Assessing Environmental Practices in Supply Chains within Trade, Manufacturing, and Logistics Companies

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Abstract **– Sustainability is progressively emerging as a critical element across all economic sectors, including supply chains. This article discusses the primary stakeholders - trade, manufacturing and logistics service provider (LSPs) organizations – and categorizes them according to the incorporation of environmental practices within their supply chains. The primary goal of this study is to evaluate how these practices are implemented and to identify patterns of adoption across three types of organizations. Cluster analysis was conducted using empirical data from different type of organizations. Internal and external sustainability metrics are used in order to identify the different stages of implementations of environmental practices. The results show three distinct categories of organizations that emerged: leading, developing and non-adopting environmental practices organizations. The empirical study reveals that companies with a higher level of sustainability integration achieve better results compared to those without such practices. The findings underline the significance of implementing environmental practices within supply chains to promote sustainability and gain a competitive advantage. This article contributes valuable knowledge for researchers and practitioners creating a basis for developing sustainable strategies aligned with the organization's environmental commitment.**

Keywords **– Sustainability, supply chains, economic performance, environmental practices.**

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1. Introduction

The incorporation of sustainability-oriented principles into logistics management is increasingly pertinent subject for research community [1]. Furthermore, green supply chain management (GSCM) is increasingly viewed as a strategic philosophy that helps organizations improve profitability and market share while reducing environmental risks and enhancing ecological efficiency [2]. Also, the impact of these organizations „is a growing concern, leading to demands for sustainable practices which meet environmental, economic and social needs" [3]. According to [4], sustainability has also become an important factor in achieving competitive advantage for companies. These statements indicate that the transition to sustainable logistics and GSCM has become a strategic decision due to escalating environmental regulations and heightened consumer awareness. As companies aim to balance profitability with ecological responsibility, the incorporation of sustainable practices in logistics emerges as an essential element for long-term success.

Studies for sustainable SCM practices can be found in different industries such as manufacturing [5], [6], [7], [8], automotive [2], [9], [10], fashion [11], [12], [13], food [14], [15], [16], [17] and other. The number of researches in sustainable logistics and sustainable supply chain management (SSCM) is increasing [18]. These studies encompass various aspects of supply chain management, including best practices for specific logistics activities such as warehousing [19], transportation [20] and packaging [21], drivers and barriers for adopting sustainable logistics practices [22], [23], [24], financial performance evaluation of the supply chain concerning sustainability [25], [26], and in-depth investigations into one of the three dimensions of sustainable development [27], [28], [29].

Sustainable logistics and sustainable supply chain practices in Bulgaria are underexplored and regarded as developing subjects of study.

The adoption of sustainable logistics methods is a crucial driver of sustainable development due to their broad application across multiple industries. This research concentrates on trade and manufacturing companies, together with logistics service providers (LSPs), due to their vital responsibilities in logistics operations and their contributions to the progression of sustainable logistics in the economy.

The objective of the current study is to analyze the three dimensions of sustainable development separately, because on the one hand they are applied to different extend and it is important to see which dimension is most important for companies, and on the other hand they cannot be measured in the same way and this creates difficulties for companies. Delineating the lagging areas of practice will allow to see the main challenges in sustainable logistics practices and outline a framework for enhancing the successful implementation and adoption of these practices by companies.

To achieve the research purpose, a cluster analysis was conducted on quantitative data representing SSCM practices in 111 Bulgarian trade and manufacturing companies and LSPs. The analysis also provides an in-depth review of the current state of sustainable practices, classifying them into different categories to consolidate the results from over 40 distinct practices. The empirical findings indicate that the companies studied are at various stages of integrating sustainable logistics and supply chain practices. Organizations that have extensively implemented these practices demonstrate significantly better performance compared to those that are either beginning or have not yet started the implementation. The findings can help trade and manufacturing organizations together with LSPs in evaluating their progress in implementing sustainable logistics practices, as well as be useful to other researchers in the field.

A limitation of this study is that with the fast-paced development and innovative technology the mentioned practices are undergoing rapid development, so it is not possible to cover all of their application variants with the toolbox of a single study. Another limitation is that the research is oriented to trade, manufacturing, and LSPs companies, which, for instance, might not be directly applicable to industries not covered in the study. A further limitation is that priority is given to environmental practices compared to social ones because companies are less aware of their effects on economic performance. Lastly, the survey includes companies in the Bulgarian market and offers important perspectives on sustainable supply chain practices. These practices might be adapted and tested in different contexts to improve their relevance and applicability, particularly within the European Union.

The structure of this paper is as follows: Section 2 examines the existing literature regarding sustainable logistics practices within the supply chain. Section 3 outlines the methodology employed in the study. Section 4 presents the results and findings. Section 5 concentrate on discussion, while Section 6 concludes the paper. The upcoming subsection analyses the existing literature on sustainable logistics and supply chain practices to establish a solid basis for the research methodology utilized in present research.

2. Literature Review

Sustainability is a relatively new aspect of the logistics field, requiring a comprehension understanding within the larger context of sustainable development. The notion of "sustainable development" was initially introduces by the World Commission on Environment and Development in the Brundtland Report [30] and then in 1994, [31] emphasized business decisions for three key dimensions: environment, economy and society. These three dimensions are also called pillars or areas of sustainable development. The underlying idea behind the three pillars of sustainable development is for companies to recognize the environmental and social impacts they contribute or detract from society, alongside their economic impacts.

An increasing interest from researchers is seen in the sustainable development of logistics and the supply chain. Over the years, numerous definitions have emerged. Frequently, in the literature, "sustainable logistics" is linked or substitute to "green logistics". The term "sustainable" is considered broader than "green", reflecting the view that "many firms, governments, and citizens now recognize the need to go beyond green and have begun thinking in terms of sustainability" [32]. Even though the necessity of incorporating environmental considerations into manufacturing has been emphasized since the early 1990s [33], according to [34], the discourse on a green and sustainable supply chain emerged only after 2000 when there is a rapid pace of development of this concept. In the scientific literature, the term "sustainable supply chain management" (SSCM) is more relevant than "sustainable logistics" due to the fact that sustainability is more relevant and functional when it is implemented throughout the whole supply chain and when all participants are involved in the processes. If sustainable logistics practices are applied by only one participant in the chain, its efficiency would be significantly reduced. Therefore, it is appropriate to specify that the concept of sustainable logistics passes into the SSCM as contemporary stage in its development.

