Krisciukaitiene, I., & Bathaei, A. (2024). Developing a tailored sustainable supply chain framework for dairy SMEs in Lithuania using Best-Worst Method. *Transformations and Sustainability, 1*(1), 43-62. https://doi.org/10.63775/sv982x31

Developing a tailored sustainable supply chain framework for dairy SMEs in Lithuania using Best-Worst Method

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Abstract. Sustainable Supply Chain Management (SSCM) plays a vital role in addressing environmental, economic, and social challenges within resource-intensive industries such as dairy production. Despite growing global interest in sustainability, the Baltic region—particularly Lithuania—remains underexplored in terms of localized SSCM frameworks. This study aims to fill this gap by identifying and prioritizing sustainability indicators relevant to Lithuanian dairy companies, using the Best-Worst Method (BWM), a multi-criteria decision-making (MCDM) approach. A total of 15 experts from top-level management positions in the Lithuanian dairy sector were engaged to assess key indicators across three dimensions: environmental, economic, and social. The results reveal that GHG Emissions, Cost Efficiency, and Labor Rights & Fair Conditions are the most critical indicators in their respective dimensions, reflecting both global sustainability priorities and local industry needs. The model also emphasizes the importance of renewable energy, return on investment, and health and safety standards. A sensitivity analysis confirmed the robustness of the BWM results by illustrating how small changes in the top-ranked indicators affect the prioritization of other factors. The study offers a practical decision-support tool for managers and policymakers, providing a clear framework for targeted sustainability strategies in the Lithuanian dairy sector. It also contributes to the academic literature by demonstrating the effectiveness of BWM in regional agri-food supply chains. Recommendations are provided for government support, and future research directions are suggested to expand stakeholder involvement and apply hybrid MCDM models.

Keywords: Sustainable supply chain management; Dairy industry; Lithuania; Best-Worst Method; Sustainability indicators.

1. Introduction

Sustainable Supply Chain Management (SSCM) has become a cornerstone of modern industrial strategy, reflecting the urgent need to reconcile economic performance with environmental protection and social responsibility (Santiago et al., 2025). In particular, the agri-food sector has faced mounting pressure to adopt sustainable practices due to its intrinsic linkages with land use, resource consumption,

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Received April 2025; Revised April 2025; Accepted April 2025.

emissions, and food security. Among agri-food subsectors, the dairy industry stands out as one of the most environmentally burdensome, with considerable contributions to greenhouse gas emissions, water consumption, and nutrient pollution (Bathaei et al., 2021).

The importance of integrating sustainability into the dairy supply chain is heightened by increasing societal expectations, regulatory demands, and international policy initiatives such as the European Green Deal and the Farm to Fork Strategy (Beber et al., 2021). Consumers are progressively shifting toward ethically produced and environmentally friendly products, compelling dairy producers to reassess their sourcing, production, distribution, and waste management strategies. However, implementing SSCM principles in this industry is particularly complex due to its biological cycles, dependency on climatic factors, and involvement of multiple small-scale actors (De Angelis et al., 2018).

In the Lithuanian context, the dairy sector constitutes a vital component of the national agri-food system, both economically and socially. Nevertheless, it remains underexplored in terms of sustainability integration, especially within the domain of supply chain management (Mazur-Włodarczyk & Gruszecka-Kosowska, 2024). While several studies have investigated SSCM practices in agriculture and food industries globally, there is a notable lack of research focusing on localized frameworks adapted to the Lithuanian dairy sector (Le et al., 2022). The current literature largely applies generalized models that may not adequately reflect the specific challenges, capacities, and institutional structures present in post-Soviet economies.

Moreover, many dairy enterprises in Lithuania are small- to medium-sized enterprises (SMEs) that often lack the financial and human resources to implement broad sustainability initiatives (Galnaitytė et al., 2023; Leal Filho et al., 2025). These limitations underscore the necessity for a targeted decision-making framework that can assist in systematically identifying and prioritizing sustainability indicators that are both feasible and impactful for local stakeholders. A one-size-fits-all model risks overlooking critical regional priorities and may hinder the effective operationalization of sustainability strategies (Liang, 2024).

In response to these challenges, there is a growing need to develop a customized, data-driven approach to SSCM that incorporates expert knowledge and stakeholder perspectives. Multi-Criteria Decision-Making (MCDM) methods provide a valuable methodological toolset to evaluate complex, multi-dimensional problems where trade-offs between environmental, social, and economic objectives must be balanced. Among these methods, the Best-Worst Method (BWM) has gained prominence due to its high consistency, lower cognitive burden on respondents, and robust performance in comparative sustainability assessments (Štreimikienė et al., 2024).

BWM is particularly suitable for contexts like the Lithuanian dairy sector, where expert judgments are limited in number and resources for large-scale empirical data collection are constrained. By asking respondents to identify the best and worst criteria and rate all others in relation to these extremes, BWM minimizes redundancy and reduces inconsistency in pairwise comparisons. This makes it highly appropriate for deriving priority weights for sustainability indicators in emerging economies or resource-constrained industries .

