Sustainable Practices in Managing Food Loss and Waste: An Empirical Study of the UK Food Supply Chain.

By

Oluwole Emmanuel Olabode

Essex Business School,

University of Essex

A Thesis Submitted to University of Essex for the Degree of

Doctor of Philosophy

2025

Abstract:

UK retail firms generate approximately 270,000 tonnes of food waste annually, illustrating a significant gap in research regarding their role in mitigating global Food Loss and Waste (FLW). With one-third of all human food discarded globally, this systemic failure severely impacts environmental sustainability, food security, and climate change. Addressing these complex consequences requires a multidimensional framework that integrates logistics, packaging, and management practices, shifting away from traditional, siloed approaches. Effective operational and inventory management not only reduces waste but also provides substantial cost savings and environmental benefits.

Consequently, this study examines sustainable management practices across the food supply chains of UK-based retail firms. Grounded in the Natural Resource-Based View (NRBV) framework, the research investigates how incorporating sustainability into core strategies builds environmental capabilities that drive a sustained competitive advantage. The methodology utilized a systematic literature review followed by 32 semi-structured interviews across five major UK food retailers, conducting in-case and cross-case evaluations to assess pollution prevention practices alongside operational performance.

The findings reveal that systemic FLW will remain a chronic issue without fundamental shifts in internal policies governing inventory, back-orders, and facility layouts. Successful reduction depends on transparent collaboration with suppliers and consumers, strategic eco-labelling to mitigate risks, environmentally friendly packaging, and optimized logistics. However, progress is hindered by inconsistent waste reviews, reliance on speculative forecasting, immediate financial pressures, and cultures of overproduction, highlighting a critical need for supportive government regulations.

Theoretically, this study expands the NRBV by demonstrating how high logistics costs inflate FLW and complicate inventory optimization, proving that firms' ability to develop environmentally sustainable capabilities which include pollution prevention and product stewardship are essential for minimizing surpluses. Practically, it offers a roadmap for UK practitioners to enhance sustainability via biodegradable packaging and partnerships with food charities, urging retailers to embrace innovation to drastically reduce their waste footprint.

Keywords: Sustainability; Food loss and waste; Sustainable practices; Food supply chain; NRBV.

Acknowledgements

I am profoundly indebted and eternally grateful to both my esteemed supervisors, Professor Niraj Kumar and Debashree De, for their truly invaluable guidance, enthusiastic encouragement, and unwavering, continuous support throughout my doctoral journey. It has been a deep and enduring privilege to work alongside such brilliant and insightful scholars, for whom I hold the utmost respect, during the past few years of my rigorous academic endeavours here at the University of Essex. Their consistent inspiration, thoughtful mentorship, and profound intellectual contributions have been a beacon, fundamentally shaping my growth and ultimately transforming me into an independent researcher. This thesis, a culmination of significant effort, simply could not have been completed without their astute guidance, delicate yet firm supervision, and sincere, consistent devotion to my progress.

My sincere appreciation also extends to the Business School of the University of Essex for generously providing the exceptional opportunity to pursue my PhD program within such a supportive academic environment. I would also like to add a heartfelt note of thanks to Dr. Wenjuan Zeng for her consistently constructive guidance and insightful feedback during our annual review meetings.

My warmest and deepest thanks are reserved for my lovely wife, Mrs. Funmilayo Olabode, whose endless support, unwavering belief, and constant prayers have been my bedrock since the day we married. Words genuinely fail to express my immense appreciation and gratitude to this jewel of inestimable value, who was always steadfastly there for me, navigating both the joyous good times and the most challenging periods with unwavering strength and love. My gratitude further extends to my wonderful children, Ayomide, Mobolaji, and Boluwatife, for their continuous support, understanding, and heartwarming words of encouragement. This thesis is lovingly dedicated to them, and to anyone for whom its message resonates.

List of Publications

The following publications have resulted directly from the work in this thesis at the time of submission.

1. Olabode, O., Kumar, N., De, D., (2025). Food loss and waste management in the retail food supply chain: Methods and framework to achieve environmental sustainability. Journal of Environmental Management. Vol. 387, July 2025, 125718. https://doi.org/10.1016/j.jenvman.2025.125718
2. Olabode, O., Kumar, N., De, D., (2025). Understanding the Environmental Impact of Inventory, Backorder Management and Flexible Facilities Layout of the UK Food Supply Chain. Business Strategy and the Environment. Under Review.
3. Olabode, O., Kumar, N., De, D., (2025). Understanding the Impact of Packaging, Logistical Efficiency and Food Alternative Uses on FLW in the UK Food Retail Firms Supply Chain Management. Will be submitting to Journal of Environmental Management.

