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# Overcoming Barriers to Sustainable Supply Chain Management in Small and Medium-Sized Enterprises: A Multi-Criteria Decision-Making Approach

**Hugo Gonçalves [1], Vanessa S. M. Magalhães [2], Luís M. D. F. Ferreira [2] and Amílcar Arantes [3,*]**

[1] Department of Mechanical Engineering, University of Coimbra, 3004-517 Coimbra, Portugal; hugoomiiguell@gmail.com
[2] CEMMPRE, ARISE, Department of Mechanical Engineering, University of Coimbra, 3004-517 Coimbra, Portugal; vanessa.magalhaes@dem.uc.pt (V.S.M.M.); luis.ferreira@dem.uc.pt (L.M.D.F.F.)
[3] CERIS, Civil Engineering, Architecture and Georesources Department, Instituto Superior Técnico, Universidade de Lisboa, 1600-190 Lisboa, Portugal
* Correspondence: amilcar.arantes@tecnico.ulisboa.pt

**Abstract:** Sustainable supply chain management (SSCM) integrates economic, social, and environmental goals within the supply chain to enhance long-term performance. It assists organizations in monitoring their performance concerning social, environmental, and economic factors to bolster sustainability. Yet, implementing SSCM poses significant challenges for most organizations, particularly small and medium-sized enterprises (SMEs). This study aims to identify key barriers and strategies for overcoming them in SMEs. A thorough literature review revealed 80 barriers across nine categories: technological, economic and financial, supplier, information, market and networking, human resources, social and cultural, regulatory and institutional, and organizational barriers. Eight experts from SMEs in focus group discussions considered 55 relevant barriers and prioritized them using the best–worst method. Then, based on the top 15 barriers they deemed key, they adapted and improved 24 strategies based on the literature that, in their opinion, could support the implementation of and improve the SSCM in SMEs. The findings from this study highlight economic and financial barriers as the foremost challenges to the implementation of SSCM, mainly due to the lack of funding and capital to make changes in activities to include sustainability. The findings are valuable for SMEs seeking to implement SSCM, offering insights into potential barriers and strategies for surmounting them. Moreover, this study provides a structured approach that can be replicated to identify the most pressing barriers to overcoming and improving long-term sustainability.

**Keywords:** sustainable supply chain management; sustainability; best–worst method; multi-criteria decision-making; barriers; SME



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## 1. Introduction

Traditional supply chain management (SCM) primarily focuses on the efficiency and flexibility of a supply chain in the process of transforming raw materials and production procedures into products for delivery to consumers [1]. However, in recent years, the environment has emerged as a global concern, driven mainly by the increasing human population and industrial activities that contribute to global warming, natural resource depletion, and biodiversity loss [2–4]. This shift in the environmental landscape makes it increasingly imperative for SCM to consider the sustainability of the supply chain.

With a strong emphasis on closed-loop production and consumption, as well as a growing awareness of the environmental impacts of supply chains and the depletion of resources and raw materials, the concept of sustainable supply chain management (SSCM) has come to the forefront [1]. Factors driving this transition include the rapid pace of production and consumption enabled by cutting-edge technologies, rising pollution levels, and

the increased exploitation of natural resources for the sake of economic growth. Moreover, implementing stricter environmental regulations, which mandate binding environmental legislation, and the pressure exerted by consumers on regulators and organizations operating within the industry have further fueled the shift toward SSCM [5].

Sustainability is generally defined as using resources to meet the needs of the present without compromising the ability of future generations to meet their own needs [6]. This concept has evolved over time to include a comprehensive approach known as the Triple-Bottom-Line (TBL) approach [7]. The TBL approach considers a broad range of indicators and criteria for measuring organizational success, encompassing not only environmental factors but also social and economic aspects [8]. SSCM integrates the TBL approach to improve long-term performance and allow organizations to distinguish themselves from their competitors, gain a greater competitive advantage in the market, and achieve long-term benefits [7,9]. Furthermore, there is strong evidence that businesses can increase revenue by implementing and promoting socially and environmentally responsible business practices, as these activities impact consumer attitudes and behavior [10]. Many organizations have already committed to transforming their supply chains into sustainable ones [11]. With increased environmental impact, developing and implementing sustainability practices in supply chains has become critical. To achieve this transformation, most organizations must adapt their supply chains by implementing various strategies, such as sourcing or producing products with recyclable, reusable, or recycled materials [11,12]. However, when transitioning from traditional supply chain management (SCM) to SSCM, some obstacles or barriers are to be expected [12,13].

SSCM practices can be enabled or hindered by various contingent factors like the organization's size, culture, location, and supply chain partners [14]. As Sarkis et al. [15] point out, it is crucial to identify the barriers to the implementation of SSCM to ensure sustainable production and development practices. Therefore, organizations must identify and prioritize the most significant barriers while understanding their links to help decision-makers formulate strategies to eliminate these challenges during SSCM implementation [13,16], particularly in small and medium-sized enterprises (SMEs)—context that has received scarce attention [17,18].

This study aims to identify and prioritize the barriers to better understanding the topic and improving the ability to implement SSCM successfully in SMEs. The approach used to achieve this objective focuses on identifying different barriers through a literature review, followed by an initial focus group discussion with experts from SMEs to identify the relevant barriers for prioritization. To achieve the main goal of the study, the best–worst method (BWM), a multi-criteria decision-making (MCDM) method, was employed with the support of the experts to prioritize the barriers hindering the implementation of SSCM so that they can be mitigated or removed from the implementation process, aiding in the transition from traditional supply chains to sustainable ones. After prioritizing the barriers, the strategies that can help overcome the barriers to adopting SSCM are analyzed and discussed in a second focus group discussion.

Developed by Jafar Rezaei [19], the BWM is a popular and efficient MCDM that, in this study, is applied to prioritize the barriers to SSCM. This method compares pairs of criteria (in this study, barriers and their categories) to determine their weights. BWM has an advantage over other commonly used MCDM approaches—namely, an analytic hierarchy process (AHP) and interpretive structural modelling (ISM) methods—because it requires a relatively smaller number of pairwise comparisons for the same number of criteria while maintaining acceptable levels of consistency between judgments and presenting reliable results [19,20]. Moreover, many researchers have preferred it, and similar studies that adopted the BWM have been made known to the public in recent years [21–23].

The paper is organized as follows: section two presents a literature review regarding SSCM and the barriers to its implementation; in section three, the research methods followed in this study are detailed; section four presents the results from employing the BWM, establishing the final rank of the barriers and linking these to suitable strategies to

overcome them; section five discusses the main results; and, finally, the main conclusions, contributions, limitations, and future research directions are presented in section six.

## 2. Literature Review

This section describes the SSCM and highlights the barriers to its implementation. Relevant literature was searched in Scopus and Web of Science databases with a combination of the following keywords: "Sustainable supply chain management", "Sustainability", "Supply chain", "Barriers", and "Challenges". After screening the abstracts, 94 articles were selected for review in order to shed light on the barriers to SSCM adoption, considering their relevance to the topic under study.

### *2.1. Sustainable Supply Chain Management*

There are various definitions of SSCM in the literature. According to Ahi and Searcy [7], SSCM can be defined as the establishment of coordinated supply chains through the voluntary integration of economic, environmental, and social considerations, with key inter-organizational business systems designed to efficiently and effectively manage the flows of materials, information, and capital associated with the acquisition, production, and distribution of products/services. The aim is to satisfy stakeholder requirements while increasing the organization's profit, competitiveness, and resilience in the short and long term. For this study, we will adopt the definition presented by Lin and Tseng [24] and Reefke and Sundaram [25], who argue that SSCM is the process of controlling and managing information, materials, capital flows, and cooperation between organizations along the entire supply chain, considering the economic, social, and environmental dimensions of sustainable development, in line with the requirements of stakeholders and needs of customers.

SSCM has garnered increased attention worldwide, primarily due to government regulations, consumer pressure for sustainable products, market dynamics, growing public concern and awareness, and the competitive opportunities it offers [26–28]. Consequently, there has been a surge in the popularity of SSCM, compelling organizations to adapt their supply chain activities accordingly [1]. This adaptation allows organizations to enhance their sustainable development while reaping social, environmental, and economic benefits [4].

Many industrial activities have resulted in global environmental impacts and harm to human life and the environment [26]. This negative increase in environmental impacts has prompted various groups to intervene, including politicians and environmental activists, to tighten government regulations [29–31]. Considering this, governments have implemented stricter standards and regulations, compelling organizations to adhere to more sustainable practices [32]. This, in turn, has led organizations to better understand the influence of environmental, economic, and social factors in their activities, fostering a growing interest in pursuing sustainability [33].

The pursuit of sustainability has started to reshape the competitive landscape, driving organizations and supply chains to re-evaluate their processes, technologies, and products. Despite understanding current market needs, many organizations still engage in unsustainable operations. However, there is an increasing trend in their efforts to integrate sustainability into their operations and supply chains [34,35]. Implementing sustainable innovation practices is the key for organizations and supply chains to achieve sustainability [36,37]. Sustainable innovation can be defined as introducing innovative practices into production processes to reduce environmental damage [36]. These practices assist organizations in addressing sustainability issues [38,39] while considering the TBL approach [40,41]. SSCM can be linked to practices such as green design, production planning and control for remanufacturing, reverse logistics, energy use, stock management, product recovery, waste management, and emission reduction [42].

