characteristics of a dynamic SOI strategy by developing three propositions—discussed in Section 5—for further scholarly investigation.

4 | RESULTS

We derive three core results from the data analysis and categorization defined above. The secondary materials present the company's actions in their temporal evolution, with details regarding the achievements obtained through the SOIs implemented. The primary data complements this information with a more nuanced narrative of the direct experience of interviewees. We observe that the company implemented a long-term sustainability approach with (i) a strategic mindset serving as the cornerstone guiding sustainability operations, reflecting a vision of 'strategy before operations', where (ii) operations are characterized by a multi-layered deployment of SOIs across different dimensions and practices, with (iii) gradual and dynamic approach to effectively respond to evolving market conditions and demands. In light of these three main results, we further examine quantitative measures of progress to support the interpretation of the outlined sustainability trajectory. Overall, we argue that the company has effectively translated its strategic commitment into coherent and adaptable processes, programmes, plans and metrics.

Each of these results is illustrated in the following sections.

4.1 | The prevalence of strategy on operations

From a strategic management perspective, we first explored whether the implementation of PG's SOI strategy followed a top-down or a bottom-up approach, finding clear evidence from primary data of a 'strategy before operations' philosophy. This mindset underscores the importance of integrating sustainability considerations into the very foundation of the company's strategic planning and decision-making processes. This approach prioritizes the sustainability strategy before the implementation of operational activities. By adopting a 'strategy before operations' mindset, PG signals a commitment to embedding sustainability principles into its core business strategies from the outset. Rather than treating sustainability as an afterthought or merely as a set of operational tactics to be implemented reactively, this approach recognizes sustainability as an integral component of long-term organizational success.

According to our interviewees, the SOI actions were possible because the company's overall approach was grounded in a strong commitment of the top management to a long-term sustainability trajectory, which took priority over short-term operational difficulties. Any pressure from clients on ESG topics was handled proactively to create a new source of competitive advantage for the company. Instead of just reacting to the clients' sustainability requests, PG used these opportunities to build internal innovations that were transferrable across multiple clients. The CEO was decisive in pushing sustainability in the relationship with suppliers and implementing sustainability actions. The company's leaders prioritized ambitious commitments, choosing to set up the company's strategy not on the current level of sustainability performance but instead on desired outcomes. For instance, PG's Sustainability Manager notes: 'First, we

committed, and then measured our results, which proved beneficial. For example, we signed a Science Based Targets initiative commitment regarding the reductions and compensations needed to achieve carbon neutrality. The commitment preceded the measurement of Scope 1-2-3. Thus, we first committed to being carbon neutral by 2023 and then conducted the measurements, which are not so trivial. But I had total support [of the top management] because the commitment had already been made; perhaps, if they had seen the numbers beforehand, we wouldn't have made the deal.'

The spillovers of this strategy for stakeholders outside the company have been significant and helped establish PG as a leader in the industry. The ESG Manager at the local Industrial Union commented: 'I must admit that the CEO was great both in territorial and supply chain tables and created a cultural change [regarding sustainability] step-by-step. As he did with PG's suppliers, he also tried to share knowledge with all participants of the associations, and, in my opinion, this has led to a recognition of their reality as a winning model'.

4.2 | Multi-layered sustainability-oriented innovations

We here present how the abovementioned strategy has been implemented through the empirical findings related to research questions RQ1 and RQ2, highlighting the strategic deployment of SOIs portfolio rather than isolated and technology-oriented innovations. The evidence illustrates the breadth and depth of the SOIs identified, following the categorization of dimensions and practices from the research framework of Figure 1, which are organized through the six categories we inductively identified in Section 3.4 (Figure 3). Each individual innovation is discussed in detail in Appendix S4, including examples of the textual material coded into the SOIs.

4.2.1 | Process dimension

In the process dimension, we found a rich range of innovations all over the spectrum of explorational, procedural and communicational practices. We highlight the large number of technology-intensive explorational innovations clustered within the category of Pioneering Projects—such as a resource-efficient 'Warehouse 4.0' Project—denoting a significant focus on high-tech solutions for processes' sustainability, coupled with a variety of SOIs oriented toward building human capital, interlinkages and a culture of sustainability, especially in communicational practices (Figure 4).

4.2.2 | Supply chain dimension

The company also invested significantly in a wide range of supply chain SOIs. Most explorational initiatives are Top-Management commitments coordinated through international initiatives, while we see fewer new technologies, such as blockchain. Procedural practices tackle sustainability, especially through innovations in self-regulation. Lastly, communicational practices enable new forms of stakeholder engagement and assessment by third supply chain parties (Figure 5). The focus is more on partnerships and managerial commitments rather than on developing completely new solutions.

