

Article

# Functional Model of Supply Chain Waste Reduction and Control Strategies for Retailers—The USA Retail Industry

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**Abstract:** *Background:* The US retail sector grapples with persistent challenges related to supply chain waste, including inefficiencies, overstocking, and logistical barriers, necessitating targeted reduction strategies to mitigate escalating costs, environmental impacts, and diminished profitability. *Methods:* This study adopts a qualitative research method that draws on secondary data sources such as books, journals, articles, and websites to explore supply chain waste reduction strategies within the US retail industry. The study delineates various supply chain waste types, examines associated challenges and drivers, and proposes a simplified model tailored to the US retail landscape to enhance efficiency and sustainability through waste reduction and control. *Results:* The findings of this paper underscore the necessity for proactive measures within the US retail sector to minimize supply chain waste, optimize operations, and bolster environmental stewardship. *Conclusions:* By offering a comprehensive overview actionable insights and proposed reverse logistics model, this study aims to equip US retailers with strategies conducive to sustainable growth and heightened competitiveness while advancing the broader discourse on supply chain efficiency and waste reduction.

**Keywords:** supply chain wastes; retail industry; waste reduction; sustainability; environmental impact; efficiency



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## 1. Introduction

In this era of economic difficulty, making every dollar and time count has been very pertinent. Inefficient processes, lack of responsiveness, breakdowns in communication, ordering errors, and mistakes lead to significant waste within a company's supply chain and result in enormous expenses of both time and money. This can be decreased by applying efficient strategies of supply chain waste reduction. Supply chain waste refers to inefficiencies or excesses while producing and delivering goods or services. It can include overproduction, excess inventory, transportation inefficiencies and unnecessary packaging [1]. As of November 2023, the landscape is evolving further, with President Biden unveiling a series of initiatives to strengthen US supply chains. This announcement reflects a commitment to ensuring timely access to essential goods and services for Americans, fostering domestic product empowerment, and bolstering job growth—a critical nexus for the nation's economic, environmental, and national security [2].

Supply chain waste encompasses a spectrum of inefficiencies and excesses throughout the production and delivery of goods or services. Examples range from overproduction and excess inventory to transportation inefficiencies and unnecessary packaging. In the United States, numerous retail firms are proactively streamlining their supply chains to mitigate wasteful activities that do not contribute direct value [3]. The impact of supply chain waste on US retailers is substantial, leading to increased costs, environmental concerns, and reduced profitability. For instance, the Apparel sector incurred significant losses of USD 15.3 billion in 2022 due to supply chain wastes, with packaging identified as a major

contributor [4]. Excessive inventory and inefficient transportation practices, such as half-empty trucks and inefficient routes, contribute to financial losses and environmental harm, including increased carbon emissions [5].

Recognizing these challenges, the retail industry strives to optimize supply chains by adopting a lean supply chain method. These strategies involve improved inventory management, streamlined logistics, and sustainable packaging practices. This paper explores the specific supply chain waste reduction and control strategies necessary to enhance efficiency in the United States retail industry's supply chain operations. By examining the relevant literature, this paper addresses the gap in supply chain waste creation by retailers and proposes strategies for controlling this waste. The paper seeks to:

- i Provide an overview of the types of supply chain wastes in the United States.
- ii To examine the impact of supply chain wastes on the United States retail industry.
- iii To explore the challenges and drivers of supply chain waste.
- iv Propose effective strategies and a simple model for the retail industry to ensure supply chain waste reduction and control and improve efficiency.

## 2. Methodology

The study adopts the qualitative research method. The qualitative approach is used to understand concepts, thoughts, and experiences. This research method enables the researcher to gather in-depth insights on poorly understood topics, with appropriate observations and systematic reviews of scholarly literature described in words and exploratory concepts and theories.

- i Research approach:

In determining the research approach for the study, it is pertinent to note that two fundamental methodologies are moderately engaged with the research approach: the inductive and the deductive research approach. This has played an indispensable role in aiding researchers in recent times to foster a solid basis for providing a good discussion [6]. The deductive methodology utilizes writing to clarify ideas collected from previous studies, recognizing these speculations and showing the clearness of these ideas, typically tried on a theoretical framework or model. An inductive methodology is a research approach that involves drawing general conclusions or theories based on specific observations or patterns. It starts with collecting and analyzing data or observations and then using that information to develop broader models, theories, or generalizations. In this vein, this study adopts the inductive methodology as the research reasoning moves from specific to general, which allows the researcher to identify patterns, trends, or relationships in the data that can inform the model, theory, or concepts derived at the end of the study.

- ii Collection of data:

Collecting data in any research is a crucial tool that includes the sources or places the study will explore. There are two types of data collection methods, which are primary and secondary sources. This research employs secondary data solely for analysis and examination. Secondary sources for this research include books, articles, journals, peer-reviewed journals, magazines, and others to support a comprehensive study. It is also pertinent to consider previous literature or theories relevant authors mention to enhance the research findings further.