### 2.2. Sustainable Supply Chain Management Adoption

The high cost associated with adopting SSCM practices often leads professionals to hesitate, even in the face of substantial market pressure [43,44]. Many organizations now outsource most of their production activities to companies in developing economies to maintain profit margins [45]. However, this profit-focused approach can sometimes lead to the neglect of social and environmental issues [46]. Multinational organizations and companies based in developed countries extend and share their sustainability initiatives and experiences with organizations in developing countries and emerging economies. This collaboration can lead to forming partnerships within various supply chains, furthering the goal of achieving sustainability [12].

In conclusion, given the adverse environmental effects, top priority should be given to implementing and maintaining sustainable supply chains to ensure proper and sustainable development for future generations [4]. Silvestre [47] argues that sustainable supply chains should be viewed as a continuous journey rather than a fixed destination. As supply chains progress toward sustainable practices, they undergo a complex, dynamic, and evolving learning process. Therefore, the transformation to SSCM is an ongoing journey where multifaceted efforts guide the transition from traditional supply chains to sustainable ones [48].

### 2.3. Sustainable Supply Chain Management Benefits

Managing operations, resources, and information within supply chains enables the maximization of profits and social welfare while minimizing environmental concerns and operating costs [36,49]. SSCM plays a pivotal role in reducing the negative impacts of supply chain operations and improving organizations' efficiency from a TBL perspective [50,51]. SSCM initiatives serve as a means for companies to achieve sustainability [52,53]. Consequently, companies have increasingly integrated sustainability into their supply chains to enhance their brand and image, manage supply chain risks such as environmental damage and labor disputes, ensure business continuity, and minimize potential disruptions and costs [32,54,55]. Therefore, sustainable management in a supply chain contributes to long-term environmental, social, and economic benefits for companies and customers. Additionally, SSCM practices enable the integration of techniques to prevent or minimize environmental degradation, including harmful gas emissions, water pollution, and soil pollution. These efforts aim to improve economic performance, maximize profit, build a reputation, and gain a competitive advantage [4,56].

SSCM ensures best production practices throughout a product's life cycle [57] and connects development with environmental concerns, thereby driving political and economic change at local, national, and global levels [58]. To create a sustainable product for end-users, sustainable practices must be embraced by producers, sellers, and suppliers [7]. Organizations aspiring to achieve sustainability within their supply chains must foster innovation to address the negative impacts [59,60]. According to Aguado et al. [61], sustainable innovation offers numerous benefits to organizations, including an enhanced social image, increased profits, and reduced operational costs. For Kusi-Sarpong et al. [36], it also leads to stock and income improvements, cost reductions, and an expanded market share.

### 2.4. Sustainable Supply Chain Management Barriers

Companies typically encounter a multitude of barriers when attempting to integrate sustainable innovations. Some of these challenges arise from the absence of strong institutions that provide systematic guidance for organizations seeking to implement innovative processes [62]. Successful innovation depends on a diverse range of resources, including financial capacity, access to funding, the recruitment of highly qualified teams, market knowledge, research, and development, as well as effective collaboration and cooperation among supply chain partners [63].

To navigate these challenges, it is essential to equip employees within supply chain companies with a better understanding of the nature of these barriers and strategies to

overcome them. This empowers them to address barriers positively and drive changes toward sustainability [12]. However, the consolidation and simultaneous implementation of all these strategies can be a complex undertaking. Therefore, companies must identify and prioritize the barriers hindering them from achieving their goals and develop strategies to overcome them [12]. Nevertheless, implementing SSCM in traditional supply chains is consistently a complex task.

According to Seuring [64], major SSCM initiatives often face challenges during implementation, whether in a production or service context, primarily due to insufficient attention given to barriers. As Ageron et al. [65] noted, 35% of organizations fail to adopt SSCM because they lack awareness of critical barriers. Consequently, it is essential for professionals to not only explore these barriers based on their organization's nature but also assess the importance of each one to determine its priority. This approach allows organizations to identify strategies for overcoming existing barriers to implementing sustainability in supply chains. These strategies involve specific action plans aimed at helping organizations, and their supply chains confront the challenges of implementing sustainability. However, the number of comprehensive studies identifying both barriers and the strategies to overcome them is still limited [12].

The 94 articles selected for an in-depth literature analysis revealed that some authors present barrier compilations without specifying their categories [66–69]. However, the in-depth analysis made it possible to compile an exhaustive list of 80 barriers to SSCM adoption and classify them into nine categories (see Table 1).

**Table 1.** Categories of barriers to SSCM implementation.

| Code | Categories of Barriers | Source |
|---|---|---|
| T | Technological | [3,12,13] |
| EF | Economic and financial | [3,12,16] |
| S | Supplier-related | [3,16] |
| I | Information-related | [16] |
| MN | Market and networking | [12] |
| HR | Human resources | [16] |
| SC | Social and cultural | [3,12] |
| RI | Regulatory and institutional | [3,16,58] |
| O | Organizational | [12,16,58] |

The exhaustive list of 80 barriers to SSCM found in the literature, organized by category, is provided in Supplementary Material S1.

Many authors have identified and assessed the barriers to the adoption of SSCM practices through a comprehensive analysis of relevant articles [46,66,70], questionnaires administered to experts in the field [3,67], and by employing various MCDM methods [12,16,68,69]. Most of these studies considered the impact of the barriers to SSCM implementation on large companies. Studies concerning SMEs are scarce [17,18]. Therefore, assessing the SSCM barriers to establish their priority is imperative, thereby determining the most important obstacles. Identifying such barriers is essential for developing effective strategies for successfully implementing SSCM within SMEs.

## 3. Research Methods

This study aims to analyze and prioritize the barriers to the implementation of SSCM and to propose appropriate strategies to overcome them. For that, a four-stage methodology was adopted (Figure 1): Stage I—Determination of the barriers to SSCM and their classification in categories; Stage II—Selection of the relevant barriers to SSCM in SMEs; Stage III—Prioritization of the relevant barriers and respective categories; Stage IV—Development of strategies for SSCM. Literature reviews were conducted in Stages I and IV. An initial focus group discussion (FGD_1) was performed to capture experts' opinions in Stages II and III, and a second one (FGD_2) was performed in Stage IV. Finally, the BWM was applied in Stage III.

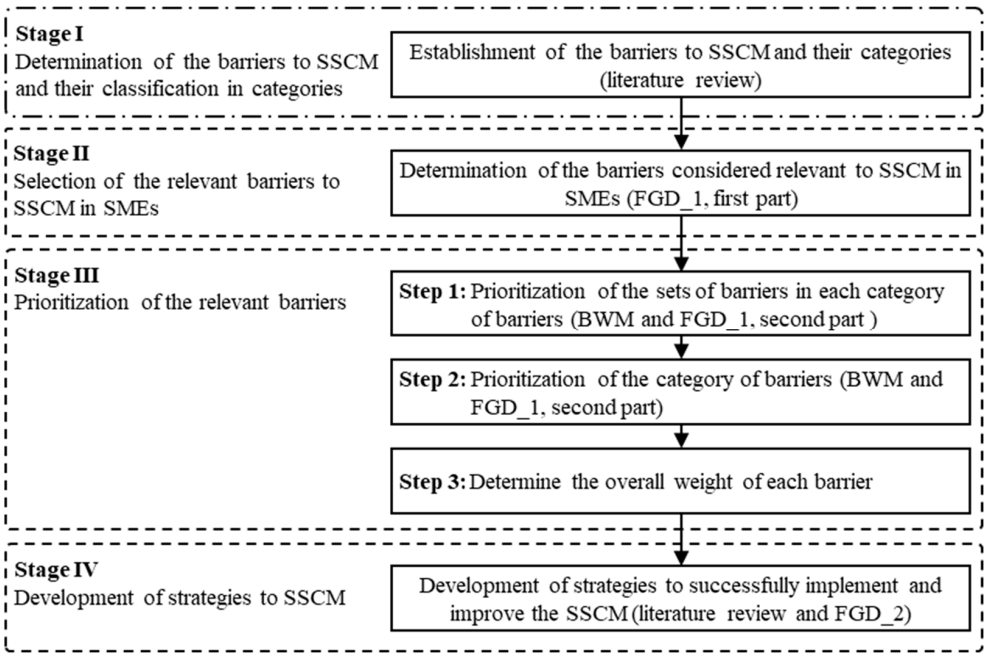


**Figure 1.** Research methodology.

### *3.1. Focus Group Discussion*

The FGD is exploratory research that gathers qualitative data on a subject through group interaction facilitated by a moderator [71] and has been used previously to research sustainability-related topics [72,73]. The FGD promotes discussion between experts about their opinions, beliefs, perceptions, and attitudes related to a theory, concept, or product [74]. The literature recommends that the number of experts participating in an FG be between 4 and 12 experts [75]. The FGD moderator was one of the authors with knowledge and experience in SSCM. His role was to assist the experts in reaching a consensus by stimulating discussion and ensuring that the discussion progressed from general to specific topics to encourage sincerity and bias reduction [76]. By questioning and exchanging comments on each expert's points of view and experiences, the moderator explored their experiences and knowledge to examine what they think, how they think, and why.