Although MCDM techniques have been widely used in sustainability assessments, their application in the Baltic agri-food sectors remains scarce (Streimikis et al., 2024). Few studies have attempted to systematically rank SSCM criteria for dairy supply chains in this region using participatory, expert-informed methods. This research addresses this gap by applying BWM to develop a localized SSCM framework tailored to the Lithuanian dairy industry. It thereby contributes to a better understanding of how sustainability priorities differ across regions and sectors, and how decision support tools can enhance strategic planning.

The proposed study will involve expert consultations with supply chain managers, agricultural economists, policymakers, and sustainability officers to identify and prioritize relevant sustainability indicators. These may include environmental metrics such as carbon intensity and water usage, social considerations like labor conditions and rural community impact, and economic factors such as cost efficiency and market resilience. The resulting indicator weights will inform the development of a practical SSCM model that can guide both strategic decision-making and future policy development.

Thus, the objective of this research is to develop a context-specific SSCM framework for Lithuanian dairy companies by identifying and prioritizing sustainability indicators using the Best-Worst Method. This framework aims to enhance the implementation of sustainability initiatives in the dairy supply chain by offering clear, evidence-based guidance on which factors should be prioritized for maximal impact. By bridging methodological rigor with local relevance, the study contributes to both academic scholarship and practical decision-making in sustainable agri-food systems.

In sum, this research offers a novel contribution to the field of sustainable supply chain management by combining theoretical insights from MCDM literature with empirical evidence from a strategically important but underexplored sector. It supports Lithuania’s broader transition toward sustainable agriculture while providing a replicable model for other countries facing similar institutional and environmental challenges. Ultimately, the study seeks to empower dairy companies and policymakers with a structured, strategic, and scientifically grounded approach to sustainability prioritization.

2. Literature review

Sustainable Supply Chain Management (SSCM) is a multidimensional approach that seeks to integrate environmental, economic, and social objectives into supply chain practices (Parvathy et al., 2025). It extends the traditional scope of supply chain management by emphasizing the responsibility of companies not only to enhance operational efficiency but also to minimize environmental harm, promote social welfare, and support long-term economic viability (Khan et al., 2023). SSCM has gained considerable traction over the past two decades, driven by global concerns over climate change, resource depletion, social inequalities, and growing consumer expectations regarding ethical sourcing and transparency (Gonçalves & Silva, 2021).

The conceptual foundation of SSCM was significantly shaped by the "Triple Bottom Line" framework, which promotes a balance among three pillars: environmental stewardship, economic performance, and social equity (Gonçalves & Silva, 2021). Building on this, scholars have increasingly sought to identify key sustainability indicators to assess the performance of supply chains across various industries. While much progress has been made in sectors such as manufacturing, automotive, and retail, agri-food supply chains and specifically the dairy sector remain underexplored, particularly in the context of emerging and transitional economies (Streimikis et al., 2024).

Dairy production is one of the most resource-intensive agri-food activities, contributing significantly to global greenhouse gas (GHG) emissions, particularly methane from livestock (Neethirajan, 2024). It also demands high volumes of water and energy, both in primary production and processing stages. Consequently, improving sustainability in dairy supply chains presents a major opportunity for reducing the environmental footprint of food systems (Miller et al., 2021). Various international initiatives, such as the Global Dairy Agenda for Action and the Dairy Sustainability Framework, have been launched to promote sustainable practices in the dairy industry globally. However, their application remains uneven across regions and is often constrained by local economic, regulatory, and infrastructural conditions (Kaiser & Barstow, 2022).

In the European Union (EU), sustainability in agriculture is increasingly driven by regulatory instruments such as the Common Agricultural Policy (CAP), the European Green Deal, and Farm to Fork Strategy (Cuadros-Casanova et al., 2023). While these policies provide a comprehensive framework, their implementation varies significantly between Western and Eastern Europe. Studies have shown that dairy companies in countries such as the Netherlands, Germany, and Denmark have made considerable progress in energy efficiency, renewable energy integration, and circular economy practices (Castillo-Díaz et al., 2023; Puente-Rodríguez et al., 2022). Conversely, the Baltic states including Lithuania are lagging behind in adopting SSCM due to structural, economic, and institutional limitations (Nazam et al., 2022).

Several gaps in the literature underline the need for this research. First, most existing SSCM models are generalized and do not account for the unique context of Lithuanian dairy companies, which are predominantly SMEs with limited financial and technological capacity (Pålsson & Sandberg, 2022). Second, while global indicators offer a useful starting point, they may not reflect the specific sustainability priorities of local actors or respond to national environmental challenges. Third, the empirical application of decision-making tools such as Multi-Criteria Decision-Making (MCDM) methods remains scarce in the Baltic region, despite their potential to support evidence-based policy and managerial decisions (Wołek et al., 2021).