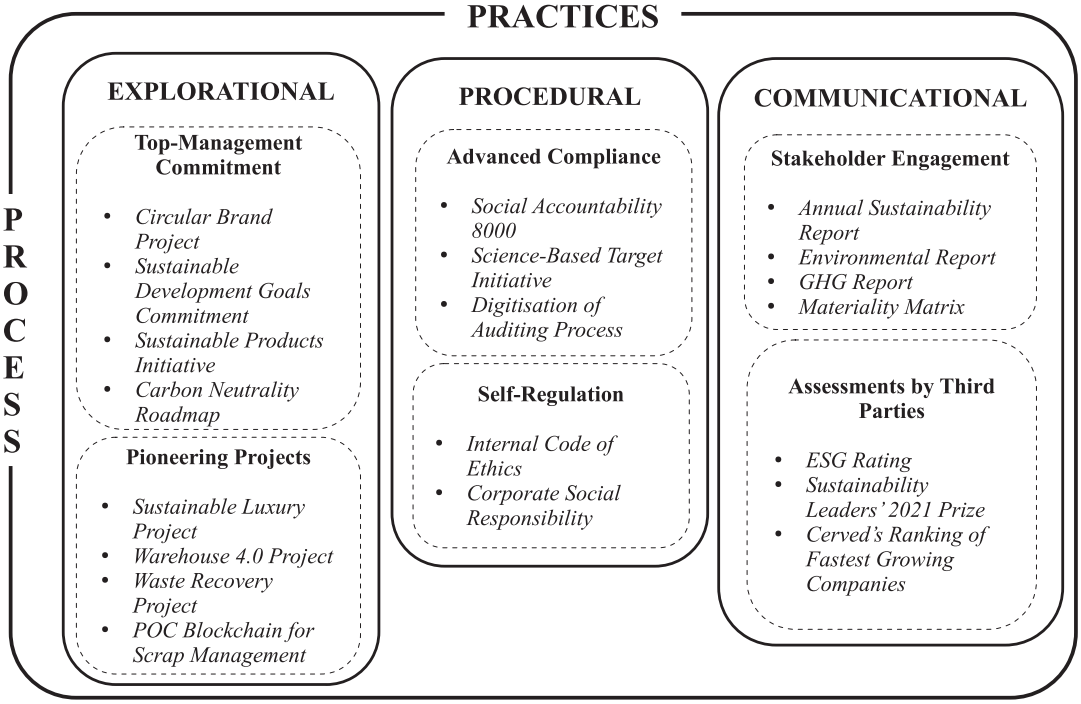


FIGURE 4 Sustainability-oriented practices implemented by PG in the process dimension.

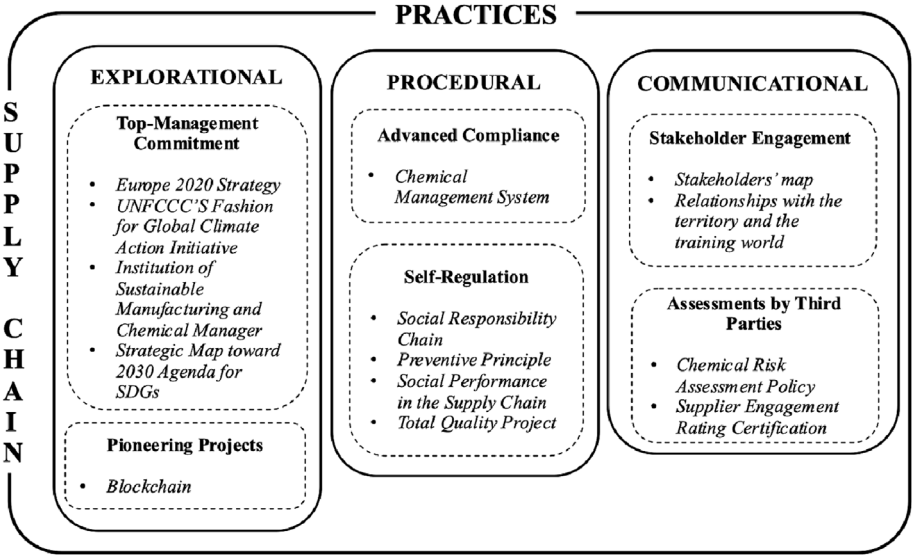


FIGURE 5 Sustainability-oriented practices implemented by PG in the supply chain dimension.

