



An analytical and bibliometric approach to decision-making in sustainable luxury supply chains

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ABSTRACT

The transition to sustainability is a key objective of global policies. However, the implementation and adoption of sustainable practices in supply chains vary significantly across market sectors. Research highlights the luxury sector as particularly critical, with key stakeholders - supply chain managers and consumers - requiring further investigation to better understand the barriers to adopting sustainable production processes and accepting green products. This study explores the current managerial capabilities and perspectives on integrating sustainable practices within luxury supply chains. A bibliometric analysis was conducted using the Scopus database and VOSviewer software to identify keyword clusters and their interrelationships. Six clusters were identified and analyzed, offering insights into effective strategies for overcoming specific managerial barriers. Practical contributions include an actionable playbook in which the sustainable luxury paradigm serves as an enabler for enhancing consumer value while creating managerial opportunities to align profitability with sustainability in circular supply chains.

1. Introduction

1.1. Background and motivation

The sustainability-oriented megatrend [16] is closely linked to a growing green awareness among both consumers and producers, driven by the need to reduce ecological impacts and ensure a sustainable future for the planet and next generations. Policy frameworks such as the SDGs [39], the EU Green Deal [11], and the EU Circular Economy Action Plan [12], reinforce the shift toward lower waste and lower carbon, encouraging companies to adopt sustainable strategies such as Extended Producer Responsibility (EPR) [44]. Under the EPR framework, producers aim to manage the entire lifecycle of their products through a circular approach that incorporates reverse logistics, enabling the return of end-of-life or end-of-use (EOL/U) products to manufacturers [34]. However, compared with forward supply chains, circular models add uncertainty [26], such as end-of-life product condition, or consumers' behavior, which complicates strategic decisions ([43]) ([43]) and can fuel managerial skepticism about remanufacturing and related practices [18] [36]. At the same time, consumer benefits are heterogeneous across segments, which leads to uncertain consumer behaviors and mixed

acceptance of “green” offerings [38].

Despite these challenges, circular SCs have become increasingly vital, as underscored by recent socio-political and economic crises. For instance, the growing scarcity of raw materials has highlighted the importance of recovering materials and components from EOL/U products [35]. This emphasizes the critical role of sustainability practices and environmental protection policies in shaping strategic decision-making within SCs.

The transition toward sustainable paradigms is expanding across all sectors, and circular supply chain management is gaining interest in research, also in small and medium enterprises where sustainability adoption could appear limited [29]. However, some remain less explored and more challenging to penetrate with sustainability practices. A striking example is the luxury sector, which exhibits a dichotomous trend. [40] present a series of studies demonstrating, on the one hand, that luxury products align with sustainability principles due to their inherent characteristics. On the other hand, they also highlight research describing compatibility issues between luxury and sustainability, attributed to their supposedly conflicting values. For instance, from a consumer perspective, a luxury item may lose its perceived quality if it contains recycled materials, just as environmental features

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could diminish its luxurious and desirable appeal. According to Wang [41], luxury can be defined as “*expensive and exclusive products and brands that are differentiated from other offers.*”, and luxury products are featured by “*...exquisite design and craftsmanship, sensory appeal, and distinct socio-cultural narratives*”. Wang also remarks that luxury consumers demonstrate specific competencies, such as expertise in luxury products, sensitivity to luxury symbolism, and an appreciation for aesthetic refinement. Their consumption of luxury goods is driven by two primary factors: wealth-based motivations and competency-based motivations, which depend on various individual and social factors, including consumption goals, considerations, choices, usage patterns, and outcomes.

Forecasting consumer acceptance of sustainable luxury products is inherently complex. Consequently, these consumer-related uncertainties affect the managerial side of the luxury supply chain, which must deal both with customer acceptance and economic profitability of adopting sustainable processes and practices. Supporting this, Bhandari et al. [3] identified 20 specific barriers to sustainable sourcing in the fashion industry, grouped into six distinct dimensions, as summarized in Table 1. Notably, such barriers can be generalized to the broader luxury supply chain, being related to SC management, also illustrating the intricate challenges of integrating sustainability into the luxury SC.

Building on the challenges and barriers identified in sustainable luxury SCs, [8]. in the LuxCo2030 report (2021) outlined a strategic roadmap for luxury brands to navigate the upcoming decade. They identified five key strategies for adapting to emerging megatrends: (1) redefining brand purpose towards the greek *kalokagathia* concept, *i.e.*: the idea that luxury embodies what is beautiful and good both for people and the planet; (2) decoupling growth from production volume: investing in circular business models, such as resale, rental, reuse, and remanufacturing. This approach aims to increase the lifecycle value of items, with re-marketing expected to contribute to a 65 % revenue boost by 2030. (3) Ensuring SC transparency and traceability: providing customers with detailed data on the environmental and social impacts of sourcing, production, and product use. (4) Maximizing environmental

Table 1
Barriers holding back sustainable luxury SC - from [3].

Barrier dimension	Specific barrier
Management, Government Support, and Infrastructure Barriers (MGI)	MG11 - Limited support from governing authorities
	MG12- Insufficient commitment from top management
	MG13 - Lack of eco-literate and skilled employees
	MG14 - Inadequate awareness
	MG15 - Hard transition to new business models
	MG16 - Inadequate infrastructure
	MG17 - Social responsibility
Supplier Barriers (S)	S1- Absence of suitable supplier training and reward system
	S2 - Weak partnerships and integration between SC partners
	S3 - Poor commitment and asymmetric customer information sharing
Finance Barriers (F)	F1 - Cost of sustainable raw materials
	F2 - Rise in cost of investment
	F3 - Uncertain return on investment
Material Barriers (M)	M1 - Shortage of superior quality raw materials
	M2 - Undersupply of sustainable raw materials
	M3 - Complex material structure and composition
Sustainable packaging and Human Resource Barriers (PH)	PH1 - Cost of eco-friendly packaging
	PH2 - Resistance to upskill and knowledge sharing
Certificates and Customer Perceptions (CC)	CC1 - Certifications
	CC2 - Customer perceptions

and social commitments: reducing greenhouse gas emissions by adopting renewable energy and sustainable raw materials, such as reusing end-of-life parts through reverse logistics. Social commitments could include leveraging inclusivity as a marketing strategy, aligned with evolving beauty standards. (5) Shifting the perception of sustainability from being a cost center to a long-term revenue driver.

In line with these strategies, the concept of positive luxury was spread in 2022 [2] highlighting how luxury businesses and sustainable growth can support and benefit each other, paving the way to the paradigm of Transformative Luxury Research (TLR), which explores how luxury brands can transition to positive practices and foster sustainability-driven innovation.

Finally, from the background analysis, it is evident that overcoming barriers to sustainable luxury requires the adoption of effective strategies able to enhance added value for both consumers and producers across each of the value dimensions identified by Wiedmann et al. [42]. These dimensions, namely: social, individual, functional and financial, currently are not explicitly involving the environmental value dimension, which should be properly embedded into the luxury business propositions to allow acceptance and widespread consensus among the consumers.

1.2. Research scope and paper's structure

The challenges of integrating sustainable practices into the luxury SC underscore the complexity of this endeavor. Prior sustainability and circular-economy research has rarely focused on luxury supply chains through a managerial lens. When luxury is covered, insights focus on specific sub-sector - *e.g.*, fashion - or consumer perception/behavior studies, leaving managerial barriers and decision tools underspecified. Therefore, this study investigates current scientific knowledge on environmentally-sustainable practices within luxury SCs, as well as the implemented strategies, results, lessons learned and future orientations that managers are adopting to drive economic growth in the evolving landscape projected by LuxCo2030 report.

In detail, our study addresses four gaps: (i) a sector-specific, manager-centric mapping of sustainable practices in luxury supply chains; (ii) a bibliometric synthesis that explicitly links knowledge clusters to actionable managerial barriers; (iii) a cross-cluster integration, including Industry 4.0 enablers with environmental assessment practices; and (iv) region-sensitive implications. The main objective is to provide practical insights to support sustainability-oriented strategic decision-making while also contributing to the theoretical understanding of research gaps in sustainable luxury SC management.

