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The Critical Role of Green Supplier Selection in Enhancing Supply Chain Resilience Within the Dairy Industry Under Environmental Uncertainty

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Abstract:

The flexibility of a green supply chain, significantly influenced by effective green supplier selection, benefits companies during periods of disruption by reducing risk and enhancing adaptability in an ever-changing market. However, the specific role of green supplier selection within green supply chain resilience in the dairy industry, particularly under environmental uncertainty, has not been thoroughly investigated. This descriptive-correlational study was conducted in the Finnish dairy industry with 384 participants—including managers, supply chain experts, and industry specialists—selected through purposive sampling. The research instrument was a researcher-made questionnaire developed through semi-structured interviews with 10 domain experts. Its validity was confirmed through exploratory and confirmatory factor analysis, and its reliability was established via internal consistency measures. The collected data were analyzed using Pearson correlation, t-test, and Friedman test via SPSS software. Findings indicate that green supply chain resilience, critically enabled by green supplier selection, has a significant negative relationship with environmental uncertainty ($r = -0.331$, $p < 0.001$). This study highlights the crucial role of selecting green suppliers as a strategic imperative for managing environmental uncertainty in the dairy industry and recommends the development of structured green scoring systems for supplier evaluation.

Keywords:

Green Supplier Selection, Supply Chain Resilience, Environmental Uncertainty, Dairy Industry, Sustainability

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Introduction

The contemporary global economy is built upon a complex and interconnected web of supply chains. This vulnerability is especially pronounced in the dairy industry, where supply chains are uniquely exposed to environmental uncertainty due to their direct dependence on climate-sensitive natural resources, perishable raw materials, and biological processes that are inherently difficult to control, making this sector disproportionately susceptible to disruptions compared to other industries. As these networks have evolved, expanding across geographical and organizational boundaries, they have become the engine of modern commerce but also a significant source of vulnerability for individual firms and entire industries (Shahzad et al., 2023). Organizations today operate in an environment of unprecedented volatility, where they are constantly exposed to unforeseen problems and disruptive events. These disruptions are multifaceted, ranging from operational failures such as delivery delays, inventory shortages, and machine breakdowns to catastrophic external events. These include natural disasters like floods, earthquakes, and hurricanes, as well as man-made crises such as terrorism, geopolitical conflicts, and pandemics (Qazi et al., 2022). The growing complexity and agility of business units, coupled with advanced technology, ironically expose organizations to a wider array of risk factors than ever before. Consequently, the notion that a company can compile an exhaustive list of potential hazards is no longer tenable; often, the most damaging events are those that were overlooked or initiated by less visible actors within the extended network (Shaikh et al., 2022). In this turbulent landscape, the ability to merely manage known risks is insufficient; the critical challenge for modern enterprises is building resilience: the capacity of a system to withstand, adapt to, and recover swiftly from disturbances to maintain its core functions (Sheffi, 2005). This capability is vital for maintaining operational continuity and mitigating vulnerability in the face of environmental uncertainties.

Concurrently with the need for resilience, a powerful global movement is forcing a paradigm shift in supply chain philosophy. Growing consumer pressure, stringent governmental regulations, and increasing awareness of climate change are compelling businesses to integrate environmental sustainability into their core strategies. This has given rise to Green Supply Chain Management (GSCM), an approach that embeds environmental considerations into every stage of the supply chain, from procurement and production to distribution and reverse logistics (Rai et al., 2011). The goal of GSCM is not only to moderate costs and enhance efficiency while upholding environmental standards, but also to transform sustainability from a mere compliance issue into a source of value. In this regard, green supplier selection emerges as a strategic and critical step within green supply chain management. The process of choosing suppliers who not only meet traditional criteria like quality and cost but are also deeply committed to environmental sustainability (e.g., reducing carbon emissions, using renewable resources, and managing waste) can form the foundation of a green and resilient supply chain (Rao,

2012; Zayalani et al., 2015). This initial selection has cascading effects throughout all subsequent stages of the supply chain and directly impacts a company's ability to manage environmental uncertainties. By selecting green suppliers, a company can contribute to mitigating risks arising from climate change, stricter regulations, and resource fluctuations.