## 3. Literature Review

Supply chain wastes include overstocking, inefficiencies, and logistical complexity, representing a significant issue to the retail industry in the United States [7]. These problems cause retailers to experience significant financial constraints and impede operational efficiency. Because supply chain wastes are complex, specific tactics are needed to improve overall sustainability, cut down on extra inventory, and expedite procedures. The industry's performance depends on finding creative solutions to these problems, which can maximize resource use and support a more robust and thriving retail sector in the United States.

Strategic interventions are required to mitigate supply chain waste in the United States retail industry. Key tactics include implementing cutting-edge technologies for real-time data analysis and encouraging cooperation throughout supply chain stages. Key components include precise demand forecasts, effective inventory control, and environmentally friendly logistics [6]. By implementing these strategies, retailers may reduce overstocking, streamline procedures, and improve supply chain visibility. Using eco-friendly packaging and embracing the circular economy are further tactics to advance sustainability. The US retail industry is becoming more accountable and robust due to these mitigation actions, which help streamline operations [8].

While existing studies have made significant strides in understanding and mitigating waste, a notable gap remains in addressing the retail sector's unique challenges. Much of the current research has primarily concentrated on supply chain waste reduction at the producer and wholesaler scale within the service sector [9,10]. However, a critical aspect often overlooked is the substantial impact of waste within the retail industry itself. In 2008, the United States reported a staggering 10% total food supply loss in the retail sector, translating to an estimated 48 billion pounds [11]. This highlights the significant contribution of retailers to overall supply chain losses. An alarming trend within the retail model is accepting waste as an inherent part of business. The USDA estimates that supermarkets alone experience annual losses of USD 15 billion in unsold food and vegetables [12]. This perception impedes the implementation of effective waste reduction strategies, necessitating a reevaluation of current practices within the retail supply chain. Large-scale service sectors have also received attention in previous research [13–15].

Mokhtar et al. (2019) identify significant gaps in the supply chain management literature, emphasizing the mediating role of leadership styles. While prior studies have suggested that Supply Chain Leadership (SCL) and governance mechanisms can jointly contribute to sustainability practices within supply chains [16,17] contend that the current literature falls short in examining these concepts together. This deficiency results in unclear explanations regarding the influence of leadership styles and governance mechanisms in managing supply chain relationships and performance. In response to these gaps, they conducted an empirical investigation to explore the relationship between SCL and Reverse Supply Chain Performance (RSCP), considering the mediating role of governance mechanisms [17].

Limited attention has been given to retailers in the existing literature, with few studies conducted in the United States [18,19]. Studies conducted in the United States have generally not adequately focused on retailers, with a notable gap in the literature [20,21]. Other studies have primarily concentrated on food loss, neglecting a comprehensive exploration of various control strategies crucial for supply chain waste reduction and efficiency [19,22,23]. In this context, this paper aims to bridge the existing gap in the literature by comprehensively examining supply chain waste reduction strategies to enhance efficiency, specifically within the United States retail industry's supply chain operations. The paper's objectives, as outlined, go beyond the existing research limitations and contribute to a more holistic understanding of effective waste reduction in retail supply chains.

In conjunction with the literature review, a theoretical framework is crucial for a holistic understanding of supply chain management (SCM) principles, including resource-based perspectives, systems thinking, and various SCM theories [24].

i. Natural Resource-Based View (N-RBV):

The N-RBV theory emphasizes the importance of a company's unique resources for achieving a competitive advantage [25]. It extends this view to supply chain management, illustrating how effective green supply chain practices can lead to competitive advantages through environmental cooperation, waste reduction, and knowledge exchange [26–28]. According to N-RBV, sustainable practices contribute to improved capabilities and overall efficiency [29], emphasizing the significance of considering diverse resources such as pollution prevention and clean technologies [30]. The RBV theory highlighted by Hitt focuses on the importance of external and relational factors in managing both individual

firms and supply chain as a whole [31]. These theories suggest that strategic decisions should be made in the benefits of the entire supply chain, rather than individual firms. This can only be achieved through supply chain partners.

ii. Systems Theory:

Applied to supply chain management, Systems Theory highlights the interconnected nature of organizational operations. It involves discovering and eradicating inefficiencies by improving interlinked processes, with a key focus on waste minimization [32,33]. According to Systems Theory, waste minimization enables companies to utilize resources more efficiently by optimizing processes and resource allocation.

iii. Supply Chain Management (SCM) Theory:

SCM theory encompasses various perspectives, including transaction cost economy, system theory, organizational learning, quick manufacturing, and just-in-time theory of constraints. In response to the evolving global market, SCM emphasizes strong relationships with suppliers and customers, highlighting the importance of leveraging external resources for effective supply chain management [34–36]. The relational category in SCM underscores the power of relationships among partners, utilizing reward systems and mutual relationships to enhance overall supply chain performance. Various SCM theories, such as strategic choice, resource-based view, organizational learning, TQM, and time-based competitive theories, offer diverse perspectives on managing the supply chain, providing insights into waste reduction strategies for internal and external processes [34,36]. The organizational learning theory [37] focuses on the inter-organizational and external aspects of supply chain management which suggests that reducing lead time and making continuous improvements should not be limited to internal processes only but should encompass all activities within the supply chain. Additionally, when training workers, firms can leverage not only their resources but also the knowledge and resource of their partners [37].

