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THE ROLE OF REUSABLE PACKAGING IMPLEMENTATION TOWARD MORE SUSTAINABLE SUPPLY CHAIN

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Abstract
This article examines the main aspects of sustainable packaging, particularly reusable plastic containers, in the development of green supply chains, considering ongoing scientific research in this area, comparing the pollution from reusable plastic containers and cardboard boxes used for packaging, and the advantages and disadvantages of both types of packaging. Although numerous studies in recent years have highlighted the advantages and disadvantages of both types of packaging, a consensus on environmental effectiveness and sustainability aspects has yet to be reached. The aim of this article is to analyze the main aspects influencing the implementation of reusable packaging to achieve sustainability in supply chains. A review of the scientific literature reveals that reusable plastic crates, despite initially higher resource consumption, become more sustainable over time, reducing the amount of waste and energy consumed. The article also presents recommendations for incorporating sustainable packaging into green supply chain practices.

Keywords: *sustainable packaging, reusable packaging, single-use cardboard boxes, life cycle analysis, green supply chains.*

JEL Codes: *O13, O21, M31.*

Introduction

Today, society increasingly recognizes that sustainability and environmental protection are integral to everyday actions and choices, particularly regarding consumption and production habits. The packaging industry, especially its impact on the supply chain and environmental sustainability, has become one of the most important topics of discussion.

Recent studies by Albrecht et al. (2022) and Potting et al. (2017) highlight the importance of transitioning to reusable packaging systems to promote resource efficiency and sustainability. However, the level of investigation into this scientific problem varies. While some researchers, like Koskela et al. (2014), focus on lifecycle assessments (LCA) of packaging systems, others, such as López-Gálvez et al. (2021), emphasize the hygienic and safety aspects of reusable packaging, particularly in the food industry. This article aims to build on these studies by analyzing the main aspects influencing the implementation of reusable packaging to achieve sustainability in supply chains.

Sustainable packaging is not only a matter of ecology but also of efficiency, innovation, and cost-effectiveness. The decision between single-use and reusable packaging is one of the most crucial choices for a circular economy, favoring "reuse" over "recycle". The European Waste Directive, along with the Lithuanian Packaging and Packaging Waste Management Act, emphasizes that priority should be given to "reuse" before recycling.

A review of the scientific literature reveals that the use of sustainable packaging, especially reusable plastic crates, is becoming increasingly important in green supply chains. This is linked not only to corporate sustainability efforts and growing consumer awareness but also to increasingly stringent legal requirements. The analysis has shown that shifting to more sustainable packaging solutions can significantly reduce waste and improve resource utilization efficiency. These results align with EUROSTAT (2022) data, which reveal the effectiveness of different European countries' packaging waste management strategies. The packaging sector is implementing necessary initiatives to enhance its

operational sustainability. Comparing reusable plastic crates with single-use cardboard boxes demonstrates a clear sustainability advantage of plastic crates. Research by Battini et al. (2016) highlighted the importance of sustainable packaging technology in maintaining food quality, reducing waste, and minimizing overall environmental impact. These results indicate that conscientious selection of packaging materials and technologies can significantly improve supply chain sustainability. A study by Antala et al. (2020) emphasized that innovations in packaging design and development are crucial for successful food product transportation. A specially designed packaging system for sapota fruits not only preserved the quality of the products during transportation but also reduced waste, promoting sustainability throughout the supply chain. These data suggest that the implementation of sustainable packaging strategies and further innovations in the packaging sector should be a primary focus for achieving the principles of a circular economy and environmental goals.

The relevance of this research stems from the pursuit to implement closed-loop economic principles and the need to reduce the amount of waste and greenhouse gas emissions associated with packaging. The topic was chosen considering the potential of the B2B sector to make a positive impact through business models, environmental awareness, and regulatory changes that accelerate and strengthen sustainability initiatives.

The aim of this research is to analyze the main aspects influencing the implementation of reusable packaging to achieve sustainability in supply chains.