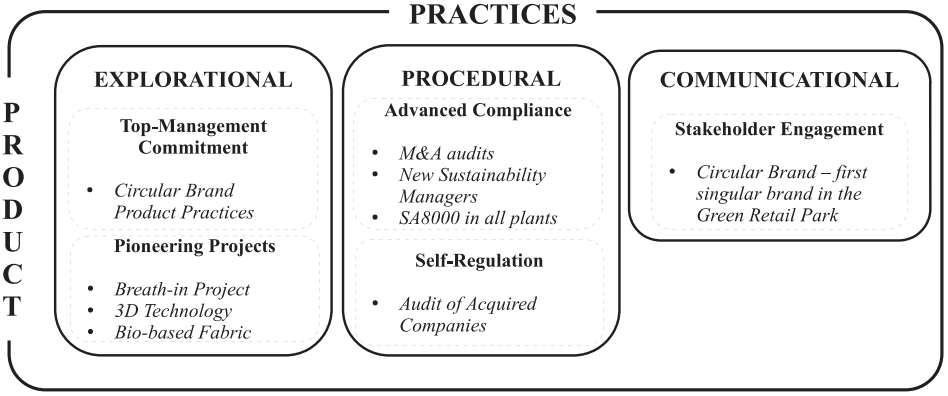


FIGURE 6 Sustainability-oriented practices implemented by PG in the product dimension.

4.2.3 | Product dimension

Finally, we find fewer radical innovations within the product dimension, suggesting that these kinds of actions are still challenging. The most significant achievements were explorational product improvements, for instance with innovative materials. This approach denotes an incremental approach, doing the same thing but better and more efficiently (Figure 6).

The multilayered SOIs identified in the process, supply chain and product dimensions above suggest a great range of innovative actions, more advanced in some areas but still characterized by a holistic approach to sustainability. However, to understand the innovation trajectory implemented, these actions must be examined in light of their evolution over time. We turn to these dynamics in the next section.

4.3 | Dynamic sustainability-oriented innovations

All the above SOIs demonstrate an integrated strategic approach across the whole company and beyond. We conclude that a comprehensive strategy that considers all areas rather than just concentrating on a few selected ones can effectively advance a company's adoption of multiple SOIs. However, as emphasized in our research framework, we want to characterize further how these dimensions and practices developed over time (RQ3). Therefore, we map the iterative stratification of PG's innovations over the years to characterize the dynamic execution of SOI dimensions and practices (Figure 7).

The strategy started focusing on the process dimension, with basic actions that laid the foundations of knowledge-building related to sustainability. These actions evolved over a long period—now more than 10 years for some activities. Then, the company sequentially included the supply chain and, recently, the products themselves. This gradual, cumulative approach to SOIs defines a core result of our analysis. Not only does our case study illustrate the importance of weaving together explorational, procedural and communicational practices within corporate processes, supply chains and product innovations, but it also demonstrates how to do so sequentially, starting when resources are still limited, to build competencies, motivation and awareness within the organization.

To exemplify the gradual, cumulative layering of innovations in the company, we zoom on one subset of SOIs (pioneering projects)