To address these gaps, it is critical to develop a localized SSCM framework that incorporates context-specific sustainability indicators. Drawing from the literature, sustainability indicators can be categorized into three main groups—environmental, economic, and social—each of which encompasses multiple sub-criteria relevant to supply chain evaluation and improvement (Ahi & Searcy, 2015; Tseng et al., 2021).

Environmental indicators are the most widely studied in SSCM due to their direct link to climate and ecological impacts. Key environmental indicators in the dairy supply chain include greenhouse gas (GHG) emissions, energy consumption (Becker et al., 2023), water usage (Bwambale et al., 2022), waste generation, land use (Khan et al., 2022), and adoption of renewable energy technologies (Bathaei & Štreimikienė, 2023b). Circular economy practices such as recycling wastewater, reusing by-products, and utilizing bioenergy also fall within this domain and are increasingly emphasized in recent studies (Manrique, 2020; Vasileiadou, 2024).

Economic indicators reflect the cost-effectiveness and financial resilience of supply chain practices. These include cost efficiency (Ekins & Zenghelis, 2021), return on investment in sustainable technologies, market adaptability, local procurement rates, and supply chain flexibility (Junaid et al., 2023). In SMEs, indicators such as operational efficiency, profitability under sustainable practices, and dependence on government subsidies are particularly relevant. These indicators help assess whether sustainable initiatives can be financially justified and maintained over time.

Social indicators, though less commonly applied in the agri-food sector, are gaining importance as consumers and regulators demand greater attention to ethical practices. Relevant indicators include labor rights, employee well-being, gender equality, health and safety standards, stakeholder engagement, and impacts on rural communities (Pyke et al., 2021). In the dairy industry, where rural employment and family-owned farms are prevalent, the social sustainability dimension is critical but often overlooked in empirical studies (Di Maddaloni & Sabini, 2022).

Despite a growing body of research, few studies offer an integrated approach that simultaneously evaluates all three dimensions of sustainability using a systematic and participatory method. The majority of existing SSCM assessments either rely on qualitative insights or focus disproportionately on environmental outcomes. There is a clear need for methodological frameworks that enable stakeholders to weigh trade-offs and identify the most critical areas for intervention based on a structured evaluation process (Fortnam et al., 2023).

Therefore, this study proposes the application of the Best-Worst Method (BWM) to determine the relative importance of sustainability indicators in Lithuanian dairy supply chains. BWM's comparative advantages such as reduced pairwise comparisons, improved consistency, and suitability for small expert panels—make it particularly well-suited for the context of Lithuanian SMEs. By applying BWM to the prioritized environmental, economic, and social indicators, the study aims to construct a context-sensitive SSCM model that aligns with both national goals and global sustainability frameworks (Tran et al., 2025).

In conclusion, this research addresses critical gaps in SSCM literature by developing a tailored sustainability assessment framework for Lithuanian dairy companies. It responds to the need for regionalized models that reflect local conditions, stakeholder preferences, and sectoral limitations. By systematically identifying and prioritizing sustainability indicators, this study not only contributes to the academic discourse but also provides actionable insights for policymakers, industry practitioners, and researchers interested in promoting sustainable agri-food systems in transitional economies. Table 1 shows the indicators based on previous studies.

Table 1
Categorization of Sustainability Indicators in Dairy Supply Chain Management

Dimension	Indicator	Description	Key References
Environmental	Greenhouse Gas (GHG) Emissions	Emissions from livestock, transportation, and processing	(Chataut et al., 2023; Jamali et al., 2021)
	Energy Consumption	Total energy used across supply chain stages	(Minoofar et al., 2023; Żyłka et al., 2021)
	Water Usage	Water used in feed production, processing, and sanitation	(Borghesi et al., 2022; Carlsson Kanyama et al., 2021)
	Waste Management	Waste reduction, recycling, and treatment practices	(Ferdeș et al., 2022; Stasinakis et al., 2022)
	Land Use Efficiency	Efficient use of agricultural land with minimal environmental degradation	(Cortés et al., 2021; Grassauer et al., 2022)
	Renewable Energy Usage	Adoption of clean energy sources in operations	(Bathaei & Štreimikienė, 2023a; Malliaroudaki et al., 2022; Shamsuddoha et al., 2023)
	Circular Economy Practices	Reuse of by-products, closed-loop systems, eco-design	(Najar et al., 2024; Oliveira et al., 2021)
Economic	Cost Efficiency	Minimizing operational costs through sustainable methods	(Moerkerken et al., 2021; Shamsuddoha et al., 2023)
	Return on Investment (ROI)	Financial gains from sustainability-focused investment	(Brasileiro-Assing et al., 2022; Springer et al., 2022)
	Local Sourcing	Share of inputs and materials sourced locally	(Beber et al., 2021; Merlino et al., 2022)