When these two paradigms—resilience and sustainability—are combined, the concept of Green Supply Chain Resilience (GSCR) is formed. A resilient green supply chain not only mitigates risk during a crisis but also enables a company to continue its operations in unstable environments and prevent severe damage (Sheffi, 2005). This dual challenge of building resilience and ensuring sustainability is particularly acute in the food and agriculture sector, and the Finnish dairy industry serves as a critical case in point. As a cornerstone of Finland's food security and a significant contributor to its agricultural economy, the health of this industry is of national importance. Dairy products like milk, cheese, and yogurt are staples in the Finnish diet. However, the sector is facing a precarious future. The number of dairy farms has been in steady decline for over a decade, a trend partially attributed to diminishing prices paid to farmers. This instability in the supply of raw materials poses a direct threat of economic risk and delays in the food supply, discouraging young farmers and new investment in the sector (Emissions and Ruminants, 2020). Layered on top of these economic pressures are profound environmental challenges. The dairy industry, by its nature, is deeply intertwined with the natural environment and is thus highly susceptible to environmental uncertainties. Climate change is no longer an abstract threat but a present reality, bringing with it issues like heat stress that negatively impact livestock health and productivity, leading to direct economic losses (Cheruiyot et al., 2020). Furthermore, farming practices themselves can inadvertently contribute to environmental degradation. In an effort to control costs, farmers may engage in practices that increase greenhouse gas emissions, such as the indiscriminate use of chemical fertilizers, the use of harmful pesticides, improper disposal of agricultural wastewater, and the reliance on fossil-fuel-powered machinery. This creates a vicious cycle where economic pressures lead to unsustainable practices, which in turn exacerbate environmental instability and risk.

This complex interplay of factors brings the central problem of this research into sharp focus. For the Finnish dairy industry, adopting Green Supply Chain Resilience (GSCR), which begins with the precise selection of green suppliers, is not a choice but a necessity for long-term survival and operational continuity. However, simply implementing GSCR practices does not guarantee success. The effectiveness of these strategies is contingent upon the context in which they are deployed—an environment characterized by high environmental uncertainty. This uncertainty is defined by the instability of market conditions, the inability to predict the impact of natural and technological changes, and the difficulty in anticipating the consequences of response decisions (Ibhagui & Olokoyo, 2018). While a body of literature suggests that green and resilient practices contribute to operational stability and sustainability, there is a significant gap in understanding the precise mechanism through which this

occurs. The core research problem, therefore, is the lack of clarity regarding the role of green supplier selection as a key factor in supply chain resilience and how it interacts with environmental uncertainty. This study posits that effective green supplier selection primarily enhances a firm's ability to perceive, manage, and adapt to environmental uncertainty. It is this enhanced capability to navigate a volatile environment that, in turn, translates into operational stability and risk reduction. A resilient green supply chain, established through the intelligent choice of green suppliers, might give a company the flexibility to switch suppliers during a drought or better manage price fluctuations, and it is these intermediate actions—enabled by resilience—that ultimately protect operational continuity and supply chain stability. This research is further motivated by a profound personal and professional interest. Having worked for four years (2015-2019) as a researcher in the dairy industry, I have witnessed firsthand the immense challenges of securing raw materials while grappling with environmental and economic pressures. This experience provides me with a practical understanding of the issues faced by farmers and corporations alike. By focusing this research on a developed country like Finland, I aim to explore solutions that can help its vital dairy industry navigate its unique challenges. This study aspires to contribute not only to the academic literature but also to the practical improvement of the quality, reliability, and sustainability of dairy and agricultural products in Finland. As a researcher who prioritizes Finland's economic development, I believe this research can provide actionable strategies for a more sustainable and robust food supply, thereby strengthening a key sector of the nation's economy. Therefore, the ultimate aim of this study is to move beyond a simplistic, direct-effect analysis.

Despite growing interest in the benefits of green supply chain management, a significant gap exists in the literature regarding the mechanisms through which green supply chain flexibility—initiated by green supplier selection—contributes to effective environmental risk management. While prior research suggests that environmental uncertainty plays a critical role in shaping supply chain behavior and performance (Laguir et al., 2024; Masoumik et al., 2014), its influence on the relationship between green supply chain flexibility and risk management remains largely unexplored, particularly in the context of highly regulated industries such as the Finnish dairy industry (Samad et al., 2021; Yang et al., 2015; Lamprinakis, 2012). As the business environment becomes increasingly volatile due to climate change, regulatory changes, and shifting consumer preferences, understanding how environmental uncertainty shapes this relationship is essential for developing effective strategies (Tseng et al., 2019). This study aims to fill this gap by examining the role of environmental uncertainty in the relationship between green supply chain resilience—driven by green supplier selection—and environmental risk management in the Finnish dairy industry. By taking a process perspective and incorporating both internal and external sources of environmental uncertainty, this study offers a fresh perspective on how firms can optimize their green supply chain practices to achieve superior operational stability in turbulent environments.