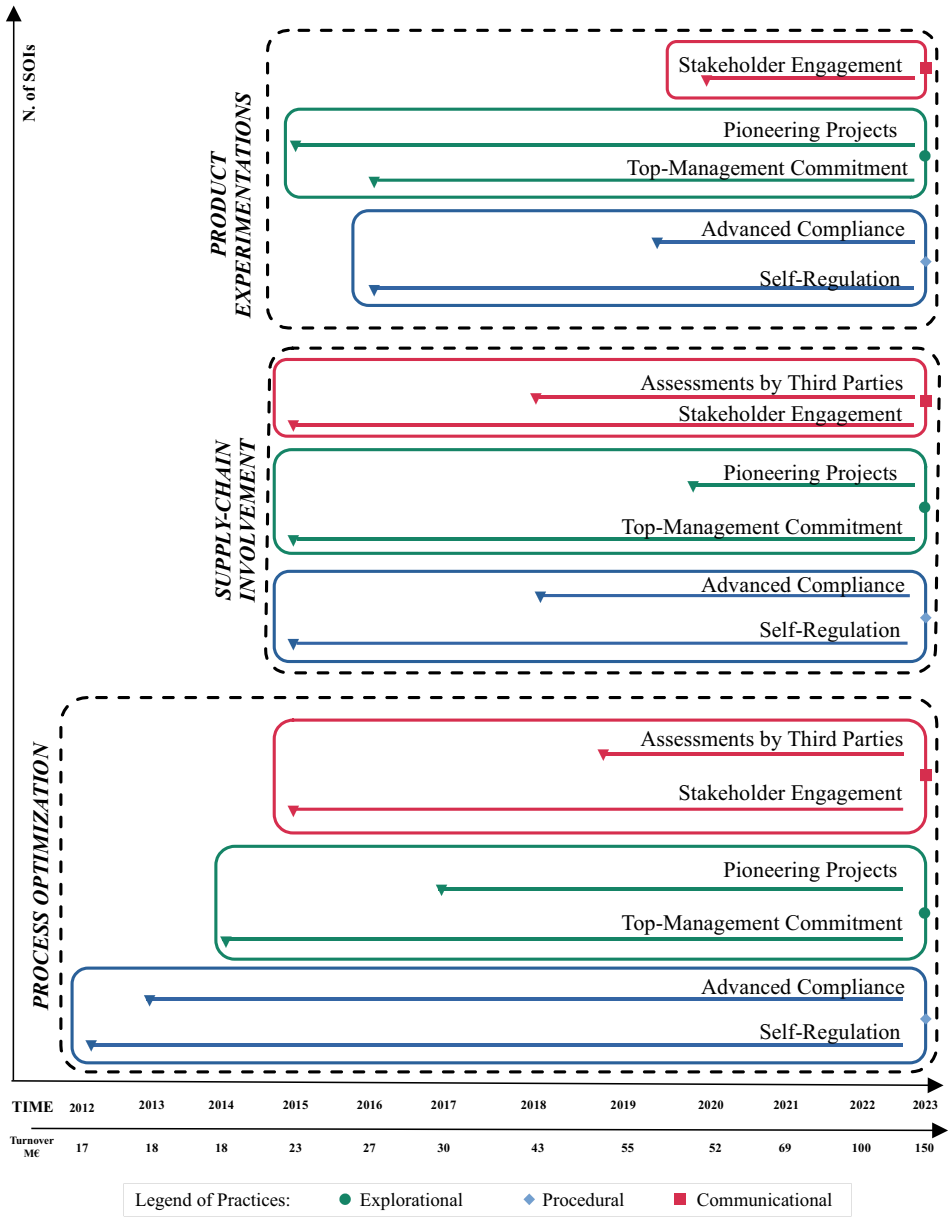


FIGURE 7 Summary of PG's building blocks for sustainable value creation over time. The length of the horizontal lines indicates the duration of individual sustainability-oriented innovations (SOIs). [Colour figure can be viewed at wileyonlinelibrary.com]

within explorational practices in the product dimension. Figure 8 shows how the company moved toward more ambitious projects over time as the learning process consolidated.

4.4 | Assessment of sustainability performance

Finally, to critically assess the sustainability performance of PG's dynamic strategy, we compare different sustainability indicators with three performance trends—number of firms in the group, turnover and SOIs. This assessment provides further evidence of how successful the SOI strategy has been so far. Due to data availability, this analysis is possible only considering the past 4 years (Figure 9), but it already sheds light on interesting achievements and roadblocks.

As a first sustainability indicator, we consider the Carbon Disclosure Project (CDP) score, an internationally recognized and science-based rating. PG has measured its ESG disclosure capacity through the CDP, starting from a low score of D in 2019, then achieving B- the following year, a rare result in the luxury world, particularly in Italy. It also improved its supplier engagement rating (SER) from C to B between 2020 and 2021. Moreover, PG was selected for the CDP 2020 Supplier Engagement Leaderboard Rating, with 400 international companies from all sectors that excel in engaging the supply chain for climate change. However, in 2021, the ESG score decreased, together with the SER in 2022.

This first sustainability trend shows a process of rapid learning and improvement in the company's capacity to measure its ESG metrics (the CDP assesses the quality of disclosures, not the absolute sustainability performance of a company). However, it also