Dimension	Indicator	Description	Key References
	Supply Chain Flexibility	Responsiveness to market, regulatory, and environmental changes	(Shamsuddoha et al., 2023; Zarei-Kordshouli et al., 2023)
	Risk Reduction	Mitigation of disruptions and reputation-related risks	(Peterson & Mitloehner, 2021; Shamsuddoha et al., 2023)
Social	Labor Rights & Fair Conditions	Fair wages, ethical contracts, workplace rights	(Hoang et al., 2021; Shamsuddoha et al., 2023)
	Health & Safety	Ensuring safety in production, farming, and transport	(Naspetti et al., 2021; Shamsuddoha et al., 2023)
	Community Engagement	Support for rural livelihoods and regional development	(Ferdeş et al., 2022; Stasinakis et al., 2022)
	Stakeholder Inclusion	Involving actors in sustainability decisions	(Fortnam et al., 2023; Manrique, 2020; Vasileiadou, 2024)
	Transparency & Traceability	Ability to verify and trace sustainability claims across the supply chain	(Minoofar et al., 2023; Tran et al., 2025; Żyłka et al., 2021)

3. Methods

This study adopts a structured Multi-Criteria Decision-Making (MCDM) approach to develop a localized Sustainable Supply Chain Management (SSCM) framework for Lithuanian dairy companies. The methodology consists of three major components: (1) identification of sustainability indicators through literature review, (2) expert-based prioritization using the Best-Worst Method (BWM), and (3) analysis of the indicator weights within three distinct dimensions of sustainability environmental, economic, and social.

3.1 Research framework

The methodological process began with a comprehensive literature review to identify sustainability indicators relevant to dairy supply chain management. These indicators were categorized into three groups environmental, economic, and social—based on theoretical frameworks such as the Triple Bottom Line and prior studies in SSCM. A total of 18 indicators were selected and grouped accordingly.

Subsequently, a structured decision-making procedure was carried out using the Best-Worst Method (BWM), which allows for systematic evaluation of criteria by capturing expert preferences. Each group of indicators (i.e., environmental, economic, and social) was evaluated independently to ensure analytical clarity and dimension-specific insight.

3.2 Expert selection and data collection

The prioritization of sustainability indicators was conducted with input from 15 experts, all of whom hold senior or top-level management positions in leading Lithuanian dairy companies. The selected participants share a common professional background in supply chain operations, sustainability management, or corporate strategy within the dairy industry. Their experience and domain-specific knowledge ensured the reliability and validity of the judgments provided.

Experts were invited to complete structured BWM questionnaires, distributed electronically, in which they were asked to identify the most and least important indicators in each sustainability category and perform pairwise comparisons based on a predefined scale. The anonymity of responses was maintained to encourage unbiased input and reduce potential conformity bias.

3.3 Justification for using the BWM

The Best-Worst Method, originally developed by Rezaei (2015), was chosen for this study due to several methodological advantages that align with the research context. First, BWM requires fewer pairwise comparisons than traditional methods such as AHP, thereby reducing cognitive load on respondents and improving consistency in judgment. This is particularly important when engaging high-level professionals with limited availability.

Second, BWM yields a higher degree of consistency and robustness in comparison to other MCDM techniques, making it suitable for situations where expert opinion is the primary source of data. Moreover, BWM is ideal for small-sample contexts, such as the present study, which involves 15 qualified participants.

Third, BWM facilitates separate analysis of indicator groups, enabling the researcher to derive dimension-specific priority weights. This is crucial in sustainability research, where trade-offs between environmental, economic, and social goals must often be carefully considered. In this study, the method was applied independently for each group of indicators, resulting in three separate weight sets for environmental, economic, and social dimensions. This not only supports targeted decision-making but also enhances the transparency of the evaluation process.

3.4 Application of the Best Worst Method

A decision-making process known as the "best worst" method typically involves evaluating the value or worth of various options in order to select the most advantageous one. To make an informed choice, it entails a thorough assessment of numerous variables, including cost, benefits, risks, and long-term effects. The "best worst" method seeks to balance a variety of conflicting priorities and goals, ultimately choosing the course of action that provides the highest overall value or return on investment. This technique is frequently used to make sure that decisions are in line with organizational objectives and provide the greatest benefit in complex decision-making situations, such as project selection, procurement, or resource allocation (Rezaei, 2015). The steps of the original BWM can be described briefly as follows:

Step 1: Establish a set of decision-making criteria (the decision maker does this): (c1,c2,...,cn).

Step 2: Ranking the criteria by importance, choose the best (B) and the worst (W).

Step 3: Use a number between 1 and 9 to indicate how much the best criterion is preferred to the other criteria. The best-to-others (BO) vector is then shown as AB = (a_{B1}, a_{B2}, a_{B3},..., a_{Bn}), where a_{Bn} represents the preference of criterion C_B over criterion Cn.