To achieve this goal, the following objectives are addressed:

1. Examine the factors that promote the application of reusable packaging.
2. Highlight the advantages of reusable RTI in supply chains, emphasizing their contribution to environmental and economic efficiency.
3. Identify the main trends and challenges faced by modern organizations in choosing secondary packaging to ensure its sustainability and compliance with supply chain requirements.

This work will employ methods such as scientific literature analysis, systematic review, and legal analysis. These methods will allow for a comprehensive assessment of the current state of scientific research and reveal the breadth and depth of scientific discussions in this area. The study will demonstrate how different packaging solutions affect the sustainability of supply chains.

The research aims to contribute to the discourse on sustainable development by presenting a new perspective on sustainable packaging and its integration into green supply chain processes.

Research Methods

The primary method employed in this study is the analysis and systematization of scientific literature related to sustainable packaging, complemented by an analysis of relevant legislation. In reviewing the scientific articles, particular attention was paid to their methodologies, the substantiation of their conclusions, and the strength of the arguments presented. A comprehensive literature review was conducted using computer databases such as Web of Science, Scopus, and Google Scholar. These databases were selected due to their recognition in the scientific community and their ability to provide high-quality, comprehensive information on the latest research in sustainability and packaging.

The literature review focused on the period from 2010 to 2024, chosen to cover recent years significant for changes in legislation and growing consumer awareness of environmental issues. Key search terms included “Sustainable Packaging”, “Reusable Packaging”, “Single-Use Cardboard Boxes”, “Life Cycle Analysis”, and “Green Supply Chains”, aimed at directing the search towards the most relevant discussions and research in this field. Initially, 90 articles were identified that had a direct connection to the research theme and methodological soundness. After a thorough analysis, 28 articles and 4 pieces of legislation were included in the final list.

The articles were analyzed using qualitative thematic analysis to distill the most important aspects and scientific contributions related to reusable and single-use packaging. Special attention was given to the sustainability of packaging, economic benefits, feasibility,

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potential drawbacks, and the impact on supply chains, as well as possible directions for improvement. The study identified key themes and highlighted fundamental arguments from the scientific literature, which will be used for further analysis and discussion in the article to better understand and evaluate the role of reusable packaging in a sustainable supply chain.

Research Results and Discussion

Scientific Articles Review: Challenges for Sustainable Packaging

Analyzing scientific articles, legislation, and statistical information reveals that the topic of sustainable packaging is complex and multifaceted. Research indicates that corporate decisions regarding the most sustainable types of secondary packaging depend on various factors, including specific product requirements and supply chain demands. This approach aligns with the findings of Albrecht et al. (2022), who emphasized that both reusable plastic crates and single-use cardboard boxes have their respective places within the sustainability spectrum, depending on their lifecycle environmental impacts. The analysis of selected scientific articles highlights key themes and factors focused on in the research, such as: factors encouraging the adoption of reusable packaging, efficiency indicators of reusable system operations; environmental impact assessment of different packaging types using Life Cycle Assessment (LCA); the role of packaging in reducing CO2 emissions; the importance of purpose-fit packaging in selecting and designing the most suitable packaging systems; the role of packaging in reducing food waste; cost and economic factors influencing packaging choices; the importance of packaging standardization in highlighting the advantages of sustainable packaging; and legal aspects such as the key EU and Lithuanian legislation regulating packaging use that promotes reusable packaging options, which will be presented in more detail in this article.

Factors Encouraging the Use of Reusable Packaging

The use of sustainable packaging is a key element of the circular economy, promoting resource efficiency and contributing to environmental sustainability. Albrecht et al. (2022) highlight that a high reuse rate is a fundamental component of the circular economy, as the repeated use of packaging reduces dependence on raw materials and promotes the reuse of resources.