Navigating diverse SCM theories reveals the keys to optimal performance in a dynamic global market. As a result, new technological approaches are required to navigate this complex network [38,39]. These insights are key in today's competitive supply chain landscape as this SCM theory provides various views regarding specific waste reduction strategies through internal and external processes, and their associated benefits to promoting efficiency among business organizations. By combining insights from the literature review and the theoretical framework, this paper presents a comprehensive and integrated approach to understanding and implementing supply chain waste reduction strategies in the United States retail industry. The findings, aligned with the outlined objectives, will contribute to a more nuanced and effective understanding of waste reduction in retail supply chains.

#### 4. Types of Supply Chain Waste

Porter (1991) and Porter and der Linde (1995) define waste in lean manufacturing as any activity that consumes resources or creates cost without producing any offsetting value stream. As noted above, organizations try to avoid waste in their supply chain due to the challenging economic times. However, this has still been evident in various retail firms. This section identifies and analyses the different types of supply chain waste in the US retail industry [40,41].

i. Overstocking in the Retail Industry: A Common Challenge

Overstocking is a prevalent issue in supply chains, particularly within the retail sector, with profound implications for sales performance. This problem arises when retailers accumulate excess inventory, leading to increased costs and wastage, often called surplus stock [42].

- *Contributing Factors to Overstocking:*

Overstocking is a complex issue influenced by various factors, including misjudged customer demand, fear of running out of stock, seasonality, inadequate inventory man-

agement, compensatory measures for supply chain challenges, ineffective promotional marketing, and industry-specific difficulties [42]. Young (2022) highlighted that large retailers in the United States face significant challenges associated with overstocking, primarily due to a mismatch between supply and demand [7].

- *Evidence from the United States Census Bureau:*

The United States Census Bureau provides insights into the extent of overstocking in the retail sector. Analyzing the ratio of inventories to sales is a key metric, with a lower ratio generally indicating efficiency. In April 2022, this ratio stood at 1.18, compared to 1.48 in April 2019 (see Figure 1 below). However, maintaining an unreasonably low ratio can lead to stockouts and lost sales, a phenomenon observed during the early stages of the COVID-19 pandemic when sudden shifts in consumer demand caught supply chains unprepared [43].



**Figure 1.** Inventory-to-sales ratios for all retailers and for general merchandise stores. Source: US Census Bureau [43].

- *Challenges in General Merchandise Stores:*

The challenges of overstocking are particularly evident in general merchandise stores where inventory levels relative to sales have surpassed pre-pandemic levels. The ratio for inventories to sales in these stores was 1.58 in April, a significant increase from 1.38 in April 2019. This indicates that restocking strategies have not aligned with evolving consumer buying patterns, resulting in unsold goods accumulating [28].

- *Consequences of Overstocking:*

The consequences of overstocking are multifaceted and adversely impact the efficiency of the retail industry. These repercussions include poor cash flow, increased storage costs, and the expiration of products. In addressing the overstocking challenge, retailers must adopt proactive inventory management strategies and align restocking practices with dynamic consumer demands to enhance overall efficiency and mitigate the associated financial and operational risks.

ii. Understocking

According to Lulemon [44], understocking can also create supply chain waste. The most significant risk associated with understocking is the unsustainable cost increase when a retailer rushes to restock items on shelves. On the other hand, understocking could create a rush job in the company due to a previous disruption in the supply chain. This leads to overtime payments to workers, which costs the company more. However, proper planning and stocking could have avoided this wastage. Also, understocking could damage customer perceptions, which could need additional work and costs to regain customers' trust, thus creating waste. Additionally, understocking can lead to inefficient use of resources, such as excess inventory of other products, increased storage costs, and potential obsolescence. It is important for retailers in the United States to carefully manage their inventory levels to avoid understocking and minimize supply chain waste [45].

### iii. Spoilage in the Supply Chain: A Costly Challenge

Spoilage, a significant type of supply chain waste, refers to the decay or expiration of products, rendering them unsuitable for use or sale. This issue has profound implications for businesses, including retailers, leading to financial losses as damaged goods must be discarded or written off. The causes of spoilage are diverse and can include improper storage conditions, surpassing expiration dates, or mishandling during transportation.

- **Global Impact of Spoilage:** The magnitude of spoilage is staggering globally. According to RTS (2023) [46], approximately 2.5 billion tons of food are wasted annually worldwide, with the United States being the leading contributor, discarding nearly 60 million tons—equivalent to 120 billion pounds—each year. This colossal amount of wasted food in the United States translates to a financial loss of nearly USD 218 billion, equivalent to 130 billion meals [46].
- **Retailers' Contribution to Food Waste:** The retail sector plays a substantial role in food waste, with approximately 40% of food products produced in the United States being wasted by retailers. The graph below illustrates the levels of food waste at various stages, from production to consumption.