Section 2 details the methodology, which employs a bibliometric analysis of literature sourced from the Scopus database. Recent bibliometric research underscores the consistency of bibliometric and network analytics to track knowledge evolution on sustainability-focused issues [30]. Using VOSviewer software, relevant keyword-clusters and their interconnections were identified and analyzed. Section 3 presents the results derived from the cluster analysis, providing a detailed discussion of the findings. Finally, Section 4 concludes the paper by summarizing the practical implications and theoretical contributions of this research, offering valuable guidance for managers and practitioners navigating the transition toward sustainable luxury.

2. Methods

2.1. Identification and selection of relevant keywords for scopus search

The search was conducted on January 2025. The Scopus database was chosen for its well-known trustworthiness for large-scale analyses [1] We built a four-block Boolean schema, based on the following elements: (*luxury domain*) AND (*manager/producer lens*) AND (*supply-chain activities*) AND (*sustainability*), each with OR-expanded synonyms in each block, targeting the “*Article Title, Abstract, and Keywords*” fields to

align with the research scope. In detail, the term “Luxury” was used to define market domain of interest. Manager’s perspective was included through the terms “producer” OR “manufacturer” OR “remanufacturer” OR “manag*”. Then, the third block regarding key SC activities and entities was referred to the industrial supply chain holons [26], i.e.: “process*” OR “product*” OR “manufacturing” OR “remanufacturing” OR “supply” OR “industry” OR “logistics”. Finally, the environmental sustainability scope was refined by the fourth block of keywords: “sustainab*” OR “eco*” OR “green” OR “environment*”.

Following, the exact syntax of the Scopus query, using “*” as truncation symbol:

TITLE-ABS-KEY(luxury AND (producer OR manufacturer OR remanufacturer OR manag*) AND (process* OR product* OR manufacturing OR remanufacturing OR supply OR industry OR logistics) AND (sustainab* OR eco* OR green OR environment*)).

This resulted in 1066 documents. Then, the results were refined by applying 6 filtering criteria as follows.

1. Publication Year. To focus on the impact of the UN’s Sustainable Development Goals (SDGs), declared in 2015, only publications from 2015 to January 2025 were included, reducing the dataset to 671 articles.
2. Language. Only English-language articles were selected, narrowing the dataset to 661.
3. Subject Area. Relevant fields were chosen, including “Business, Management and Accounting”, “Social Sciences”, “Engineering”, “Environmental Science”, “Economics, Econometrics and Finance”, “Energy”, “Computer Science”, “Materials Science”, “Arts and Humanities” and “Decision Sciences”. This filter reduced the results to 610.
4. Document Type. Since journal papers are subject to formal review and evaluation processes, we assumed that those categories represent a “certified knowledge” [9], of highest quality in terms of form and content compared to other document types. Thus, limiting the search to “Article” the number of documents was reduced to 355.
5. Authors. Articles without author names were excluded, reducing the dataset to 352.
6. Abstract content analysis. Abstracts were analyzed to ensure alignment with the study’s objectives—exploring managerial and producer perspectives on sustainable transitions in luxury SCs. Articles focusing on consumer-related topics (e.g., customer acceptance, brand loyalty, or luxury value perception) were excluded. This final step resulted in a dataset of 156 articles.

Fig. 1 summarizes the documents selection steps following the PRISMA flow diagram.

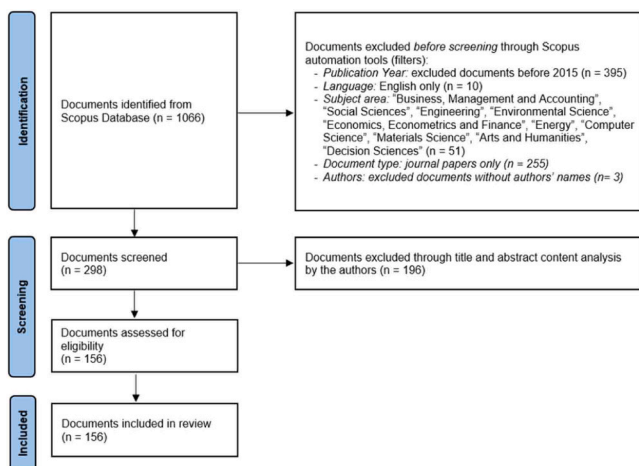


Fig. 1. Documents search step on PRISMA flow diagram.

2.2. Search filter analysis

The final corpus of selected papers was analyzed to assess current trends in publication year, country distribution, subject area, source title, and affiliation. This approach allows for a preliminary evaluation of the search results.

Fig. 2 illustrates research productivity trends and key insights in this field. Panel (a) shows a consistent increase in research output from 2015 to 2022, reflecting growing attention to the topic over time. Panel (b) highlights China as the leading contributor, accounting for nearly 20 % of the research in this area. Alongside India (11 %), it is remarkable that these two developing countries [45] collectively contribute almost one-third of the scientific literature on this topic. Panel (c) reveals that “Business, Management and Accounting” represents the most investigated area (28,1 %), remarking the significant interest in managing the sustainable transition within the luxury sector. Additionally, “Social Sciences” accounts for 18 % of the research, demonstrating that, even if consumers’ perspective has been excluded from the search, it remains a critical factor influencing luxury SC managers’ decisions.

Table 2 summarizes the analysis of source journals. Notably, the

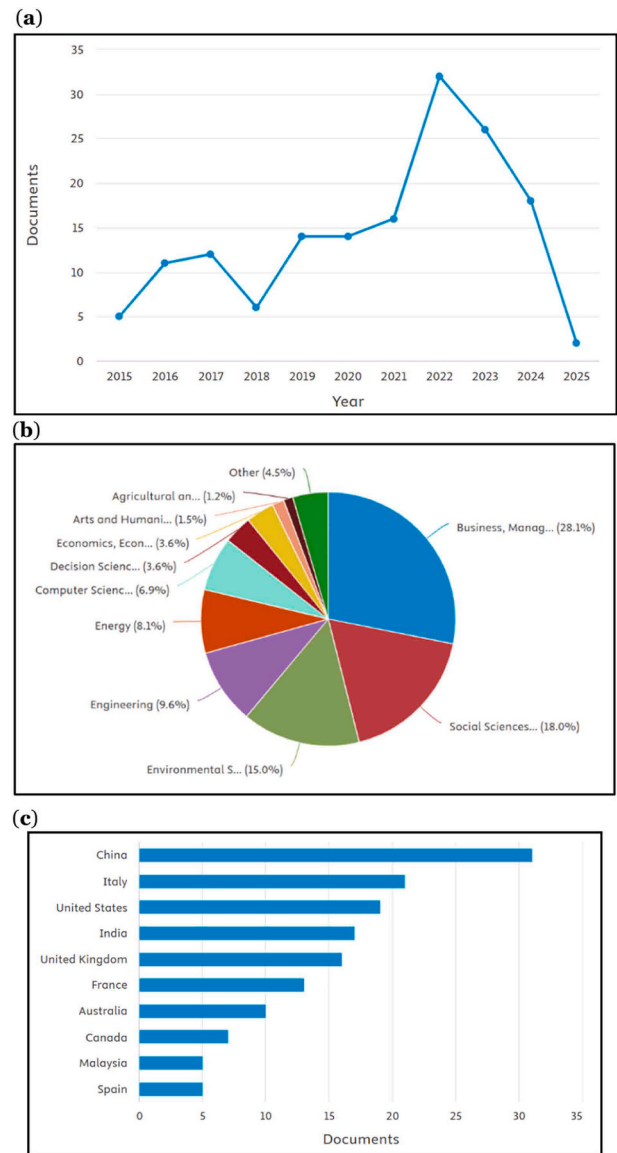


Fig. 2. (a) Paper distribution per Year; (b) Paper distribution per Country; (c) Paper distribution per Subject Area.

Table 2
Paper distribution per source title.