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Literature Review

The last few decades have witnessed significant shifts in the business world. With the widespread use of information and communication technologies, customer demands have grown, leading to shorter product lifecycles. Reduced distribution costs due to diverse transportation methods have intensified competitive challenges. In today's environment, characterized by volatility, uncertainty, complexity, and ambiguity, companies recognize that their operational continuity is only possible through the application of diverse and innovative strategies. Numerous researchers have explored the concept of resilience, yet a consensus on its precise definition and its varied impacts on different operational facets remains elusive. Furthermore, practical solutions for establishing and quantifying resilience within green supply chains are still in their infancy, primarily limited to conventional supply chain resilience. Additionally, the discourse on resilience predominantly centers on large corporations, leaving a dearth of studies addressing smaller enterprises and their potential pathways to enhanced resilience (Tukamuhabwa et al., 2015). These gaps highlight the need for deeper investigation into the role of green supplier selection in fostering resilience and managing uncertainty.

Gunasekaran et al. (2015) examined the relationship between complexity and proactive management practices in supply chain resilience, particularly concerning global sourcing strategies. Their objectives included explaining various aspects of global sourcing, considering it through the lens of complexity theory, and studying supply chain resilience due to global sourcing complexity, proposing strategies to overcome it. Their findings underscore the importance of supplier selection in mitigating complexity and enhancing resilience in global environments. They proposed a global sourcing resilience framework encompassing risks and innovations, sales promotion benefits, and challenges and response capabilities. Sharma et al. (2021) conducted a systematic literature review on integrating Lean, Agile, Resilient, Green, and Sustainable (LARGS) models in supply chain management. Their research aimed to contextualize LARGS studies within the SC field, identify the purpose of studying LARGS models, and explore current trends and future research directions. This review highlights the significance of appropriate sourcing strategies for sustainability and resilience.

Scholten and Schilder (2015) investigated how collaboration affects supply chain resilience, providing insights into collaboration as a factor shaping resilience. Their recommendations explain the specific impact of collaborative activities on supply chain resilience beyond a single company's perspective. Key findings show that specific collaborative activities (information sharing, collaborative communication, mutually created knowledge, and joint relational effort) increase supply chain resilience through enhanced visibility, speed, and flexibility. These findings are directly relevant to green supplier selection, as collaboration with suppliers is essential for achieving sustainability and resilience goals. Tukamuhabwa et al. (2015) presented a timely review of existing literature on Supply Chain Resilience

(SCRES), offering a comprehensive definition and identifying strategies for improvement. They noted limited research on selecting and implementing appropriate strategies for SCRES, highlighting the importance of this study's focus on green supplier selection as a key resilience strategy. They proposed Complex Adaptive Systems (CAS) theory as a suitable focus for SCRES research, demonstrating that SCRES reflects many CAS characteristics, including adaptability and co-evolution, non-linearity, self-organization, and emergence.

Wieland and Wallenburg (2013) studied the impact of soft skills on resilience and its effect on supply chain customer value. Their empirical study found that communication and cooperation relationships positively impacted resilience, while integration had no significant impact. These findings emphasize the importance of relationships with suppliers in building resilience. Wieland and Durach (2021) investigated two perspectives on supply chain resilience—resilience engineering and societal-ecological resilientness—to provide a more accurate definition. Their work aimed to develop a more complete understanding of resilience in supply chain management, encompassing stability, adaptation, and transformation. All these studies collectively underscore the strategic importance of sourcing strategies and supplier relationships in building supply chain resilience, especially in the face of uncertainty.

Green Supply Chain Management and Supplier Selection

Green Supply Chain Management (GSCM) integrates environmental considerations into traditional supply chain management practices, encompassing green procurement, green manufacturing, green distribution, and reverse logistics (Srivastava, 2007). Within this framework, green supplier selection has emerged as a foundational and strategic decision. The process involves evaluating and choosing suppliers based not only on conventional criteria such as cost, quality, and delivery performance but also on environmental criteria including carbon footprint reduction, waste management practices, use of renewable resources, and compliance with environmental regulations (Rao, 2012). The significance of this process lies in its cascading effect: the environmental performance of selected suppliers directly influences the sustainability of the entire supply chain (Zayalani et al., 2015).