In this study, the same eight experts from SMEs participated in two FGDs (FGD_1 and FGD_2), including two general managers, two supply chain managers, two finance managers, and two process engineers. However, except for the process engineers, who had more than five years of experience in their relevant field, all the other experts had more than ten years of experience and had worked in more than one sector. FGD_1 was held in a single afternoon, lasting almost four hours, divided into two parts, separated by a half-hour break. In the first part of the FGD_1, the experts established the relevant barriers to SSCM for SMEs and the respective categories (Stage II, research methodology, Figure 1). In the second part, through scoring pairwise comparison judgments using the BWM, they prioritized the barriers in each category first and then the categories (Stage III, Steps 1 and 2). In FGD_2, which was carried out one week later and took about two hours, the experts were requested to adapt and improve a set of strategies grounded in the literature to implement SSCM in SMEs (Stage IV).

### *3.2. Best–Worst Method*

In generic terms, in BWM, the decision maker (experts, in this case) starts by defining the best and worst criteria (barriers or barrier categories, in this study), after which the best alternative is compared with the other alternatives. Then, the other alternatives are compared with the worst alternative. This process produces two vectors of pairwise comparisons, while other MCDM methods produce matrices that compare each alternative

to all alternatives. Ultimately, the optimal weights of the two vectors are estimated using a simple mathematical programming algorithm, which may or may not be linear [21]. BWM has been used in various areas, such as transportation, supplier selection, risk identification, and innovations in sustainable supply chains [26,36]. As suggested by Rezaei [19,20], the BWM algorithm used to derive the criteria weights is as follows:

1. Identify a set of decision criteria $\{c1, c2, \ldots, cn\}$;
2. Establish the best (most desirable, most important, most significant) and worst (least desirable, least important, least significant) criterion. However, if more than one criterion is considered the best or worst, it can be chosen arbitrarily. At this stage, the decision-maker identifies the best and worst criteria;
3. Determine the preference or intensity of importance of the best criterion over all the other criteria based on a based on a comparison scale. The scale consists of verbal judgments ranging from equal to extreme (equal, moderately more, significantly more, much more, extreme); corresponding to the verbal judgments are the numerical judgments (1, 3, 5, 7, 9) and compromises between these values [77]. The best-to-others result is represented by this vector:

$$A_B = (a_{B1}, a_{B2}, \ldots, a_{Bn}) \tag{1}$$

where $a_{Bj}$ denotes the preference of the best criterion $B$ over criterion $j$. Thus, we can conclude that $a_{BB} = 1$;
4. Determine the preference of all criteria over the worst criterion, as in the previous step. The others-to-worst result is represented by this vector:

$$A_W = (a_{1W}, a_{2W}, \ldots, a_{nW})^T \tag{2}$$

where $a_{jW}$ denotes the preference of the criterion $j$ over the worst criterion $W$. Thus, we can conclude that $a_{WW} = 1$;
5. Calculate optimal weights of all criteria by minimizing, for all the values of $j$, the maximum absolute difference $\left|\frac{W_B}{W_j} - a_{Bj}\right|$ and $\left|\frac{W_j}{W_W} - a_{jW}\right|$. Based on the non-negativity and sum condition for the weights, the following problem emerges:

$$\text{Min } max_j \left\{ \left| \frac{W_B}{W_j} - a_{Bj} \right|, \left| \frac{W_j}{W_W} - a_{jW} \right| \right\} \tag{3}$$

subject to:

$$\begin{gathered} \sum_j W_j = 1 \\ W_j \geq 0, \ for\ all\ j \end{gathered} \tag{4}$$

This model can be transferred to a linear programming model:

$$\text{Min } \xi \tag{5}$$

$$\left|W_B - a_{Bj} W_j\right| \leq \xi \tag{6}$$

$$\left|W_j - a_{jW} W_W\right| \leq \xi \tag{7}$$

subject to (4).

By solving model (4), the optimal weights of each criterion $\left(W_1^*, W_2^*, \ldots, W_n^*\right)$ and the optimal value $\xi$ are computed. $\xi$ is a measure of consistency, and the closer it is to 0, the higher the consistency of the pairwise comparisons and, consequently, the more reliable the comparisons are.

## 4. Results

### *4.1. Determination of the Barriers to SSCM*

A literature review was carried out (Stage I, Figure 1) to determine the barriers to SSCM and classify them into categories (see Section 2.4), resulting in 80 barriers in Table S1 (see Supplementary Material S1).

### *4.2. Selection of the Relevant Barriers to SSCM in SMEs*

Before implementing the BWM, selecting the barriers relevant to SSCM adoption by SMEs from Table S1 was necessary. The selection process was also crucial to reducing the number of barriers due to the limitations of the chosen method, the BWM, for pairwise comparisons. Therefore, the selection process aimed to confine each category of barriers to a maximum of 9, ensuring no constraints when applying the method [19].

The selection process (Stage II, Figure 1) was grounded in the experts' opinions during the first part of the FGD_1. The experts were asked to select the barriers they considered most hindering the implementation of SSCM, particularly considering the context of SMEs. This selection process aimed to pinpoint the most relevant barriers for assessment and prioritization using the BWM method. The resulting list of 55 barriers identified by the experts is presented in Table 2.

**Table 2.** Barriers to SSCM adoption by SMEs considered relevant by the experts, organized by category.

| (Code) Barrier Category | (Code) Barrier |
| --- | --- |
| (T) Technological | (T1) Lack of technology to facilitate resource optimization<br>(T2) Lack of technological knowledge and training<br>(T3) Lack of research and development (R&D) and innovation capacity<br>(T4) Lack of waste management and recycling facilities<br>(T5) Lack of technological solutions for effective environmental measures<br>(T6) Lack of new technologies, materials, and processes and their sharing<br>(T7) Lack of implementation of information technology (IT) solutions for communication and coordination |
| (EF) Economic and Financial | (EF1) Lack of funds for sustainable production practices<br>(EF2) Lack of capital to carry out innovation activities<br>(EF3) High investment and perceived low economic return<br>(EF4) High cost of implementation and maintenance<br>(EF5) High cost of disposing hazardous waste<br>(EF6) Cost of environmentally friendly packaging<br>(EF7) Pressure for lower prices |
| (S) Supplier | (S1) Scarcity of sustainable suppliers<br>(S2) Lack of trust between supply chain partners<br>(S3) Lack of a reward system for suppliers<br>(S4) Low supplier commitment |
| (I) Information | (I1) Uncertainty of the green outcome<br>(I2) Lack of information sharing<br>(I3) Lack of awareness of environmental impacts in companies<br>(I4) Lack of understanding regarding market competition<br>(I5) Lack of knowledge and training on reverse logistics<br>(I6) Ineffective training and education on information systems |
| (MN) Market and Networking | (MN1) Misunderstanding the different types of customers<br>(MN2) Low market demand<br>(MN3) Lack of understanding from customers<br>(MN4) Lack of competitiveness<br>(MN5) Unwillingness to collaborate<br>(MN6) Insufficient consumer support and encouragement |
| (HR) Human Resources | (HR1) Lack of work culture<br>(HR2) Lack of technical knowledge on sustainability<br>(HR3) Lack of training and information on sustainable practices<br>(HR4) Lack of training courses and institutions to train specific staff |

**Table 2.** *Cont.*

| (Code) Barrier Category | (Code) Barrier |
|---|---|
| (SC) Social and Cultural | (SC1) Perception that sustainable products are of poor quality<br>(SC2) Fear of extra workload and loss of flexibility<br>(SC3) Lack of entrepreneurial skills and thinking outside the box<br>(SC4) Negative attitudes towards sustainability concepts<br>(SC5) Popularity of traditional technologies<br>(SC6) Corruption |
| (RI) Regulatory and Institutional | (RI1) Inadequate institutional framework<br>(RI2) Lack of laws and legislation<br>(RI3) Lack of incentives<br>(RI4) Multiple, complex, and changing regulations<br>(RI5) Bureaucratic and lengthy documentation process<br>(RI6) Lack of guidance and support from regulatory authorities |
| (O) Organizational | (O1) Inability to integrate and cooperate between organizational functions<br>(O2) Insufficient commitment from top management<br>(O3) Inadequate communication<br>(O4) Inadequate strategic planning of the supply chain<br>(O5) Lack of commitment to corporate social responsibility (CSR)<br>(O6) Restrictive company policies for product/process management<br>(O7) Misalignment between short- and long-term strategic objectives<br>(O8) Reduced employee involvement and participation<br>(O9) Lack of an effective model to guide SSCM implementation |

### *4.3. Prioritizing the SSCM Barriers with the Best–Worst Method*

After selecting the barriers deemed relevant to SSCM adoption by SMEs, the next step was prioritizing the 55 barriers presented in Table 2 using BWM. The prioritization process comprised three steps of Stage III of the research methodology (Figure 1). In Step 1, the BWM was applied separately to each set of barriers in each category, resulting in their respective weights (within the category). In Step 2, the BWM was applied to the barrier categories, resulting in the category weights. Finally, in Step 3, the global weight of each barrier was obtained by multiplying the barrier's weight by the weight of its category. Steps 1 and 2 were supported by the experts' judgments during the second part of the FGD_1 discussion. Namely, they were asked to judge the pairwise comparisons inherent to the application of BWM.