Table of Contents

References

Appendix

List of Figures

List of Tables

List of Abbreviations

BOR – Backorder Rate
EDEI – Ecosystem Dynamics and Environmental Impact
FAO – Food and Agriculture Organization (United Nations)
FL – Food Loss
FLW – Food Loss and Waste
FSC – Food Supply Chain
FW – Food Waste
GFM – Greenhouse Facilities Management
LME – Logistical Management and Efficiency
NRBV – Natural Resource-Based View
SC – Supply Chain
SCM – Supply Chain Management
SKU – Stock Keeping Unit
SLR – Systematic Literature Review
SP – Sustainable Practices
WRAP – Waste and Resources Action Programme

Chapter 1 - Introduction

This introductory chapter presents a comprehensive overview of the thesis, establishing context and highlighting the relevance of the research topic. It explains the project's significance by addressing key gaps and limitations in the current literature. The chapter clearly defines the central problem and the specific research questions guiding the study. Furthermore, it details the precise objectives and expected outcomes, providing a brief background to the overall thesis structure.

1.1 Research Background

Food loss and waste (FLW) defined as a decrease in food quantity or quality throughout the supply chain, stands as a critical global challenge. The FAO (2019) differentiates between food loss, occurring in the earlier stages from post-harvest to retail (including storage, transportation, processing, and importing), and food waste, which arises in the later stages, from retail to consumption. The sheer scale of this problem is alarming: approximately one-third of the world's food is disposed of annually. Globally, about 13% of food produced is lost between harvest and the supply chain, while 17% is wasted domestically, in food services, and within the supply chain (UNEP, 2022). Specifically, within the retail food supply chain, around 30% of global food production becomes FLW across various stages such as production, handling, processing, distribution, and consumption (Varese *et al.*, 2022). The magnitude of this issue is starkly evident in the UK, where retail firms alone generate approximately 270,000 tonnes of waste annually (Malik *et al.*, 2024).

The multifaceted causes of FLW are pervasive throughout the supply chain. Despite global technological advances, managing perishable products remains a significant challenge in food retail sector (Kumar *et al.*, 2020) and agri-food (Weerabahu *et al.*, 2022). logistical drivers are crucial for Food Loss and Waste (FLW). Inventory management, backorders, and facility layout are central to minimizing FLW by optimizing product freshness and efficiency. Similarly, effective packaging, logistics, and management practices are vital as they directly influence the entire supply chain's ability to reduce waste, ensure safe delivery, and enhance customer satisfaction. For instant, without proper packaging, food is highly susceptible to damage, spoilage, and subsequent waste. Inefficient logistics and inadequate warehousing lead to increased spoilage during distribution, generating significant losses. Furthermore, inappropriate management of inventory, backorder and facilities layout not aligned with waste reduction efforts exacerbate environmental degradation.

Reducing FLW presents a significant opportunity for both public authorities and the private sector to adopt proactive actions and foster innovation. FLW directly threatens sustainable development, impacting food security, waste management, and climate change, while incurring high socioeconomic costs (Carter *et al.*, 2022). The moral implications are also profound, considering that 12% of the global population suffers from hunger (Lohnes and Wilson, 2010). Despite ongoing efforts, FLW remains persistently high, with nearly half of all root crops, vegetables, and fruits wasted worldwide (Gustavsson *et al.*, 2011). Therefore, studies

addressing FLW is paramount for a sustainable future, necessitating continued research and concerted action across the food supply chain.

Moreover, food safety, critical for public health, is directly linked to food freshness (Kucha and Ngadi, 2020; Baba and Esfandiari, 2023). Innovations like chemometrics (the science of applying mathematical and statistical methods to chemical measurements, especially those from dynamic processes, to extract meaningful information and relate it to the state of the chemical system) enable precise assessment and real-time freshness monitoring (Zhang *et al.*, 2024). Reducing food waste is vital for environmental sustainability and improved nutrition. The Waste and Resources Action Program (WRAP) highlights that investing in food loss reduction enhances food security and sustainability. Economically, every dollar invested in FLW reduction can yield up to $14 in operational savings (Aramyan *et al.*, 2021), significantly improving a firm's brand reputation and customer loyalty (Garcia-Garcia *et al.*, 2019).