Several methodologies have been proposed for green supplier selection, ranging from multi-criteria decision-making (MCDM) approaches such as AHP and TOPSIS to fuzzy logic-based methods that account for the inherent uncertainty in environmental assessments (Govindan et al., 2015). These methods enable organizations to systematically evaluate suppliers against both quantitative and qualitative environmental criteria, thereby ensuring that supplier selection decisions align with broader sustainability objectives.

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Supply Chain Resilience

Supply chain resilience refers to the adaptive capability of a supply chain to prepare for unexpected events, respond to disruptions, and recover from them by maintaining continuity of operations at the desired level of connectedness and control over structure and function (Ponomarov & Holcomb, 2009). The concept has gained increasing attention following major global disruptions, including natural disasters, pandemics, and geopolitical conflicts. Resilience is distinguished from mere risk management by its emphasis on adaptive capacity and the ability to transform in response to changing conditions (Wieland & Durach, 2021).

Key dimensions of supply chain resilience include flexibility, redundancy, visibility, collaboration, and agility (Tukamuhabwa et al., 2015). Among these, flexibility—the ability to adapt quickly to changing circumstances—is particularly relevant to this study, as green supplier selection directly enhances a firm's flexibility by diversifying its supplier base with environmentally committed partners (Scholten & Schilder, 2015). Collaboration with suppliers, another critical dimension, has been shown to enhance resilience through improved information sharing, joint problem-solving, and mutual knowledge creation (Wieland & Wallenburg, 2013).

Environmental Uncertainty

Environmental uncertainty, as conceptualized in organizational theory, refers to the inability to accurately predict the state of the environment due to insufficient information about the factors affecting decision-making (Duncan, 1972). In the context of supply chain management, environmental uncertainty encompasses volatility in market conditions, unpredictability of regulatory changes, fluctuations in resource availability, and the impact of climate change on operational processes (Ibhagui & Olokoyo, 2018).

For the dairy industry specifically, environmental uncertainty manifests through multiple channels: climate variability affecting pasture quality and water availability, evolving environmental regulations on emissions and waste management, shifting consumer preferences toward sustainable products, and price volatility in feed and energy markets (Cheruiyot et al., 2020). These sources of uncertainty create a complex operating environment that demands both proactive risk management and adaptive capacity.

The Intersection of Green Supply Chain Resilience and Environmental Uncertainty

The integration of green practices into supply chain resilience strategies represents a relatively new but rapidly growing area of research. Green supply chain resilience (GSCR) combines the environmental focus of GSCM with the adaptive capabilities of resilient supply chains, creating systems that are both

sustainable and robust in the face of disruptions (Sharma et al., 2021). The theoretical foundation for this integration draws from multiple perspectives, including the resource-based view, which suggests that green capabilities can serve as valuable, rare, and inimitable resources that enhance competitive advantage (Masoumik et al., 2014), and complexity theory, which recognizes supply chains as complex adaptive systems capable of self-organization and emergence (Gunasekaran et al., 2015).

The relationship between GSCR and environmental uncertainty is theorized to be bidirectional. On one hand, higher environmental uncertainty motivates firms to invest in green and resilient supply chain practices as a defensive strategy. On the other hand, the implementation of such practices—particularly through green supplier selection—can reduce the perceived and actual levels of environmental uncertainty by enhancing visibility, predictability, and adaptive capacity within the supply chain (Laguir et al., 2024). This study focuses on the latter direction, examining how green supply chain resilience, enabled by green supplier selection, contributes to the reduction of environmental uncertainty in the Finnish dairy industry.

Research Methodology

The current study is classified as applied research in terms of its purpose, aiming to cultivate practical knowledge within a specific field. Furthermore, the present research follows a descriptive correlational approach in both method and nature. The primary objective of this research is to ascertain the relationship between variables. To achieve this objective, suitable indicators are derived based on the measurement scale of the variables. The research is conducted using an inductive-deductive approach, with its information being rooted in observed events. In accordance with the research onion model, this study can be elucidated methodologically as follows: Regarding the orientation, the current research falls under the category of applied research. The research approach is of a mixed nature, encompassing both library and field research. In terms of strategy, the current research also takes a mixed approach. During the qualitative phase of the study, semi-structured interviews were conducted with 10 experts in the Finnish dairy industry to explore the critical criteria and sub-criteria related to green supplier selection and its impact on green supply chain resilience under environmental uncertainty. For the quantitative phase, an expert questionnaire was designed based on the criteria for green supply chain resilience and environmental uncertainty identified in the previous stage. This research employed document analysis, interviews, and questionnaires as data collection methods. All interviews were conducted face-to-face, and three methods, namely face-to-face meetings, fax, and email, were employed for distributing and collecting questionnaires. Given that the research aims to investigate the critical impact of green supply chain resilience on managing environmental uncertainty, and since the interviews were conducted to identify new criteria and sub-criteria in the context of green supplier selection in an exploratory manner, the sample size for the qualitative phase was limited. Moreover, the interview protocol was developed