Table 1. Factors Encouraging the Use of Reusable Packaging

Influencing Factor	Author(s)	Main Argument
Circular Economy Component	Albrecht et al. (2022); Potting et al. (2017); Weidema (2019)	Reusable packaging systems reduce the use of primary resources and promote resource reuse. Innovations and economic principles are vital for sustainable reusable packaging systems.
Economic Efficiency	Abejón et al. (2020); Baruffaldi et al. (2019)	Reusable packaging is economically beneficial due to the reduction of production and waste management costs. Optimized systems can reduce overall supply chain costs.
Environmental Efficiency	Koskela et al. (2014); Maga et al. (2022); Weidema (2019)	Reusable packaging reduces waste quantity, supporting waste minimization strategies and resource efficiency. Lifecycle assessment (LCA) experience is crucial for accurate and objective sustainability assessments.
Consumer Awareness	Pajula and Sundqvist-Andberg (2022); López-Gálvez et al. (2021)	Growing consumer awareness of sustainability issues increases the adoption of reusable packaging. Packaging design allows compliance with ecological standards.

Innovation and Technological Advancement	López-Gálvez et al. (2021)	Innovative packaging design and production lead to high-quality reusable packaging that meets ecological and sustainability standards.
Climate Goals Achievement	FEFCO (2022); Franklin Associates (2016)	Reusable packaging is important for meeting climate goals. Packaging recycling is vital for reducing greenhouse gas emissions. Reusable packaging can reduce CO2 emissions over its lifecycle.
Food Product Safety Assurance	López-Gálvez et al. (2021)	Reusable Plastic Containers (RPCs) are a sustainable packaging alternative, but attention must be paid to hygiene risks such as the potential risk of cross-contamination. Reusable packaging systems must be safe to maintain product quality over multiple uses.

** Compiled by the author, 2024.*

The life cycle analysis conducted by Abejón et al. (2020) and Koskela et al. (2014) indicates that, in the long term, plastic packaging could be the most sustainable option, reducing the amount of waste and overall greenhouse gas emissions. Packaging that can be used multiple times decreases energy consumption and waste compared to single-use packaging alternatives.

Baruffaldi et al. (2019), Accorsi et al. (2020), and Pajula and Sundqvist-Andberg (2022) emphasize the integration of sustainability principles into packaging usage processes, demonstrating how circular economy models can effectively reduce waste and optimize resource utilization. Their studies show that integrated sustainability models can help achieve not only ecological but also economic efficiency.

López-Gálvez et al. (2021) and Franklin Associates (2016) highlight the importance of hygiene and food safety assurance when using reusable packaging, especially in the food industry. These aspects are essential to avoid cross-contamination and ensure consumer health.

The German Environment Agency (2022) discusses the role of recycling and reusable packaging in sustainability, underlining the importance of life cycle analysis for the implementation of sustainability practices. Their research indicates that effective integration of reusable packaging systems can significantly reduce CO2 emissions and waste, making an important contribution to climate goals.

All these studies unanimously agree that reusable packaging is a crucial step towards sustainability. They contribute not only to reducing waste and environmental protection but also ensure high product quality and safety, based on hygiene and food safety standards. It is also emphasized that the implementation of sustainability strategies requires an integrated approach where innovation, clear policy, and public education play a significant role.

The assessment of the effectiveness of reusable/returnable packaging

In the analysis of reusable packaging systems, it is crucial to consider various factors that contribute to their effectiveness. For instance, the turnover number and durability of reusable packaging directly influence their sustainability. Studies by Albrecht et al. (2022) and Weidema (2019) suggest that packaging systems with a high turnover number and low damage rate are more resource-efficient. Additionally, ensuring hygiene and safety throughout the packaging lifecycle, as emphasized by López-Gálvez et al. (2021), is essential to prevent contamination and maintain consumer health.

Table 2: Evaluation Based on Turnover, Damage, and Leakage Indicators

Evaluation Indicators	**Authors**	**Findings**
Turnover Number and Packaging Durability Analysis	Albrecht et al. (2022)	Emphasizes that the effectiveness of reusable packaging systems can be assessed based on the turnover number and durability. The study reveals that a high turnover number and a low damage or wear rate are crucial indicators, leading to a reduction in waste quantity and promoting resource efficiency.