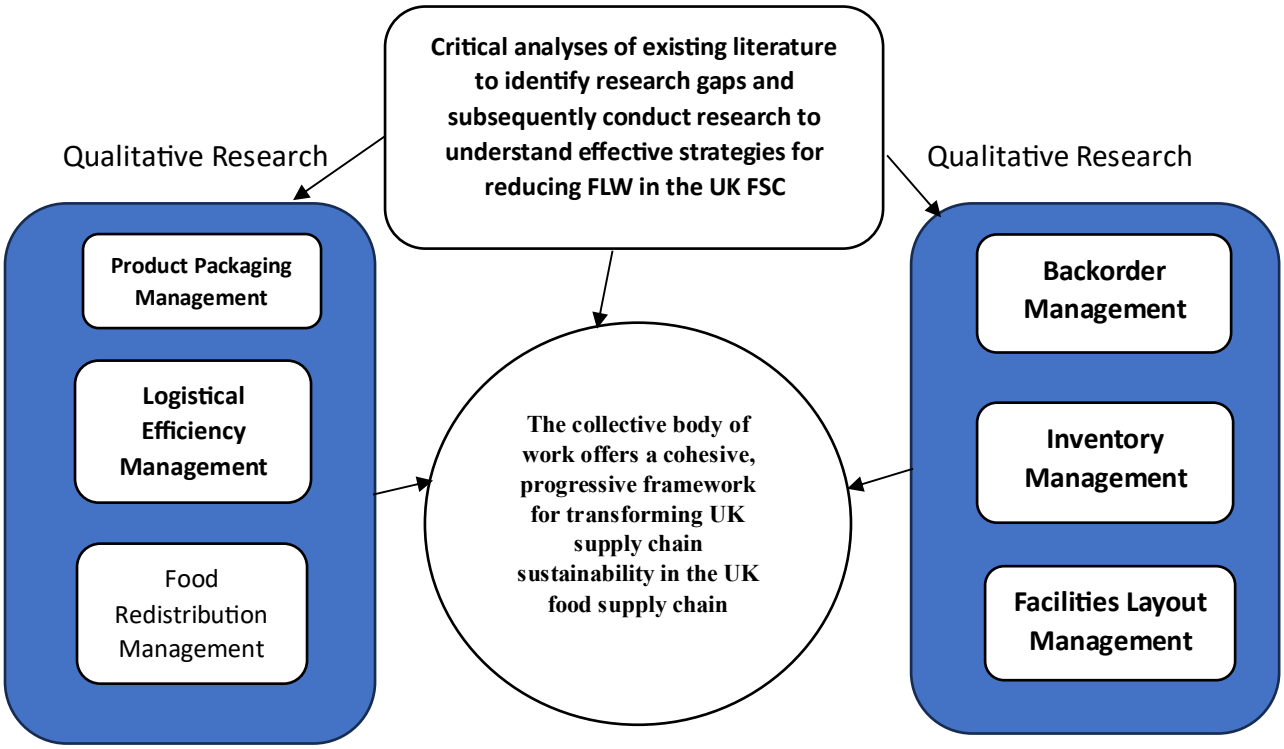

Figure 1 The Research Cohesive Structure. (Designed by Researcher)

The thesis aims to critically analyse existing literature and conducts empirical research to identify effective food loss and waste (FLW) reduction strategies across the UK food supply chain. This aim is holistically achieved through three interconnected research papers as shown in the cohesive structure in Figure 1 above. Paper One (Chapter 2) utilizes a systematic literature review (SLR) to establish a structured, transparent foundation, deliberately steering the qualitative phase away from saturated topics and toward under-researched areas requiring

urgent attention and further studies. Consequently, the distinct research gaps exposed by this baseline review directly formulate the targeted research questions addressed in Paper Two (Chapter Three) which are treated as food product protection and sustainability cost saving centers, and also in Paper Three (Chapter Four) which focuses on storage costs and demand forecasting. By bridging these empirical gaps, the collective body of work offers a cohesive, progressive framework for transforming UK supply chain sustainability.

1.2 Significance of this Research

Supermarkets are major food waste contributors primarily because their purchasing and inventory miscalculations lead directly to significant excess stock and spoilage. (Filimonau and Gherbin, 2017; Teller *et al.*, 2018). While existing literature reviews offer a crucial foundation (Campbell and Feldpausch, 2022), several limitations persist. Previous research often exhibits an imbalanced focus on customer responsibility for food waste, overlooking the crucial roles of other supply chain stakeholders in the UK. Bhattacharya and Fayezi, (2021) emphasize that tackling Food Loss and Waste (FLW) requires a collaborative and coordinated effort among all stakeholders in the food supply chain. The complex and multi-faceted causes of FLW cannot be solved by a single entity making it crucial to examine and foster cooperation among different players. Secondly, many research studies like supplier relationship management and risk assessment in sourcing adopt a narrow, singular viewpoint, concentrating on specific points within the supply chain (Malacina and Teplov, 2022). This approach fails to capture the complexity of FLW, which cannot be attributed to a single factor. Consequently, a limited perspective is insufficient for developing comprehensive FLW reduction strategies. Finally, some studies lack transparency and thoroughness, potentially introducing researcher bias when interpreting existing literature (Tranfield *et al.*, 2003).