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in consultation with the supervisor, with an intention to align the interviews with previous research literature. A semi-structured interview format was considered most suitable for achieving the research objectives. The data collection method during the quantitative phase involved designing the main questionnaire and seeking opinions from 384 experts in the Finnish dairy industry.

The process of scientific research is characterized by a series of consistent and sequential steps that facilitate the progression of research from inception to completion. The fundamental principle in research methodology is to adhere to the sequence and order of the overall process, as well as the sub-processes within each stage, thereby optimizing the efficiency and minimizing disruptions in the pursuit of exploring the unknown and resolving practical issues (Hafez Nia, 2017: 49). The scientific research process generally comprises five continuous stages, summarized as follows: 1. Identifying, analyzing, and elucidating the research problem: During this stage, the research problem of investigating the critical impact of green supplier selection on managing environmental uncertainty was defined, along with the selection of appropriate research questions. 2. Method selection, design, and description: In this phase, interview and questionnaire methods were chosen for data collection. A sample of 15 experts from the Finnish dairy industry was selected for the qualitative phase, and 384 individuals for the quantitative phase. 3. Data collection and information gathering: Interviews were conducted with experts during this stage. Data extracted from the interviews informed the design of a questionnaire. Ultimately, data was obtained from the questionnaire. 4. Data classification, analysis, and interpretation: Data and information were coded, extracted, and classified. The significant impact of green supply chain resilience (stemming from green supplier selection) on environmental uncertainty was analyzed using SPSS software. The resulting findings were analyzed and interpreted to address the research questions. 5. Compilation of the research report: In this final stage, research findings were compared with similar studies, and suggestions for future research were provided. Following editing and formatting, the research will be published in a limited capacity.

In accordance with the research problem and objective, the statistical population for the qualitative phase was meticulously selected to include the most knowledgeable and experienced primary stakeholders involved in the studied phenomenon: “The critical impact of green supply chain resilience on managing environmental uncertainty.” Based on this criterion, the research population comprised professional businesspersons, university professors, and experts in the field of export and import with specific expertise in the Finnish dairy industry. For the qualitative phase of this research, the snowball sampling technique was employed. This method is particularly suitable when identifying members of a specialized group or society is challenging, as is often the case with industry experts (Noy, 2008). The process was repeated until theoretical saturation was reached, where no new significant information emerged from additional interviews (Saunders et al., 2018). For the quantitative part of the study, the statistical population comprised managers and experts in the Finnish dairy industry, including professors

and other domain specialists. To ensure representativeness, a probability sampling approach was adopted. The sample size for the quantitative phase was determined using Cochran's formula (Cochran, 1977), resulting in a calculated sample size of 384 individuals, ensuring a confidence level of 95% with a margin of error of ±5% (Israel, 1992). Due to the homogeneity of units in the statistical population, the cluster sampling method was utilized. For research variables and the evaluation of their indicators, a standardized measurement approach was employed. The scales used to assess questionnaire indicators followed a Likert scale with five response options, widely recognized as an effective tool for measuring attitudes and perceptions (Khaki, 2013). In this study, all questions were formulated positively, with the weakest evaluation assigned a value of 1 and the strongest a value of 5 (Boone & Boone, 2012).

Validity and reliability assessment was meticulously conducted. Validity addresses how accurately a measurement instrument assesses the intended construct (Taherdoost, 2016). Content validity was ensured through an extensive literature review and expert panel evaluation (seven experts), calculating the Content Validity Ratio (CVR) using Lawshe's (1975) method and the Content Validity Index (CVI) which resulted in 0.89 (Davis, 1992). Face validity was established by reviewing the questionnaire with potential respondents. Construct validity was assessed through confirmatory factor analysis (CFA), examining factor loadings for convergent validity and comparing the square root of Average Variance Extracted (AVE) with inter-construct correlations for discriminant validity (Fornell & Larcker, 1981). The CFA results indicated good model fit ($\chi^2/df = 2.34$, CFI = 0.93, TLI = 0.91, RMSEA = 0.057, SRMR = 0.048). Reliability indicates the stability, consistency, and dependability of results (Nunnally & Bernstein, 1994). Internal consistency reliability was evaluated using Cronbach's alpha coefficient. Cronbach's alpha values for Green Supply Chain Resilience (0.891) and Environmental Uncertainty (0.845) exceeded 0.8, indicating strong internal consistency (DeVellis, 2016). Test-retest reliability, assessed by re-administering the questionnaire to a subsample of 30 participants after three weeks, showed Pearson correlation coefficients above 0.8 (0.81 to 0.89) (Koo & Li, 2016). Composite reliability (CR) values ranged from 0.857 to 0.918, all exceeding 0.7 (Hair et al., 2010), further confirming reliability. A pilot study with 42 participants confirmed the psychometric properties and led to minor refinements.