One of the most frequently cited definitions of "green supply chain management" (GSCM) is given by [35]: "integrating environmental thinking into supply-chain management, including product design, material sourcing and selection, manufacturing processes, delivery of the final product to the consumers as well as end-of-life management of the product after its useful life". In a newer definition, [36] define the term Green supply chain management as: "integrating environmental concerns into the inter-organizational practices of SCM including reverse logistics". One of the most commonly cited definitions of SSCM is given by [37] as follow: "the strategic, transparent integration and achievement of an organization's social, environmental, and economic goals in the systematic coordination of key inter-organizational business processes for improving the long-term economic performance of the individual company and its supply chain". The other commonly cited authors are [38], who determine SSCM as: "as the management of material, information and capital flows as well as cooperation among companies along the supply chain while taking goals from all three dimensions of sustainable development, i.e., economic, environmental and social". From the definitions above and as [29] confirm, the concept of GSCM limits sustainability to environmental practices, i.e., the SSCM extends the GSCM and is the wider concept. While the GSCM emphasis on integrating environmental thinking into the supply chain, in almost all definition of SSCM a distinction of the three pillars of sustainable development with its three dimensions is made, i.e. it covers the environmental aspect of the "green" chains, but extends and complements it with the two other dimensions. Despite the incontestable importance of these definitions, in newer researches [39], [40], [41] they are confirmed and extended with "collaboration and communication between all parties involved in the supply chain, including suppliers, manufacturers, retailers, and customers" [39], the use of digital technologies [42], [43] and others.

There are different approaches connected with sustainable logistics and SCM such as: waste management, circular economy [44], [45], life-cycle assessment [46], [47], digitalization and Industry 4.0 [48], [49] and others. In this research, they will be considered as complementary approaches that can have added value to sustainability in logistics and supply chain. It is fundamental to recognize that digitalization assumes a pivotal and dominant role, as the research indicates considerable potential for digital transformation within Bulgaria's logistics sector [50].

Another key aspect of the SSCM concept is the significance of collaboration among the various actors within the supply chain.

To attain comprehensive sustainable outcomes in supply chain operations, it is necessary for all participants in the logistics processes to be involved in the application of sustainable principles. As crucial participants in logistics processes, logistics service providers (LSPs) help foster strong relationships between major players such as manufacturers and traders.

In order to conceptualize the sustainable logistics practices term and the impact of their implementation, it is necessary to conduct an analysis and evaluation of the research in the field, encompassing the dimensions of the concept of sustainable development, including its environmental, social and economic aspects. In some studies, such as this of [32] is noted that there are difficulties in measuring and comparing indicators across the different dimensions of sustainable development, emphasizing that measures must be taken in each of them to achieve sustainability, and that these measures must be applied by all actors in the supply chain, not just at corporate level. The issue is coming from that the economic performance indicators can usually be measured with strong quantities scales, while the environmental and social performance indicators are more often qualitative and can hardly be measured in the same way. For that reason, they are also difficult to compare. According to prior research, the social dimension of the triple bottom line is often considered more challenging to quantify, which may contribute to its relatively limited representation in sustainability reporting [23]. Other researches indicate that the impact of green practices within the supply chain yields a substantial positive effect on firm's economic performance [51] while corporate social responsibility practices result in a favorable effect on firm financial performance [52]. These two studies confirm that the implementation of the three dimensions lead to improvement of company's performance and does not have only positive impact on environment.

On the basis of the different definitions of sustainable logistics and SSCM, sustainable logistics services can be defined as: A variety of logistics activities and management functions that trade, manufacturing and non-manufacturing companies apply or outsource and which meet the sustainable development goals, namely economic, environmental and social. In the present article, the term sustainable logistics practices refer to the implementation of specific activities aimed at improving logistics services. These practices contribute to the achievement of sustainability in logistics operations by fostering the development of efficient applications and outcomes.

As the publications concerning the sustainable logistics or supply chain practices are constantly growing the literature review is structured according to the theoretical structure outlined in Figure 1.

The topics identified from the review of the practices are categorized into three groups as following: environmental, social and economic dimension. Despite the considerable significance of each dimension, this study will concentrate on the influence of environmental practices on economic performance.

This conclusion was made based on other studies that demonstrate the significant influence of environmental practices on economic indicators [51], [53], [54]. Research has shown that while social performance is positively related to economic performance, the relationship is often mediated by environmental performance [55]. Consequently, the social aspect will be evaluated on a reduced scale.