Step 4: Using a number between 1 and 9, calculate each criterion's preference to the worst criterion. The others-to-worst (OW) vector is then shown as AW = (a_{1W} ,a_{2W} ,a_{3W} ,...,a_{nW})^T, where a_{jW} denotes criterion cj's preference over criterion c_W.

Step 5: The objective of this step is to determine the weights of criteria by minimizing the maximum absolute differences $\left|\frac{W_B}{W_j} - a_{Bj}\right|$ and $\left|\frac{W_j}{W_w} - a_{jw}\right|$ for all j . To solve this problem, a min–max Model (1) is formed:

$$\text{Min}\max_j\left\{\left|\frac{W_B}{W_j} - a_{Bj}\right| - \left|\frac{W_j}{W_w} - a_{jw}\right|\right\}$$

s.t. (1)

$$\sum_j W_j = 1,$$

$$\text{Wj} \geq 0, \quad \text{for all j.}$$

Model (1) is equivalent to Model (2) by using ξ to denote the maximal deviation.

min ξ

s.t. (2)

$$\left|\frac{W_B}{W_j} - a_{Bj}\right| \leq \xi, \quad for\ all\ j,$$

$$\left|\frac{W_j}{W_w} - a_{jw}\right| \leq \xi, \quad for\ all\ j,$$

$\sum_j W_j = 1$, Wj $\geq$ 0, for all j.

The value of the ideal weight is discovered by solving Model (2) for each criterion. The criteria would be prioritized based on the weights that were obtained. Priority would be given to the criterion with the highest weight. The consistency ratio in this method ranges from 0 to 1, as determined by Eq. (1). Higher consistency is indicated by a value nearer to 0:

$$\text{Consistency Ratio} = \frac{\xi}{\text{Consistency Index}}$$

Here, Table 2 is used to calculate the consistency index in relation to the number of criteria. Given the benefits, the BWM has received more and more attention in recent years.

Table 2
Consistency index (CI) table

The maximal preference degree of the best over the worst	1	2	3	4	5	6	7	8	9
Consistency Index	0.00	0.44	1.00	1.63	2.30	3.00	3.73	4.47	5.23

The mathematical formulation and steps of BWM will be detailed in the next section, including the linear programming model used to derive weights and ensure consistency.

By applying BWM in this structured manner, the study provides a systematic and stakeholder-informed prioritization of sustainability indicators in the Lithuanian dairy sector. The results will serve as the basis for developing a tailored SSCM framework that can guide sustainability strategy, performance measurement, and policy design in the regional context

4. Results

The Best-Worst Method (BWM) was applied to prioritize sustainability indicators across three dimensions—environmental, economic, and social—based on expert judgment. Fifteen senior professionals from top-level positions in Lithuanian dairy companies participated in the evaluation process. Each expert independently completed BWM questionnaires, identifying the most and least important indicators in each group and performing pairwise comparisons accordingly. The collected data were then analyzed using a linear programming model to compute the optimal weights and consistency ratios for each indicator. Separate analyses were conducted for each dimension to ensure clear and comparable prioritization within environmental, economic, and social domains.

Environmental Sustainability results. The Best-Worst Method (BWM) analysis revealed that among the environmental indicators, *GHG Emissions* was the highest priority (weight = 0.319), reflecting its critical role in Lithuania's dairy-related climate impact. *Energy Consumption* (0.160) and *Renewable Energy Usage* (0.128) followed, highlighting energy concerns in production and the growing shift toward green alternatives. *Water Usage* (0.128) and *Waste Management* (0.106) were of moderate importance, while *Circular Economy Practices* (0.091) and *Land Use Efficiency* (0.068) ranked lower, likely due to their limited application and lower land pressure in Lithuania.

Table 3
Environmental indicators final ranking

Rank	Indicator	Weight
1	GHG Emissions	0.319
2	Energy Consumption	0.16
3	Water Usage	0.128
3	Renewable Energy Usage	0.128
5	Waste Management	0.106
6	Circular Economy Practices	0.091
7	Land Use Efficiency	0.068

Economic Sustainability results. The BWM results for economic indicators indicate that Cost Efficiency is the most critical factor (weight = 0.409), highlighting the central concern of Lithuanian dairy SMEs in maintaining financial viability under rising production and energy costs. Return on Investment (ROI) ranks second (0.204), emphasizing the importance of sustainable investments yielding tangible economic returns. Supply Chain Flexibility (0.163) and Risk Reduction (0.136) follow, reflecting moderate concern for adaptability and stability in response to geopolitical or market disruptions. Local Sourcing was rated the least important (0.088), likely due to Lithuania's integration within the EU market, which already provides stable regional sourcing options. The wide spread between weights illustrates clear economic priorities shaped by cost pressures and investment returns.