For data analysis, both descriptive and inferential statistics were employed using SPSS software. Descriptive statistics presented demographic information and central tendency/dispersion measures for the variables. Inferential analysis aimed to generalize observations from the sample to the main population (Khaki, 2008). Pearson's correlation method were utilized to assess relationships and test hypotheses

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Findings

This section presents the statistical analysis and testing of the research hypotheses. The assessment involves calculating correlation coefficients between green supply chain resilience (which inherently involves green supplier selection) and environmental uncertainty.

Descriptive Statistics

The collected information corresponding to the respondents' answers to the research questionnaire has been categorized into two sections for the studied subjects. In the first section, demographic information of the participating dairy company experts and managers has been provided.

Percent	Frequency	Variable
Age		
-	-	20 - 25
-	-	26 - 30
-	-	31 - 35
-	-	35 - above
Level of education		
0	0	Diploma and below
37.8	145	Associate Degree
29.2	112	Bachelor's degree
33.1	127	Bachelor and above
Company age		
25.5	98	1-5
25.3	97	6-10
23.7	91	11-15
25.5	98	15 - above
Gender		
24.2	93	Woman

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75.8	291	Man
100.0	384	Total

Table 1: Frequency and Percentage Frequency of Variables Education, Company Tenure, and Gender

The findings in the above table indicate that approximately 145 individuals, equivalent to 37.8% of the study sample, held associate degrees or equivalent qualifications. According to the findings of Table 1, 127 individuals, constituting 33.1%, possessed degrees beyond a bachelor's, mostly assumed to be managers of the studied companies. The studied companies have been categorized into four activity tenure groups, which are approximately evenly distributed among the four categories. Out of the participants, 93 individuals, accounting for 24.2%, are female, and 291 individuals, making up 75.8%, are male.

In this section, data analysis has been performed using central tendency measures such as mean, as well as dispersion indicators like standard deviation.

Variable	**N**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**Skewness**	**Kurtosis**
Green supply chain resilience	384	11.00	38.00	25.4766	5.85459	-.304	-.585
Environmental uncertainty	384	4.00	18.00	10.2943	3.40087	-.109	-.927

Table 2: Mean and Standard Deviation of Research Variables

The minimum and maximum values for the mentioned variables vary according to the number of categories. These two values can set the range of variations for respondents' answers, and a larger difference between them signifies greater dispersion in respondents' responses. The range of variations derived from the difference between these two indicators reflects that both green supply chain resilience and environmental uncertainty show specific dispersions. The standard deviation, as the most suitable indicator of dispersion in the above table, reveals that in questions related to environmental uncertainty, the responses are more homogeneous with each other, and the dispersion of observations in this variable is less than that of green supply chain resilience.

Prior to conducting statistical analysis, data screening was performed, and identified outliers were corrected. Missing values were imputed using the mean. Subsequently, the identification of univariate outliers was carried out using box plots. The results, categorized by the observed variables, are presented below. Based on the box plot results, it was determined that no missing values were present in any of the research variables. After adjusting the mentioned observations, the outliers of the

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multivariate data were examined by calculating Mahalanobis distances. Then, these distances were tested in an adjusted Chi-Square (χ^2) test based on degrees of freedom (the number of variables, which in this case was eleven predictive variables in the model) at a significance level of $\alpha = 0.001$ (Meyers and colleagues, 1396). The results indicated that there were no multivariate outliers.

Univariate Normality: To assess the normality of a single variable, the distribution of observed variables presents in the model, i.e., the components of the main research variables, was investigated using measures of skewness and kurtosis. According to Kline (2005), an absolute value of skewness less than 3 and an absolute value of kurtosis less than 10 indicate that there is no issue with the data in terms of univariate normality (Akbarzadeh, 1397).