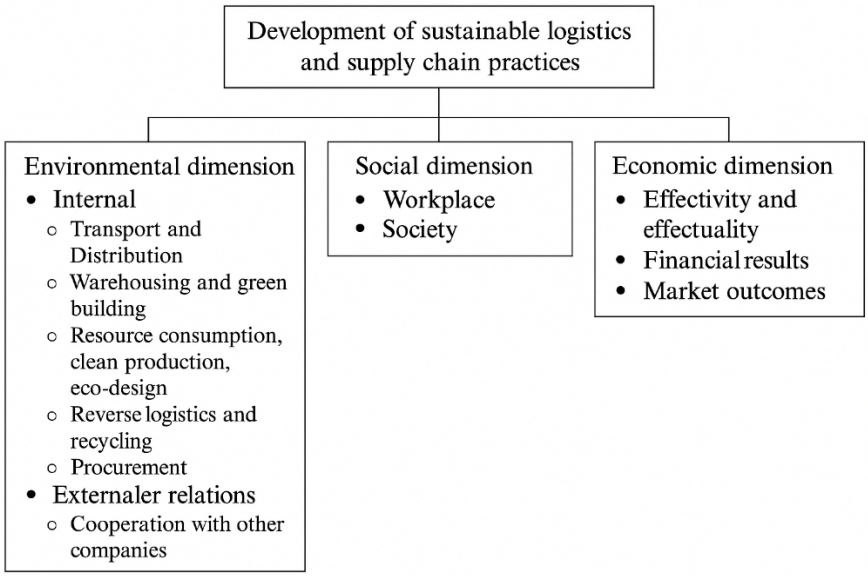

Figure 1. Framework for classification of literature review topics

For the present empirical study, the most valuable is the presentation of the three dimensions of sustainable development through specific practices, such as the study made by [56]. They assess the impact of 21 practices on efficiency of the sustainable supply chain. The same approach is followed by [57] with more than 30 green logistics practices. Furthermore, [58] have made an exhaustive literature review and a comprehensive analysis of applied sustainable practices among 10 large logistics organizations (DHL, Kuehne + Nagel, DB Schenker, etc.). According to subsequent literature summarizing the same research, the environmental practices implemented by LSPs can be classified into two categories: 1) Intra-organizational (internal) practices – including distribution strategies and transportation execution, warehousing and green building, reverse logistics, packaging management and internal management; and 2) Inter-organizational (external) practices – including collaboration with customers and external collaborations [58]. The conclusions reached by the authors are that logistics providers mainly implement transport and distribution practices, while those related to management are less applied. Many of the practices explored by [58] help to develop the measures and indicators of the current study/research.

Other researchers have another type of scale and they group sustainable supply chain management practices into four sections: “environmental management practices, socially inclusive practices, operations practices, and supply chain integration” [26]. In this case it can be conclude that they observe the environmental practices in the supply chain but also consider other practices concerning the social and performance aspects. An accepted method in prior research involves grouping categories including sustainable packaging and distribution, sustainable transportation, sustainable information sharing, environmental reputation, and waste management, among others [25]. In another categorization the main groups of practices are connected to “internal environmental management, green purchasing, customer environmental collaboration, investment recovery, reverse logistics, design for environment and supplier environmental collaboration” [2]. These various approaches demonstrate the existence of a diverse array of sustainable practices that can be categorized differently. Based on these studies, the environmental logistics practices can be classified into internal and external, as shown in Table 1. Following paragraphs will consider additional research based on various categories of indicators.

Another type of division seen in many researches focuses on a specific logistic activity, such as procurement, reverse logistics, transportation, storage and packaging, and particularly on systems for their modernization, optimization or integration. GHG and CO2 emissions have reached unprecedented levels, with the freight transport and logistics service sector identified as a significant contributor to environmental degradation [59]. For that reason, the sustainable logistics practices in transportation are very important and such practices could be: reduction of greenhouse gases and consumption of energy, optimal speed and routing planning [60], use of alternative fuels, eco-driving, use of intermodal transport, avoidance of empty running [59], [61] etc. The importance of carbon footprint reduction in the supply chain in Bulgaria is also researched and proved with logistics practices by [62]. In the field of warehousing is important to consider the phases of construction and exploitation of the building itself. Practices in this group could be the following: The use of eco efficient construction material, adoption of energy efficient operations [63], daylight usage and artificial lighting scheme, temperature control, water consumption [64], enhance bio-diversity, green energy production within the warehouse, humidity control, heating systems, green building certification (LEED, BREEM) [65] etc.

Sustainable practices concerning the social aspect are also considered recently. They include practices within the procurement process including supplier relationships and supplier development strategies [29]. Theoretical concepts related to logistics practices are also found in the field of environmental management systems (EMS) and their engagement with logistics activities or the entire supply chain. For example, some authors [66] evaluate the relationship between EMS and sustainable supply chain practices through an empirical survey of US companies and conclude that organizations implementing EMS apply more frequently sustainable practices in their supply chains. These results approve that EMS and sustainable logistics practices can complement one another as well as that adopter companies already adopted an EMS are more likely to apply sustainable practices not only within the company but also across the entire supply chain. Other research, [67] also present the positive effect from implementation of EMS on the sustainable logistics services. Based on the mentioned researches and others, an additional section on procurement practices has been added into the current study.

Reverse logistics and recycling are also very important topics recently, and gain more and more attention with the circular economy concept. Practices in this section can be found in different researches and they include hazardous material content, materials recycling [32], retrieved used packaging for reuse or recycling [25], practicing remanufacturing, salvaging the company's end-of-life product [3] and others.

In order to be able to achieve many of the activities in the reverse logistics it is very important to have a product designed to be repaired, remanufactured or recycled. For that reason, the practices for eco-design are equally important and are subject of interest, such as: Design of products that lessens the utilization of materials or energy, that allows reuse, recycling, and recovering of materials and component parts [3] design for resource efficiency/reuse/recycle [2], [26], [68] etc.

Until now the research of the trade, manufacturing and logistics sector in Bulgaria has been made by [69] and it has partially affected the sustainability in logistics and supply chain. Other researches in Bulgaria are focused on other sectors related to logistics and at the same time concern sustainability. For example, [70] makes a sectoral analysis of transport as a factor for sustainable development and emphasizes the widespread use of transport as one of the most visible and major pollutants. It can be assumed that so far, the sustainable logistics practices have been the subject of independent research in Bulgaria in the research of [69] of the logistics sector.

The examination of trade, manufacturing companies and LSPs is influenced by their complex organizational structures and by the significant consumption of raw materials, components and products. For the purposes of this study the sustainable logistics practices will be presented in order to classify to which extend the Bulgarian trade, manufacturing companies and LSPs implement these practices in their activities and to give them opportunities for further improvement. Detailed descriptions of the practices corresponding to each group are provided in Table 1 as scale items used in the survey.