Table 4
Economic indicators final ranking

Indicator	Weight	Rank
Cost Efficiency	0.41	1
Return on Investment (ROI)	0.20	2
Supply Chain Flexibility	0.16	3
Risk Reduction	0.14	4
Local Sourcing	0.09	5

Social Sustainability Indicators. The BWM analysis indicates that Labor Rights & Fair Conditions is the most critical social factor (weight = 0.355), reflecting the strong influence of EU labor standards and ethical certification requirements in the Lithuanian dairy sector. Health & Safety follows (0.237), underscoring concerns about farm and factory conditions in light of labor regulations and food safety obligations. Transparency & Traceability (0.178) ranks third, consistent with growing consumer demand for ethical sourcing and supply chain visibility. Community Engagement (0.142) holds moderate importance, especially in rural areas, while Stakeholder Inclusion (0.089) ranks lowest, likely due to its limited implementation among small and medium enterprises (SMEs). The distribution of weights confirms that compliance-driven and operationally visible aspects of social sustainability are prioritized in Lithuania's dairy industry.

Table 5
Social indicators final ranking

Indicator	Weight	Rank
Labor Rights & Fair Conditions	0.36	1
Health & Safety	0.24	2
Transparency & Traceability	0.18	3
Community Engagement	0.14	4
Stakeholder Inclusion	0.09	5

Sensitivity Analysis. To evaluate the stability of the calculated weights, a sensitivity analysis was performed for each sustainability dimension environmental, economic, and social—by adjusting the weight of the top-ranked indicator by ±10%, while proportionally redistributing the remaining weights.

Figure 1 presents the sensitivity results for environmental indicators. Increasing the weight of *GHG Emissions* led to a noticeable decline in the weights of *Energy Consumption*, *Water Usage*, and *Renewable Energy Usage*, confirming the dominant influence of emission control in the environmental profile of Lithuanian dairy supply chains.

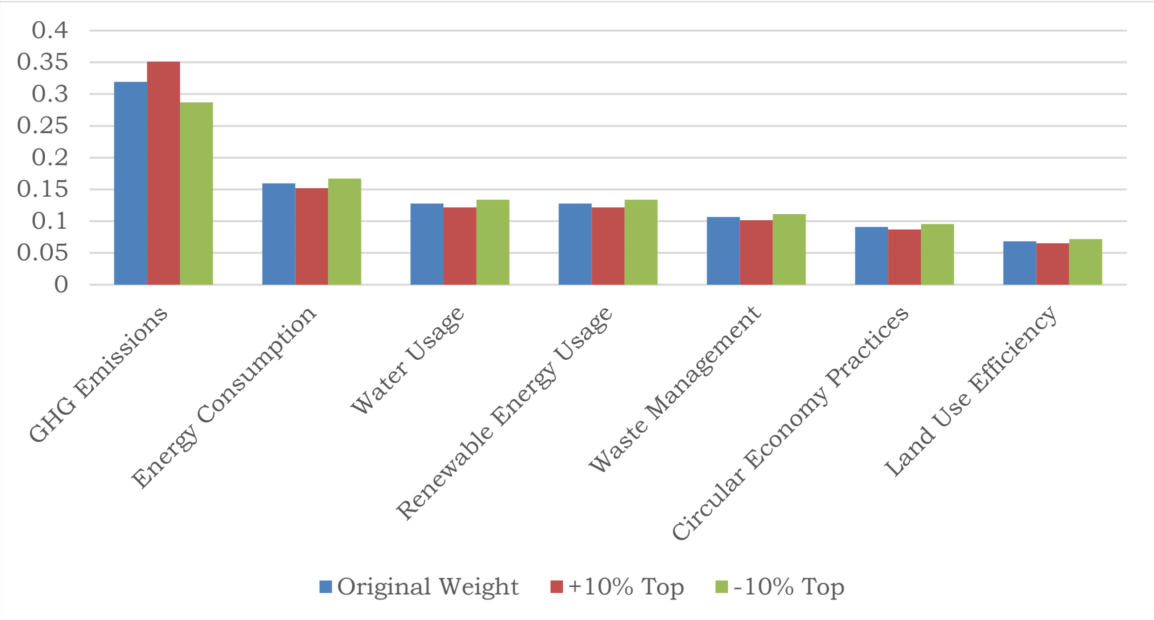

Figure 1. Environmental Indicators Sensitivity Analysis

Figure 2 shows the sensitivity of economic indicators. When the weight of *Cost Efficiency* was increased or decreased, other criteria such as *Return on Investment* and *Supply Chain Flexibility* showed significant variation. This reflects the financial sensitivity of SMEs in the sector, where cost considerations heavily influence strategic priorities.