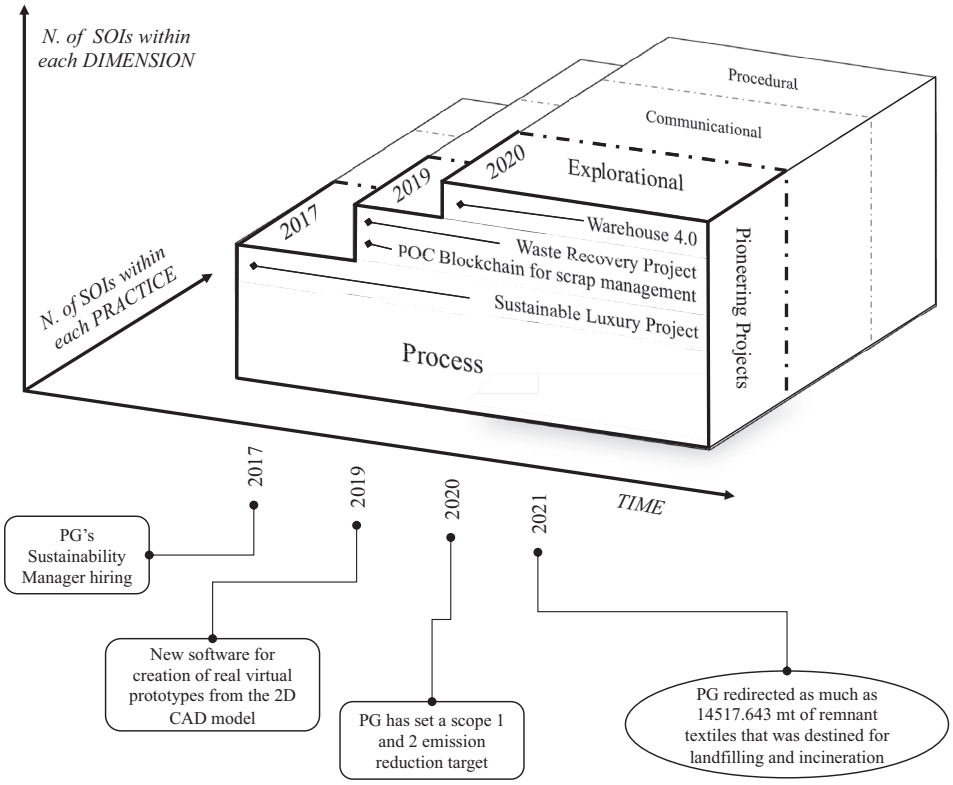


FIGURE 8 Vertical analysis of one case of cumulative layering ('pioneering projects') within explorational practices in the process dimension. Round-cornered rectangles indicate a decision, while circles describe an activity. Inspired by Langley (1999).

		2019	2020	2021			2022			
PG performance	**N. of companies**	**3**	**3**	**7**			**13**			
	Turnover (M€)	**55**	**52**	**69**			**100**			
	N. of SOIs	**25**	**39**	**41**			**42**			
CDP rating	Environment, Social, Governance (ESG) score	D	B-	C			C			
	Supplier Engagement Rating (SER)	C	C	B			D			
GHG Scope in tCO2e/year	**PG Companies**	-	**Alpha + Beta**	**Alpha + Beta**	**Gamma**	**Delta**	**Alpha + Beta**	**Gamma**	**Delta**	**All PG's companies**
	Scope 1	-	301,59	256,96	152,78	81,84	249,69	152,81	73,75	548,23
	Scope 2	-	112,84	0,00001	16,28	45,04	0,12	6,53	45,07	315,63
	Scope 3	-	-	2.846,16	-	-	5.140,54	-	-	14.993,45
Waste generated (Scope 3)	**PG Companies**	-	-	**Alpha**			**All PG's companies**			
	tCO2e/year	-	-	131,96			267,76			

FIGURE 9 Sustainability metrics against the company's performance over time.

emphasizes the difficulty of keeping up with these results, most likely due to a significant expansion of the group, with the acquisition of four new companies in 2021 and six in 2022, which made such disclosures more complex. Moreover, during the expansion of the PG group, the number of new SOIs in the company portfolio plateaued compared with their rapid growth from 2019 to 2020, possibly also because of the uncertainties posed by the COVID-19 pandemic.

The second sustainability performance indicator examined is GHG emissions. The measurement of Scopes 1 and 2 began in 2020, considering only two companies (Alpha and Beta), which in the following year recorded an improvement of 15% in Scope 1 and 100% in Scope 2. The full abatement of Scope 2 emissions does not represent a significant innovation, given that corporations can purchase 100% renewable energy through Energy Attribute Certificates, as PG did. However, it is encouraging that PG chose to make this investment for those two plants. The reduction in Scope 1 emissions is instead more noteworthy because it plausibly required some significant innovations within the production structure; moreover, taking 2020 as a base year, when most manufacturing companies reduced production and thus emissions due to COVID-19, makes any reduction particularly challenging, so this improvement is particularly commendable. But once again, we note the difficulty in tackling emissions across the group, as the reductions are concentrated in Alpha and Beta, but no equivalent change is observed for the other two companies under measurement (Gamma and Delta) between 2021 and 2022.

Scope 3 emissions from the supply chain nearly doubled for Alpha and Beta between 2021 and 2022. This increase is attributable to purchased products and services, which rose from €1 to €17 million in those years, as PG subcontracted services for its processing stages. Because this 17-fold increase in purchased services corresponds to only a twofold increase in Scope 3 emissions, we can still consider this change as relatively sustainable.