The present study has the following research questions:

- *Q1: Can trade, manufacturing and LSPs companies be classified into distinct groups according to their adoption of similar sustainable logistics and supply chain management (SLSCM) practices?*
- *Q2: In what way do varying patterns of SLSCM practices affect the economic performance of trade, manufacturing companies, and LSPs?*

Based on these research questions the study aims to deepen the understanding of environmental sustainability by examining its role and influence on business performance within supply chain. It considers how sustainability practices shape operational strategies and outcomes across divers sectors, providing insights into both environmental and economic implications. The first question set an exploratory framework in order to understand whether companies can be categorized according to their sustainability practices, utilizing cluster analysis as the methodological approach. The second question explores the impact of identified SLSCM patterns on the financial and operational success of these organizations, presenting the relation between sustainability practices and economic performance.

3. Methodology

The mythological approach of this study is based on the concept of sustainable development and its three dimensions as applied to logistics and supply chain management. First, previous research on sustainable logistics and supply chains was reviewed in order to identify the most commonly used sustainability practices and research methods. Based on this review, key environmental logistics practices were summarized in Table 1. Second, the empirical part of the research is based on primary data collected from 111 organizations in Bulgaria. To examine similarities and differences in the adoption of sustainability practices across these organizations, cluster analysis was used.

The extent of sustainable practices in supply chains across various organizations is assessed using indicators categorized into three groups aligned with the dimensions of sustainable development: environmental, social, and economic.

The environmental dimension is divided into two aspects: internal and external. Similar approach can be found in other researches [3], [58] and it gives better understanding for the application of practices. Internal practices refer to procedures that can be handled and executed by one specific organization [71], [72]. The range of good practices in sustainable logistics services is constantly expanding, with major innovators being global leaders developing their own sustainable programs in the field. Environmental practices can be developed in different areas of logistics. Activities where they are most applicable are first in transport and distribution as the most polluting; secondly, warehousing and green building are assumed as a significant volume of activity where energy efficiency is becoming an increasingly discussed issue. Other activities where environmental practices are gaining popularity also among consumers are procurement, eco-design, packaging, reverse logistics and recycling.

Last but not least, the management of logistics companies possesses the potential for various innovative programs and systems for process management and staff motivation. For external practices, those stemming from customers and suppliers are taken, because only with good cooperation relation or partnership it is possible for sustainable practices to cover the whole supply chain. The external aspect requires the application of a cooperative approach on the one hand to customers (for example, implementing customer recommendations, helping customers to certify and achieve their eco objectives, collaborating with customers in relation to their recycling and reverse logistics programs) and on the other hand with other participants in the supply chain (choice of suppliers based on environmental criteria, joint implementation of environmentally friendly practices, mutual information and exchange of information on the provision of sustainable logistics services).

Some of the practices considered correspond to more than one dimension of sustainability - economic, social and environmental. For the purposes of this study, they are categorized as external and internal environmental practices. Table 1 has been constructed based on multiple studies referenced in the literature review. In this research a set of 111 organizations – trade, manufacturing and LSPs is used.

The social dimension includes the assessment of working conditions at workplace, affecting the conditions of transport safety, warehousing and occupational health protection at work, as well as the measures to improve safety conditions (medical examinations, trainings, improvements to the transport and warehousing security systems, etc.). The social dimension also covers the attitudes and activities of companies towards the society. Example of such attitude could be donations or other support for social projects, training of disabled persons, hiring long-term unemployed people, promoting eco-projects.

The economic dimension includes an assessment of the results achieved from the application of sustainable logistics practices in terms of effectiveness and efficiency (cost reduction, improvement of service and process quality, improvement of productivity, innovation in services and processes), financial results that can be measured by the change in profit after introducing sustainable logistics practices and market outcomes (increasing market share, entering new markets, acquiring new customers, increasing corporate image, etc.)

The current study is focused on the three type of organizations because they are considered as important participants in the supply chain and because all of them apply logistics activities i.e. logistics practices to some extent.

Comparable studies demonstrate the utilization of qualitative [2], [3], [25] and quantitative [57] analysis based on interviews or case-study [63]. However, [25] apply "partial least square structural equitation modelling (PLS-SEM) method" [3], [25], fuzzy TOPSIS method [2], correlations and CFA model [26], exploratory factor analysis [60] and others. The cluster analysis [73], [74], [75], [76] is another method that is used for SLSC practices. The Cronbach's alpha is commonly used [25], [61] and in the present study it is also applied. As the quantitative methods prevails in most researches, for this study cluster analysis was chosen to determine the impact of sustainable logistics practices.

The empirical data for the present research was collected through a survey questionnaire, which includes scale items designed to measure sustainable logistics and supply chain practices, detailed in Table 1. The development of these scales was made after a review of the existing literature on sustainable logistics and supply chain practices. This review encompassed a wide range of conceptual studies and empirical surveys, as well as numerous case studies within the research domain that address various topics. Additionally, studies employing to different supply chain participants and sustainable practices in areas such as transportation, warehousing, packaging, reverse logistics and others were examined.

The studies reviewed were conducted by researchers from diverse countries and were thoroughly analyzed to identify SSCM practices relevant to the trade, manufacturing sectors and LSPs. Table 1 also includes references to the literature that underpins the selection of these practices. The scales were reviewed by supply chain management professionals working in trade, manufacturing companies and LSPs. The pretesting phase involved refining the survey by removing or modifying certain measurement items. These validation processes ensured that the final measures and scales accurately reflect the content of sustainable logistics and SCM practices and that the survey instrument is both reliable and precise.

The methodology examines sustainable logistics and supply chain management practices through two widely recognized dimensions: internal and external. Based on the existing literature, this study accepts the practices in the categories of transport and distribution, warehousing and green buildings, resource consumption, clean production, eco-design, reverse logistics and recycling, procurement, packaging and management as internal ones, because these decisions are strongly dependent from the company itself. The relationships with consumers and stakeholders in the supply chain were regarded as external, as they are influenced by factors beyond the company's control. Detailed descriptions of these dimensions and measures are provided in Table 1.