Source Title	Number of Articles
Sustainability Switzerland	15
Business Strategy and the Environment	6
Journal of Cleaner Production	5
Transportation Research Part E Logistics and Transportation Review	5
Int. J. Of Retail and Distr. Manag.	4
Journal of Business Research	4
Int. J. Of Contempor. Hospitality Manag.	3
Int. J. Of Hospitality Manag.	3
Worldwide Hospitality and Tourism Themes	3
Cogent Business and Manag.	2
Computers and Ind. Eng.	2
Emerald Emerging Market Case St.	2
Industrial Market. Manag.	2
Int. J. Of LCA	2
Int. J. Of Op. and Prod. Manag.	2
Journal of Global Fashion Mark.	2
Journal of Sust. Tourism	2
J. of Korean Soc. of Cloth. and Textiles	2
Psychology and Marketing	2
Other 88 journals	1

most prominent journal in this field is *Sustainability Switzerland*, with 15 articles. It is worth highlighting that 44 % of the papers are concentrated in just 18 % of the journals, indicating a clear trend toward specialization. For example, journals such as *Business Strategy and the Environment*, *Journal of Business Research*, and *Cogent Business and Management* demonstrate a diverse focus on business research. Similarly, journals like *Emerald Emerging Market Case Studies*, *Industrial Marketing Management*, *Journal of Global Fashion Marketing*, and *Psychology and Marketing* reflect diverse orientations within marketing research, including respectively: case studies in emerging markets, marketing management, the fashion sector, and the psychological dimensions of marketing. [Table 3](#) reveals that the institutions primarily focusing on SC management are based in China, Italy, and the UK. This finding aligns with the distribution of papers by country discussed earlier.

2.3. Bibliometric analysis

The second type of analysis conducted in this study focuses on keyword correlations, supplementing the Scopus filter results. The VOSviewer software was chosen for its technical robustness and suitability for exploratory bibliometrics [21]. For validation and robustness, we ran sensitivity checks by varying the minimum occurrences, minimum link strength and minimum cluster size. The cluster structure remained stable across reasonable thresholds, with only minor keyword movements that did not affect interpretation. We reviewed high-salience terms, assigned cluster labels, and mapped clusters to managerial barriers using the rule set reported below. These steps provide parameter robustness and expert judgment appropriate to an exploratory, manager-centric analysis, tailored to the objectives of this study applying the following settings:

Table 3
Affiliation paper distribution.

Affiliation	Number of Articles
Donghua University (China)	4
Sun Yat-Sen University (China)	4
Politecnico di Milano (Italy)	4
University of Manchester (UK)	3
Hong Kong University (China)	3
Other 24 institutions	2
Other 90 institutions	1

- Co-occurrence Analysis.** The frequency of two or more keywords appearing together across different articles was analyzed, resulting in 1100 keywords. To refine the output, the minimum number of occurrences for a keyword to be included was set to 2, narrowing the list to 154 keywords. Although this broad approach may seem inclusive, it aligns with the exploratory nature of this research.
- Relevant Keywords.** In this step, some keywords were excluded due to limited relevance or redundancy. These exclusions were based on: (i) duplicate keywords already included with higher occurrence counts, (ii) generic terms that lacked clear meaning without context, and (iii) niche terms that were irrelevant to the broader analysis.
- Lines Parameter (Min. Strength).** Defines the minimum number of links required for a line connecting two keywords to be displayed. The setting was adjusted based on each cluster analysis. At a setting of “1,” a comprehensive map was generated, while “2” reduced the number of lines, highlighting the strongest connections in the most populated clusters. Setting the value to “3” further narrowed the focus, displaying only Cluster 1. Although “3” was useful for emphasizing the strongest links, “2” was also used in clusters where stronger links were sparse or absent.
- Cluster Analysis.** The “Min. Cluster Size” parameter was set to 14, meaning that a cluster needed at least 14 keywords to be considered significant. This setting was chosen based on the observation that when the parameter was set to 1, there were 6 clusters, with the smallest containing 14 keywords. A preliminary cluster analysis confirmed the consistency of topics across the 6 clusters.
- Cluster labeling.** Labels were assigned by examining, within each cluster, the highest-salience keywords (those with the largest numbers of links and occurrences and strong link strengths) and the internal ties highlighted by VOSviewer.
- Mapping to managerial barriers.** Using the barrier framework reported in [Table 1](#), we independently coded cluster/barrier relevance with the following decision rules: a cluster “contributes” to a barrier when at least one high-salience keyword in that cluster denotes a managerial lever/constraint that directly addresses the barrier (e.g., *blockchain/traceability* for S2; *LCA/energy efficiency* for F3 and M3; *CSR/green practices* - MG17). In detail, high-salience keywords were those that (i) lie in the top quartile by occurrences or links for that cluster and (ii) match the barrier lexicon (exact term or close stem). To avoid over-interpretation, we kept labels close to the observed keyword structure and provided concrete examples in each cluster (e.g., *CSR/China/India* in Cluster 2; *LCA/renewables* in Cluster 4), which supports the barrier links. We then summarized the count of supporting keywords for each barrier/cluster and listed their occurrence/links values, eventually evaluating pairwise link strength (LS) between supporting terms. Even if this overlap metric is descriptive, it provides a transparent, reproducible basis for the cluster/barrier crosswalk.

3. Results

[Fig. 3](#) presents the clustering output. As mentioned above, each cluster has been labeled in alignment with its thematic focus, as follows:

- Cluster 1 (Red): “Towards sustainable circularity in luxury SCM”;
- Cluster 2 (Green): “Sustainable tourism and luxury hospitality industry management”;
- Cluster 3 (Blue): “Economic strategies and SC management in luxury commerce”;
- Cluster 4 (Yellow): “Energy efficiency, renewable solutions, and environmental impact assessment”;
- Cluster 5 (Purple): “Sustainable luxury marketing and fashion trends”;
- Cluster 6 (Light-blue): “Decision making and knowledge management in luxury urban housing”.

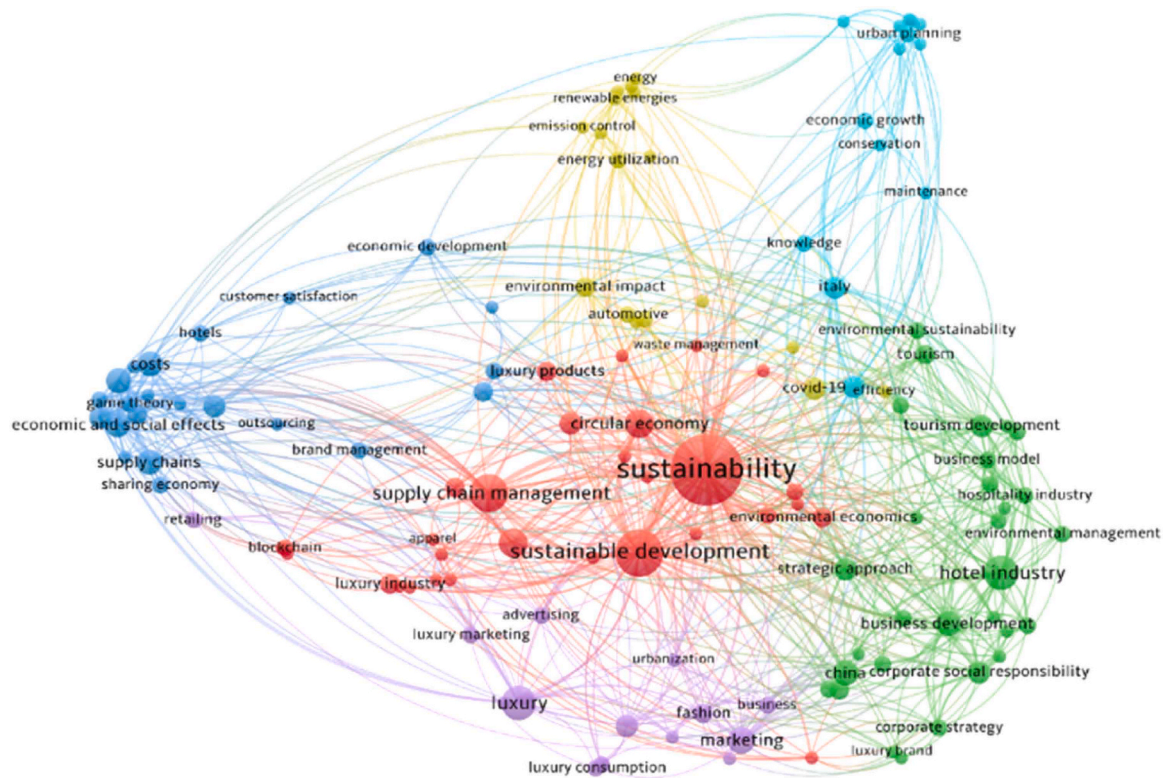


Fig. 3. Clustering analysis output as per VOSviewer.