Therefore, more comprehensive research is essential to adequately address FLW across the entire supply chain (Chaboud and Daviron, 2017). A review of previous literatures aims to overcome these limitations by focusing on waste reduction throughout the supply chain, highlighting the importance of technologies, innovative solutions, and effective management practices. Furthermore, reducing waste provides significant environmental, social, and economic benefits. Previous research on food supply chains in the UK has significant limitations regarding the reduction of food loss and waste (FLW) in major retail firms. Specifically, there have been limited studies on how packaging strategies influence FLW in the firms operating in the UK food retail sector (Lindh *et al.*, 2016). Additionally, despite the recognized role of a sustainable supply chain in improving competitiveness, there's little

evidence on the FLW caused by logistical efficiency drivers like technology, material handling, stacking of food products, and performance targets (Priefer *et al.*, 2016; Pietzsch *et al.*, 2017). Furthermore, for food retailers, research is scarce on how sustainable management practices, particularly food alternative use, can ensure both FLW reduction and enhanced operational performance (Bamber, 2019). Also, Existing studies have examined the impact of Supply Chain Management (SCM) on sustainable inventory practices (Rajabion *et al.*, 2019; Bhatia and Gangwani, 2021; Beske *et al.*, 2022). However, research on food loss and waste (FLW) resulting from inventory strategies in major UK retail food supply chains remains limited (Yang *et al.*, 2023; Jeswani *et al.*, 2021; Rao, 2020; Mastos and Gotzamani, 2022). Minimal attention has been devoted to back-order rate issues, such as transportation delays, unpredictable demand, unreliable suppliers, inadequate safety stock, and excessive lead times in the reduction of FLW (Rodger, 2014; Hofmann *et al.*, 2014; Kumar *et al.*, 2020; Madarász *et al.*, 2023).

While prior studies suggest effective supply chain management can enhance sustainability in operations (Shi *et al.*, 2018), current literature has not sufficiently addressed how facility layout, including the arrangement of equipment, technology, machines, and workers, impacts the food supply chain. This results in unclear explanations of its impact on FLW and operational performance (Perez-Gosende *et al.*, 2021; Pourvaziri *et al.*, 2021). Although many studies have previously highlighted these gaps in operational and management strategies that exacerbate FLW, this study demonstrates that effective inventory management, proper backorder handling, and flexible layout design are essential for reducing food loss and waste. By adopting practices such as efficient inventory control, optimized warehouse layouts, and improved demand forecasting, food retailers can significantly mitigate food waste and enhance sustainability across their operations. This approach provides a clearer understanding of the interdependencies between these factors and their collective impact on reducing FLW.

This thesis aims to address these limitations by examining sustainable FLW reduction in the supply chain of major UK food retail companies. It extends its scope to critically analyse the role of product packaging, logistical efficiency, food alternative use, inventory, backorder management and facilities layout adopted by the firms operating in the food retail sector, given their substantial environmental impact.

This research makes several significant contributions:

1. Empirical Contribution: By investigating the practices and challenges faced by retailers operating in the food retail sector in the UK, this research provides and offers valuable empirical findings that advance the field about and beyond what was previously known about the complexities of the FLW management in the food retail sector.
2. The research established that organizational inherent resistance to reducing FLW stems from an unwillingness to integrate sustainable practices, driven by overriding financial considerations and a systemic reliance on overproduction and surplus within current supply chain operations. This reinforces the NRBV principle that pollution prevention initiatives, linked to continuous logistical innovation (Vachon and Klassen, 2008; Golicic and Smith, 2013) and process innovation (Aragon-Correa and Sharma, 2003 is vital to FLW reduction and managerial change in policy and focus is very important
3. This research offers a significant theoretical contribution by identifying the specific operational mechanisms required to bridge the gap between high-level sustainability goals and practical supply chain execution. By demonstrating that stringent environmental policies, quarterly waste audits, and a strategic shift from speculative forecasting to demand-driven inventory management (based on actual sales trends) directly mitigating Food Loss and Waste (FLW), this study provides much-needed granularity to the Natural Resource-Based View (NRBV). By empirically validating these specific management interventions, this paper transforms abstract resource-based concepts into actionable, evidence-based strategies for the food retail sector.
4. This research shows that active cooperation with both suppliers and customers is vital for promoting environmentally friendly packaging thereby making the food products secure and hygienic. This collaboration facilitates the use of robust, non-hazardous and biodegradable materials, thereby reducing the overall environmental risk. This is in support of the NRBV product stewardship principle (Younis et al., 2016; Zaid et al., 2018; Zhu, Sarkis & Lai, 2013) as it minimises the product environmental impact throughout its lifecycle.
5. It supports sustainable development as it is directly linked to united nation development goals including responsible production and environmentally friendly practices within the FSC and it provides significant economic benefits by reducing costs and increasing food security.