Figure 2 below underscores the necessity of upstream solutions to address the escalating levels of food waste effectively. The root causes are intricate and multifaceted, beginning with homes in the United States (43%), followed closely by retailers, encompassing restaurants, grocery stores, and food service companies (40%). Farms contribute 16%, and manufacturers/wholesalers, where excess food production occurs, make up the remaining 2%. This overproduction further exacerbates environmental waste.

#### Where our waste comes from:



**Figure 2.** Recycle Track Systems: Food Wastes in America 2023 [46].

To combat this issue, a comprehensive approach is required. Solutions should span across:

- **Households (43%):** Educating consumers on responsible food consumption, meal planning, and proper storage practices can significantly reduce waste at the source.
- **Retailers (40%):** The retail sector, including restaurants, grocery stores, and food service companies, must prioritize measures such as quality control, rigorous monitoring of storage conditions, and optimizing inventory management to minimize spoilage and decrease overall supply chain waste [46].
- **Farms (16%):** Implementing efficient harvesting practices, aligning production with market demand, and exploring sustainable farming methods can help reduce waste at the production stage.
- **Manufacturers/Wholesalers (2%):** Focusing on demand-driven production, better forecasting, and responsible inventory management can address excess production, contributing to a more sustainable supply chain.

Recognizing that excessive food waste also poses environmental challenges beyond the economic impacts is crucial. Overproducing food strains natural resources, exacerbates greenhouse gas emissions, and intensifies the overall ecological footprint. By adopting a holistic and collaborative approach across all supply chain stages, from households to

manufacturers, stakeholders can work together to implement targeted solutions. This ultimately reduces food waste, promotes sustainability, and mitigates the environmental impact associated with this global challenge.

#### iv. Excess Packaging

This refers to the unnecessary use of materials and resources in packaging products. This can include using oversized boxes, excessive layers of wrapping, or non-recyclable materials. Excess packaging increases retailers' costs in the United States and contributes to environmental pollution and waste.

National Geographic reported that 91% of plastic ever produced has become waste. Three companies actively utilizing their considerable platforms to reduce single-use plastic waste are Aramark, The Coca-Cola Company, and McDonald's [47]. According to Shamsuddoha [48], many companies need to adopt sustainable practices to protect the environment for future generations. Green initiatives, such as implementing reverse supply chains, can benefit the company and society. By utilizing reverse supply chains, companies can minimize the adverse environmental effects of extracting new raw materials and disposing of waste [49]. Retailers must adopt sustainable packaging practices, such as using recyclable materials and minimizing packaging size. Eliminating such waste is a reputational imperative and commercial opportunity for retailers [50].

#### v. Transportation Inefficiencies

Transportation inefficiencies can result in and have resulted in significant supply chain waste among retailers in the United States. This includes delays, incorrect routing, inefficient use of vehicles, and poor coordination between suppliers, manufacturers, and distributors [51]. These inefficiencies can lead to increased costs, longer lead times, and higher carbon emissions. According to Puslecki, businesses want to be close to consumers to reduce transportation costs, but consumers want to locate businesses nearby [51]. Therefore, there are multiple equilibria, and, at a critical point, the positioning decision of a single company or single consumer can significantly affect transportation waste. To minimize transportation waste, businesses can optimize their logistics operations, implement route planning systems, and utilize technology for real-time tracking and coordination. Finding these issues and implementing new processes that address such communication/technology breakdowns is the first step to eliminating transportation waste [52].

### 5. Drivers of Supply Chain Waste

Demand variability, forecasting errors, over-ordering, and inefficient logistics present formidable challenges in the supply chain, contributing to waste and inefficiencies.

#### i Demand Variability:

Demand variability introduces uncertainties that can disrupt the supply chain flow. Instances of running out of stock or holding excessive inventory led to delays and heightened expenses. Unpredictable fluctuations in customer demand make accurate forecasting and production planning challenging for businesses. Both overstock and understock situations contribute to supply chain waste by tying up resources, incurring holding costs, and causing missed sales opportunities [53].

#### ii Forecasting Errors:

Overestimating demand through forecasting errors can result in excess inventory and increased carrying costs [54]. Unreliable or outdated data further exacerbates the challenges in making accurate predictions, causing inefficiencies in the supply chain [55–57].

#### iii Over-ordering:

Overordering, a prevalent cause of supply chain waste, occurs when consumers order more goods than necessary. This leads to excess stock lingering in stores, tying up valuable resources like storage space and capital. Overordering also elevates holding costs and the risk of obsolescence, as products may expire or become damaged before being

sold. The disruptions experienced during the COVID-19 pandemic intensified supply chain challenges, emphasizing the need for improved inventory management practices to minimize waste [58].