Finally, the available data on waste shows a doubling between 2021 and 2022, but in the first year, these waste figures applied only to Alpha, while in the second year, to the entire PG group, making comparisons challenging. The only other result available on waste metrics is that, from its industrial symbiosis projects, PG achieved more than 7000 kg of recycled materials in 2022.

The comparison of these data helps us critically assess PG's sustainability performance following its SOI strategy, highlighting some key challenges. From the growing turnover, we see that the increasing number of SOIs has not harmed PG's profitability. We observe, however, that the translation of SOIs into tangible sustainability results is still underway. PG is in a learning-by-doing phase where accurate measurement is still difficult, and long-term improvements are preliminary. Some critical points remain even in this initial stage, still mostly focused on measurements: for instance, PG reports only market-based and not location-based Scope 2 emissions; also, it does not provide any intensity factor (emission or energy intensity per euro or product) that would help comparison over time as the company expands. However, we expect the large number of SOIs deployed over the years (starting well before 2019, as discussed previously) will support future sustainability performance, even if measurable benefits materialize with a time lag.

5 | DISCUSSION

The evolution of this luxury B2B company offers new insights for understanding how fashion engineering firms can handle SOIs over time strategically. We now discuss the broader implications considering the existing literature and derive three propositions for future research that stem from our results.

5.1 | Relationship with previous literature

Our results can be contextualized in a broad trajectory of innovation-based organizational change. We found that the company's journey toward sustainability has so far encompassed three evolutionary stages (Figure 10), which are quite closely related to existing frameworks in the literature (Adams et al., 2016; Lubin & Esty, 2010).

Stage 1. **Process optimization** adopts an internally-oriented sustainability perspective, with a 'doing the same things better' approach to reduce harm by introducing reactive, incremental SOIs driven by compliance or eco-efficiency. In alignment with the literature, we found that the company focuses on reducing costs and risks and delivering proof-of-value (Jum'a et al., 2022). This stage requires integrating different types of knowledge on economic, social and environmental considerations for more complex future SOI implementation.

Stage 2. **Supply chain involvement** represents a shift in philosophy to think beyond the firm with the purpose of 'doing good things with others'. The company is involved in a network of relationships to create shared value collaboratively. This approach is necessary to extend sustainability principles to the supply chain (Baya & Gruman, 2011). At this stage, the external knowledge that resides in the value chain is central, and long-term engagement with key stakeholders can increase a firm's SOIs (Ayuso et al., 2011). One critical factor is the company's ability to manage business relationships with supply chain actors, leveraging positive and collaborative relationships rather than using coercive methods to extend sustainability along the supply chain (Brun & Ciccullo, 2022). As such, our findings show that it is indeed possible to respond innovatively to the pressure of clients by cascading up sustainability requirements with a collaborative attitude. This supply chain stage is novel compared with the model of Lubin and Esty (2010).

Stage 3. **Product experimentations** reflect the company's willingness to redesign whole products and progress toward 'doing good by doing new things'. With such a vision, SOIs can become a source of net positive impact (Souto, 2021). At this stage, the knowledge accumulated beforehand inspires and makes it possible to explore new technological opportunities at the product level to realize new value configurations.

This stagewise approach is feasible even for companies with a long-term ambition but limited initial capabilities, with dynamic integration of sustainability innovations in the core business, as discussed in the next section.