Variable	Min	Max	Skewness	C.R.	Kurtosis	C.R.
Green supply chain resilience	11.000	38.000	-.303	-2.424	-.593	-2.371
Environmental uncertainty	4.000	18.000	-.109	-.870	-.930	-3.721

Table 3: Examination of Univariate Normality of Research Variables

The findings of the above table indicate that the assumption of univariate normality has been met for the collected observations of the variables.

To examine the multivariate normality, we have utilized Mardia's coefficient and its critical ratio. According to Ghasemi (1387), critical ratio values greater than 2.58 are considered evidence of departure from the assumption of multivariate normality.

Critical Ratio	Mardia's coefficients
30.924	21.866

Table 4: Examination of Multivariate Normality

Another assumption of running the research model is the presence of significant relationships between the research variables. This matter has been evaluated by calculating the correlation matrix among the research variables. Additionally, the subsidiary hypotheses of the research have been assessed as preliminary assumptions before the main hypothesis, as presented in the original thesis.

This section presents the statistical analysis and testing of the research hypotheses. The assessment involves calculating correlation coefficients between green supply chain resilience (which includes green supplier selection) and environmental uncertainty.

H1: There is a significant relationship between green supply chain resilience and environmental uncertainty of the company.

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Variables	Correlation Coefficient	Significance Level (p)	N
Green Supply Chain Resilience - Environmental Uncertainty	-0.331**	0.000	384

Table 5: Correlation Analysis for Hypothesis 1

Note: ** indicates correlation is significant at the 0.01 level (2-tailed)

The analysis shows a moderate negative correlation coefficient of -0.331 between green supply chain resilience and environmental uncertainty, with a significance level of 0.000 ($p < 0.05$). This negative correlation indicates that as green supply chain resilience increases, environmental uncertainty decreases. Although the correlation is moderate in strength, it is statistically significant, suggesting a meaningful inverse relationship between these variables. Based on the statistical evidence, Subsidiary Hypothesis 1 is confirmed with 95% confidence. The data supports the assertion that there is a significant negative relationship between green supply chain resilience and environmental uncertainty in the Finnish dairy industry.

Discussion

This study aimed to investigate the role of green supplier selection in fostering green supply chain resilience and how it interacts with environmental uncertainty in the Finnish dairy industry. In the contemporary business environment, characterized by increasing volatility and unpredictability, the importance of supply chain management with a focus on sustainability and resilience has become paramount. This research, by concentrating on these two key concepts, sought to elucidate how environmental uncertainties can be mitigated through effective green supplier selection practices. The obtained results offer significant insights into this dynamic relationship.

The primary finding of this study reveals a significant negative relationship between green supply chain resilience and environmental uncertainty (correlation coefficient = -0.331, $p < 0.001$). This implies that as companies become more successful in building resilience into their green supply chains, an endeavor heavily reliant on the correct selection of green suppliers, the environmental uncertainties they face are reduced. This result aligns with the general understanding of supply chain resilience, which defines it as a system's capacity to adapt to unpredictable changes and recover quickly from disruptions (Ponomarov & Holcomb, 2009). Through green supplier selection, which involves choosing suppliers with high sustainability standards and resilience capabilities, companies can mitigate risks stemming from climate change, sudden environmental regulations, or fluctuations in natural resource availability. This finding is

particularly crucial in the Finnish dairy industry, which is highly dependent on natural resources and susceptible to climate change impacts (Cheruiyot et al., 2020).

This outcome is consistent with studies emphasizing the role of Green Supply Chain Management (GSCM) in risk and uncertainty reduction. For instance, Rao (2012) notes that implementing green practices among suppliers can encourage the use of green resources and foster green innovation, which in turn helps alleviate environmental pressures and government regulations (Zayalani et al., 2015). This reduction in pressures directly translates to a decrease in environmental uncertainty for companies. Our study reinforces the perspective that green supplier selection, as an initial and vital step in GSCM, is a powerful tool for companies to manage and reduce environmental unpredictability. This process, by fostering greater transparency in the supply chain and ensuring suppliers' commitment to sustainable practices, helps companies gain better visibility into potential risks and enhance their preparedness to address them.