In the following subsections, each identified cluster is analyzed in detail, along with a correlation analysis between them. Throughout this section, in round parentheses are indicated the number of links (L#) and of occurrences (O#) for each keyword that are read in VOSviewer. Also, the link strength is considered to analyze specific correlation between couples of keywords.

3.1. Cluster 1 (red). Towards sustainable circularity in luxury SCM

Cluster 1 highlights key themes related to sustainability within luxury supply chain management. The leading keywords, with the highest number of links and occurrences, include "sustainability" (L90, O42), "sustainable development" (L63, O20), "supply chain management" (L37, O13) and "circular economy" (L31, O8). Together, these four keywords account for nearly 54 % of the occurring keywords and 50 % of the link network in this cluster. This concentration underscores the significant focus of luxury managers on implementing circular economy strategies and achieving sustainability through effective supply chain management. This emphasis is further supported by the following link strengths (LS), which reflect the relationships between these core concepts:

- LS equal to 8 for the link between "sustainability" and "supply chain management";
- LS equal to 5 for the following links: "sustainability" and "circular economy"; "circular economy" and "sustainable development"; "supply chain management" and "sustainable development".

Next, the analysis identifies the luxury sectors most engaged in sustainable circularity. The fashion sector emerges as a primary focus, with keywords such as "luxury fashion" (L19, O8) and "fashion industry" (L9, O4), as well as the "textile industry" (L12, O2). The LS between "sustainability" and "luxury fashion" is 5, indicating a strong relationship between these concepts in the context of sustainable SCs. In fashion sector, several emerging concepts are capturing the attention of practitioners, reflecting new directions in

designing sustainable luxury supply chains. Key terms in this regard include: "environmental economics" (L18, O4), "resource management" (L10, O2), "pollution control" (L9, O2), "carbon footprint" (L10, O2), "waste management" (L8, O2), "traceability" (L6, O2), "ethics" (L5, O2), "blockchain" (L7, O3), "triple bottom line" (L5, O2). Also, it's remarkable that key agents driving the development of sustainable luxury SCs include small and medium-sized enterprises "smes" (L9, O2), "developing countries" (L3, O2) and "France" (L11, O2).

The leading keywords in Cluster 1 have been further analyzed in connection with other clusters. By setting the minimum link strength (LS) to 3 for relevance, we found that "sustainability" is the only keyword providing significant links to other clusters, as follows:

- Links to Cluster 2: "hotel industry" (LS4), "business development" (LS4), "stakeholder" (LS3), "strategic approach" (LS3);
- Links to Cluster 5: "luxury" (LS4), "fashion" (LS3)
- Links to Cluster 6: "knowledge" (LS3), "Italy" (LS5)

3.2. Cluster 2 (green). Sustainable tourism and luxury hospitality industry management

Cluster 2 focuses on the luxury tourism industry, with over 30 keywords identified. Among these, 8 (27 %) are directly related to "tourism" and "hotels". This is evident in the prominence of keywords such as "hotel industry" (L33, O11), "tourism development" (L26, O5), "hospitality industry" (L20, O3), "sustainable tourism" (L16, O3), "tourism" (L16, O4), "ecotourism" (L15, O3), "luxury hotels" (L7, O4), "tourism management" (L5, O2). The connection strengths further underscore the strong correlation between "hotel industry" and "business development" (LS3). Moreover, there are occurring keywords revealing that the focus of managers and "stakeholders" (L16, O3) in "corporate strategy" (L16, O3) for "business development" (L31, O6) passes across sustainable "strategic approaches" (L22, O5) supporting "green economy" (L12, O2). This enables "corporate social responsibility" (L21, O5), "environmental management" (L11, O3) for "environmental

sustainability” (L13, O3) and “green practices” (L11, O3). The developing countries “China” (L22, O11) and “India” (L10, O2) stand out as the most frequently studied countries in the “implementation process” (L12, O2) of sustainable luxury tourism.

The leading keywords of Cluster 2 were analyzed in relation to other clusters. Setting the minimum link strength (LS) at 3 to ensure significance, we observed connections primarily with Cluster 1. This highlights the increasing consideration of sustainable practices in the luxury tourism and hospitality industry. Specifically, the following links were identified: “hotel industry” to “sustainability” (LS4), “business development” to “sustainability” (LS4), “stakeholder” to “sustainability” (LS3), “strategic approach” to “sustainability” (LS3) and to “environmental economics” (LS3) (Table 4).

3.3. Cluster 3 (blue). Economic strategies and SC management in luxury commerce

Cluster 3 shifts the focus to managers’ economic evaluations within the “commerce” (L16, O4) and “supply chains” (L22, O6) of “luxury goods” (L15, O5). Here, the “sales” (L19, O6) are evaluated not only in terms of “costs” (L22, O6) and the “profitability” (L11, O3), but also in relation to the “economic and social effects” (L22, O6), “social influence” (L14, O5) and “customer satisfaction” (L7, O2). “Game theory” (L16, O3) emerges as a key tool for the “strategic management” (L4, O2), now looking at “sharing economy” (L6, O3) and “outsourcing” (L5, O2) solutions in the “globalization” (L6, O2) scenario for effective “economic development” (L11, O3). In this approach, the “human” (L11, O2) and the environment are central stakeholders in sustainable luxury “product development” (L11, O3).

The link strengths analysis within Cluster 3 shows “economic and social effects” strongly linked to “social influence” (LS4), “sales” (LS4), “profitability” (LS3) and “supply chains” (LS3). Also, “social influence” is linked to “sales” (LS3) and “profitability” (LS3). Finally, “sales” are strongly correlated to “costs” (LS4) and “profitability” (LS3). Notably, there are no significant links to other clusters in this analysis.

Table 4 Cluster 1.

CLUSTER 1 (red)		
Keyword	Links	Occurrences
sustainability	90	42
sustainable development	63	20
supply chain management	37	13
circular economy	31	8
luxury fashion	19	8
environmental economics	18	4
case study	15	5
research work	13	3
textile industry	12	2
france	11	2
luxury products	11	4
carbon footprint	10	2
creativity	10	3
resource management	10	2
fashion industry	9	4
pollution control	9	2
smes	9	2
sustainable supply chain	9	2
waste management	8	2
blockchain	7	3
luxury industry	6	4
traceability	6	2
apparel	5	2
conceptual framework	5	2
ethics	5	2
triple bottom line	5	2
counterfeit	4	2
developing countries	3	2
product innovation	3	2
sustainability-oriented innovation	2	2

3.4. Cluster 4 (Yellow). Energy efficiency, renewable solutions, and environmental impact assessment

Cluster 4 emphasizes the “environmental impact” (L20, O4) of luxury supply chains, particularly as a “performance” (L5, O2) indicator for “sustainable development” (L7, O2). The “emissions control” (L8, O2) can be achieved by “controlled study” (L11, O3) of “energy utilization” (L14, O3), for example conducting a “life cycle assessment” (L9, O2) study, as confirmed by the link strength equal to 2 between “life cycle assessment” and “controlled study”. Additionally, the use of “renewable energies” (L11, O2), such as “solar power generation” (L7, O2), contributes to achieving “energy” (L8, O2) “efficiency” (L6, O2). This topic gained even more significance during the “covid-19” (L10, O5) pandemic.

Cluster 4 does not exhibit strong internal links (i.e., greater than LS3), prompting the minimum link strength to be adjusted to 2. Nevertheless, links to Cluster 1 were observed, particularly with “energy utilization” linking to “sustainability” (LS2) and “sustainable development” (LS2), as well as “renewable energies” linking to “sustainability” (LS2).