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Hygiene and Safety Assurance	López-Gálvez et al. (2021)	Draws attention to the importance of ensuring hygiene and safety throughout the reusable packaging cycle. Emphasizes that proper packaging cleaning and disinfection are essential for preventing food contamination and ensuring consumer health, thereby reducing the risk of spoilage and leakage in packaging.
Damage Indicator	Thorbecke et al. (2019)	The damage indicator highlights how often and how likely a package can be used before becoming unfit for use, underlining the importance of durability and resource efficiency aspects.
Turnover Indicator	Maga et al. (2022)	The turnover indicator leads to evaluating how effective a package is over its lifecycle, thereby reducing environmental impact.
Leakage Indicator	Weidema (2019)	The leakage indicator analyzes the proportion of the package that can lose its integrity. Highlights the advantages of non-leaking, efficient use or inefficient recycling, emphasizing the importance of system design and maintenance in preventing leakage.

** Compiled by the author, 2024.*

When evaluating the efficiency of reusable packaging systems, particular attention must be paid to the circulation number, durability, and leakage indicators, as these factors directly influence each packaging system's ecological footprint. To maximize the efficiency of packaging use, it is essential to ensure that the circulation number is as high as possible. However, as research shows, attention must be paid not only to circulation but also to the packaging's resistance to breakage and the risk of loss. All these conditions are necessary to reduce waste and encourage sustainable use of resources. Packaging that can be used multiple times and is properly managed at the end of the cycle aligns with sustainability principles. It is also crucial to assess how all participants in the supply chain are interested in returning the packaging system boxes, which reduces the risk of improper disposal of packaging and contributes to more efficient use of resources.

Albrecht et al. (2022) emphasize the importance of the circulation number—the more frequently packaging can be reused, the less waste it generates and the more resource-efficient it becomes. Meanwhile, Weidema (2019) and Maga et al. (2022) show that improper use of packaging or inefficient recycling can compromise sustainability advantages. Proper packaging design and end-of-cycle management are vitally important to maximize resource efficiency and maintain a low environmental impact.

The deterioration and leakage indicators, examined by Thorbecke et al. (2019), reveal crucial information about how long and effectively packaging can be used before becoming unfit for use. The durability of packaging directly affects its cyclic use and impacts long-term economic efficiency.

Beyond economic effectiveness, hygiene and safety assurance, especially in the food industry, are critically important, as emphasized by López-Gálvez et al. (2021). Proper cleaning and disinfection throughout the entire use cycle are necessary to prevent cross-contamination and ensure consumer health, as well as to minimize the risk of packaging deterioration or leakage.

In evaluating the effectiveness of reusable packaging, it is essential to consider the motivation of all supply chain participants to return packages to the cycle. This reduces the risk of improper disposal and contributes to the more efficient use of resources.

Considering these scientific studies, it is clear that reusable packaging is essential for a sustainable supply chain, but their effectiveness depends on a comprehensive life cycle analysis and proper management. A holistic and responsible approach to these aspects is crucial for achieving ecological and economic sustainability.

Life Cycle Assessments (LCA) as a Comparative Analysis Tool

Life cycle assessments (LCA) offer a scientific and industrial tool that allows for the objective evaluation and comparison of the environmental impact of various packaging

types. This instrument is crucial for understanding and minimizing the environmental footprint of any product or packaging material from its creation to its disposal. LCAs not only uncover direct impacts, such as CO2 emissions but also indirect effects such as water usage and resource expenditure over the entire lifecycle of a product.