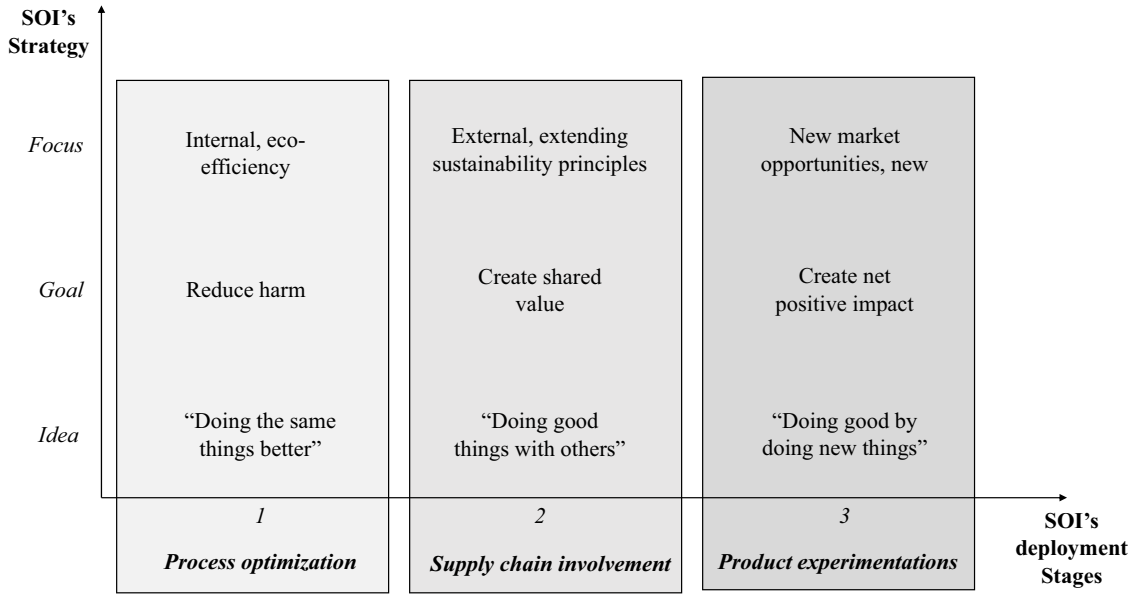


FIGURE 10 Sustainability-oriented innovations' (SOIs) deployment stages. Adapted from Adams et al. (2016) and Lubin and Esty (2010). [Colour figure can be viewed at wileyonlinelibrary.com]

5.2 | Theory-building: dynamic integration of SOIs

Our analysis allows us to conceptualize some key characteristics of a dynamic SOI strategy. We propose three propositions for further scholarly investigation, consistent with the theory-building process of exploratory case research (Eisenhardt, 1989; Grodal et al., 2021). The propositions serve to provide greater empirical and theoretical consistency to the observations we made, allowing us to fill the gap in the strategic management of SOIs.

Innovation is critical for introducing new products and services, ensuring an organization's long-term survival, and it can also be mobilized to pursue environmental and social objectives (Adams et al., 2016). Previous research outlines the positive relationship between corporate social responsibility policies and improved outcomes at the organizational level (Aguinis & Glavas, 2012). Our findings align with these results, as the case company has sustained significant financial and non-financial development over the past decade while deploying strategic innovations for sustainability.

Our in-depth analysis of the diffusion of SOIs inside and outside the company under examination allows us to formulate the first proposition:

> **Proposition 1.** Sustainability-oriented strategies based on wide-ranging innovations can improve ESG performance without eroding financial results. Such innovations need to be multi-layered and progressively cover all areas of activity of a company. The dimensions of a process, supply chain and product innovation should be included through explorational, procedural and communicational practices, avoiding isolated flagship projects.

This first proposition may seem daunting for companies that cannot immediately address sustainability with innovations in all their areas of activity. However, following our longitudinal exploration, we conclude that a gradual dynamic approach is also effective. Thus, our second proposition posits the following:

> **Proposition 2.** SOIs rely on capacity and knowledge-building over time. Companies can start with less complex innovations and gradually approach more challenging solutions, layering internal expertise over time.

This second proposition has important managerial implications: the crucial factor in building a sustainability strategy is not so much money but rather time. The company considered in our case study did not start implementing SOIs at the peak of its turnover. However, when it was still relatively small, and rather than betting on a few massive projects, it diffused the sustainability strategy throughout the company, favouring progressively more ambitious innovations. Lastly, our third finding leads to the following proposition:

> **Proposition 3.** Multilayered SOIs deployed dynamically over time should be sustained through a commitment and a unified vision of the top management for the company's sustainability strategy. The successful implementation of SOIs is grounded on an approach that prioritizes strategy over operations.

A commitment of a company's CEO is essential to navigate changes in the company's structure over time. Our case study

illustrates how sustainability measurements and improvements can become more challenging with the acquisition of other brands and evolving supply chains in the new phases of business development. Therefore, the idea of starting from a broader strategic viewpoint to handle changes remains a core managerial best practice (Collins & Porras, 1996), even in the context of SOIs.

5.3 | Limitations

Despite the careful empirical design behind our study, our research has some limitations. The analysis is based on a single longitudinal case study, which limits the external validity of the results. Our theoretical propositions can guide future explorations but require further testing in other industries where sustainability and classic value creation strategies seem conflictual. For example, the cost dimension in high-end fashion is less relevant for shaping strategic decision-making than in other sectors. Nonetheless, we believe our results have broad applicability because tier-one companies are not the final price makers, and they need to remain competitive in terms of costs and quality to satisfy the demand of downstream retailer brands. Therefore, the fact that, in our case study, a tier-one engineering company has successfully managed to implement this sustainability strategy attests not only to the value of its leadership but also to the feasibility of such a trajectory, even without substantial price margins.