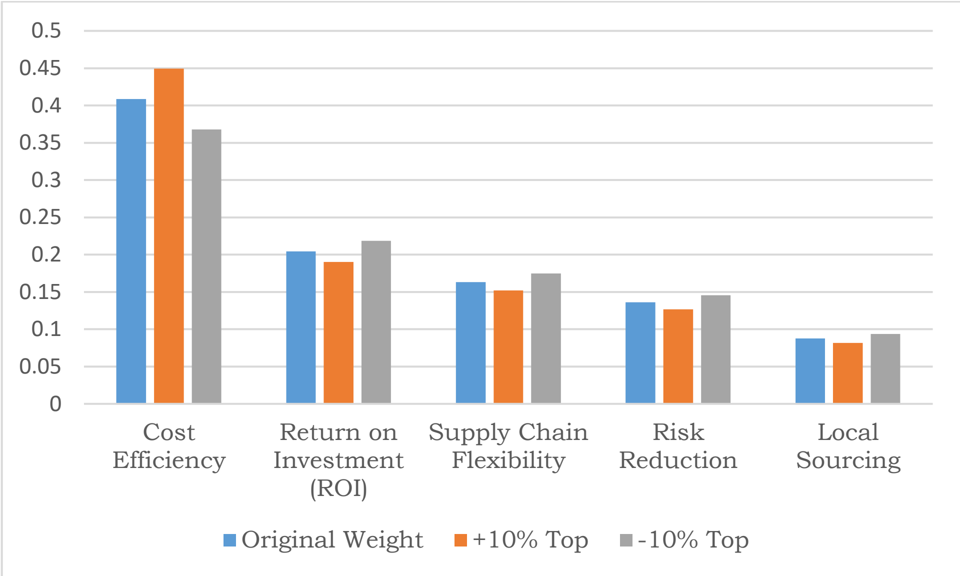

Figure 2. Economic Indicators Sensitivity Analysis

Figure 3 illustrates the results for the social dimension. Modifying the weight of Labor Rights & Fair Conditions affected the distribution of weights across Health & Safety, Transparency, and Community Engagement. The findings suggest that while labor compliance is central, secondary social indicators also gain relevance when the weight of the dominant criterion is reduced.

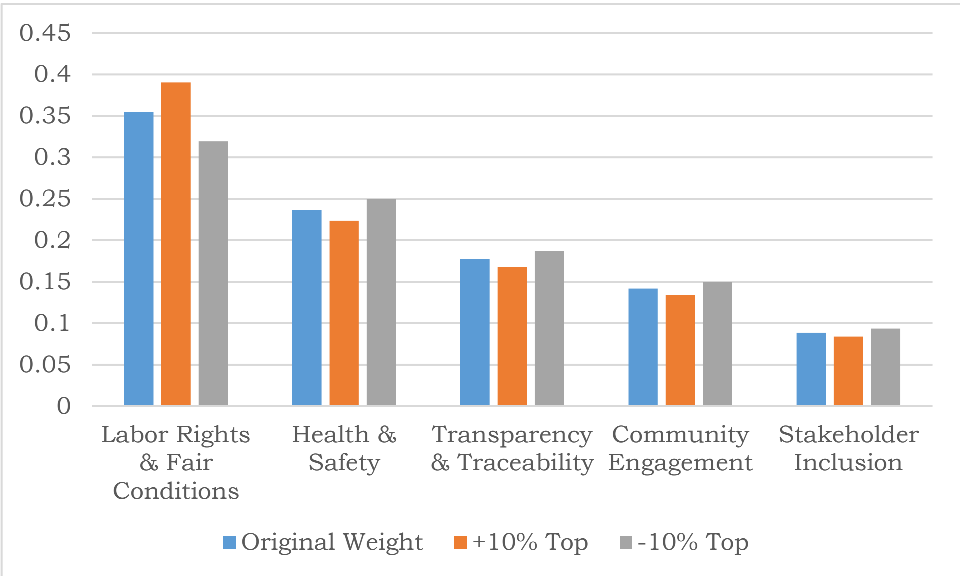

Figure 3. Social Indicators Sensitivity Analysis

Overall, the sensitivity analysis demonstrates that while the model remains consistent under moderate variations, top-ranked indicators exert substantial influence over sustainability prioritization. These results further validate the appropriateness of using BWM for structured decision-making in this context.

5. Discussion

Sustainable Supply Chain Management (SSCM) in the dairy sector has gained increasing attention due to the industry's considerable environmental impact, economic importance, and social responsibilities. The Lithuanian dairy sector, dominated by small- and medium-sized enterprises (SMEs), faces significant challenges in integrating sustainability practices due to limited resources and lack of tailored frameworks. While global and European SSCM models offer general guidance, few studies have addressed the specific needs of the Baltic context, especially Lithuania. This research sought to fill this gap by developing a localized, multi-dimensional SSCM framework using the Best-Worst Method (BWM) to prioritize sustainability indicators across environmental, economic, and social dimensions.