Table 1. Groups of environmental practices in logistics and supply chain

Group	References	Scale items / Practices	Coefficient Alpha Cronbach
Internal			
Transport and Distribution	[25], [57], [58], [60]	Use of alternative fuels with zero emissions Use of fuels with low greenhouse gas emissions (propane-butane, compressed and liquefied gas) Use of newer and environmentally friendly (low-emission) means of transport Improved fuel efficiency of vehicles Use of alternative vehicles (electric, hybrid) Reducing the speed of vehicles to save fuel and reduce harmful emissions Utilization of more eco-friendly transportation methods (rail, water, intermodal) Efficient cargo consolidation and full loading of vehicles Route optimization systems to shorten distances travelled Avoid peak hours and heavy traffic for deliveries Training drivers to drive efficiently	0.930
Warehousing and green building	[58], [63], [64], [65]	Ecologically designed warehouse (energy-saving lighting, thermal insulation, etc.) Energy efficient handling equipment Techniques for improving the energy efficiency of uploading and unloading processes Use of renewable energy sources (solar, wind, hydro-electric, etc.) Full utilization of warehouse capacity Reducing water use (e.g. using low water plants and landscaping) Efficient use of land Introduced standards for green buildings (BREEAM, LEED)	0.939
Reverse logistics and recycling	[2], [3], [25], [26], [32], [57], [58]	Distribution of products for resale, repair, recycling Processing product returns Carrying out repair work Perform after sales service Performing product service Making exchanges and picking up products Redistribution Spare parts management Allocation of different categories of materials for recycling Recycle materials when possible	0.964
Procurement	[29] [2], [26], [32]	Working together with key suppliers to achieve common sustainable goals Environmental audit for internal management of suppliers Requirements to suppliers for eco-labelling or implemented EMS Green purchasing processes Helping suppliers to implement an EMS/become certified Request a design specification that includes environmental requirements for purchased items	0.949
Packaging	[25], [32], [57], [77]	Recycling and reuse of packaging Use of biodegradable packaging Use of packaging from recyclable materials	0.913
Management	[2], [25], [26], [32], [57], [58]	Implementation of ISO 14001 eco-compliance and auditing programs Implementing a Corporate Social Responsibility (CSR) program Utilization of EMS (environmental management systems) Regular measurement and control of the results of sustainable practices Use of green information technologies (e.g. reducing the number of servers, using green software....) Programs for training and motivating personnel Existence of an organizational unit that deals with ecological and socially oriented management Establishment of cross-organizational groups with expertise on sustainable development Promoting eco-consciousness among managers Providing motivation for green behavioural practices Publication of annual reports with the company's achievements Development of a company policy for sustainable development	0.966
External			
Customer relations	[2], [3], [58], [76], [78]	Implementation of customer referrals Helping customers get certified and achieve their eco goals Collaborate with customers on their recycling and reverse logistics programs	0.923
Cooperation with other companies	[2], [3], [68], [76], [78]	Selection of suppliers based on environmental criteria Together with other participants in SC, we implement environmentally friendly practices We are pushing for environmental protection systems Mutual awareness and exchange of information in connection with the provision of sustainable logistics practices	0.942

For the purposes of the study, respondents were questioned to express whether they concur with the statements presented in Table 1. A five-point Likert scale was used for measurement of the practices. This type of scale is used in many researches [2], [3], [26] and is proven to be effective. The questionnaire was distributed and collected from October 2023 to May 2024. The respondents were mainly at management level in the organizations and had access to the appropriate information. The total number of respondents is 111, comprising 44 from trade companies, 22 from manufacturing companies, and 45 from logistics service providers.

Cronbach's alpha is utilized to evaluate the reliability of scales, including the extent to which they are accurately constructed. Values exceeding 0.7 tend to be considered as acceptable, as they indicate a high degree of interrelation among the items of a construct. All Cronbach's alpha values surpass 0.7, including that the scales are reliable and appropriate for subsequent analysis (the coefficients are detailed in Table 1). A cluster analysis is conducted on the SLSCM practices adopted by trade, manufacturing and LSP organizations to address the initial research question. This analytical method enables the categorization of the sample into distinct groups based on similar patterns of adopting environmental sustainability practices. The resultant clusters establish a basis for categorizing these organizations based on their sustainable logistics and supply chain management practices. The analysis incorporates the k-means clustering method, which is extensively utilized to minimize the within-cluster sum of squares. The optimum amount of clusters had been determined by balancing interpretability with statistical validity. The approach is particularly valuable in exploratory research where predefined group labels are absent, enabling the identification of natural grouping based on shared characteristics.

4. Results

This section presents the empirical findings of the study, structured into two subsections. The first subsection focuses on the cluster analysis, which classifies organizations based on their characteristics such as organizational type, ownership and the extent of which Environmental Management System (EMS) have been implemented. The second subsection examines how the identified clusters differ in their adoption of sustainable logistics practices by examination areas such as transportation, warehousing, packaging and reverse logistics. Together, these results represent a comprehensive perspective on the role of environmental practices and highlights that companies implementing these practices often demonstrates stronger performance within supply chains.

4.1. Results from the Cluster Analysis

Through cluster analysis, three groups of organizations were identified based on the extent of environmental practices implementation. The distribution of three types of organizations – trade, manufacturing and LSPs is presented in Table 2, while Figure 2 graphically represents the degree of implementation of environmental practices (with average scores for each group of indicators), resulting from the cluster analysis. A group-based approach has been chosen to present the indicators outlined in the methodology in Table 1, in order to highlight clearly the difference between clusters. The clusters indicate a relatively even distribution, facilitating the comparison of these groups of organizations.