3.5. Cluster 5 (Purple). Sustainable luxury marketing and fashion trends

Cluster 5 provides insights into “marketing” (L27, O7) within the context of “luxury” (L23, O11) “business” (L16, O3). As observed in Cluster 1, “fashion” (L16, O4) remains a central sector in “luxury consumption” (L6, O3), with a notable shift in consumer behavior. Specifically, customers are increasingly open to “sustainable luxury” (L5, O3) “purchase intention” (L3, O2), including a growing interest in “second-hand” (L8, O2) luxury products. For managers, “marketing management” (L7, O2) is closely linked to understanding “consumption behavior” (L21, O5), as emphasized by the strong connection between the two keywords (LS3). This relationship is particularly relevant in the context of “urbanization” (L15 O2) which informs effective “advertising” (L13, O3) policies (Table 5).

Table 5 Cluster 2.

CLUSTER 2 (green)		
Keyword	Links	Occurrences
hotel industry	33	11
business development	31	6
tourism development	26	5
china	22	6
strategic approach	22	5
corporate social responsibility	21	5
hospitality industry	20	3
corporate strategy	16	3
management practice	16	3
stakeholder	16	3
sustainable tourism	16	3
tourism	16	4
ecotourism	15	3
business model	14	3
environmental sustainability	13	3
perception	13	3
green economy	12	2
human resource	12	3
implementation process	12	2
environmental management	11	3
green practices	11	3
india	10	2
luxury brand	9	2
innovation	8	3
luxury hotels	7	4
scarcity	7	2
willingness to pay	7	2
institutional framework	6	2
tourism management	5	2
leadership	4	2

Cluster 5 provides strong links to Cluster 1. As expected, “Luxury” (LS4) and “fashion” (LS3) are closely associated with “sustainability”. By reducing the minimum link strength to 2, we observe that “luxury” and “marketing” which are linked with LS2, act as central points of focus. “Luxury” attracts links to keywords such as “retailing”, “experience”, “consumption behavior” and “second-hand”, highlighting the need for managers to understand consumer acceptance, experiences, behaviors, perceptions towards sustainable products. The keyword “marketing” is also linked to “consumption behavior”, confirming the previous deduction. As well, it is linked in LS2 to Cluster 2 keywords “corporate strategy” and “business development”, to Cluster 3’s “decision making” and to Cluster 1’s “sustainable development” and “sustainability”. These correlations clearly indicate that managers are adopting sustainability-driven marketing strategies, which play a pivotal role in corporate strategy and business development.

This suggests that marketing and consumption are moving in step with sustainable luxury and rising interest in second-hand, while prior work warns that overt “eco” cues can affect perceived quality and exclusivity. This creates a sustainability/exclusivity conflict. We address it by framing sustainability with provenance-verified exclusivity: traceability-backed limited editions with auditable claims and repair/long life positioned as craftsmanship, rather than compromise. This aligns with Cluster 5 linkage between marketing management and consumption behavior - and with the observed acceptance of second-hand luxury - preserving desirability while favoring sustainability (Table 6).

3.6. Cluster 6 (Light-blue). Decision making and knowledge management in luxury urban housing

Cluster 6 focuses on key managerial insights related to the role of “decision-making” (L21, O5) and “knowledge management” (L12, O2) in the context of “urban planning” (L13, O3) and “economic growth” (L9, O3) for luxury sustainable supply chains. Geographical contexts like “Italy” (L23, O5) and “Turkey” (L12, O2) highlight regional influences on “conservation” (L8, O2) and “housing” (L7, O2) - specifically “urban housing” (L7, O2) - strategies. Analytical tools such as the “analytic hierarchy process” (L9, O2) are used to assess “environmental risks” (LL5, O2), with a focus on “maintenance” (L12, O2) and sustainable practices. This cluster suggests that the managerial approach is evolving to balance economic growth and sustainability, particularly in the context of luxury urban housing. Italy and Turkey have emerged as key

Table 6 Cluster 3.

CLUSTER 3 (blue)		
Keyword	Links	Occurrences
costs	22	6
economic and social effects	22	6
supply chains	22	6
sales	19	6
commerce	16	4
game theory	16	3
luxury goods	15	5
manufacturing	15	4
social influence	14	5
economic development	11	3
human	11	2
product development	11	3
profitability	11	3
pricing	10	2
brand management	9	3
hotels	9	3
customer satisfaction	7	2
competition	6	2
globalization	6	2
sharing economy	6	3
outsourcing	5	2
strategic management	4	2

models for practitioners in this field (Table 7).

Strong links are observed only to Cluster 1. Specifically, “Italy” is strongly connected to “sustainability (LS5), and also “knowledge” is linked to “sustainability” (LS3). These connections indicate that managers in luxury housing in Italy are heavily oriented towards sustainable practices, with these green practices being informed by knowledge of current policies, green standards, and novel sustainable development strategies. To explore the keyword correlations further, we reduced the minimum link strength to 2, revealing new significant connections. For example, “decision making” is linked to Cluster 1 keywords “sustainability” and “sustainable development”, underscoring that sustainability is a key driver of decision-making processes. Also, “decision making” is linked to “marketing” (Cluster 5) and to “strategic approach” (Cluster 2), highlighting that profitability within the marketing system is another primary driver for strategic decisions (Table 8).

3.7. Cross-cluster mechanisms for sustainability adoption

To clarify how the six clusters operate together, we here synthesize the main cross-cluster mechanism that runs from data generation to environmental assessment, across market communication, investment, and organizational scaling (Table 9).

Cluster 1 provides the granular operational data that Cluster 4 requires to move from sector averages to product environmental footprints. In practice, lot-level IDs (e.g., QR/RFID, barcodes), ERP/MES routing, together with line/machine energy sub-metering populate LCA inventories with verified provenance and process energy. This reduces data gaps and strengthens the attribution of impacts to specific products, materials, and process steps. The mechanism, then, closes the loop. Outputs from Cluster 4, such as hotspot analyses, feed back into Cluster 1 decisions - e.g., eco-design, material simplification, process upgrades, maintenance strategies -, ensuring that operational improvement and environmental assessment work as a single feedback cycle. The same evidence base supports Cluster 5 (market/consumer): it makes certifications and sustainability claims auditable, enabling provenance-rich positioning, authenticated recommerce, while preserving the brand’s exclusivity. Cluster 3 (economic and strategic evaluation) provides the financial logic - resulting in ROI, payback, risk sharing - to price LCA-identified options and reduce the risk of capital investment decisions. Cluster 6, on decision tools and knowledge management) institutionalizes choices through multi-criteria project selection and a knowledge hub -templates, checklists, playbooks, etc. - accelerating replication across products and regions. Cluster 2 situates adoption in hospitality and tourism, making the cluster 1 and 4 evidence visible to stakeholders, favoring implementation.

In summary, Cluster 1 provides the data; Cluster 4 turns data into

Table 7 Cluster 4.

CLUSTER 4 (yellow)		
Keyword	Links	Occurrences
environmental impact	20	4
energy utilization	14	3
controlled study	11	3
renewable energies	11	2
covid-19	10	5
energy efficiency	9	2
life cycle assessment	9	2
power	9	2
solar power generation	9	2
emission control	8	2
energy	8	2
sustainable development	7	2
automotive	6	3
efficiency	6	2
performance	5	2
food waste	2	2

Table 8
Cluster 5.

CLUSTER 5 (purple)		
Keyword	Links	Occurrences
marketing	27	7
luxury	23	11
consumption behavior	21	5
business	16	3
fashion	16	4
urbanization	15	2
advertising	13	3
retailing	8	3
second-hand	8	2
luxury marketing	7	3
marketing management	7	2
luxury consumption	6	3
sustainable luxury	5	3
experience	3	2
purchase intention	3	2
employee engagement	2	2

Table 9
Cluster 6.

CLUSTER 6 (light-blue)		
Keyword	Links	Occurrences
Italy	23	5
decision making	21	5
knowledge	15	3
urban planning	13	3
knowledge management	12	2
maintenance	12	2
turkey	12	2
analytic hierarchy process	9	2
economic growth	9	3
conservation	8	2
housing	7	2
urban housing	7	2
environmental risk	5	2
informal settlement	5	2

environmental performance metrics; Cluster 5 communicates and differentiates information; Cluster 3 provides economic appraisal and investment prioritization; Cluster 6 codifies practices for scaling; Cluster 2 adapts to service contexts. Such a cross-cluster logic provides the analytical bridge to the barrier-wise recommendations discussed in the next sections.