The objective of this study was to identify and rank the most relevant sustainability indicators for the Lithuanian dairy supply chain, allowing practitioners and policymakers to focus efforts on the most critical areas. The results revealed that in the environmental dimension, *GHG Emissions*, *Energy Consumption*, and *Renewable Energy Usage* were top priorities, aligning with findings from Chataut et al., 2023 and Jamali et al., 2021, who emphasized the role of methane and energy use in dairy-related environmental impacts. Similarly, the relatively lower importance of *Land Use Efficiency* supports the observations of Grassauer et al., 2022 and Jamali et al., 2021, who noted that land availability is less constraining in Eastern Europe compared to Western Europe (Chataut et al., 2023; Cortés et al., 2021; Grassauer et al., 2022; Jamali et al., 2021).

In the economic category, *Cost Efficiency* emerged as the dominant factor, followed by *Return on Investment (ROI)* and *Supply Chain Flexibility*. These results are consistent with Shamsuddoha et al., 2023, who argue that SMEs adopt sustainable practices only when there is a clear economic rationale. The low ranking of *Local Sourcing* may reflect Lithuania's integration within the EU single market, where regional trade reduces the need for strictly local procurement, as also noted by Moerkerken et al., 2021 (Moerkerken et al., 2021; Shamsuddoha et al., 2023).

The social dimension showed *Labor Rights & Fair Conditions* as the highest priority, consistent with the regulatory pressures of the EU labor framework. This aligns with the conclusions of Hoang et al., 2021, who stressed the foundational role of fair labor practices in social sustainability. *Health & Safety* and *Transparency* also scored highly, which reflects growing concerns about worker welfare and supply chain accountability. However, indicators like *Community Engagement* and *Stakeholder Inclusion* were ranked lower, likely due to their underrepresentation in operational practices, particularly in SMEs—a pattern also reported by Shamsuddoha et al., 2023 (Hoang et al., 2021; Shamsuddoha et al., 2023).

The sensitivity analysis confirmed the model's internal consistency while highlighting the strong influence of top-ranked indicators in shaping the overall prioritization. A ±10% variation in the most important criteria led to notable shifts in the weight distribution of lower-ranked indicators. This outcome supports the argument by Rezaei (2015) that BWM provides reliable yet adaptable decision support for sustainability evaluations (Rezaei, 2015).

In summary, this study not only addresses a significant gap in SSCM literature by focusing on the Baltic dairy sector but also provides practical, evidence-based priorities to guide sustainable development strategies. The results align with and reinforce previous empirical findings, while also offering new localized insights that can inform both industry practice and future academic research

6. Conclusion

This study aimed to develop a localized and multi-dimensional framework for Sustainable Supply Chain Management (SSCM) in Lithuanian dairy companies by identifying and prioritizing key sustainability indicators. Addressing a clear research gap in the Baltic context, the study applied the Best-Worst Method (BWM) to evaluate environmental, economic, and social indicators based on expert input from top-level professionals in the dairy industry. The findings provide a structured, stakeholder-informed basis for improving sustainability performance in a sector that plays a vital role in Lithuania's agri-food economy.

The results demonstrated that *GHG Emissions*, *Cost Efficiency*, and *Labor Rights & Fair Conditions* are the most critical indicators in their respective dimensions. These priorities reflect both global sustainability imperatives and local operational realities, such as compliance with EU regulations, resource constraints among SMEs, and increasing consumer awareness. The study's sensitivity analysis further validated the robustness of the results, showing that changes in the top-ranked indicators significantly influence the prioritization of other sustainability factors.

However, this research is not without limitations. The expert sample, although well-qualified, was limited to 15 participants from the Lithuanian dairy industry. Broader inclusion of stakeholders from government, academia, and NGOs could further enrich the analysis. Additionally, the study focused on indicator prioritization but did not assess performance levels or implementation gaps, which are crucial for actionable strategy development.

Based on the findings, several recommendations can be proposed for policymakers. First, the government should support dairy SMEs through targeted subsidies and technical assistance programs to reduce GHG emissions and improve energy efficiency—areas identified as top environmental priorities. Second, incentive structures for investments in renewable energy and digital traceability tools should be enhanced. Third, social sustainability regulations should be complemented with outreach initiatives to increase engagement with rural communities and supply chain stakeholders.

Future research could expand this model by incorporating performance data and developing composite sustainability indices for benchmarking companies or regions. Methodologically, hybrid approaches combining BWM with other MCDM techniques (e.g., TOPSIS or fuzzy logic) could improve precision. Additionally, comparative studies across the Baltic states or other sectors within agriculture would offer valuable insights into regional differences and common sustainability challenges.
In conclusion, this study contributes both theoretically and practically to the growing literature on SSCM by providing a context-sensitive and decision-oriented tool for sustainability planning in the Lithuanian dairy industry. The results can guide both managerial decisions and public policy efforts aimed at building a more sustainable, resilient, and competitive agri-food sector in the Baltic region.

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