Table 2. Classification of the examined organizations into clusters according to the degree of implementation of environmental practices

Clusters/Group of organizations	Number of organizations	Relative share in %
Cluster 1 – Leading organizations	33	29.7 %
Cluster 2 – Not applying environmental practices organizations	40	36%
Cluster 3 – Developing organizations	38	34.3%
Total:	**111**	**100%**

Based on the degree of application of environmental practices in the formed clusters, the companies in Cluster 1 comprising nearly 30% of respondents, can be identified as ***leading organizations*** in the implementation of environmental practices. This is evidenced by their significantly higher average evaluations (4.04 on a scale of medium to high), indicating that these companies consistently apply these practices to the greatest extent.

Cluster 3, comprising 34.3% of the companies, constitutes the second largest distinct group characterized by a lower degree of environmental practice application. The overall score for this cluster is 2.78, with significant variation, with the transport sector receiving the highest scores. The partial implementation of environmental practices, coupled with a low overall average score for their integration within the supply chain, categorizes this group as ***developing organizations***.

Cluster 2, which includes the highest number of firms (40), presents the least implementation of environmental practices, showing a pronounced tendency towards non-adoption, as indicated by an average cluster score of approximately 1.57.

The primarily low ratings where only six indicators surpass a value of 2, validate the categorization of this group of companies as ***not applying environmental practices***. The significant relative proportion of these providers, accounting for 36% of all respondents, is concerning. This also provides an opportunity for the progression of these companies.

Future research, especially case studies, should examine the fundamental causes of the limited interest in adopting sustainable practices within the supply chain among this group of firms. Figure 2 graphically presents the differences among the three clusters according to the implementation of groups of environmental practices.

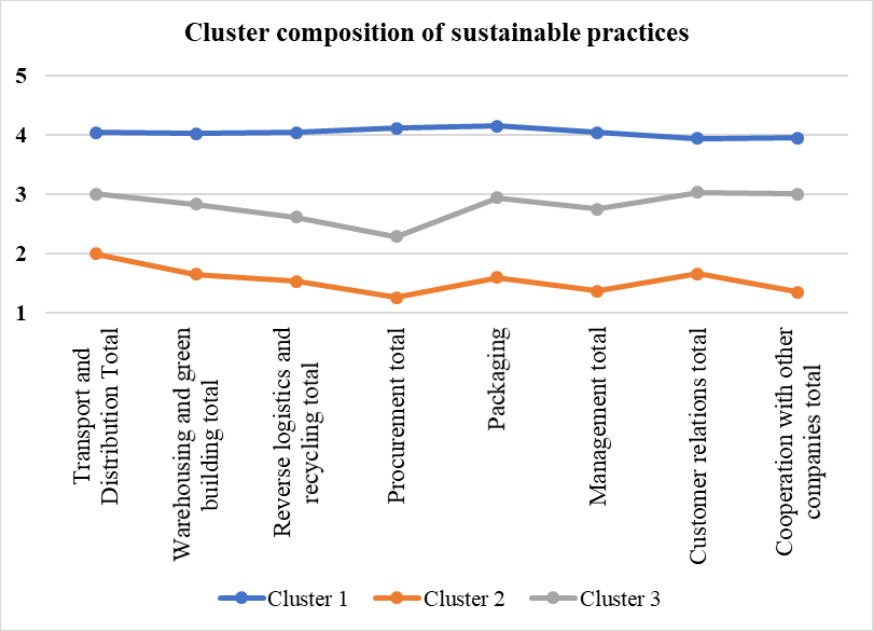

Figure 2. Assessment of the implementation of environmental practices across the three groups identified through cluster analysis

To enhance the distinction and characterization of the clusters, the next figures illustrate the distribution of companies within them based on organizational type, ownership structure, and EMS implementation.

As shown in Figure 3, regarding the types of organizations, it has been found that among the leading organizations (Cluster 1), trade organizations and logistics service providers have equal shares. This similarity could largely be attributed to the fact that many commercial organizations handling material flows also perform numerous logistical activities. In this cluster, manufacturing organizations are limited to just 7, but as a relative share of the total number of organizations studied, it can be noted that approximately 30% of each type of organization falls into the leading category. This suggests a trend toward the uniform development of environmental practices among the three types of organizations studied. The situation in the developing organizations (Cluster 3) is different, with over 50% of manufacturing organizations (13 out of 22) falling into the developing category, following the leading organizations.

Additionally, 23% of commercial organizations and 32% of logistics service providers are also in this category, indicating that logistics service providers are more prepared to transition to the stable application of environmental practices compared to commercial organizations. In the group of organizations not applying environmental practices (Cluster 2), 2 manufacturing organizations, nearly 47% of commercial organizations, and 39% of logistics service providers are represented. This reveals a trend where manufacturing organizations are the most developed and open to applying environmental practices compared to other companies. On the other hand, commercial and logistics organizations show a lag, leaving ample room for improvement in the development of comprehensive sustainable practices in the supply chain.

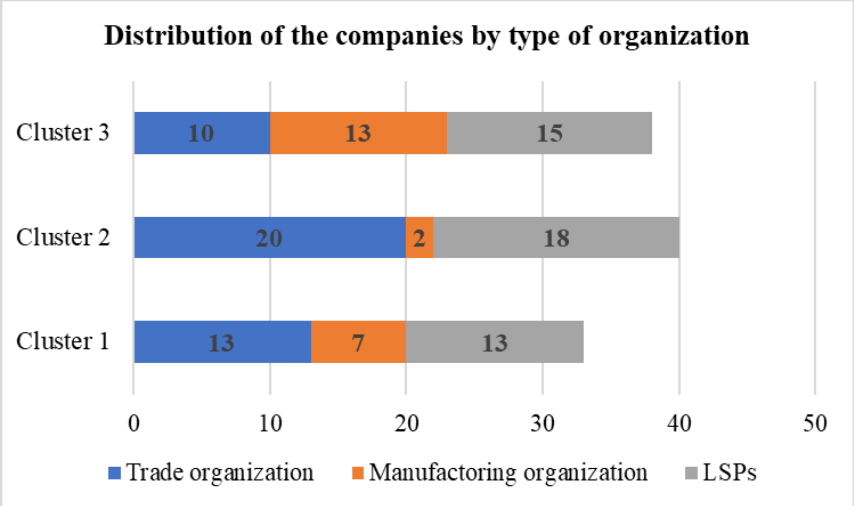

Figure 3. Classification of companies by organizational type

An essential factor to consider is whether companies have implemented an EMS. As illustrated in Figure 4, both the leading organizations in Cluster 1 and the developing organizations in Cluster 3 each have 9 companies with an EMS in place. However, this represents approximately 28% of Cluster 1 (9 out of 32 companies) but only 25% of Cluster 3 (9 out of 36 companies).