Table 3. Life Cycle Assessments (LCA) as Comparative Analysis Tools

LCA Capabilities	Author	Assertion
Objective and Comprehensive Package Type Impact Assessment	Abejón et al. (2020); Reike et al. (2018); Maga et al. (2022); Weidema (2019); Accorsi, Baruffaldi & Manzini (2020)	LCA allows for the disclosure of the environmental impact of the packaging's life cycle, assessing both direct (CO2 emissions, waste quantity) and indirect (water and energy consumption) impacts. Ensures the objectivity of the studies.
Decision Making and Strategy Development for Sustainability	Castellani, Aigner & Aagaard (2022); European Commission (2010); Tua, Biganzoli, Grosso & Rigamonti (2019)	LCA aids in making sustainable decisions, for example, in the food packaging sector, and encourages the creation of more efficient resource utilization. The European Commission's report underscores the importance of life cycle thinking for the development of effective business and policy practices.
Integration of Efficiency and Environmental Goals into Business Processes	Levi et al. (2011); Fraunhofer IBP (2018); Krieg, Gehring, Fischer & Albrecht (2018)	LCA's use allows organizations to make informed sustainability-related decisions, backed by comprehensive analysis encompassing logistics, production efficiency, and the end-of-life cycle aspects.

** Compiled by the author, 2024.*

The study by Accorsi, Baruffaldi, and Manzini (2020) demonstrates how a circular supply chain model, built upon LCA, can diminish waste and CO2 emissions by integrating sustainability strategies into packaging design and usage. Castellani, Aigner, and Aagaard (2022) underscore the application of LCA in the food packaging sector, emphasizing its significance in making sustainability decisions.

Abejón et al. (2020) highlight the indispensable role of LCA in the assessment of packaging decisions, allowing for the revelation of both direct and indirect effects. Meanwhile, research by Thorbecke et al. (2019) illustrates how LCA contributes to identifying the sustainability advantages of reusable containers compared to single-use cardboard boxes. The European Commission's publication "Making sustainable consumption and production a reality" (2010) stresses the importance of integrating life cycle thinking into business and policy strategies to promote more efficient and sustainable consumption and production models. Tua et al. (2019)'s research presents data showing that reusable plastic containers (RPCs) represent a sustainable choice, lessening environmental impact throughout their life cycle.

Levi et al. (2011)'s research indicates that reusable packaging reduces energy consumption and greenhouse gas emissions compared to single-use alternatives, due to their durability and recyclability. Publications by Fraunhofer IBP (2018) and Krieg, Gehring, Fischer, and Albrecht (2018) emphasize the significance of analyzing greenhouse gas emissions to achieve effective and sustainable packaging solutions.

All these studies collectively affirm that LCA is an invaluable tool for achieving sustainability within the supply chain. It allows organizations and policymakers to make well-informed decisions based on comprehensive data about environmental impact. Hence, life cycle assessments are an essential component of creating and implementing sustainability strategies, helping to apply principles of sustainability at all stages of packaging decisions.

Presentation of Perspectives and Recommendations to Change the Situation

To shift towards more sustainable packaging practices, it is important to address both the economic and environmental benefits of reusable packaging. Economic incentives, such as reduced waste management costs and improved resource utilization, make reusable

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packaging a viable option for businesses. Furthermore, from an environmental perspective, the reduction in greenhouse gas emissions and waste generation aligns with global sustainability goals. Future research should focus on developing innovative packaging designs that enhance the usability and durability of reusable packaging, thereby increasing their adoption in various industries.

Table 4: Perspectives and Recommendations for Improving Sustainable Packaging Practices Compiled by the author 2024

Aspects	Authors	Claims
Economic Benefits	Abejón et al. (2020); Baruffaldi et al. (2019)	Reusable packaging can lead to reduced waste management costs and improved resource utilization, making it a viable economic option for businesses.
Environmental Impact Reduction	Maga et al. (2022); Abejón et al. (2020)	LCA reveals that reusable packaging reduces CO2 footprint and waste generation, aligning with global sustainability goals.
Role of Retailers and Regulatory Support	López-Gálvez et al. (2021); Pålsson and Olsson (2023)	Policies should encourage retailers to adopt reusable plastic crates by highlighting long-term benefits and providing incentives. Collaboration with policymakers is crucial.
Innovation in Packaging Design	Yokokawa et al. (2018); Verghese et al. (2015)	Effective packaging innovations can enhance the usability and durability of reusable packaging, promoting wider adoption.
Food Safety Assurance	López-Gálvez et al. (2021); Thorbecke et al. (2019)	Reusable packaging can ensure high food safety standards with proper cleaning and disinfection, preventing contamination and food waste.