The result of the pairwise comparisons for each barrier and respective categories are shown in Supplementary Material S2. Figure 2 presents the category weight, and Table 3 presents the barrier weight in each category and the overall weight of the barriers.

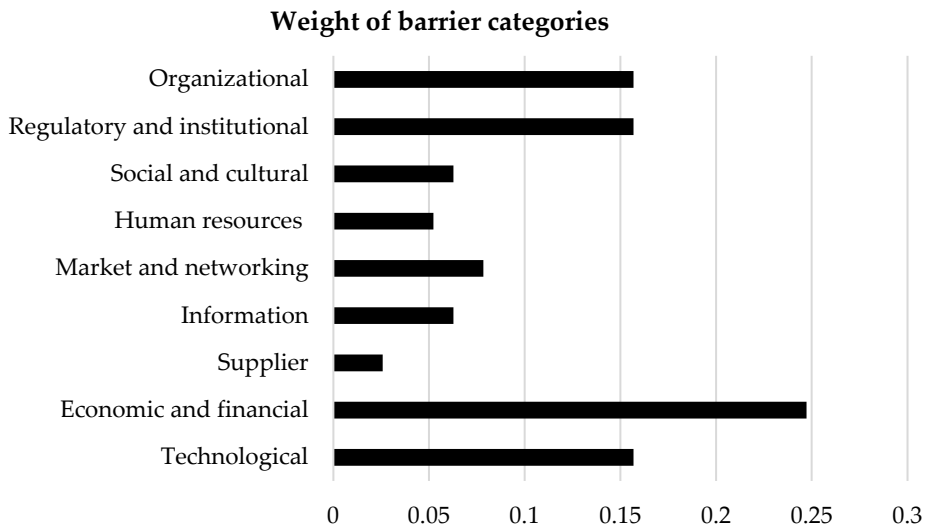


**Figure 2.** Weight of barrier categories to SSCM adoption by SMEs.

**Table 3.** Weight of the barriers to SSCM adoption by SMEs and final ranking.

| Barrier Category | Barrier Code | Barrier Weight | Overall Weight | Barrier Rank |
|---|---|---|---|---|
| Technological | T1 | 0.130019 | 0.020397 | 19 |
| | T2 | 0.195029 | 0.030595 | 9 |
| | T3 | 0.315488 | 0.049492 | 3 |
| | T4 | 0.097514 | 0.015298 | 26 |
| | T5 | 0.034417 | 0.005399 | 46 |
| | T6 | 0.130019 | 0.020397 | 18 |
| | T7 | 0.097514 | 0.015298 | 27 |
| Economic and financial | EF1 | 0.329628 | 0.081520 | 1 |
| | EF2 | 0.195477 | 0.048343 | 4 |
| | EF3 | 0.130318 | 0.032229 | 8 |
| | EF4 | 0.130318 | 0.032229 | 7 |
| | EF5 | 0.078191 | 0.019337 | 20 |
| | EF6 | 0.038329 | 0.009479 | 36 |
| | EF7 | 0.097739 | 0.024172 | 15 |
| Supplier | S1 | 0.071429 | 0.001846 | 55 |
| | S2 | 0.178571 | 0.004614 | 48 |
| | S3 | 0.607143 | 0.015687 | 25 |
| | S4 | 0.142857 | 0.003691 | 50 |
| Information | I1 | 0.108427 | 0.006810 | 42 |
| | I2 | 0.045220 | 0.002838 | 53 |
| | I3 | 0.180879 | 0.011350 | 34 |
| | I4 | 0.135659 | 0.008513 | 38 |
| | I5 | 0.077519 | 0.004864 | 47 |
| | I6 | 0.452196 | 0.028375 | 12 |
| Market and networking | MN1 | 0.160985 | 0.012627 | 32 |
| | MN2 | 0.096591 | 0.007576 | 39 |
| | MN3 | 0.080492 | 0.006314 | 43 |
| | MN4 | 0.039773 | 0.003120 | 51 |
| | MN5 | 0.241477 | 0.018941 | 21 |
| | MN6 | 0.380682 | 0.029860 | 11 |
| Human resources | HR1 | 0.057471 | 0.003005 | 52 |
| | HR2 | 0.229885 | 0.012021 | 33 |
| | HR3 | 0.574713 | 0.030053 | 10 |
| | HR4 | 0.137931 | 0.007213 | 40 |
| Social and cultural | SC1 | 0.148392 | 0.009312 | 37 |
| | SC2 | 0.089035 | 0.005587 | 45 |
| | SC3 | 0.222589 | 0.013967 | 28 |
| | SC4 | 0.111294 | 0.006984 | 41 |
| | SC5 | 0.041220 | 0.002587 | 54 |
| | SC6 | 0.387469 | 0.024314 | 14 |
| Regulatory and institutional | RI1 | 0.216319 | 0.033935 | 6 |
| | RI2 | 0.349146 | 0.054772 | 2 |
| | RI3 | 0.144213 | 0.022623 | 16 |
| | RI4 | 0.108159 | 0.016967 | 24 |
| | RI5 | 0.037951 | 0.005954 | 44 |
| | RI6 | 0.144213 | 0.022623 | 17 |
| Organizational | O1 | 0.109890 | 0.017239 | 22 |
| | O2 | 0.274725 | 0.043097 | 5 |
| | O3 | 0.082418 | 0.012929 | 30 |
| | O4 | 0.164835 | 0.025858 | 13 |
| | O5 | 0.109890 | 0.017239 | 23 |
| | O6 | 0.082418 | 0.012929 | 31 |
| | O7 | 0.082418 | 0.012929 | 29 |
| | O8 | 0.065934 | 0.010343 | 35 |
| | O9 | 0.027473 | 0.004310 | 49 |

### *4.4. Strategies for Overcoming SSCM Barriers*

To overcome the barriers to SSCM in a given organization, it is imperative to identify strategies and practices that can enable the successful implementation of SSCM and provide a framework that allows proactive decision-making to assess performance and future problems, determine significant risks, and implement strategies to address the risks [78]. A strategy can be understood as a vision that helps reduce waste and inefficiencies in an organization's processes and enables sustainable competitive gains [79,80]. The strategy aims to boost TBL performance in economic, environmental, and social dimensions, involving employees and stakeholders [81].

The experts in the FGD_2 were requested to adapt and improve a set of strategies based on the literature to support and guide SMEs in enhancing SSCM (Stage IV of the research methodology, Figure 1). For this task, the experts considered only the 15 top barriers, which they deemed key to hindering the implementation and improvement of SSCM in SMEs. This helped limit the burden on the experts in this task. These barriers are presented in Table 4, ranked in a decreasing order of importance for mitigation. The experts ended up adapting and improving a set of 24 different strategies, as presented in Table 5.

**Table 4.** Key barriers to be mitigated.

| Code | Barriers | Rank |
|---|---|---|
| EF1 | Lack of funds for a sustainable production practice | 1 |
| RI2 | Lack of laws and legislation | 2 |
| T3 | Lack of research and development (R&D) and innovation capacity | 3 |
| EF2 | Insufficient capital to carry out innovation activities | 4 |
| O2 | Insufficient commitment from top management | 5 |
| RI1 | Inadequate institutional framework | 6 |
| EF4 | High cost of implementation and maintenance | 7 |
| EF3 | High investment and perceived low economic return | 8 |
| T2 | Lack of technological knowledge and training | 9 |
| HR3 | Lack of training and information on sustainable practices | 10 |
| MN6 | Insufficient consumer support and encouragement | 11 |
| I6 | Ineffective training and education on information systems | 12 |
| O4 | Inadequate strategic planning of the supply chain | 13 |
| SC6 | Corruption | 14 |
| EF7 | Pressure for lower prices | 15 |

**Table 5.** Strategies to overcome barriers to sustainability, based on [12,27,82,83].

| Code | Strategy |
|---|---|
| Str1 | Foster an environment conducive to developing ecological and sustainable skills for employees, such as the know-how to generate ideas for sustainable technologies. |
| Str2 | Ensure the formulation of policies and regulations by the government to promote sustainability practices through, for instance, tax cuts, infrastructural support, and waste management and recycling policies. |
| Str3 | Develop technological skills to support sustainable development through innovation. |
| Str4 | Create research laboratories to develop and improve product and process innovation. |
| Str5 | Develop collaboration capacities and skills within the organization and between external organizations and institutions through the exchange of technology, the joint training of employees, and the collaborative development of new sustainable technologies. |
| Str6 | Promote the allocation of funds for sustainable innovation initiatives, including investment in sustainability-related technologies. |
| Str7 | Promote the benefits of sustainable products in the market to increase demand for green and sustainable products. |
| Str8 | Ensure top management support, commitment, and involvement in the SSCM adoption process. |
| Str9 | Integrate sustainability into an organization's policy and vision to enable superior performance. |
| Str10 | Promote training programs for employees on topics related to sustainability and the adoption of SSCM. |
| Str11 | Foster collaborations and partnerships with other partners to achieve effective SSCM adoption. |

**Table 5.** *Cont.*

| Code | Strategy |
|---|---|
| Str12 | Share strategies, knowledge, and business expectations with supply chain partners to enhance SSCM. |
| Str13 | Employ the use of clean technologies to reduce waste in processes. |
| Str14 | Require organizations to take responsibility for their products in order to reduce their ecological, social, and safety impact. |
| Str15 | Obtain raw materials from environmentally friendly sources to promote sustainability. |
| Str16 | Implement prevention and maintenance strategies to maximize equipment efficiency. |
| Str17 | Implement production and packaging solutions that promote the reduction, reuse, or recycling of materials. |
| Str18 | Collaborate with industrial partners or local organizations to recycle products. |
| Str19 | Disseminate information on productivity, employee health and safety, and environmental performance. |
| Str20 | Promote greater involvement and interaction with the customer and stakeholders to produce cleaner and more environmentally friendly products in line with market needs. |
| Str21 | Develop a long-term strategy for implementing SSCM. |
| Str22 | Promote an organizational culture that encourages employees to support SSCM implementation. |
| Str23 | Develop strategic plans considering social legitimacy, responsibility, and trust to achieve a sustainable business framework. |
| Str24 | Motivate employees to adopt sustainable practices to facilitate the SSCM implementation process. |

Finally, experts in the FGD_2 were asked to indicate which of the 24 strategies could mitigate each of the 15 barriers. The results are presented in Table 6.