**iv Inefficient Logistics:**

Inefficiencies in the transportation, storage, and distribution of goods within retail companies result in delays, increased costs, and elevated levels of waste. Addressing these logistical challenges is paramount to enhancing overall supply chain efficiency [14]. By acknowledging and proactively addressing these challenges, retailers can adopt strategic measures and technologies to optimize their supply chain processes, minimize waste, and cultivate a more resilient and responsive system. According to Gunder's [12] summary of food waste in the retail supply chain, the process was divided into 'Drivers' of food waste and 'Potential remedies' in both in-store and beyond stores. Emphasis lay on impulse promotions, rejected shipments, and wrong packaging. Some potential challenges and considerations enhance its effectiveness, such as limited integrations, lack of quantitative analysis, consumer behavior consideration, communication strategies, and long-term sustainability. These limitations are being addressed in this paper's proposed strategies.

## 6. Strategies for Eliminating Waste

This paper proposes the strategies below for eliminating supply chain waste within the United States Retail Industry:

*i Lean Principles and Waste Reduction:*

Adopting lean principles empowers retailers to achieve more with fewer resources, aligning with the core principles of customer satisfaction and business profitability [38]. Lean principles focus on identifying various types of waste, including overproduction, excess inventory, transportation inefficiencies, and unnecessary waiting times. Implementing lean principles enables retailers to streamline processes, optimize resource utilization, and enhance productivity. A concrete application of the lean principle involves using Kanban, a visual tool that facilitates inventory and production management. Kanban signals when it is time to replenish supplies or move materials to the next production stage [59]. Its adoption enhances communication and coordination across departments, reducing lead times and minimizing waste. The benefits of adopting lean principles are as follows: embracing lean principles results in higher efficiency, improved quality, optimal use of employees, space optimization, and increased employee satisfaction. Lean principles enable retailers to identify and eliminate waste, fostering more efficient and effective supply chains [60]. By incorporating lean principles into their operations, retailers in the US can significantly enhance their supply chain efficiency, reduce wastage, and create a more sustainable and customer-centric business model.

*ii Inventory Management and Optimization:*

This process involves ensuring the proper inventory meets demand while keeping logistics costs in check and avoiding inventory problems like running out of stock or too much stock. There are some strategies for optimizing inventory levels, which are discussed below:

- Just-in-time inventory:

With this method, customers receive goods only when needed. This helps to optimize inventory levels. With JIT, retailers can minimize excess inventory and reduce holding costs while still ensuring that materials and products are available when needed. By closely monitoring demand patterns and maintaining strong supplier relationships, retailers can achieve a leaner and more efficient supply chain [61].

- Demand forecasting:

This involves analyzing historical sales data, market trends, and other relevant factors to predict future demands. This helps retailers determine the appropriate inventory levels

to meet consumer needs without excessive overstocking or stockouts [53]. Retailers with this strategy can align their supply with consumer demands, reduce waste and improve overall inventory management.

- Safety stock management:

This strategy helps optimize inventory levels by accounting for uncertainties in demand and supply. This includes inventories that could be sold quickly and safety stocks [62]. By having a safety stock, retailers can reduce the risk of stockouts and customer dissatisfaction. However, it is pertinent to strike a balance because carrying too much safety stock can tie up capital and increase holding costs.

*iii Technology and Automation:*

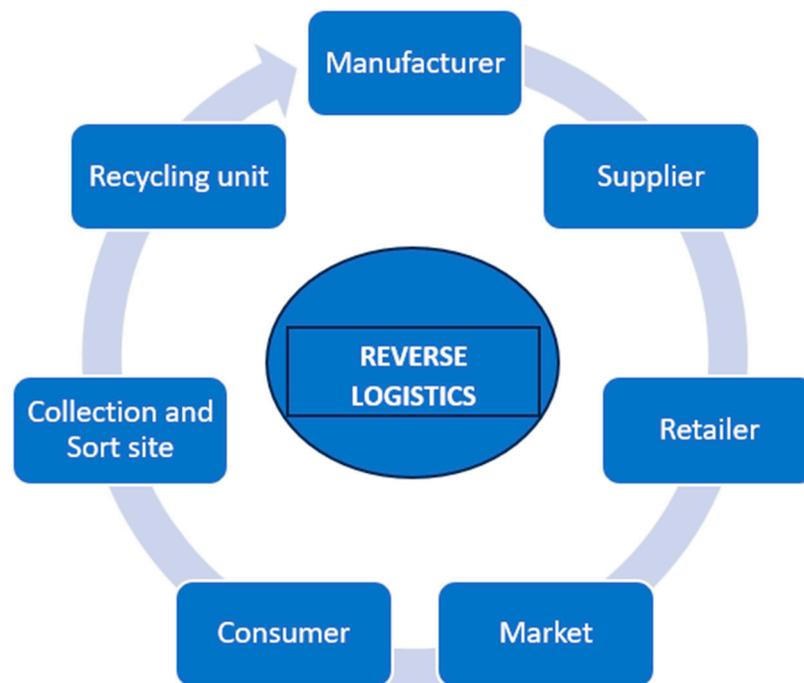
Technology has an active role in supply chain waste reduction. It aids better collaboration between supply chain partners, more accurate order tracking, and easier control of overproduction, and it helps reduce carbon footprints and comply with environmental legislation. For example, IoT technology, which allows for the connection and communication of various devices and sensors through the supply chain, thus enabling real-time data collection and analysis, can monitor environmental conditions during transportation, ensuring that products are stored at optimal temperatures and reducing the risk of spoilage or damage [63]. Also, RFID (radio frequency identification) tags could be attached to products, which aid in tracking the movement of goods in real-time, reducing the risk of stockouts and overstocking, and helping to optimize inventory levels and minimize waste. It also enables better visibility and traceability throughout the supply chain, making it easier to identify and address issues such as delays, bottlenecks, or quality concerns.