4. Discussion

4.1. Sustainable strategies in luxury SC

Our bibliometric analysis identifies six research clusters that, taken together, describe how managers in luxury supply chains adopt sustainability. We first summarize how clusters address the barrier families, then derive practical implications and regional recommendations. Insights from the identified clusters serve as strategic recommendations to address specific barriers, as detailed in Table 10.

The “Management, Government Support, and Infrastructure” (MGI) dimension results strongly linked to Cluster 1, which focuses on sustainable circularity in luxury SC management and is particularly effective in addressing specific barriers within this dimension. Clusters 2, 4, and 6 also contribute to MGI, contributing to four out of seven specific barriers. The “Supplier” barrier dimension (S) benefit equally from Clusters 1, 2, and 3, whereas Clusters 4 and 6 are not relevant in this context. Cluster 5 addresses only one specific barrier (S3). For “Finance” barriers (F), clusters 4 and 3 provide the most substantial support, addressing four and three barriers out of a total of three, respectively. Clusters 1, 2, and 6 provide contributions for only one specific barrier

Table 10
Clusters’ contributions to barriers in luxury sustainable SC strategy.

Barrier dimension	Specific barrier	Cluster contribution					
		1	2	3	4	5	6
Management, Government Support, and Infrastructure Barriers (MGI)	MGI1 - Limited support from governing authorities	x	x	x	x		
	MGI2 - Insufficient commitment from top management	x		x		x	x
	MGI3 - Lack of eco-literate and skilled employees	x	x	x			x
	MGI4 - Inadequate awareness	x	x			x	
	MGI5 - Hard transition to new business models	x			x		x
	MGI6 - Inadequate infrastructure	x			x		x
	MGI7 - Social responsibility	x	x		x		
Supplier Barriers (S)	S1 - Absence of suitable supplier training and reward system	x	x	x			
	S2 - Weak partnerships and integration between SC partners	x	x				
	S3 - Poor commitment and asymmetric customer information sharing				x		x
Finance Barriers (F)	F1 - Cost of sustainable raw materials	x		x	x		
	F2 - Rise in cost of investment		x		x		x
	F3 - Uncertain return on investment			x	x		
Material Barriers (M)	M1 - Shortage of superior quality raw materials	x	x				
	M2 - Undersupply of sustainable raw materials	x			x		
	M3 - Complex material structure and composition				x		x
Sustainable packaging and Human Resource Barriers (PH)	PH1 - Cost of eco-friendly packaging	x				x	
	PH2 - Resistance to upskill and knowledge sharing	x				x	
Certificates and Customer Perceptions (CC)	CC1 - Certifications		x			x	
	CC2 - Customer perceptions	x				x	x

each, while Cluster 5 is not relevant in this context. The “Material” barriers dimension (M) primarily relies on Clusters 1 and 4, which can address two out of three barriers. Clusters 2 and 6 address one specific barrier each, while Clusters 3 and 5 are not significant contributors. The “Sustainable Packaging and Human Resources” (PH) barrier dimension benefits exclusively from Clusters 1 and 5, which together address all two barriers in this category. Other clusters are not involved. The “Certificates and Customer Perceptions” (CC) dimension relies on contributions by all clusters except Clusters 3 and 4.

The cluster analysis provides concrete ways to turn barriers into managerial levers. The following subsections synthesize targeted responses by barrier family, with cluster links in parentheses.

4.1.1. Overcoming MGI barriers

MGI1. To deal with external barriers coming from governing authorities, managers should advance CSR partnerships (Cluster 2) and strategic sustainability roadmaps (Clusters 1, 4). Also, they can support policy engagement with brand cases (Cluster 5) and LCA/economic

evidence (Clusters 4, 3) to unlock support and profitability.

MGI2. The insufficient commitment from top management can be addressed by building top-management commitment by showing profitability via business models and luxury marketing (Clusters 1, 5), reinforced by game-theory insights (Cluster 3) and sectoral cases (Clusters 1, 6).

MGI3. The shortage of eco-literate and skilled employees can be mitigated by investing in human resource development, closing skills gaps through targeted training (Cluster 1) and knowledge management (Cluster 6), supported by academic partnerships (Clusters 2, 3).

MGI4. Limited awareness can be raised with sustainable luxury marketing and employee engagement (Cluster 5), using data-driven outreach tied to urbanization/green-economy work (Clusters 1, 2).

MGI5. The difficulties in the transition to new business models can benefit from innovative decision-making frameworks such as the AHP for project prioritization (Cluster 6), circular pilots (Cluster 1) and controlled studies (Cluster 4).

MGI6. Inadequate physical infrastructures can be improved by investments in renewable energy systems (Cluster 4) and urban planning projects (Cluster 6) to address supply chain infrastructure needs. Digital solutions, including blockchain technology (Cluster 1), can enhance traceability. Additionally, emphasizing energy efficiency and maintenance practices (Clusters 4, 6) can optimize existing infrastructure.

MGI7. Social responsibility can be improved by fostering partnerships with non-governmental organizations and local governments to promote ecotourism and sustainable SC practices (Clusters 1, 2), integrated CSR with waste/energy programs (Clusters 1, 4; Cluster 2) and public education (Cluster 2).

4.1.2. Overcoming S barriers

S1. The lack of suitable supplier training and reward systems can be faced by establishing supplier engagement programs (Cluster 2; Cluster 3) with training in traceability/circularity and certification incentives (Cluster 1).

S2. Weak partnerships and scarce integration between SC partners can benefit from building trust and integration using blockchain-enabled information sharing (Cluster 1) within collaborative frameworks. Textiles and hospitality are promising arenas (Clusters 1, 2).

S3. The poor commitment and asymmetric information sharing from buyers/customers could be improved by reducing asymmetry with strategic management frameworks (Cluster 3) and customer-behavior/satisfaction metrics (Cluster 5) to stabilize commitments.

4.1.3. Overcoming F barriers

F1. The high cost of sustainable raw materials can be mitigated by optimizing material sourcing using analytics-supported sourcing (Cluster 3) and local resource strategies (Cluster 1), as well as showing total-cost benefits with controlled studies (Cluster 4).

F2. The rise in cost of investment can be solved by CSR-linked funding (Cluster 2), green financing (Cluster 4) and supportive economic frameworks (Cluster 6).

F3. Uncertainty regarding ROI can be reduced by scenarios/game theory (Cluster 3), LCA quantification (Cluster 4), and sector cases.

4.1.4. Overcoming M barriers

M1. The shortage of high-quality raw materials leads to promote materials innovation (Cluster 2), green/local sourcing, collaborations in developing countries (Cluster 1).

M2. The undersupply of sustainable raw materials would benefit from the use of blockchain forecasting/allocation (Cluster 1), renewable energy upstream (Cluster 4) and incentives for eco-materials.

M3. The complex material structure and composition suggest cutting complexity through design-for-remanufacturing aligned with LCA principles (Cluster 4) and knowledge tools (Cluster 6).

4.1.5. Overcoming PH barriers

PH1. The cost of eco-friendly packaging can be reduced by pairing sustainable branding with lightweight/recyclable designs (Cluster 5; Cluster 1) and validating cost/impact over time (Cluster 4).

PH2. The resistance to upskill and knowledge sharing would benefit from developing employee-engagement and knowledge-sharing programs (Clusters 1, 5).

4.1.6. Overcoming CC barriers

CC1. Product certifications should be aligned with green practices (Cluster 2) and eco-friendly standards, using them in luxury marketing (Cluster 5), as well as in leveraging institutional recognition.

CC2. Customers' perceptions can be predicted - and shaped - via luxury consumer-behavior insights and by framing exclusivity within sustainability (Cluster 5), informed by successful campaigns in France and Italy (Clusters 1, 6).

4.2. From managerial actions to luxury value

Bringing together the cluster evidence and the barrier mapping (Table 10), we identify four priority areas for practice, following ordered by barrier-reduction influence, value potential and implementation feasibility. The first is data-enabled operations. Industry 4.0 capabilities emphasized in Cluster 1 -e.g., traceability and digitalization - create the data infrastructure that makes Cluster 4 tools (e.g., LCA and energy/emissions monitoring) actually decision-ready. By equipping production lines and logistics flows with basic data capture - such as QR/RFID or barcode scans for lot-level provenance and metrics for energy use - managers can target retrofits with demonstrable payback and substantiate certification claims. This directly addresses F and M barriers, as well as MGI concerns about governance and transparency. Accordingly, operational improvement and environmental assessment become a single feedback loop rather than separate agendas.