**Table 6.** Barriers to the adoption of SSCM by SMEs mitigated with the implementation of each strategy.

| | | **Strategies (Str)** | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** | **19** | **20** | **21** | **22** | **23** | **24** | **Total** |
| Barriers | EF1 | | | | | | x | | | | | | | | | | | | | | | x | x | | | 3 |
| | RI2 | | x | | | | | | | | | | | | | | | | | | | | | | | 1 |
| | T3 | | x | x | x | x | | | | | | x | | | | | | | x | x | | | | | | 7 |
| | EF2 | | | | | x | x | | | | | x | | | | | | | | | | | | | | 3 |
| | O2 | | | | | | | | x | | | | | | | | | | | x | | x | | | | 3 |
| | RI1 | | x | | | | | | | | | | | | | | | | | | | | | x | | 2 |
| | EF4 | | | | | | | | | | | | | | | | x | x | | | | | | | x | 3 |
| | EF3 | | | | | | x | | | | | | | | | | x | x | x | | | x | | | | 5 |
| | T2 | x | | x | | x | | | | | x | | | | | | | | | | | | | | | 4 |
| | HR3 | x | | x | | x | | | | | x | | | | | | | x | | | | | x | | | 6 |
| | MN6 | | | | | | | | | | | | | | | x | | x | | x | x | | | x | | 5 |
| | I6 | x | | | | x | | | | | x | | | | | | | | | | | | | | | 3 |
| | O4 | | | | | | | | x | x | | x | x | x | | | | | x | | | x | x | x | | 9 |
| | SC6 | | x | | | | | | | | | | | | x | | | | | x | | | | x | | 4 |
| | EF7 | | | | | | | x | | | | | x | | | x | | x | x | | | | | | | 5 |
| | Total | 3 | 4 | 3 | 1 | 5 | 3 | 1 | 2 | 1 | 3 | 3 | 2 | 1 | 1 | 2 | 2 | 5 | 4 | 4 | 1 | 4 | 3 | 4 | 1 | |

According to Table 6, all the barriers have associated strategies that can be implemented to address them. Moreover, Table 6 highlights how certain strategies have the potential to address multiple barriers, specifically strategies 5 and 17 (applied to 5 barriers); 2, 18, 19, 21, and 23 (applied to 4 barriers); and 1, 3, 6, 10, 11, and 22 (applied to 3 barriers). Understanding these strategies is important for improving the mitigation of barriers and enabling the successful implementation of SSCM.

## 5. Discussion and Managerial Implications

According to the findings from Figure 2, the category of barriers with the greatest importance is the economic and financial barrier since it has the highest weight value

(0.247309), followed by the technological, regulatory and institutional, and organizational categories; all of these have the same weight (0.156875), meaning they have similar importance. Next is the market and networking category (0.078437), followed by the social and cultural category and the information category, both with the same weight (0.06275). The human resources category came in eighth place (0.052292), and the supplier category was considered the least important and had the lowest weight (0.025838). In fact, Table 3 shows that 5 out of the 7 economic and financial barriers considered in this study are among the 15 key barriers identified, explaining why this category must be carefully considered during the adoption of SSCM.

In order for organizations to transition to sustainable processes and implement sustainability in their supply chains, it is essential to have funds and capital to carry out innovation activities, which is the higher-ranked barrier (see Table 3). However, the investment made by companies to build infrastructure often disrupts their finances and hinders the financing of sustainable innovation activities [84]. In particular, the most important economic and financial barriers are a lack of funds for a sustainable production practice (EF1), insufficient capital to carry out innovation activities (EF2), the high cost of implementation and maintenance (EF4), high investment and perceived low economic return (EF3), and pressure for lower prices (EF7). The following strategies can help overcome these barriers: develop collaboration capacities and skills within the organization and between external organizations and institutions through the exchange of technology, joint training of employees, and collaborative development of new sustainable technologies (Str5); promote the allocation of funds for sustainable innovation initiatives, including investment in technologies related to sustainability (Str6); promote the benefits of sustainable products in the market to increase demand for green and sustainable products (Str7); foster collaborations and partnerships with other partners to achieve effective SSCM adoption (Str11); share strategies, knowledge, and business expectations with supply chain partners to enhance SSCM (Str12); obtain raw materials from environmentally friendly sources to promote sustainability (Str15); implement prevention and maintenance strategies to maximize equipment efficiency (Str16); implement production and packaging solutions that promote reduction, reuse, or recycling of materials (Str17); collaborate with industrial partners and/or local organizations to recycle products (Str18); develop a long-term strategy for implementing SSCM (Str21); promote an organizational culture that encourages employees to support SSCM implementation (Str22); and motivate employees to adopt sustainable practices to facilitate the SSCM implementation process (Str24).

As the technological, regulatory and institutional and organizational categories have the same weight, it can be said that they have the same degree of importance. Technology is a crucial element for implementing sustainability, given that many organizations do not have the technological know-how required for sustainable innovation [22] nor the technological capacity for waste management, recycling, and the reuse of products/materials [85,86]. Many of these problems stem from a lack of R&D facilities and a lack of innovation capacities, which hinders the growth of an organization's technological capacity [37]. The most important technological barriers are the lack of R&D and innovation capacities (T3), as well as a lack of technological knowledge and training (T2). Formulating policies and regulations by the government to promote sustainability practices through, for instance, tax cuts, infrastructural support, and waste management and recycling policies (Str2); developing technological skills to support sustainable development through innovation (Str3); creating research laboratories to develop and improve product and process innovation (Str4); developing collaboration capacities and skills within the organization and between external organizations and institutions through the exchange of technology, joint training of employees and collaborative development of new sustainable technologies (Str5); fostering collaborations and partnerships with other partners to achieve effective SSCM adoption (Str11); collaborating with industrial partners and/or local organizations to recycle products (Str18); and disseminating information on productivity, employee health and safety, and environmental performance (Str19) can help overcome T3.

To surmount T2, organizations can foster an environment conducive to the development of ecological and sustainable skills for employees, such as the know-how to generate ideas for sustainable technologies (Str1); develop technological skills to support sustainable development through innovation (Str3); develop collaboration capacities and skills within the organization and between external organizations and institutions through the exchange of technology, joint training of employees and collaborative development of new sustainable technologies (Str5); and promote training programs for employees on topics related to sustainability and the adoption of SSCM (Str10).

On the other hand, regulatory and institutional barriers are also significant, as there is a lack of laws and legislation (RI2) and an inadequate institutional framework (RI1). However, this is a category external to the organizations, as it does not depend solely on the organizations but rather on the regulatory and administrative authorities. These entities must work together with organizations to create and formulate environmental management policies so that they are complied with as strictly as possible [12]. The formulation of policies and regulations by the government to promote sustainability practices through, for instance, tax cuts, infrastructural support, and waste management and recycling policies (Str2) can help overcome the barriers RI2 and RI1. The latter barrier can also be addressed by the development of strategic plans considering social legitimacy, responsibility, and trust to achieve a sustainable business framework (Str23).

When it comes to the organizational barriers, it is essential to motivate top management to be more committed to adopting sustainable practices, in order to develop innovative thinking and greater employee participation in the adoption of SSCM [12]. However, decision-makers also need a strategic plan aligning with the organization's objectives to achieve sustainability in the supply chain [87] successfully. Therefore, the most important organizational barriers are insufficient commitment from top management (O2) and inadequate supply chain strategic planning (O4). These barriers can be overcome by the implementation of the following strategies: ensuring top management support, commitment to and involvement in the SSCM adoption process (Str8); integrating sustainability into an organization's policy and vision to enable superior performance (Str9); fostering collaborations and partnerships with other partners to achieve effective SSCM adoption (Str11); sharing strategies, knowledge, and business expectations with supply chain partners to enhance SSCM (Str12); using clean technologies to reduce waste in processes (Str13); collaborating with industrial partners and/or local organizations to recycle products (Str18); disseminating information on productivity, employee health and safety, and environmental performance (Str19); developing a long-term strategy for implementing SSCM (Str21); promoting an organizational culture that encourages employees to support SSCM implementation (Str22); and developing strategic plans considering social legitimacy, responsibility, and trust to achieve a sustainable business framework (Str23).