By exploring the practices, challenges, and opportunities for improvement in FLW management amongst the retailers operating in the food retail sector, this research provides

valuable insights and recommendations for promoting sustainability and reducing FLW in the FSC.

1.3 Research Gaps

Despite the clear environmental, social, and economic imperatives to reduce FLW, and ongoing efforts to address it, the problem remains pervasive, particularly within complex retail food supply chains due to the vast number of interconnected components including types of perishable food, demanding logistics for freshness, and global sourcing. It faces challenges such as high FLW, increasing consumer demand, low margins for retailers, and the ever-present risk of spoilage and contamination.

This research introduces a new framework designed to holistically manage food waste within the UK retail sector, addressing a significant void left by previous studies. (Morashti et al., 2022; Ada et al., 2022). As identified through the rigorous literature review in paper 1, existing scholarship has failed to produce a comprehensive analysis of the root causes of Food Loss and Waste (FLW) specifically within the UK context. A primary oversight has been the insufficient attention paid to diverse packaging functions; yet, these are critical for sustainable food product and package design. . Research indicates that different perishable food products encounter entirely unique waste challenges (Humbert et al., 2009; Lindh et al., 2016; Verghese et al., 2015). Consequently, integrating these product-specific packaging requirements into the development process is essential for mitigating FLW throughout the Food Supply Chain (FSC).

In addition, further studies are needed to explicitly investigate the relationship between food waste and the functions of packaging along the FSC (Lindh *et al.,* 2022; Wikström *et al.,* 2019). The impact of food packaging and its functional role in reducing FLW is important and requires further studies. Similarly, despite the recognized benefits of a sustainable supply chain, evidence remains scarce regarding FLW caused by logistical inefficiencies, including material handling, stacking, and meeting expected targets (Priefer *et al.,* 2016; Williams *et al.,* 2020). These areas require more focused investigation to develop effective reduction strategies.

Furthermore, research supporting how sustainable management practices, like food alternative uses, contribute to FLW reduction and improved operational performance in food retail is scarce (Bamber, 2019). Studies on inventory strategies in UK retail food supply chains and their impact on FLW also remain limited (Yang *et al.,* 2023; Jeswani *et al.,* 2021).

Furthermore, the study highlights that financial constraints often dictate firm-level decisions regarding infrastructure, such as investments in advanced facilities for food product stacking,

which directly correlates to waste generation (Beausang et al., 2017). Beyond hardware, the integration of health and safety protocols into logistics training is shown to enhance management practices that influence FLW outcomes (Derqui et al., 2018). The research also identifies worker productivity and the pressure to meet aggressive targets as hidden drivers of waste, necessitating deeper exploration into their environmental implications. This work bridges the gap by holistically examining neglected management practices including inventory strategies, back-order rates, facility layout, and supplier overproduction which have historically been analysed in isolation rather than as an integrated system (Silvestri et al., 2021).

While past studies have examined the impact of Supply Chain Management (SCM) on sustainable inventory practices (Rajabion *et al.,* 2019; Bhatia and Gangwani, 2021; Beske et al., 2022), research on food loss and waste (FLW) specifically caused by inventory strategies in major UK retail food supply chains is limited (Yang *et al.,* 2023; Jeswani *et al.,* 2021; Rao, 2020; Mastos and Gotzamani, 2022). This gap highlights the need for more focused investigation into how inventory decisions in the UK retail sector contribute to FLW.

Past research has placed minimal emphasis on how back-order rate issues contribute to FLW. Factors such as, unpredictable demand, unreliable suppliers, inadequate safety stock, and excessive lead times have not been adequately explored in the context of FLW reduction (Rodger, 2014; Hofmann *et al.,* 2014; Kumar *et al.,* 2020; Madarász *et al.,* 2022).

While some studies suggest effective Supply Chain Management can enhance operational sustainability (Shi *et al.,* 2018; Jia *et al.,* 2018), current literature insufficiently addresses how facility layout influences the food supply chain. This includes the arrangement of equipment, technology, machines, and workers, leading to unclear explanations of its specific impact on food loss and waste (FLW) and overall operational performance (Jackson and Drougas, 2002; Russell and Taylor, 2022).

This thesis demonstrates that effective inventory management, backorder handling, and flexible layout design are crucial for reducing food loss and waste (FLW). While past studies highlighted operational gaps, this research shows how practices like efficient inventory control, optimized warehouse layouts, and improved demand forecasting can significantly mitigate food waste and enhance sustainability across retail operations.

This study primarily focusses on examining the impact of packaging, logistical efficiency strategies, food alternative uses, inventory management, back-order rate issues, and facility layout management on FLW and operational performance of retail supply chain.