This suggests that organizations in Cluster 3 are making progress toward EMS adoption, though they still lag slightly behind the leaders in Cluster 1. Notably, Cluster 2, which has the lowest overall adoption of sustainable practices, still includes 4 companies (10% of the cluster) that have implemented an EMS. Given that the highest scores in this cluster are related to transportation, it is likely that these EMS implementations focus on enhancing sustainable transport practices.

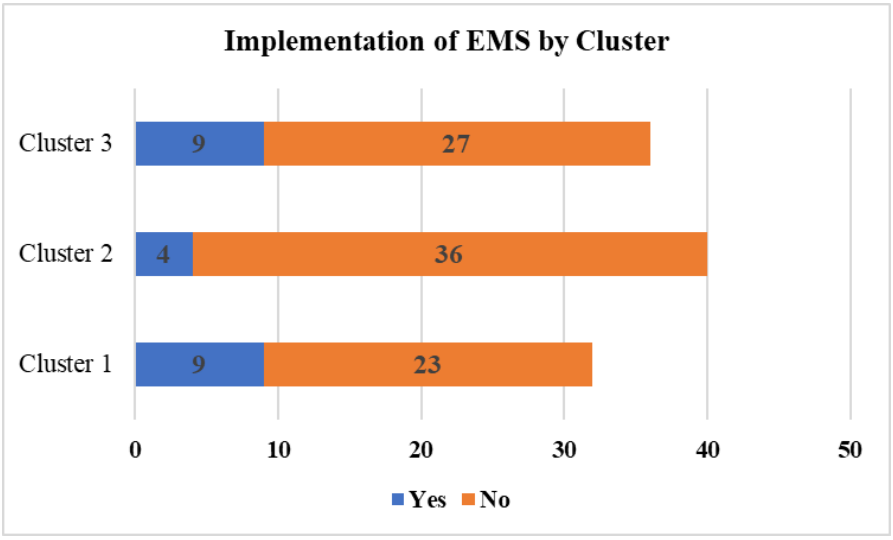

Figure 4. Implementation of EMS by clusters

The ownership structure of the studies organizations may influence the adoption of sustainable practices within companies. This is evident in Figure 5, which illustrate a relatively even distribution between clusters for Bulgarian and mixed-ownership companies.

Notably, among Bulgarian-owned organizations, Cluster 2 - where sustainable practices are not applied - predominates. Despite the small number of foreign companies in the sample, it is noteworthy that only one company falls into Cluster 2, with the majority positioned in the developing and leading clusters.

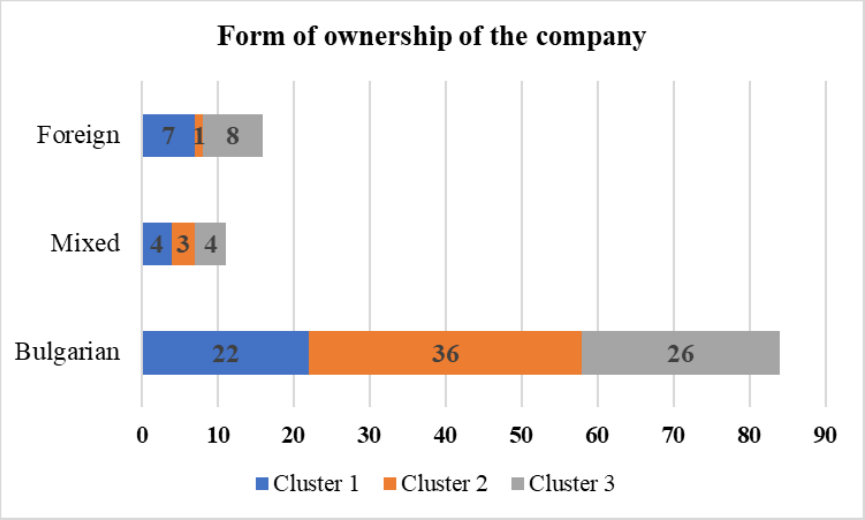

Figure 5. Form of ownership of the company

This indicates that foreign companies are more inclined to adopt and implement sustainable practices across all countries in which they operate. Consequently, attracting such companies could enhance competition and promote the implementation of sustainable practices within the supply chain.

4.2. Environmental Practices and Economic Performance within Sustainable Supply Chains

The literature review on the concept of sustainable development indicates that there are multiple arguments for emphasizing one or more of its dimensions. In this context, environmental and economic practices are typically easier to quantify compared to social practices, which often involve qualitative metrics that can be more subjective and challenging to measure consistently. This research chooses to explore the connection between environmental and economic indicators within the supply chain, primarily because social indicators are challenging to directly compare and because companies often view information related to social practices as sensitive. Additionally, the study considers that other researches have similarly focused on the environmental and economic dimensions, and also reflecting the stronger interest of participating organizations in this approach. Although social practices are important, they are often seen as secondary or may vary significantly across different regions and sectors. By concentrating on environmental and economic factors, the research can draw on more robust data, allowing for more rigorous statistical analysis and more definitive conclusions.

For this reason, this section examines the links between environmental and economic practices, focusing on the incentives and obstacles to their implementation, which can significantly influence the decision to adopt them.

This paragraph assesses the relationship between sustainable practices in the supply chain and whether suppliers that apply them to a higher degree achieve higher economic performance from their operations.