For market and networking barriers, it is important to encourage consumers to purchase sustainable or sustainably produced products and help them realize the benefits of sustainable products [12]. The most important market and networking barrier is insufficient consumer support and encouragement (MN6). Organizations can obtain raw materials from environmentally friendly sources to promote sustainability (Str15); implement production and packaging solutions that promote reduction, reuse, or the recycling of materials (Str17); disseminate information on productivity, employee health and safety, and environmental performance (Str19); promote greater involvement and interaction with the customer and stakeholders to produce cleaner and more environmentally friendly products in line with market needs (Str20); and develop strategic plans considering social legitimacy, responsibility, and trust to achieve a sustainable business framework (Str23) to surmount the MN6 barrier.

Regarding the social and cultural barriers, corruption has acted as the biggest barrier (SC6), as many of the decision-makers do not comply with the established rules and falsify documents, both to the local government and to certification bodies, in order to deceive the consumer by promoting sustainable products with certifications, when, in fact, the

products may not be certified, to obtain higher profit margins [47]. The strategies best suited to overcome this barrier are formulating policies and regulations by the government to promote sustainability practices through, for instance, tax cuts, infrastructural support, and waste management and recycling policies (Str2); organizations taking responsibility for their products in order to reduce their ecological, social, and safety impact (Str14); disseminating information on productivity, employee health and safety, and environmental performance (Str19); and developing strategic plans considering social legitimacy, responsibility, and trust to achieve a sustainable business framework (Str23).

Information barriers have the same weight as the social and cultural barriers, meaning these categories are equally important. It is essential to train and educate the organization's employees, so that they have adequate knowledge about sustainability and the adoption of SSCM occurs smoothly [88]. In fact, this is the only information barrier among the 15 key barriers identified: ineffective training and education on information systems (I6). The strategies that organizations can implement to neutralize barrier I6 are to foster an environment conducive to the development of ecological and sustainable skills for employees, such as the know-how to generate ideas for sustainable technologies (Str1); develop collaboration capacities and skills within the organization and between external organizations and institutions through the exchange of technology, joint training of employees, and collaborative development of new sustainable technologies (Str5); and promote training programs for employees on topics related to sustainability and the adoption of SSCM (Str10). The human resources category also features just one barrier among the 15 key barriers to the implementation of SSCM, which underscores the lack of training and information on sustainable practices (HR3). In other words, there is a significant percentage of employees or managers without the essential ecological training required for sustainable production. Consequently, by training supply chain members, organizations can enhance their environmental and operational performance [89]. Applicable strategies include the strategies previously referred to in order to overcome I6, Str1, Str5, and Str 10, in addition to the development of technological skills to support sustainable development through innovation (Str3); the implementation of production and packaging solutions that promote reduction, reuse, or the recycling of materials (Str17); and the promotion of an organizational culture that encourages employees to support SSCM implementation (Str22).

While none of the supplier category barriers rank among the 15 most important barriers (see Table 4), having a reward system for suppliers can help promote the use of sustainable, or sustainably produced, products. This approach also helps in skill development and performance enhancement, potentially leading to a growth in the number of sustainable suppliers [90,91].

In summary, all of the barriers impact the adoption of SSCM within an organization. However, particular emphasis should be placed on the key barriers. Consequently, the SSCM adoption process is more likely to succeed when organizations comprehend the most important barriers and develop and integrate strategies tailored to overcome them.

## 6. Conclusions

Various industries and sectors have increasingly adopted sustainable supply chain management (SSCM), as it makes it possible to reduce environmental impact and, at the same time, achieve a better brand image and a competitive advantage. However, there are many barriers preventing organizations from adopting SSCM. This makes it essential to identify, rank, and prioritize the barriers so that the process of implementing SSCM is easier and more successful in SMEs. This study aimed to identify the barriers that prevent sustainability in supply chains and, using the BWM, to rank and prioritize the barriers considered relevant by a group of experts, according to their importance, in order to help decision-makers, organizations, and policymakers formulate policies and strategies to overcome existing barriers and successfully adopt SSCM.

The literature review identified 80 barriers to the implementation of SSCM, from 9 categories (technological, economic and financial, supplier-related, information-related,

market and networking, human resources, social and cultural, regulatory and institutional, and organizational barriers), of which 55 were considered relevant for the context of small and medium-sized enterprises (SMEs). With the help of the best–worst method (BWM), it was possible to assess the importance of each barrier and identify the 15 key barriers hindering the implementation of SSCM. The barriers that present the greatest challenge are economic and financial barriers—in particular, the lack of financial resources for sustainable production, the insufficient capital available for innovation activities, and the need for large investments to implement and carry out maintenance corresponding to activities whose economic return is uncertain, as well as the pressure for lower prices, which has shown a significant increase.

A total of 24 strategies reported in the literature can help overcome the SSCM barriers, particularly the 15 key barriers prioritized. If SMEs implement 8.3% of the considered strategies—specifically, working towards the development of collaboration capacities and skills within the organization and between external organizations and institutions through the exchange of technology, joint training of employees, and collaborative development of new sustainable technologies, coupled with striving to implement production and packaging solutions that promote reduction, reuse, or the recycling of materials—they can potentially overcome 60% of the key barriers identified.

This study has threefold contributions. First, it provides a list of barriers that hinder the adoption of SSCM, assessing which are the most important and the biggest obstacles in the case of SMEs. Second, it analyses strategies with the potential to overcome priority barriers to ensure the successful sustainable development of supply chains. Last but not least, it offers a structured approach based on a multi-criteria decision-making (MCDM) method, particularly BWM, to identify and prioritize the barriers to the implementation of SSCM.

Although this study provides valuable contributions, it is important to recognize its limitations. The opinions and judgments of experts who participated in the focus group discussions (FGDs) were a potential source of bias, namely in selecting the relevant barriers to the adoption of SSCM by SMEs, in the prioritization process, and in selecting appropriate mitigation strategies for them. Despite the moderator's efforts in conducting the FGDs, the composition of the group of experts in terms of the size of their enterprises of origin, location, and industrial sector may have influenced the study's outcomes and, thus, reduced their generalization. Therefore, this study should be replicated with a broader and more diverse range of experts, including those from different industries, geographic locations, and representing SMEs of various sizes, to develop strategies more effective in supporting the adoption of SSCM by SMEs.

Another limitation of this study is its methodological approach; although practical and efficient, it fails to consider the barriers' interrelationships and hierarchal structure and their driving and dependence powers, which would allow for more concrete and tailored, and therefore more effective, strategies to mitigate the barriers to the adoption of SSCM by SMEs. Thus, in future methodological developments, the BWM could be complemented by the combined approach of interpretive structural modeling (ISM) and matrix cross-impact matrix multiplication (MICMAC) analysis.

**Supplementary Materials:** The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su16020506/s1, Supplementary Material S1: List of barriers to SSCM implementation; Supplementary Material S2: Evaluation of the importance of barriers and main categories based on the BWM technique.