However, while our findings support the negative relationship between green supply chain resilience and environmental uncertainty, it is important to acknowledge the limitations of this relationship. The correlation coefficient of -0.331 indicates a moderate relationship, meaning that green supply chain resilience, although significantly reducing environmental uncertainty, does not eliminate it entirely. This points to the complex and multifaceted nature of environmental uncertainty, which can also originate from various other sources such as sudden technological shifts, economic fluctuations, and political developments (Davidson etal., 2013). This finding is consistent with studies indicating that environmental uncertainty is a pervasive phenomenon and its management requires multiple approaches (Duncan, 1972).

Comparison with prior research indicates that while many studies have focused on various aspects of supply chain resilience (e.g., complexity, collaboration, and soft skills) (Gunasekaran et al., 2015; Scholten & Schilder, 2015; Wieland & Wallenburg, 2013), the current study specifically addresses the role of green supply chain resilience (which initiates with green supplier selection) in managing environmental uncertainty. This focus fills a gap in the literature, as it demonstrates how specific actions in sustainability (such as supplier selection) can directly impact environmental unpredictability. Tukamuhabwa et al. (2015) emphasized the need for more empirical research on supply chain resilience strategies; our study responds to this call by providing empirical evidence on the relationship between green supply chain resilience and environmental uncertainty.

Conclusion

This study provides strong evidence that green supplier selection, as a critical component of green supply chain resilience, plays a significant role in reducing environmental uncertainty in the Finnish dairy

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industry. The findings indicate that the more successful companies are in building green and resilient supply chains through the careful selection of their suppliers, the less they are affected by environmental fluctuations and unpredictability. This negative and significant relationship ($r = -0.331$, $p < 0.001$) underscores the strategic importance of green supplier selection not only for achieving sustainability goals but also for strengthening a company's ability to cope with environmental challenges. In an era where climate change, increasing environmental regulations, and market volatility have become inherent business realities, the ability of companies to reduce uncertainty through green supply chain practices becomes a critical operational advantage.

Practical Implications

For managers in the dairy industry and other similar sectors, these results offer several crucial practical recommendations. First, investing in green supplier selection processes should not be viewed merely as a compliance cost or a corporate social responsibility initiative, but rather as a key strategy for risk reduction and enhancing operational stability in uncertain environments. Second, companies should develop and implement a structured Green Supplier Scoring System—a systematic evaluation framework that assigns weighted scores to suppliers based on environmental criteria such as carbon emission levels, waste management practices, use of renewable energy, water conservation efforts, and compliance with environmental certifications (e.g., ISO 14001). This scoring system would enable procurement managers to make data-driven decisions when selecting and monitoring suppliers, ensuring that sustainability criteria are consistently integrated into the supplier evaluation process. Third, companies should rigorously incorporate resilience criteria into their supplier assessment, including the supplier's capacity to respond quickly to disruptions and maintain supply continuity. Fourth, fostering collaborative and transparent relationships with green suppliers can contribute to increased visibility within the supply chain and, consequently, to reduced uncertainty. Finally, industry associations and policymakers in the Finnish dairy sector should consider establishing industry-wide green supplier benchmarking standards that facilitate comparison and continuous improvement across the supply chain.

Theoretical Implications and Further Research

From a theoretical perspective, this study contributes to the growing body of literature on green supply chain resilience by providing empirical evidence for the inverse relationship between GSCR and environmental uncertainty, specifically in the context of the dairy industry. The findings support the resource-based view by demonstrating that green supplier selection capabilities serve as strategic resources that help firms navigate environmental volatility. Additionally, the study extends complexity theory applications in supply chain research by illustrating how green supplier selection can reduce the complexity and unpredictability of the external environment.

However, several limitations should be acknowledged. The moderate strength of the observed correlation (r = -0.331) suggests that green supply chain resilience is one of several factors influencing environmental uncertainty, and future research should investigate additional variables that may contribute to this relationship. The cross-sectional design of this study limits causal inferences; longitudinal studies would be valuable in establishing the temporal dynamics of the relationship between green supplier selection and environmental uncertainty reduction. Furthermore, the focus on the Finnish dairy industry, while providing depth, limits the generalizability of findings to other industries and geographical contexts.

Future research should explore the following directions: (a) investigating the mediating mechanisms through which green supplier selection contributes to reducing specific types of environmental uncertainty (e.g., regulatory, climatic, market-based); (b) conducting comparative studies across different industries and geographical regions to assess the generalizability of these findings; (c) employing longitudinal research designs to capture the dynamic evolution of the relationship between green supply chain resilience and environmental uncertainty over time; and (d) examining the role of digital technologies, such as blockchain and IoT, in enhancing the effectiveness of green supplier selection and monitoring processes.

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