** Compiled by the author 2024.*

Food safety assurance is another critical aspect of reusable packaging. According to López-Gálvez et al. (2021), proper crate cleaning and disinfection are necessary to prevent contamination and food waste, particularly for fresh food products. The study shows that reusable packaging, with appropriate hygiene practices, can ensure a high level of food safety and contribute to sustainability goals.

The environmental benefits of reusable packaging are further supported by Maga et al. (2022) and Abejón et al. (2020), who highlight the significance of Life Cycle Assessment (LCA) in evaluating the impact of different packaging decisions. LCA reveals that reusable plastic crates have a lower CO2 footprint and maintain food freshness longer than single-use alternatives, thus reducing food waste and offering both environmental and economic benefits.

Innovative packaging solutions that take into account consumer behavior can also reduce food waste significantly. Yokokawa et al. (2018) and Verghese et al. (2015) demonstrate how effective packaging design can extend the shelf life of food products and improve logistics efficiency, ensuring that food stays fresh longer and waste is minimized.

The cumulative findings of these studies emphasize the need for a responsible approach to packaging design, integrating sustainability principles to reduce food waste and enhance supply chain efficiency. Organizations should consider both environmental and economic factors when selecting packaging materials and technologies to ensure a sustainable future.

Costs of Packaging and the Importance of Selecting the Appropriate Packaging

When considering the perspective of packaging costs and expenses, it is particularly relevant to evaluate reusable packages, which not only meet sustainability principles but are also economically beneficial in the long term. The analysis by Abejón et al. (2020) reveals that initial higher investments in reusable packaging can be offset by reduced operating expenses, thereby contributing to efficient resource use and waste reduction. Packaging, especially when “fit for purpose”, is important for achieving efficiency and sustainability in supply chains. It is crucial that the packaging not only protects the

product but also meets specific usage requirements, such as resistance to damage or suitability for digital solutions, the ability to stack pallets, and the capability to nest crates for efficient return and storage. Reusable plastic crates, due to their standardized dimensions and durability, are considered a more efficient choice than single-use cardboard boxes.

Table 5. The Importance of Packaging Costs and Proper Packaging Selection

Aspects	Authors	Assertions
Packaging Economy and Long-term Costs	Albrecht et al. (2022); Abejón et al. (2020)	Reusable packaging, considering all stages of operation, can be economically competitive with single-use packaging. Their use can lead to lower processing costs, especially in the supply chain, reducing waste quantities.
Packaging Standardization and Logistics Efficiency	Thorbecke et al. (2019); Albrecht et al. (2022)	Optimizing the quantity of product per package and packaging standardization can help avoid "empty space" transportation and reduce transportation emissions, thereby ensuring efficient and sustainable movement of goods in the supply chain.
Integration of Sustainability Principles and Life Cycle Analysis	Maga et al. (2022); Weidema (2019)	The use of life cycle analysis (LCA) is crucial when assessing the packaging's economic and ecological impact. Sustainable solutions integrated into LCA are important in making informed decisions because they allow for consideration of all stages of packaging use and combine costs.
Adaptation of Packaging for Product Protection	Maga et al. (2022); Abejón et al. (2020)	Reusable packaging should be adapted to different product types, ensuring their suitability and protection during transportation, while minimizing waste quantity and maintaining product quality.
The Impact of Packaging Design and Optimization on Economic Benefit	Pålsson and Olsson (2023)	Innovative packaging design and optimization, based on circular economy principles, can reduce waste and recycling costs, as well as extend the packaging's life cycle. Standardized and modular packaging effectively disperses logistics costs, reducing not only transportation but also packaging preparation and management costs.