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## References

1. Shekarian, E.; Ijadi, B.; Zare, A.; Majava, J. Sustainable Supply Chain Management: A Comprehensive Systematic Review of Industrial Practices. *Sustainability* **2022**, *14*, 7892. [CrossRef]
2. Luthra, S.; Garg, D.; Haleem, A. An analysis of interactions among critical success factors to implement green supply chain management towards sustainability: An indian perspective. *Resour. Policy* **2015**, *46*, 37–50. [CrossRef]
3. Ghazilla, R.; Sakundarini, N.; Rashid, S.; Ayub, N.; Olugu, E.; Musa, S. Drivers and barriers analysis for green manufacturing practices in Malaysian SMEs: A preliminary findings. *Procedia CIRP* **2015**, *26*, 658–663. [CrossRef]
4. Moktadir, M.A.; Ali, S.M.; Rajesh, R.; Paul, S.K. Modeling the interrelationships among barriers to sustainable supply chain management in leather industry. *J. Clean. Prod.* **2018**, *181*, 631–651. [CrossRef]
5. Rajeev, A.; Pati, R.K.; Padhi, S.S.; Govindan, K. Evolution of sustainability in supply chain management: A literature review. *J. Clean. Prod.* **2017**, *162*, 299–314. [CrossRef]
6. Pazienza, M.; de Jong, M.; Schoenmaker, D. Clarifying the Concept of Corporate Sustainability and Providing Convergence for Its Definition. *Sustainability* **2022**, *14*, 7838. [CrossRef]
7. Ahi, P.; Searcy, C. A comparative literature analysis of definitions for green and sustainable supply chain management. *J. Clean. Prod.* **2013**, *52*, 329–341. [CrossRef]
8. Goel, P. Triple bottom line reporting: An analytical approach for corporate sustainability. *J. Financ. Account. Manag.* **2010**, *1*, 27–42.
9. Paul, A.; Shukla, N.; Paul, S.K.; Trianni, A. Sustainable Supply Chain Management and Multi-Criteria Decision-Making Methods: A Systematic Review. *Sustainability* **2021**, *13*, 7104. [CrossRef]
10. Hou, Y.; Khokhar, M.; Sharma, A.; Sarkar, J.B.; Hossain, M.A. Converging concepts of sustainability and supply chain networks: A systematic literature review approach. *Environ. Sci. Pollut. Res.* **2023**, *30*, 46120–46130. [CrossRef]
11. Govindan, K.; Azevedo, S.G.; Carvalho, H.; Cruz-Machado, V. Impact of supply chain management practices on sustainability. *J. Clean. Prod.* **2014**, *85*, 212–225. [CrossRef]
12. Gupta, H.; Kusi-Sarpong, S.; Rezaei, J. Barriers and overcoming strategies to supply chain sustainability innovation. *Resour. Conserv. Recycl.* **2020**, *161*, 104819. [CrossRef]
13. Govindan, K.; Kaliyan, M.; Kannan, D.; Haq, A.N. Barriers analysis for green supply chain management implementation in Indian industries using analytic hierarchy process. *Int. J. Prod. Econ.* **2014**, *147*, 555–568. [CrossRef]
14. Mastos, T.; Gotzamani, K. Sustainable Supply Chain Management in the Food Industry: A Conceptual Model from a Literature Review and a Case Study. *Foods* **2022**, *11*, 2295. [CrossRef] [PubMed]
15. Sarkis, J.; Zhu, Q.; Lai, K. An organizational theoretic review of green supply chain management literature. *Int. J. Prod. Econ.* **2011**, *130*, 1–15. [CrossRef]
16. Majumdar, A.; Sinha, S.K. Analyzing the barriers of green textile supply chain management in Southeast Asia using interpretive structural modeling. *Sustain. Prod. Consum.* **2019**, *17*, 176–187. [CrossRef]
17. Tsvetkova, D.; Bengtsson, E.; Durst, S. Maintaining sustainable practices in SMEs: Insights from Sweden. *Sustainability* **2020**, *12*, 10242. [CrossRef]
18. Edeigba, J.; Arasanmi, C. An empirical analysis of SMES' triple bottom line practices. *J. Account. Organ. Chang.* **2022**, *18*, 238–259. [CrossRef]
19. Rezaei, J. Best-worst multi-criteria decision-making method. *Omega* **2015**, *53*, 49–57. [CrossRef]
20. Rezaei, J. Best-worst multi-criteria decision-making method: Some properties and a linear model. *Omega* **2016**, *64*, 126–130. [CrossRef]
21. Munim, Z.H.; Sornn-Friese, H.; Dushenko, M. Identifying the appropriate governance model for green port management: Applying Analytic Network Process and Best-Worst methods to ports in the Indian Ocean Rim. *J. Clean. Prod.* **2020**, *268*, 122156. [CrossRef]
22. Gupta, H.; Barua, M.K. Supplier selection among SMEs on the basis of their green innovation ability using BWM and fuzzy TOPSIS. *J. Clean. Prod.* **2017**, *152*, 242–258. [CrossRef]
23. Malek, J.; Desai, T.N. Prioritization of sustainable manufacturing barriers using Best Worst Method. *J. Clean. Prod.* **2019**, *226*, 589–600. [CrossRef]
24. Lin, Y.H.; Tseng, M.L. Assessing the competitive priorities within sustainable supply chain management under uncertainty. *J. Clean. Prod.* **2016**, *112*, 2133–2144. [CrossRef]
25. Reefke, H.; Sundaram, D. Sustainable supply chain management: Decision models for transformation and maturity. *Decis. Support Syst.* **2018**, *113*, 56–72. [CrossRef]

26. Badri Ahmadi, H.; Kusi-Sarpong, S.; Rezaei, J. Assessing the social sustainability of supply chains using Best Worst Method. *Resour. Conserv. Recycl.* **2017**, *126*, 99–106. [CrossRef]
27. Luthra, S.; Mangla, S.K. When strategies matter: Adoption of sustainable supply chain management practices in an emerging economy's context. *Resour. Conserv. Recycl.* **2018**, *138*, 194–206. [CrossRef]
28. Kusi-Sarpong, S.; Gupta, H.; Khan, S.A.; Jabbour, C.J.C.; Rehman, S.T.; Kusi- Sarpong, H. Sustainable supplier selection based on industry 4.0 initiatives within the context of circular economy implementation in sustainable supply chain operations. *Prod. Plan. Control.* **2023**, *34*, 999–1019. [CrossRef]
29. Kumar, A.; Dixit, G. An analysis of barriers affecting the implementation of e-waste management practices in India: A novel ISM-DEMATEL approach. *Sustain. Prod. Consum.* **2018**, *14*, 36–52. [CrossRef]
30. Kumar, A.; Dixit, G. Evaluating critical barriers to implementation of WEEE management using Dematel approach. *Resour. Conserv. Recycl.* **2018**, *131*, 101–121. [CrossRef]
31. Luthra, S.; Govindan, K.; Kannan, D.; Mangla, S.K.; Garg, C.P. An integrated framework for sustainable supplier selection and evaluation in supply chains. *J. Clean. Prod.* **2017**, *140*, 1686–1698. [CrossRef]
32. Bai, C.; Kusi-Sarpong, S.; Badri Ahmadi, H.; Sarkis, J. Social sustainable supplier evaluation and selection: A group decision-support approach. *Int. J. Prod. Res.* **2019**, *57*, 7046–7067. [CrossRef]
33. Zhang, H.; Li, L.; Zhou, P.; Hou, J.; Qiu, Y. Subsidy Modes, Waste Cooking Oil and Biofuel: Policy Effectiveness and Sustainable Supply Chains in China. *Energy Policy* **2014**, *65*, 270–274. [CrossRef]
34. Ferreira, L.M.D.F.; Silva, C. Integrating Sustainability Metrics in the Supply Chain Performance Measurement System. In *Multiple Helix Ecosystems for Sustainable Competitiveness*; Peris-Ortiz, M., Ferreira, J., Farinha, L., Fernandes, N., Eds.; Springer: Cham, Switzerland, 2016; pp. 113–132. [CrossRef]
35. Bai, C.; Sarkis, J. Integrating sustainability into supplier selection: A grey-based Topsis analysis. *Technol. Econ. Dev. Econ.* **2018**, *24*, 2202–2224. [CrossRef]
36. Kusi-Sarpong, S.; Gupta, H.; Sarkis, J. A supply chain sustainability innovation framework and evaluation methodology. *Int. J. Prod. Res.* **2019**, *57*, 1990–2008. [CrossRef]
37. Gupta, H.; Barua, M.K. A grey DEMATEL-based approach for modeling enablers of green innovation in manufacturing organizations. *Environ. Sci. Pollut. Res.* **2018**, *25*, 9556–9578. [CrossRef] [PubMed]
38. Cai, W.G.; Zhou, X.L. On the drivers of eco-innovation: Empirical evidence from China. *J. Clean. Prod.* **2014**, *79*, 239–248. [CrossRef]
39. Isaksson, R.; Johansson, P.; Fischer, K. Detecting supply chain innovation potential for sustainable development. *J. Bus. Ethics* **2010**, *97*, 425–442. [CrossRef]
40. Beise, M.; Rennings, K. Lead markets and regulation: A framework for analysing the international diffusion of environmental innovations. *Ecol. Econ.* **2005**, *52*, 5–17. [CrossRef]
41. De Marchi, V. Environmental innovation and R&D cooperation: Empirical evidence from Spanish manufacturing firms. *Res. Policy* **2012**, *41*, 614–623. [CrossRef]
42. Zailani, S.; Jeyaraman, K.; Vengadasan, G.; Premkumar, R. Sustainable supply chain management (SSCM) in Malaysia: A survey. *Int. J. Prod. Econ.* **2012**, *140*, 330–340. [CrossRef]
43. Keating, B.; Quazi, A.; Kriz, A.; Coltman, T. In pursuit of a sustainable supply chain: Insights from westpac banking corporation. *Supply Chain Manag.* **2008**, *13*, 175–179. [CrossRef]
44. Kleindorfer, R.; Singhal, K.; Wassenhove, L. Sustainable operations management. *Prod. Oper. Manag.* **2009**, *14*, 482–492. [CrossRef]
45. Pagell, M.; Wu, Z.; Wasserman, M. Thinking Differently About Purchasing Portfolios: An Assessment of Sustainable Sourcing. *J. Supply Chain Manag.* **2010**, *46*, 57–73. [CrossRef]
46. Ansari, N.; Kant, R. A State-of-Art Literature Review Reflecting 15 Years of Focus on Sustainable Supply Chain Management. *J. Clean. Prod.* **2017**, *142*, 2524–2543. [CrossRef]
47. Silvestre, B.S. Sustainable supply chain management in emerging economies: Environmental turbulence, institutional voids and sustainability trajectories. *Int. J. Prod. Econ.* **2015**, *167*, 156–169. [CrossRef]
48. Roy, V.; Schoenherr, T.; Charan, P. Toward an organizational understanding of the transformation needed for sustainable supply chain management: The concepts of force-field and differential efforts. *J. Purch. Supply Manag.* **2020**, *26*, 100612. [CrossRef]
49. Hassini, E.; Surti, C.; Searcy, C. A literature review and a case study of sustainable supply chains with a focus on metrics. *Int. J. Prod. Econ.* **2012**, *140*, 69–82. [CrossRef]
50. Wong, W.P.; Tseng, M.L.; Tan, K.H. A business process management capabilities perspective on organisation performance. *Total Qual. Manag. Bus. Excell.* **2014**, *25*, 602–617. [CrossRef]
51. Chacón Vargas, J.R.; Moreno Mantilla, C.E.; de Sousa Jabbour, A.B.L. Enablers of sustainable supply chain management and its effect on competitive advantage in the Colombian context. *Resour. Conserv. Recycl.* **2018**, *139*, 237–250. [CrossRef]
52. Danese, P.; Lion, A.; Vinelli, A. Drivers and enablers of supplier sustainability practices: A survey-based analysis. *Int. J. Prod. Res.* **2018**, *57*, 2034–2056. [CrossRef]
53. Das, D. Sustainable supply chain management in Indian organisations: An empirical investigation. *Int. J. Prod. Res.* **2018**, *56*, 5776–5794. [CrossRef]
54. Gouda, S.K.; Saranga, H. Sustainable supply chains for supply chain sustainability: Impact of sustainability efforts on supply chain risk. *Int. J. Prod. Res.* **2018**, *56*, 5820–5835. [CrossRef]