1.4 Research Aim and Objectives

This thesis aims to critically analyse existing literature and subsequently conduct research to understand effective strategies for reducing FLW in the UK food supply chain. Specifically, the objectives are:

1. To conduct systematic literature review on Food loss and waste management in the retail food supply chain. Its methods and framework to achieve environmental sustainability.
2. To examine the impact of food packaging strategies on FLW generation and explore effective reduction methods.
3. To analyse how logistical efficiency strategies, including products handling, stacking of food products, and expected targets, impact FLW.
4. To investigate the extent to which management practices, such as facility layout, inventory strategy, back-order rate management, and food alternative uses, could solve or adversely affect FLW and operational performance.

This aim is holistically achieved through three interconnected research papers. The first research objective is comprehensively addressed in paper one (Chapter 2) of this thesis, which presents a systematic literature review utilizing the Scopus and Web of Science databases. Subsequently, the second and third objectives are investigated within paper two (Chapter 3). The fourth aim is explored across both papers two and three. Specifically, food alternative uses management is analysed in paper two, while inventory, back-order, and facility layout management are detailed in paper three (Chapter 4). These latter components were evaluated through rigorous qualitative research involving five prominent firms within the UK food retail sector.

1.5 Research Questions

To achieve the key aim of this study, four key research questions are framed as follows:

1. How do sustainable and circular supply chain practices, specifically within logistics, mitigate the generation of food loss and waste?

2. How do different types of packaging strategies of food products affect FLW generation in the food supply chain?
3. How does logistical efficiency (e.g., products handling, stacking of food products, and expected targets) impact the intensity of FLW in the food supply chain?
4. How do sustainable management practices (e.g., food alternative uses, inventory management, back-order rate issues, and facility layout arrangement) solve or adversely affect FLW issues in the supply chain?

The structural alignment of this thesis maps specific research questions to distinct papers across chronological chapters. The first research question is comprehensively addressed in paper one, located within chapter two. Subsequently, the second and third research questions are answered in paper two, which comprises chapter three. Finally, the investigation culminates with the fourth research question being fully resolved in paper three, situated in chapter four of this thesis.

The research aim and objectives above align with the research questions across the three papers. This aim is holistically achieved through three interconnected research papers. Paper One utilizes a systematic literature review (SLR) to establish a structured, transparent foundation, deliberately steering the qualitative phase away from saturated topics and toward under-researched areas requiring urgent attention. Consequently, the distinct research gaps exposed by this baseline review directly formulate the targeted research questions addressed in Paper Two (Chapter Three) and Paper Three (Chapter Four). By bridging these empirical gaps, the collective body of work offers a cohesive, progressive framework for transforming UK supply chain sustainability.

The first research objective is comprehensively addressed in the first paper in chapter 2 of this thesis, which presents a systematic literature review utilizing the Scopus and Web of Science databases. Subsequently, the second and third objective are investigated within paper two in chapter 3. The chapter addresses how food packaging strategies and logistical efficiencies such as product handling, stacking methods, and target-setting impact FLW generation and mitigation. The fourth objective is explored across both papers two and three in chapters three and four. The exploration of how facility layout, inventory strategies, and back-order rate

management influence FLW and broader operational performance is integrated into Chapter four (Paper Three). Meanwhile, the examination of alternative food uses as a strategic solution to FLW is comprehensively addressed in Chapter three (Paper Two). Together, these objectives form a synchronized investigation into supply chain interventions.

1.6 Rationale of Paper 2 and 3.

Food loss and waste (FLW) within the retail supply chain represents a systemic failure with devastating economic, social, and environmental consequences, necessitating the development of robust, innovative frameworks. Research on product packaging, logistical efficiency and food alternative uses as addressed in paper 2 focuses on the micro-level, physical preservation of perishable food and logistical management, whereas, the research on inventory, backorder and facilities layout management as addressed in paper 3 of chapter 4 of the thesis focuses on the macro-level, operational flow of goods which includes, stock rotation, demand forecasting and supply chain capacity management, It is expedient to note that all these are crucial for management of FLW but they addressed fundamentally different root causes in the supply chain. By synthesizing these multifaceted elements, the framework provides a rigorous, all-encompassing approach to mitigating waste and enhancing operational performance throughout the entire supply chain.

Also, despite the close relationship in fulfilment of management goals, the separate investigation allows firms to optimise for different, often conflicting goals. For example, packaging and logistical efficiency are often treated as marketing protection and sustainability cost saving centers respectively, while inventory and backorder management focuses on financial velocity, storage costs and demand forecasting which demands investigating these deferent aspects separately. Furthermore, separating them allow for more detailed analysis for practitioners and stakeholders. For example, in a publication compiled by Packaging drive, packaging materials could represent 15 to 25% of total cost of food product (Coelho et al., 2020), yet poor management create different falling problems like emergency rush orders which impact logistical efficiency compared to inventory and backorder management driven by holding costs, capital tie-up and obsolescence.