**Compiled by the author in 2024.*

The design and optimization process of packaging has a direct impact on its economic benefit. As illustrated by Pålsson and Olsson (2023), innovative packaging design based on circular economy principles not only reduces waste and recycling costs but also extends the packaging life cycle. Standardized and modular packaging increases logistical efficiency by optimizing not only transportation costs but also packaging management expenses.

Weidema (2019) emphasizes the importance of life cycle analysis for determining economic impact, advocating for comprehensive economic efficiency studies that include all stages of packaging use. This provides a deeper understanding of packaging costs and allows for well-founded economic efficiency decisions.

Sustainability concerns, addressed by Maga et al. (2022) and Albrecht et al. (2022), highlight that reusable packaging can reduce expenses not only during direct use but throughout the entire life cycle, ensuring efficiency and contributing to environmental goals.

Packaging standardization, as presented by Thorbecke et al. (2019), is significant not just for efficiency and cost-effectiveness, but also as a means to maintain high-quality products, reducing transportation and storage costs and potential food waste. Reusable packaging systems involve greater initial investments, hence they have been primarily implemented in the B2B sector among major market players to date. Standardization and regulatory systems that help protect investments can make reusable packaging systems more widespread.

Lopez-Gálvez et al. (2021) stress the importance of hygiene aspects, demonstrating that proper packaging hygiene is essential to ensure food safety and long-term freshness, reducing the risk of product contamination and waste.

The analysis of these sources reveals a complex structure of packaging costs, indicating that proper packaging selection is more than just the initial price. It includes a thorough assessment of the packaging's life cycle and economic

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impact, including cleaning, transportation, life cycle costs, and the integration of sustainability principles, which are important not only for economic efficiency but also in the context of contemporary consumption culture.

Legal Aspects Promoting the Use of Reusable Packaging

Legal aspects form a significant part of any sustainability study, as they establish both the regulatory environment and corporate accountability. In the European Union, legislation and policy guidelines can set requirements for product design, waste management, reuse, and recycling, and encourage sustainability initiatives and investments in sustainable technology and practices. These legal documents can be seen as a framework that directs the course of sustainability and the packaging industry's activities.

Table 6: Legal Aspects

Aspect	Document	Key Point
Package Reduction and Recycling	Packaging Directive (94/62/EC)	Set requirements to reduce packaging waste and increase packaging materials recycling to minimize packaging's environmental impact.
Waste Hierarchy and Sustainability	Waste Framework Directive (2008/98/EC)	Promotes waste prevention, reuse, recycling by applying the waste hierarchy principle, which aids in transitioning to a circular economy.
Plastic Pollution Reduction	Single-Use Plastics Directive (2019/904)	Introduce requirements to reduce pollution from single-use plastic products and encourage the use of alternative materials.
Stimulating the Circular Economy	EU Circular Economy Package	Proposals on how businesses and society can move towards a circular economy model and actions aimed at increasing sustainability throughout the product lifecycle.

** Prepared by the author 2024.*

Legal aspects are crucial for any sustainability and packaging industry research, setting not only the regulatory environment but also corporate responsibility. The European Union's legislative and policy guidelines establish clear requirements for product design, waste management, reuse, recycling, and encourage sustainability initiatives and investments in sustainable technology and practices.

The Packaging Directive (94/62/EC) is a key regulation shaping packaging waste management practices in the European Union. This directive ensures the reduction of packaging waste and promotes the recycling and reuse of packaging materials for sustainability and efficiency. In Lithuania, the provisions of this directive are embodied in the Packaging and Packaging Waste Management Act, which specifically regulates the packaging waste management process and encourages the implementation of recycling and other sustainability practices.

The Waste Framework Directive (2008/98/EC) establishes a waste management hierarchy and targets that are fundamental steps towards a circular economy. This directive emphasizes waste prevention, reuse, recycling, and promotes an economic model where resources are used more efficiently, and waste generation is minimized. In Lithuania, waste management principles are implemented through the Waste Management Act, following the waste hierarchy concept.