The second priority area concerns circularity with suppliers. Circular practices from Cluster 1 gain traction when combined with Cluster 3 insights on incentives. Managers can co-design simpler, remanufacturing-ready bills of materials (i.e.: fewer materials, standardized components, designed for disassembly) and share demand and quality signals upstream so suppliers can plan. In parallel marketing strategies such as buy-back prices, take-back incentives, risk-sharing contracts or shared-savings can help aligning behavior, while reducing material complexity and waste (M), improving supplier data completeness for audits (S) and lowering investment risk (F).

Third priority area regards market-facing trust and desirability. Evidence on certifications and consumer perception (CC) shows that provenance and verified impact are not just about compliance, but now core to luxury positioning in Cluster 5. Managers should consider limited collections using certified or reclaimed inputs, and regenerative practices as a mark of craftsmanship, so that sustainability and exclusivity can reinforce each other. This contributes to address CC1-CC2 and helps close PH skill/knowledge gaps. In hospitality and tourism (Cluster 2), the same logic works through property-level CSR and eco-standards.

Finally, the last priority area is about regional tailoring. In Western markets, it is remarkable to prioritize standardized sustainability disclosures, materials and parts traceability and redesign key SKUs using LCA findings so material and packaging choices - and the related claims - are evidence-based. In emerging markets, early traction comes from visible CSR and greener on-site operations in hospitality and retail (Cluster 2), coupled with staged capability-building for local suppliers. Across contexts, adopting simple governance by selecting projects (e.g., with AHP techniques) and sustaining a central knowledge hub (templates and playbooks informed by Cluster 6) can help standardize choices and shorten adoption cycles. Together, these moves translate the six clusters into a coherent path from barriers to scalable practice.

The above discussed strategies show the potential to increase the sustainability of the luxury SCs. Nevertheless, it is worth considering

that to enhance the feasibility of adopting sustainable approaches in luxury sector, the consumer perspective is crucial. According to the latest research by Kaur et al. [20], the luxury buyers are shifting from being “self-oriented” to “sustainability-oriented”, claiming for a rethinking of the luxury sector strategic positioning towards more sustainable practices. The opportunities identified here can amplify perceived value across Wiedmann’s (2009) luxury dimensions, also pointing to a novel, emerging, environmental value dimension that complements the traditional ones and increasingly meets customer expectations. The environmental value involves the verified reduction of life-cycle impacts attributable to a product/service consumption, established through traceability and LCA at product – or lot - level and made auditable across certifications or product passports. This differs from other dimensions like the functional value, which concerns user-experienced performance and workmanship (e.g., durability, precision). Still, it is distinct from social value, which instead concerns status, approval or identity signaling (e.g., exclusivity, recognition). Circular design choices (repairability, longevity, recycled inputs) may improve functional value and amplify social value via credible narratives, but environmental value remains a separate, evidence-based dimension enabled by data-and-assessment loop deduced from clusters 1 and 4. Although the consumer lens was not the focus of our analysis, the findings support a testable proposition: a sustainable luxury paradigm can simultaneously enable managerial opportunities and accelerate added value for consumers, as shown in the integrative framework proposed in Fig. 4.

4.3. Regional tailoring of luxury sustainability adoption pathways

This study results indicate that sustainability adoption in luxury SCs begins from different entry points across regions. Cluster 2 highlights hospitality and tourism as a principal arena of practice, with a strong emphasis on CSR, environmental management, and green operations, and with China and India especially significant in the evidence base. Read alongside the cluster–barrier mapping (Table 10), this pattern motivates distinct pathways for Western and emerging markets.

In Western markets, regulatory requirements and stakeholder expectations make standardized sustainability reporting the natural starting point, with traceability of high-impact inputs and LCA then used

to steer eco-design. For example, using impact data to guide product and packaging choices strengthens governance and supports investment decisions, while making market claims defensible. In line with Cluster 5’s link between marketing and consumption behavior, the same approach supports brand-owned authenticated recommerce and clear certification roadmaps, converting operational progress into customer trust and market differentiation.

In emerging markets such as China and India, early progress typically comes from visible CSR and on-site operational improvements in hospitality and retail, (e.g. property energy and water efficiency, adherence to environmental standards, guest-facing disclosure, etc.) consistently with Cluster 2. In parallel, supplier capability in traceability, data provision, circular operations, sustainable product compliance is developed in stages. The process begins with training on lot-level traceability and basic impact reporting (e.g., energy/water consumption). Adoption is reinforced through targeted incentives (such as performance bonus or preferred-supplier status), then certifications are introduced gradually in categories where they are most material. This staged approach addresses social responsibility and supplier integration barriers first and, as data quality improves, paves the way for deploying Industry 4.0 tracking systems (as per Cluster 1) and LCA/assessment tools (as per Cluster 4).

Across both contexts, a simple, lean governance of sustainability initiatives helps standardize decision-making and shortens adoption cycles. Although the regional entry points differ, both pathways ultimately feed into the management cycle outlined in Section 3.7: data and traceability inform environmental assessment; assessment guides design and operations; communication supports the market interface; economic appraisal steers investment; organizational learning enables scale. Framed this way, regional tailoring becomes a practical route for addressing the barriers summarized in Table 10 without restating the cross-cluster mechanics.

5. Conclusions

This study provides a comprehensive analysis of luxury supply chain maturity in the transition to sustainability, along with practical insights for managers to overcome critical barriers. In this concluding section, we highlight theoretical contributions, research directions, as well as

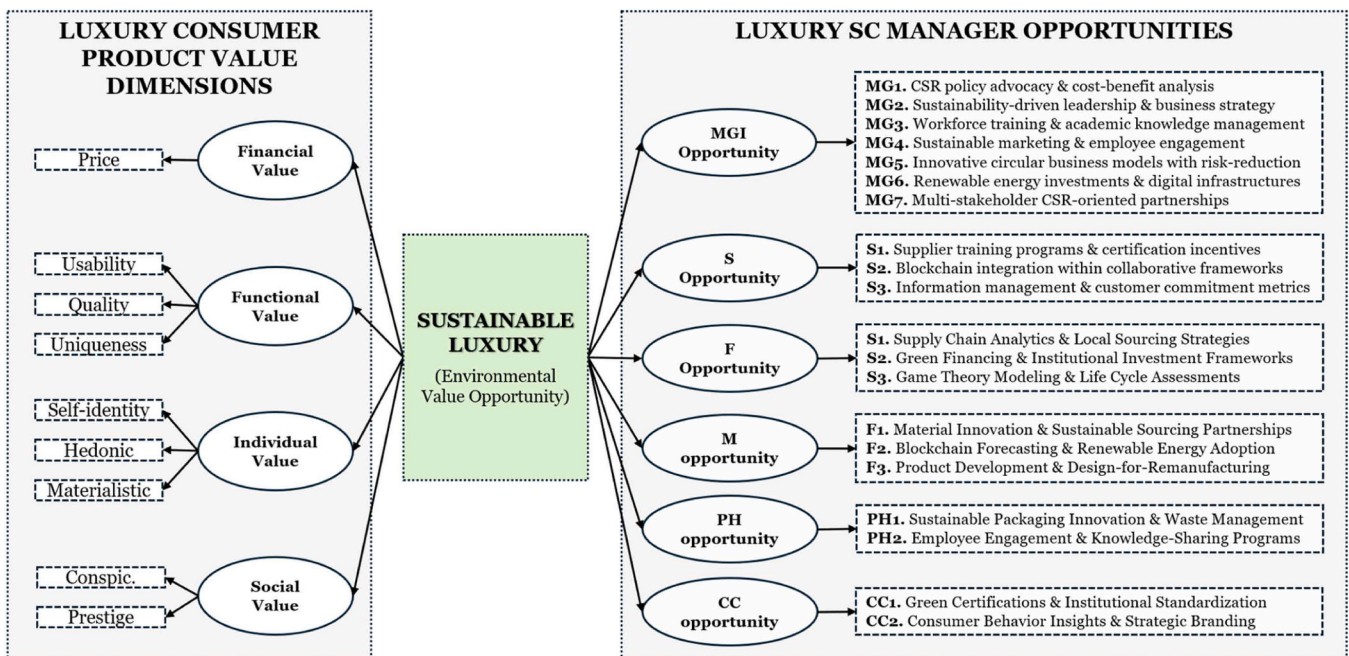


Fig. 4. Future development framework towards sustainable luxury as an enabler of joint convenience of circularity.

limitations and opportunities for future development.