*iv Supply Chain Resilience and Risk Mitigation:*

The world of supply chain management has undergone remarkable transformations. From navigating the complexities of a post-pandemic era to tackling geopolitical uncertainties and digital disruptions, businesses have realized the indispensable need for supply chain resilience and effective risk management [8]. Supply chain resilience plays a pertinent role in mitigating risks and ensuring the continuity of operations. According to [8], a resilient supply chain can quickly adapt and recover when disruptions occur, such as natural disasters, supplier failures, or geopolitical events. This involves building flexibility, redundancy, and agility into the supply chain to minimize the impact of disruptions. Retailers could adopt strategies such as diversifying suppliers, establishing relationships with vendors, and implementing some backup plans. Real-time data analysis and supply chain visibility can help ensure effective risk management and quick responses to potential disruptions [8].

*v Reverse logistics and Returns Management*

Kumar Singh et al. [64] positioned end-of-life (EOL) electronic products and advocated for incorporating reverse logistics in the e-waste nullification concept. Figure 3 depicts the proposed reverse logistics flow based on waste collections and uses them for value additions. This approach involves sending e-waste for repair and recycling, with scraps directed to the second manufacturer for use as raw materials. The result is a reduction in environmental damage, the promotion of raw-material conservation, cost savings, and a more environmentally friendly supply chain. In the realm of retail, a crucial aspect is ensuring the smooth flow of products from the point of return to their rightful destinations, whether for repair, recycling, or resale. The challenge lies in meticulously inspecting, sorting, and appropriately disposing of returned items to ensure they are directed to the next step. This meticulous handling is vital to both the efficiency of the supply chain and the responsible management of returned products. See figure [8] for proposed flow chart on Reverse logistics and recycling process in the supply chain industry.



**Figure 3.** Proposed a reverse logistics flow chart.

#### *vi Supplier Collaboration and Vendor Management*

Effective supplier collaboration and efficient vendor management enhance order management processes. These practices contribute to the timely delivery of orders, streamlined order processing, and the availability of products when needed. When these elements align seamlessly, customer satisfaction is boosted, fostering repeat business. Supplier collaboration and vendor management initiatives are crucial in optimizing inventory levels, reducing costs, and maximizing savings [8]. Moreover, these collaborative efforts facilitate the sharing of best practices and innovative solutions, leading to waste reduction and the establishment of efficient processes. By leveraging the expertise and insights of suppliers and vendors, retailers can enhance their operational efficiency and contribute to a more sustainable and responsive supply chain.

#### *vii Sustainability Reporting and Environmental Impact*

According to Suhi, many retailers do not practice sustainability reporting. However, measuring or disclosing their environmental performance, including waste generation and resource consumption, could provide this [65]. It helps to reduce waste through the supply chain and identify areas for improvement. Environmental impact assessments evaluate the effects of business activities or products. It aids the identification and mitigation of risks by implementing waste management strategies and recycling programs.

## **7. Future Trends and Innovations**

### *7.1. Success Stories and Best Practices*

Micro, small, medium-sized, and large-scale businesses form the backbone of global economies, contributing significantly to employment, innovation, and community livelihoods. However, these businesses confront vulnerabilities like inflation and supply chain disruptions [66]. With supply chain disruptions ongoing, many firms in the United States are learning analytics to gain insights into their supply chain and operations [67]. According to Olavsrud (2022) [67], it was noted that UPS has reported that predictive analysis has given their firm insight into their logistics network. According to the author, on average, UPS delivers roughly 21 million packages on any given day. That number gets far bigger in December. In the past, the shipping multinational has relied on historical data and know-how from expert planners to track package status. Today, it uses the Harmonized

Enterprise Analytics Tool (HEAT), a business intelligence platform, to capture and analyze customer data, operational data, and planning data to track the real-time status of every package as it moves across the company’s shipping network [67]. Also, Pfizer’s digital transformation has helped retailers to manage their supply chain. According to the firm, “the data has helped the firm and her customers (retailers) reduce the cycle-time in particular processes and also ensure the continuity of critical supply for patients that rely on their pharmaceuticals” [67].