1.7 The Theoretical Underpinning

This paper addresses these logistical challenges through the lens of the Natural Resource-Based View (NRBV) (Hart, 1995), a framework incorporating corporate social responsibility (CSR), entrepreneurship, and environmental commitment (Johnsen *et al.,* 2014). CSR aligns with pollution prevention, entrepreneurship with product stewardship, and environmental commitment with sustainable development, including clean technologies (Menguc and Ozanne, 2005).

It is not just Shi *et al.,* (2012) who argue for inherent links between the Natural Resource-Based View (NRBV) and the Food Supply Chain (FSC), but rather an implicit reliance on supply chain management (SCM) is evident throughout established NRBV literature (e.g., Hart, 1995; Hart and Dowell, 2011; Johnsen et al., 2014; Matopoulos *et al.,* 2014). This connection is logical, stemming from the argument that sustainability falls within the jurisdiction of the supply chain (Faisal, 2010), primarily because it is widely accepted that achieving sustainability depends on a collaborative contribution from every player within the chain (Seuring and Müller, 2008; Abbasi and Nilsson, 2012; Giminez and Tachizawa, 2012; Miemczyk *et al.,* 2012; Jensen *et al.,* 2013). More specifically, a core tenet of this perspective is that SCM should be extended to support the protection and conservation of natural resources (Matopoulos *et al.,* 2014; Lau et al., 2018). The same principle applies to competitiveness, which is not derived from a firm operating in isolation but rather from the collective strength of the entire FSC (Markley and Davis, 2007; Prajogo and Sohal, 2013). Thus, the links between the NRBV and SCM emerge with compelling logic.

Of particular interest of this research is the growing field of Sustainable Supply Chain Management (SSCM). As a result of its focused pursuit of both competitiveness and sustainability (Faisal, 2010; Ashby *et al.,* 2012; Walker and Jones, 2012; Golicic and Smith, 2013; Prajogo and Sohal, 2013; Wu, 2013), SSCM bears considerable parallels with the NRBV. Interestingly, it also holds profound connections with broader concepts such as corporate social responsibility and the triple-bottom-line framework (Boken *et al.,* 2013; Berger-Walliser and Shrivasta, 2015). In addition to benefiting from extensive research surrounding its successful application in practice (Abbasi and Nilsson, 2012; Giminez and Tachizawa, 2012; Miemczyk *et al.,* 2012; Johnsen et al., 2014; Fahimnia *et al.,* 2015), SSCM is also argued to benefit from widespread industry acceptance (Johnsen *et al.,* 2014). Linking the NRBV with SSCM is therefore of great value: the latter offers practical applicability and a defined framework for the former, while both benefit from mutual refinement.

NRBV theory has been successfully applied in numerous environmental and sustainability studies (Ashby *et al.,* 2012; Pagel and Shevchenko, 2014; Sharma & Aragon-Correa, 2003). It is widely accepted that the NRBV provides a foundational resolution for firms, encouraging them to acknowledge that sustainability represents one of the most prominent business opportunities of the 21st century (Ashby *et al.,* 2012; Pagel and Shevchenko, 2014). From a resource-based theory perspective, a firm's resource array can be proactively realized through diverse sustainability approaches that support Food Loss and Waste (FLW) management (McWilliams & Siegel, 2001; Ashby *et al.,* 2012; Pagel and Shevchenko, 2014). The consistent theme of innovation emerges as a crucial element in both NRBV theory and sustainable FLW management (Hart and Dowell, 2011; Yam *et al.,* 2010).

The NRBV is the foundation to this study because Corporate Social Responsibility (CSR) corresponds with pollution prevention and product stewardship. Environmental commitment is consistent with sustainable development. This study will contribute in expanding the theory in context of FSC.

This study contributes to this NRBV by shifting the focus from simple waste-reduction metrics to developing strategic corporate capabilities that proactively prevent FLW. This framework transitions food firms from reactive disposal to proactive practices, leveraging data mining, demand forecasting, and real-time inventory tracking to avoid surplus. Additionally, it drives innovation in sustainable packaging to extend product shelf life. Ultimately, this study aligns supply chain food distribution strategies with ecological limits, embedding environmental sustainability into core operational competitiveness in line with NRBV.

1.8 Methodology

This research employs an inductive approach, starting with observations and data collection to identify patterns and relationships,

which in turn develop general conclusion. This approach is particularly appropriate due to the limited existing knowledge on using Natural Resource-Based View (NRBV) resources to explore capabilities like packaging, logistical efficiency, food alternative uses, "inventory and back-order management", and facility layout in the context of minimizing food loss and waste (FLW) (Vijayamohan, 2025).