Another caveat regarding our results is related to the rapidly changing regulatory context on the topic of sustainability. The company we studied started as a pioneer in the sector when most innovative experiments were voluntary, informal and unregulated. In the coming years, increasing stringency from policymakers could erode some of the competitive advantages that PG has enjoyed from being a first mover and could make it less feasible to follow a slow, gradual trajectory toward sustainability. Other companies may need to carefully coordinate the entire supply chain around policymakers' and final clients' legislative and market signals.

6 | CONCLUSIONS

In this paper, we explored the strategic layering of SOIs in a fashion engineering company operating in the luxury apparel sector. We find three main results: first, experimentation occurs across all company areas. Second, innovative actions in the earlier stages set the foundations for more substantial and ambitious cumulative innovations over time. Third, the CEO's commitment and strategic vision are essential to support the innovations. Overall, we see that this dynamic sustainability strategy does not rely on a few major innovative projects but rather on the accumulation of broad-ranging innovative activities with a clear, long-term vision.

Most companies with consolidated businesses in a 'dirty' sector find it hard to incorporate sustainability principles in their core activities to achieve triple-bottom-line benefits. As a result of the pressure of final clients, value chains and regulators, most companies would prefer a simple, fast and relatively cheap recipe to become 'sustainable'. Our analysis sheds light on the strategy of a B2B luxury fashion company based on incremental innovations that advanced from the pilot stage to encompass the entire company and beyond. The importance of time and integration for this process cannot be understated. From this viewpoint, iterative cycles of SOI adoption represent a business opportunity for fashion and textile companies relevant to practitioners and scholars.

From a managerial perspective, the principles discussed in this study are particularly relevant for businesses operating in sectors with limited sustainability culture. Our study offers a practical case of how the luxury industry can leverage sustainable innovations strategically. We provide concrete patterns for companies to rethink their 'old' business strategies, treating sustainability as a core value embedded in all company's dimensions and practices. Our analysis shows how strategically incorporating sustainability innovations can be a business opportunity rather than a cost.

From an academic perspective, this research contributes to the nascent literature on the strategic management of SOIs. Our three propositions enhance this research field's theory and open the possibility to test them in other contexts. We hope future studies will engage with this question in a multiple case study design with other firms with similar industries and perform a cross-case analysis. Moreover, it would be essential to compare the experience of different supply chains that have undergone a similar dynamic multi-layered implementation of SOIs. Finally, an interesting avenue for future research could be to test our theoretical propositions with quantitative methods through a large-scale investigation.

Acquiring new partner companies appears as one of the key challenges for a sustainability-innovation strategy. In the case of PG, as the group expanded, new complexities emerged, as reflected in the sustainability performance of different plants. Additionally, larger companies will likely be pushed toward more substantial innovations as the fashion industry becomes more sensitive to this topic. Our case study indicates that an innovative but relatively small first mover, such as PG, did not require a massive shift to remain a sustainability leader in the past decade. However, a prudential strategy based on small incremental steps might not be sufficient in the future as more competitors adopt sustainable production innovations. We leave this hypothesis for future studies.

Our research is the first step in exploring how innovations can strategically ensure a synergistic interaction between luxury and sustainability. SOIs are key to developing new win-win solutions for this (so far) highly unsustainable industry. Thus, our analysis brings new ideas on how to reconcile the new sustainability solutions and old value-creation strategies based on unsustainable business mentalities. One of the core values of luxury apparel has always been a long-term perspective: brand names that evoke timeless products whose design will be stylish for decades to come. This longstanding perspective should increasingly include the external impacts of luxury companies on the planet. Meeting this challenge will require a substantial innovative effort on all fronts.

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DATA AVAILABILITY STATEMENT

Data are available on request from the authors.

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ENDNOTES

[1] Anecdotally, luxury retail brands have been promoting various sustainable initiatives. Louis Vuitton established an environmental department already in 1992; Gucci, Saint Laurent, Prada and Chanel soon followed with some innovative environmentally-friendly materials like bioplastics; Stella McCartney recently substituted virgin cashmere with regenerated cashmere and sustainable viscose (Lo & Ha-Brookshire, 2018).

[2] The engineering of garment manufacturing entails: (i) pattern-making from a designer's sketch through technological applications and, in the most advanced cases, 3D software; (ii) the cutting process; (iii) prototyping, with the involvement of end-customers for the fitting, final checks and approval; (iv) sample collection creation and production ready for runways, showrooms and fashion shows.

[3] The literature uses definitions like eco-innovations, eco-friendly innovations, environmental innovations, green innovations when focusing on the environment; or broader terms, such as sustainable innovations, sustainability-driven innovations or sustainability-focused innovations. We use 'sustainability-oriented innovations' (SOIs) throughout this paper as a synonym for these terms, encompassing environmental and social sustainability (Varadarajan, 2017).

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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