The Single-Use Plastics Directive (2019/904) reflects the EU's commitment to reducing plastic waste pollution and promotes sustainability initiatives. In Lithuania, this directive is implemented through amendments to laws that encourage the use of alternative, environmentally friendly products and strengthen recycling infrastructure.

The EU's Circular Economy Package proposes actions on how the transition to a circular economy model can be achieved, encompassing product design, sustainable

production, consumption, and waste prevention and recycling. In Lithuania, these principles are encouraged through a national strategy that sets clear goals and actions in the waste management sector to become a sustainability exemplar.

The implementation of the EU Circular Economy Package and its transposition into national laws and strategies, such as Lithuania's National Waste Management Plan, helps shape and promote the integration of circular economy principles into business operations. These documents create a legal and strategic basis that allows both businesses and society to apply practical sustainability solutions focused on waste reduction, recycling, and reuse, fostering long-term sustainability and economy.

Pålsson and Olsson (2023) emphasize that new policy measures and sustainable practices must be encouraged not only through regulations but also through economic incentives, such as tax breaks or subsidies that promote the use of sustainable packaging and raise consumer awareness about the importance of reducing waste.

Recommendations

Based on the findings of this study, the following recommendations are proposed to enhance the implementation of reusable packaging in sustainable supply chains:

Increase Awareness and Education. Educate stakeholders and specialists about the long-term economic and environmental benefits of reusable packaging systems through targeted campaigns and training programs.

Policy and Regulatory Support. Advocate for stronger regulatory frameworks for the use of reusable packaging. Governments should consider implementing tax breaks or subsidies for businesses adopting sustainable packaging practices. Additionally, it is important to address the role of retailers in promoting sustainable packaging. Retailers often prefer shelf-ready carton boxes for their convenience and ease of use. However, policies should encourage retailers to adopt reusable plastic crates by highlighting their long-term environmental and economic benefits.

Innovation in Packaging Design. Encourage innovation in packaging design to improve the durability and usability of reusable packaging. Research and development should focus on creating packaging solutions that are both cost-effective and environmentally friendly.

Lifecycle Analysis and Monitoring. Organizations are advised to perform comprehensive life cycle analyses before implementing reusable packaging solutions to fully exploit their potential in terms of economic and environmental benefits. Regular conducting of lifecycle assessments (LCA) to monitor and evaluate the environmental impact of packaging choices will ensure that the most sustainable options are being utilized.

Collaboration Across the Supply Chain. Foster collaboration among supply chain participants to ensure the efficient return and reuse of packaging materials. Shared responsibility will enhance the overall sustainability of the supply chain.

Conclusions

The literature analysis revealed that reusable plastic containers (RTI) are a significant component of a sustainable supply chain, contributing to the reduction of waste, prolonging the freshness of products, and decreasing the economic burden associated with packaging recycling and disposal. The study highlights that the application of RTIs is encouraged not only by better product protection during transport but also by the ability to extend the shelf life of unpackaged products, which directly affects the reduction of food waste.

Reusable packaging significantly contributes to the optimization of supply chains by reducing costs related to packaging materials and waste management over a longer period, and also by improving the quality and freshness of products, often influenced by the possibility of cleaning and disinfecting containers. Furthermore, RTIs offer opportunities for more efficient logistics due to standardization and suitability for digital solutions, which contribute to increased logistics efficiency.

The transition to reusable packaging is based not only on economic benefits but also on environmental advantages, allowing the achievement of supply chain sustainability goals. The challenges modern organizations face with the implementation of sustainability standards

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reveal an increasing need to adapt to new requirements and conditions. Reusable packaging systems, despite causing higher initial investments and infrastructure requirements, can significantly contribute to waste reduction and sustainable raw material consumption in the long run. This suggests that companies offering rental and washing services for reusable containers have good prospects to fill emerging market opportunities.

Finally, this study confirms that integrating reusable packaging into supply chains is inseparable from the continuous search for a balance between cost-efficiency, functionality, and environmental sustainability. This means that organizations need to conduct thorough lifecycle analyses and develop innovative packaging solutions that meet tightening legal requirements and consumer expectations.

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