7.2. Strategy Propositions

Sustainability in supply chain management addresses various challenges, from waste minimization to resource efficiency maximization. The wastage problem has been shown to increase costs, lead to environmental damage, and reduce profitability. As a result of these consequences, the retail industry has been working to optimize the supply chains to minimize waste. This paper proposes a supply chain waste reduction and control optimization model using CoDaReCSS (Collaboration, Data-Driven Decision Making, Reverse Logistics and Product Life Cycle Management, Consumer Education and Engagement, Sustainable Sourcing and Packaging and Supply Chain Resilience and Risk Mitigation) (see Figure 4). These proposed solutions provide strategies to reduce and control supply chain waste in the retail industry. By implementing the CoDaReCSS model, retailers can contribute to a more efficient and sustainable supply chain, reducing waste and environmental impact while meeting the needs of consumers. This is outlined below:

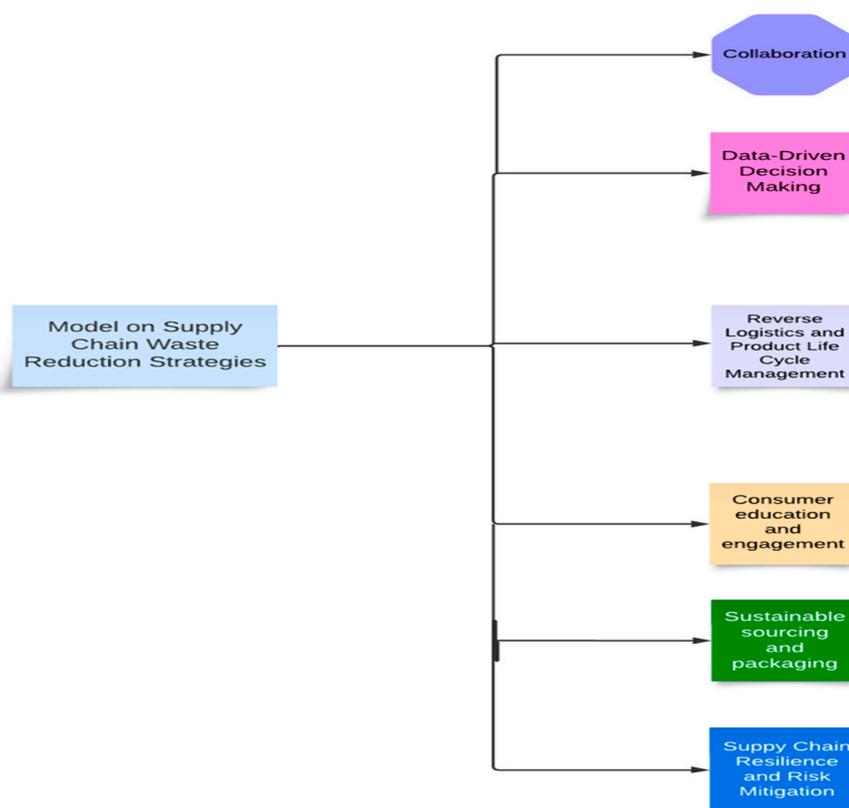


Figure 4. Proposed a simple model on various control strategies that the US retail industry could adopt to ensure supply chain waste reduction and improve efficiency.

i Collaboration:

There should be improved relationships between retailers, suppliers, manufacturers, and logistics providers in the United States to promote shared responsibility, open communication and transparency in waste reduction efforts [68]. Recognizing the essential role of small and mid-size companies in American supply chains, [69] recommend government

and industry assistance in upgrading the technology of these smaller firms. This proactive support would address the existing productivity and technology adoption challenges and significantly improve supply chain resilience. The proposed collaborative approach is crucial to preventing waste, ensuring sustainability, and fostering a more efficient and responsive supply chain system.

ii Data-driven decision making:

Retailers should adopt a strategic approach integrating data-driven decision making to prevent supply chain waste and enhance overall resilience. McDougall et al. [30] emphasize the significance of this approach, as it enables the identification of waste hotspots, the detection of performance levels, the setting of realistic targets, and the understanding of customer behavior. Small traders in the US, facing challenges in technology adoption and productivity [69], experienced a significant 38.8% delay in supply chain processes due to COVID-19, according to Zippa (2022) [70]. To address this issue, collaborative efforts from governments and industry should be directed towards upgrading the technology used by these small traders. This collective initiative can effectively minimize delays, mitigate waste, and contribute to an overall reduction in supply chain inefficiencies. Furthermore, Sacco [71] suggests that small businesses can leverage data-driven decision-making to identify key sales, profit, and inventory metrics within supply chain processes, even when using automated spreadsheets. By doing so, businesses can strategically allocate resources, realize tangible cost savings and implement preventive measures, thereby minimizing waste and optimizing operational efficiency.

iii Reverse logistics and product lifecycle management:

Retailers need to set up efficient processes for handling the return of products and recycling. They need to ensure that products flow from the point of return to the right destination for repair, recycling, or resale. Products need to be properly accessed, sorted, and disposed of [49].

iv Consumer education and engagement:

Additionally, retailers can make a significant impact by educating consumers about waste reduction and promoting sustainable consumption habits. When there is effective consumer education and engagement, customers can be encouraged to make more sustainable choices.

v Sustainable sourcing:

Retailers should make sustainable sourcing practices a priority. They should always work with suppliers who adhere to environmental standards and promote eco-friendly materials and production methods. This should also be applied in the packaging of products, as recyclable or biodegradable materials could be used to reduce waste [10].

vi Supply Chain Resilience and Risk Mitigation:

Retailers should ensure improvement in their supply chain resilience. Supply chain resilience is incredibly important. A resilient supply chain is crucial as it helps minimize the impact of disruptions. This involves building flexibility, redundancy, and agility into the supply chain to minimize the impact of disruptions [8]. Retailers could adopt strategies such as diversifying suppliers, establishing relationships with vendors, and implementing some backup plans. With alternative sourcing options, backup plans, and robust risk management strategies, retailers can continue to meet customer demands even in challenging times [72]. It also enhances operational efficiency. Businesses can optimize their supply chain processes by identifying vulnerabilities and implementing measures to mitigate risks. It will also help to promote customer satisfaction by having a resilient supply chain; retailers can maintain reliable product availability, minimize delays, and provide timely customer updates [73].

In ensuring sustainability in supply chain management, risk mitigation is pertinent. Retailers can employ several risk mitigation techniques to enhance their resilience [74].

These include diversifying suppliers, building strong relationships with suppliers, implementing supply chain visibility, maintaining safety stock, developing contingency plans and risk assessments, and enhancing communication with suppliers, customers and other stakeholders. It is pertinent for retailers to continuously evaluate and update their risk mitigation strategies to adapt to changing circumstances [75].

### 8. Limitations to the Study

The study findings were limited and specific to the retail industry in the United States. Thus, supply chain waste management findings specifically address retailers' challenges and might not be generalized to other business populations. The study was also limited due to the non-availability of primary data. The study findings were deduced solely with secondary data due to the limited timeframe, which restricted the ability to gather comprehensive primary data from specific respondents across the United States.

### 9. Further Research

The study has provided a functional model of supply chain waste reduction and control strategies for retailers. However, further studies could be carried out based on the gaps not filled by this study. Further studies that could be explored include the impact of technology on supply chain waste reduction and control among wholesalers and retailers (such as IoT or artificial intelligence) and an exploration into the adoption of circular economy principles such as product life extension, remanufacturing, or resource recovery for increased sustainability in the retail supply chain. Finally, future studies can develop a simulation model to find what-if scenarios to optimize this waste problem.

### 10. Conclusions

This paper closely monitored a case of Walmart's strategic initiatives targeting the reduction of supply chain waste and suggesting effective strategies for better outcomes. The noteworthy "American Lighthouses" project is centered on fortifying the 'Made in the US' initiative, emphasizing promoting items manufactured, grown, or assembled in the US. This initiative contributes to job growth in the American market and strives to reduce CO<sub>2</sub> emissions by 100 million metric tons through proximity sourcing to customers [76]. Also, the introduction of "Project Gigaton" in 2017 underscores Walmart's commitment to engaging suppliers in climate action [77]. Aligned with the Paris Agreement's objective of limiting global warming to below two degrees Celsius, Project Gigaton aspires to avoid or reduce 1 billion metric tons of greenhouse gases in the global supply chain by 2030. The project advocates for suppliers and companies to align with this target, encouraging them to implement critical measures for reducing gas emissions across six key areas: Energy, Waste, Packaging, Nature, Transportation, and Product Use or Design. This success story from Walmart is a compelling example for the broader business community. Encouraging other companies to emulate such sustainable projects contributes to environmental and social responsibility and strengthens their position in a rapidly evolving market. By adopting similar initiatives, companies can demonstrate their commitment to sustainable practices in the chains, enhance their brand image, and contribute positively to global environmental goals.

The paper highlights strategies for reducing supply chain waste in the US retail industry, identifying it as a significant challenge leading to increased costs, environmental concerns, and diminished profits. Various forms of supply chain waste, including overstocking, understocking, spoilage, excess packaging, and transportation inefficiencies, were identified, stemming from factors such as demand variability, forecasting errors, over-ordering, and inefficient logistics. Lean principles were proposed as a solution to help retailers achieve more with fewer resources by streamlining processes, optimizing resource utilization, and enhancing overall productivity. The paper emphasizes the importance of actively focusing on optimizing supply chains to reduce waste and promote sustainability. This requires a comprehensive approach involving collaboration, innovation, and contin-

uous improvement. The suggested key areas for achieving efficient supply chain waste reduction encompass effective inventory management and optimization, sustainable packaging and eco-friendly practices, technology and automation, supply chain resilience and risk mitigation, reverse logistics and returns management, transportation efficiency, supplier collaboration and vendor management, sustainability reporting and environmental impact, and data-driven decision making. Such a holistic approach benefits the environment and enables retailers to conserve resources and enhance their financial performance.

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