55. Romano, A.L.; Ferreira, L.M.D.; Caeiro, S.S.F. Modelling sustainability risk in the Brazilian cosmetics industry. *Sustainability* **2021**, *13*, 13771. [CrossRef]
56. Diabat, A.; Govindan, K. An analysis of the drivers affecting the implementation of green supply chain management. *Resour. Conserv. Recycl.* **2011**, *55*, 659–667. [CrossRef]
57. Mathivathanan, D.; Kannan, D.; Haq, A.N. Sustainable supply chain management practices in Indian automotive industry: A multi-stakeholder view. *Resour. Conserv. Recycl.* **2018**, *128*, 284–305. [CrossRef]
58. Mangla, S.; Govindan, K.; Luthra, S. Prioritizing the barriers to achieve sustainable consumption and production trends in supply chains using fuzzy Analytical Hierarchy Process. *J. Clean. Prod.* **2017**, *151*, 509–525. [CrossRef]
59. Klewitz, J.; Hansen, E.G. Sustainability-oriented innovation of SMEs: A systematic review. *J. Clean. Prod.* **2014**, *65*, 57–75. [CrossRef]
60. Koberg, E.; Longoni, A. A systematic review of sustainable supply chain management in global supply chains. *J. Clean. Prod.* **2019**, *207*, 1084–1098. [CrossRef]
61. Aguado, S.; Alvarez, R.; Domingo, R. Model of efficient and sustainable improvements in a lean production system through processes of environmental innovation. *J. Clean. Prod.* **2013**, *47*, 141–148. [CrossRef]
62. Guerin, T.F. Why sustainable innovations are not always adopted. *Resour. Conserv. Recycl.* **2001**, *34*, 1–18. [CrossRef]
63. D'Este, P.; Iammarino, S.; Savona, M.; Tunzelmann, N. What hampers innovation? Revealed barriers versus deterring barriers. *Res. Policy* **2012**, *41*, 482–488. [CrossRef]
64. Seuring, S. A review of modeling approaches for sustainable supply chain management. *Decis. Support Syst.* **2013**, *54*, 1513–1520. [CrossRef]
65. Ageron, B.; Gunasekaran, A.; Spalanzani, A. Sustainable supply management: An Empirical Study. *Int. J. Prod. Econ.* **2012**, *140*, 168–182. [CrossRef]
66. Patel, A.; Desai, T. A systematic review and meta-analysis of recent developments in sustainable supply chain management. *Int. J. Logist. Res. Appl.* **2019**, *22*, 349–370. [CrossRef]
67. Tumpa, T.J.; Ali, S.M.; Rahman, M.H.; Paul, S.K.; Chowdhury, P.; Rehman Khan, S.A. Barriers to green supply chain management: An emerging economy context. *J. Clean. Prod.* **2019**, *236*, 117617. [CrossRef]
68. Lamba, N.; Thareja, P. Developing the structural model based on analyzing the relationship between the barriers of green supply chain management using TOPSIS approach. *Mater. Today Proc.* **2020**, *43*, 1–8. [CrossRef]
69. Lamba, N.; Thareja, P. Modelling of barriers pertaining to implementation of green supply chain management using ISM approach. *Mater. Today Proc.* **2020**, *43*, 9–16. [CrossRef]
70. Jia, F.; Zuluaga-Cardona, L.; Bailey, A.; Rueda, X. Sustainable supply chain management in developing countries: An analysis of the literature. *J. Clean. Prod.* **2018**, *189*, 263–278. [CrossRef]
71. Morgan, D.L. Focus Groups. *Annu. Rev. Sociol.* **1996**, *22*, 129–152. [CrossRef]
72. Magalhães, V.S.; Ferreira, L.M.D.; Silva, C. Prioritising food loss and waste mitigation strategies in the fruit and vegetable supply chain: A multi-criteria approach. *Sustain. Prod. Consum.* **2022**, *31*, 569–581. [CrossRef]
73. Magalhães, V.S.; Ferreira, L.M.D.; Silva, C. Using a methodological approach to model causes of food loss and waste in fruit and vegetable supply chains. *J. Clean. Prod.* **2021**, *283*, 124574. [CrossRef]
74. Marshall, C.; Rossman, G.B. *Designing Qualitative Research*, 6th ed.; SAGE Publications: Thousand Oaks, CA, USA, 2015.
75. Kitzinger, J. Qualitative Research: Introducing focus groups. *BMJ* **1995**, *311*, 299. [CrossRef] [PubMed]
76. Larson, K.; Grudens-Schuck, N.; Allen, B. Can You Call It a Focus Group? *Methodology Brief* May 2004, 1–4. Available online: https://store.extension.iastate.edu/Product/pm1969a-pdf (accessed on 16 November 2023).
77. Saaty, T.L. How to Make a Decision: The Analytic Hierarchy Process. *Eur. J. Oper. Res.* **1990**, *48*, 9–26. [CrossRef]
78. Mudgal, R.K.; Shankar, R.; Talib, P.; Raj, T. Modeling the barriers of green supply chain practices: An Indian perspective. *Int. J. Logist. Syst. Manag.* **2010**, *7*, 81–107. [CrossRef]
79. Harms, D.; Hansen, E.G.; Schaltegger, S. Strategies in sustainable supply chain management: An empirical investigation of large German companies. *Corp. Soc. Responsib. Environ.* **2013**, *20*, 205–218. [CrossRef]
80. Satyro, W.C.; de Mesquita Spinola, M.; de Almeida, C.M.; Giannetti, B.F.; Sacomano, J.B.; Contador, J.C.; Contador, J.L. Sustainable industries: Prod. Plan. Control. as an ally to implement strategy. *J. Clean. Prod.* **2021**, *281*, 124781. [CrossRef]
81. Schaltegger, S.; Wagner, M. *Managing the Business Case for Sustainability: The Integration of Social, Environmental and Economic Performance*; Routledge: New York, NY, USA, 2017.
82. Kumar, A.; Moktadir, M.A.; Khan, S.A.R.; Garza-Reyes, J.A.; Tyagi, M.; Kazançoğlu, Y. Behavioral factors on the adoption of sustainable supply chain practices. *Resour. Conserv. Recycl.* **2020**, *158*, 104818. [CrossRef]
83. Dahooie, J.H.; Babgohari, A.Z.; Meidutė-Kavaliauskienė, I.; Govindan, K. Prioritising sustainable supply chain management practices by their impact on multiple interacting barriers. *Int. J. Sustain. Dev. World Ecol.* **2021**, *28*, 267–290. [CrossRef]
84. Neri, A.; Cagno, E.; Di Sebastiano, G.; Trianni, A. Industrial sustainability: Modelling drivers and mechanisms with barriers. *J. Clean. Prod.* **2018**, *194*, 452–472. [CrossRef]
85. AlSanad, S. Barriers to implementation sustainable cement manufacturing in Kuwait. *Eur. J. Sustain. Dev.* **2018**, *7*, 317–322. [CrossRef]
86. De Jesus, A.; Mendonça, S. Lost in transition? Drivers and barriers in the eco- innovation road to the circular economy. *Ecol. Econ.* **2018**, *145*, 75–89. [CrossRef]

87. Bratt, C.; Sroufe, R.; Broman, G. Implementing strategic sustainable supply chain management. *Sustainability* **2021**, *13*, 8132. [CrossRef]
88. Jabbour, C.J.C. Environmental training in organisations: From a literature review to a framework for future research. *Resour. Conserv. Recycl.* **2013**, *74*, 144–155. [CrossRef]
89. Rao, R.V. Introduction to Multiple Attribute Decision-making (MADM) Methods. In *Decision Making in the Manufacturing Environment*; Rao, R.V., Ed.; Springer: London, UK, 2007; pp. 27–41. [CrossRef]
90. Fletcher, C. Performance appraisal and management: The developing research agenda. *J. Occup. Organ. Psychol.* **2001**, *74*, 473–487. [CrossRef]
91. Kuvaas, B. Performance appraisal satisfaction and employee outcomes: Mediating and moderating roles of work motivation. *Int. J. Hum. Resour. Manag.* **2006**, *17*, 504–522. [CrossRef]