5.1. Theoretical contributions and research directions

Cluster 1 highlights the call for adopting sustainable practices within luxury SCs. This is a key topic in current research, particularly regarding sustainable reverse logistics adoption [33] and design [13], while also comparing diverse production strategies to evaluate their overall sustainability impact [25]. Industry 4.0 technologies such as blockchain, Internet of Things, Digital Twins and Cyber-Physical Systems [23] can enhance key SC sustainability principles like traceability, transparency and the triple bottom line. The fashion sector emerged as crucial, especially since small and medium-sized enterprises (SMEs) are gaining road in emerging markets in developing countries. It is noteworthy to conduct further research on how those SMEs could support sustainability by a quick integration of Industry 4.0 technologies [24].

Cluster 2 extends the focus to the luxury tourism industry, suggesting that the sustainability paradigm is shaping strategic decisions, particularly in the hotel and hospitality industries. The increasing relevance of corporate social responsibility (CSR), green practices, and environmental management within tourism, particularly in emerging economies like China and India, suggests to focus the research on a cohesive approach that integrates supply chain practices with sustainable tourism goals, opening to novel forms of luxury tourism, such as ecotourism and regenerative tourism [28].

Cluster 3 shifts the emphasis toward economic evaluations, exploring how profitability, social influence, and customer satisfaction can be joined to sustainability in the luxury sector. Game theory models emerged as suitable tools to navigate complex decisions regarding product pricing [15], suppliers selection [10] or consumer behavior in returning exhausted products [32]. This cluster also highlighted the emerging paradigm of the sharing economy [31] which promises to strike a balance between economic performance and environmental responsibility. In this context, another promising approach worth considering is the Remanu-Leasing model [27]. This model emphasizes the collaboration of stakeholders within the closed-loop supply chain, including both human agents and the environment-as-agent, to achieve mutual benefits in terms of economic viability and the minimization of environmental impact. These efforts to integrate sustainability into economic assessments represent a significant research direction, in the attempt to align financial outcomes with broader social and environmental objectives.

Cluster 4 brings attention to the environmental impact of luxury SCs, emphasizing the importance of renewable energies adoption and life cycle assessments (LCA) studies. Industry 4.0 technologies have demonstrated their potential to enhance environmental sustainability [19]. For instance, the integration of the Internet of Things (IoT), Digital Twins, and Cyber-Physical Systems can significantly improve emissions monitoring and control while enabling sustainable production strategies, such as Maintenance 4.0 [4]. To fully leverage these advancements, substantial research efforts are needed to build confidence in investments that support upgraded technological solutions aimed at both energy efficiency and economic cost-effectiveness. Examples of such research include studies by Leoni et al. [22] and by Cantini et al. [7]. Furthermore, Cluster 4 underscores the importance of measuring environmental impact not only to mitigate ecological harm but also as a key performance indicator for evaluating supply chain management effectiveness [14] and driving sustainable development. The COVID-19 pandemic has further highlighted the significance of environmental sustainability, creating opportunities to explore renewable energy solutions [17] and improve resource efficiency within luxury SCs [6].

In Cluster 5, the focus shifts to marketing and luxury consumer behavior. The findings reveal a significant change in consumer preferences, with increasing acceptance of second-hand luxury products and a stronger inclination toward sustainable purchasing behaviors. Current research aims to gain a deeper understanding of consumers' purchase

intentions, which are closely tied to the unique experiences sought by luxury consumers. This highlights the need to further explore luxury experience management, as proposed by Tarquini et al. Tarquini et al., [37] in the context of luxury craftsmanship. Moreover, the analysis of consumption behavior emphasizes the importance of embedding sustainability into marketing strategies. Aligning luxury brands with evolving consumer expectations can help shape perceptions and drive demand for eco-conscious luxury goods, ultimately fostering stronger connections between brands and their environmentally aware audiences.

Cluster 6 addresses decision-making and knowledge management within the context of sustainable urban planning. Decision-making tools, such as the analytic hierarchy process (AHP) and knowledge-sharing practices emerged to help optimize strategies for balancing environmental risks with development goals. Regional examples, particularly from Italy and Turkey, provide valuable insights into how localized approaches can inform broader sustainable practices in luxury urban housing and infrastructure development.

5.2. Operational remarks

This research provides a solid foundation for advancing sustainable luxury practices through interdisciplinary exploration. It is important to note that this study is exploratory in nature and does not constitute a systematic literature review. Even this could appear as a limitation, the rationale for this approach lies in the suitability of bibliometric analysis for exploring the state of art and future directions of sustainable supply chains in luxury sector. To this end, the bibliometric analysis provided a macro-level perspective, revealing the structure, dynamics, and emerging trends within the current body of scientific knowledge.

This study focused on the managerial perspective. This excluded the viewpoint of consumers. Consumer demand and acceptance play a critical role in shaping luxury management strategies and supply chain dynamics. While the keyword search intentionally excluded literature adopting the consumer's perspective, Cluster 5 still identified keywords such as "consumption behavior" and "purchase intention," underscoring the recursive influence of these factors on managerial evaluations. Accordingly, we adopted a deductive stance: consumer-related signals were not analyzed as a separate corpus but were translated into managerial levers – after all, remarked in in Fig. 4. This preserves the managerial focus while acknowledging the influence of demand on supply-chain decisions. Consequently, a logical next step for this research is to explore in depth the consumer perspective, particularly regarding the acceptance and perception of sustainable luxury products, through targeted surveys and interviews. The involvement of luxury consumers in different sub-sectors (i.e., fashion, furniture, hi-tech) will be required considering that different attitude towards sustainability issues are expected based on the customers' segmentation, e.g., across different age, gender and country.

Our four-block Boolean schema prioritized precision over recall. Despite OR-expanded synonyms, works using divergent terminology may have been missed. We mitigated this by broad OR-expansion within each block and then assessing topic breadth via the Scopus filter analysis; still, omissions remain possible. About cluster interpretability, co-word maps and cluster labels involve interpretive judgment. To reduce subjectivity, we varied minimum occurrences, minimum link strength, minimum cluster size, and we applied dual review/face-content validity criteria for labeling and the barrier mapping. Nevertheless, labels should be read as heuristic summaries rather than definitive taxonomies.

Further investigations also concern the need to provide a quantitative analysis of the market value that sustainable practices could bring, highlighting the potential increase in market share, customer base and additional revenues. Additionally, expanding the search to non-English technical reports can be valuable to explore regional contexts. As study validation steps, we will engage luxury SC managers through semi-structured interviews and targeted surveys to assess the consistency –

in real case studies - of the cluster/barriers links.

From the operational perspective, the findings coming from this study highlight the importance of systematically integrating sustainability measures across each stage of the luxury supply chain, particularly in production processes. Enabling condition is the collaborative behavior between upstream and downstream partners, *i.e.* suppliers and consumers. Furthermore, Industry 4.0 provides effective tools supporting operations sustainability [5]. For instance, a data-driven modelling approach for inventory, resource and waste management can help managers to control – and reduce - the SC operations ecological footprint while reinforcing brand “green” responsibility within their luxury sector.

CRedit authorship contribution statement

Francesco Mancusi: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Fabio Fruggiero:** Writing – review & editing, Supervision, Software, Resources, Investigation, Formal analysis, Conceptualization. **Chiara Cimini:** Writing – review & editing, Supervision, Software, Resources, Methodology, Investigation, Formal analysis, Data curation. **Alexandra Lagorio:** Writing – review & editing, Validation, Supervision, Formal analysis, Data curation.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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