Figure 6 illustrates the economic results of the application of environmental practices in the supply chain. The most substantial economic gains are observed in Cluster 1, where companies report strong advantages in cost reduction, efficiency improvement, and productivity, with average scores consistently above 4 on a 5-point scale. They also have the highest scores for other indicators, which could indicate that sustainability practices contribute to a competitive advantage. For instance, Cluster 1 achieves the highest rating in cost reduction (4.2), increasing sales (4.3), and improving corporate image (4.4), indicating that sustainable practices in logistics and supply chain are linked to better financial performance. Conversely, Cluster 3, which represents companies that are in the process of adopting sustainable practices, experiences moderate improvements in economic performance, with scores ranging between 3.2 and 3.8. While this group have difficulties to reach that level of achievements as Cluster 1, they still demonstrate progress in productivity, innovation and market share. On the other hand, Cluster 2 consistently lags behind in all economic indicators with most scores falling below 3.0. The most pronounced gap is evident in long-term economic benefits, patenting of services and processes, and the ability to influence government policies. For instance, the score for achieving long-term benefits in Cluster 2 is only 2.3, compared to 4.1 in Cluster 1, while their ability to patent services and processes is rated at just 2.2, reinforcing the idea that a lack of sustainability efforts limits innovation and future growth opportunities.

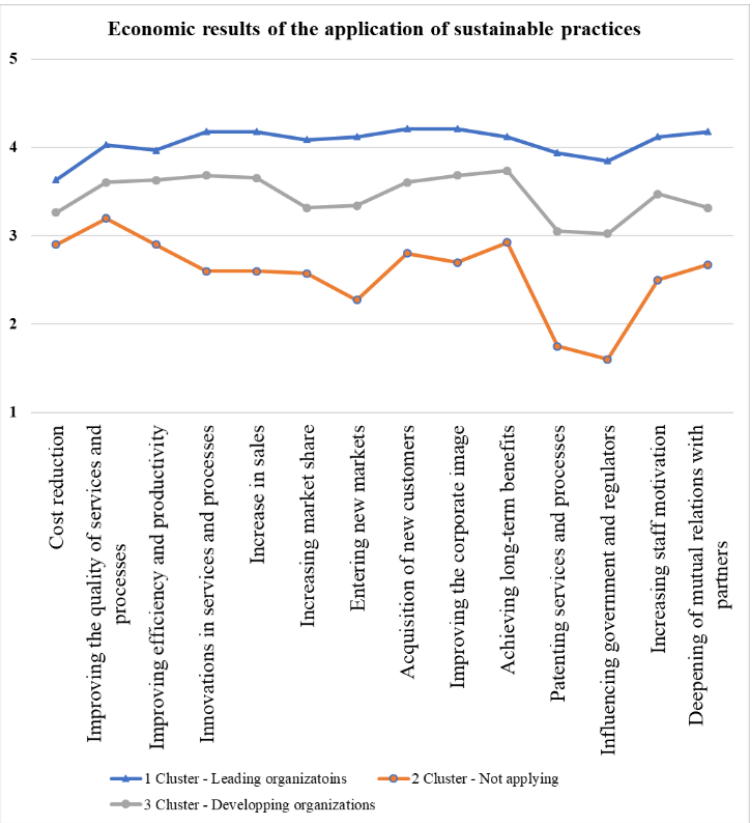

Figure 6. Average summary scores of the achieved results from the application of sustainable practices in the supply chain by cluster

Additionally, the figure highlights the role of sustainability in fostering employee motivation and strengthening business relationships. Leading organizations in Cluster 1 report the highest levels of staff engagement and deepened mutual relations within the supply chain, reinforcing the idea that sustainability contributes to a more committed workforce and stronger industry collaborations. Overall, the figure presents compelling evidence that the implementation of sustainable practices enhances economic performance among key participants in the supply chain, including trade, manufacturing, and logistics service providers.

5. Discussion

This article investigated the influence of environmental practices on economic performance within sustainable supply chains, focusing on trade, manufacturing and LSPs organizations. The research addressed two key questions: Whether organizations could be classified into distinct groups based on their level of adoption of SLSCM practices and second how these patterns influence economic performance.

Regarding the first question, the findings reveal that trade, manufacturing and LSPs organizations can be categorized into three different groups according their implementation of environmental practices such as: leading organizations, developing organizations and those not applying environmental practices.

This classification presents different levels of maturity, awareness and commitment to sustainability, showing a nuanced understanding of how companies implement environmental practices into their business strategies.

The results for the second research question reveals that the state of development in adopting environmental practices has a greater influence on economic performance than the type of organizations itself. Leading organizations more often achieve higher economic performance, understanding the tangible benefits of implementing advanced environmental practices. This finding outlines the importance of prioritizing sustainable practices as s strategic decision for economic results across supply chain stakeholders.

6. Conclusion

While the study provides meaningful information, several limitations should be noted. The growing number of environmental practices in supply chains as well as evolving technologies means that this study may not capture all emerging trends or applications. Additionally, the focus on environmental over social sustainability practices reflects current industry awareness but leaves opportunities for further exploration. Finally, even though as the data is specific to Bulgarian organizations, broader studies could be conducted to validate these findings to other contexts or other European countries, as a part of EU.

Future research could address the mentioned limitations by expanding the scope to include specific industries and regions while also exploring new technologies and social sustainability dimension. Another track for exploration is longitudinal study that could provide valuable insights into how organizations evolve in their adoption of SCSCM practices over time and how this impact the economic performance of organizations. Additionally, further investigation can be conducted in terms of relations between environmental and social sustainability initiatives and could give a more holistic view of their combined impact on economic performance.

In conclusion, this study highlights the critical role of environmental practices in supply chains in driving economic performance. By categorizing companies based on their adoption levels and analyzing their outcomes, it presents insights for both practitioners and researchers. These findings underline the necessity of ongoing innovation and adaptation to attain sustainable supply chain goals while maintaining competitive advantage.

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