1.8.1 **Justification for Systematic Literature Review (SLR).**

The decision to conduct a Systematic Literature Review (SLR) prior to engaging in primary qualitative research was a strategic methodological choice designed to provide a structured,

transparent, and comprehensive foundation for the study. Given the highly fragmented nature of existing Food Loss and Waste (FLW) research, an SLR ensures that subsequent qualitative inquiries such as the 32 semi-structured interviews conducted in this study are precisely targeted toward genuine, well-evidenced research gaps rather than merely duplicating established knowledge.

Within the complex ecosystem of the UK food retail supply chain, the SLR served as a critical mapping tool. It allowed for the identification of recurring themes, such as food waste-inducing factors including inadequate packaging, logistical inefficiencies, rigid inventory management, and inflexible facility layouts. By synthesizing these fragmented data points, the SLR prevented the qualitative phase from exploring saturated topics, instead pivoting the focus toward under-researched areas that require urgent empirical attention. This process moves beyond a traditional narrative review by employing an objective, replicable protocol that minimizes subjective bias through pre-defined inclusion and exclusion criteria (Chauhan et al., 2021).

Furthermore, the SLR addressed a significant limitation in current FLW literature: the prevalence of empirical studies that quantify waste without providing robust theoretical grounding. By systematically identifying which theories have been applied and which remain absent, the SLR strengthened the integration of the Natural Resource-Based View (NRBV) within this study. It provided the necessary theoretical justification to transition from "what" is occurring (current trends and gaps) to the "why" and "how" explored during the interviews. This alignment ensures that the research is not only rigorous but also theoretically defensible, acting as a solid ground for scholarly inquiry. (Francesco et al., 2023).

Ultimately, the SLR established a credible entry point into the global scholarly conversation, ensuring that the qualitative findings offer original insights into the strategic and operational nuances of food retail firms. By defining the landscape of established factors first, the study was better positioned to investigate the root causes of food loss from the unique perspectives of logistics service providers and retail managers (Francesco et al., 2023). This sequential approach ensures that the final framework for aligning operational performance with sustainability goals is both innovative and deeply rooted in the existing body of knowledge

1.8.2 Data Collection Context

The study utilizes a case study methodology (Patton, 2002; Yin, 2017) to provide an in-depth examination of how packaging, logistical efficiency, food alternative uses, inventory and back-order management, and facility layouts impact FLW across various supply chain stages. The methodology also explores the significant challenges of integrating these practices to enhance overall operational performance. To gather rich qualitative data, semi-structured interviews were conducted. This method was chosen for its balance between the structured nature of surveys and the flexibility of unstructured interviews, allowing for both an in-depth exploration of individual responses and a systematic comparison across participants (George, 2022).

A total of 32 semi-structured interviews were conducted with senior managers from five firms operating within the food supply chain. This sample included two supermarkets, their associated warehouses, and one supplier. The firms were strategically selected based on their shared experience with significant FLW, with sales revenues ranging from £800 million to £30 billion and employee counts between 200 and 1,200. The in-depth nature of these interviews enabled the exploration of tacit phenomena through a discursive data analysis process (Saunders *et al.,* 2012). Group discussions were also conducted with operatives from two of the food firms to specifically ascertain their views on the mechanisms and points of Food Loss and Waste generation within their respective organizations. This approach fostered an interactive engagement between the theoretical framework (NRBV) and real-life supply chain practices (Ackroyd, 2004), allowing researchers and interviewees to collaboratively co-create valuable information (Edwards et al., 2012).

The selection criteria for the case studies were specifically focused on firms that were most likely to experience significant FLW, ensuring the data collected would be highly relevant to the research questions. The research provided valuable insights into each firm's unique operations, the food products they handle, and the profiles of their customers and partners.

The interviewees were all management-level representatives. To ensure consistency and thoroughness, a structured procedure was developed as a practical guide for data collection. This procedure recommended a semi-structured interview format with no pre-defined time limits, allowing for the emergence of unexpected insights and providing flexibility to adapt to interviewee responses. Each interview lasted an average of 60 minutes and was conducted at the interviewee's chosen location within their company premises to ensure comfort and privacy. All interviews were audio recorded, and the researchers also observed and documented non-verbal cues and reactions.

1.8.3 Rationale for Employing Qualitative Approach.

The decision to prioritize semi-structured interviews over quantitative surveys was a strategic methodological choice designed to capture the deep, behavioural, and contextual motivations underlying waste generation nuances that traditional surveys frequently overlook. While quantitative surveys are effective for measuring the sheer volume of food waste, they often fail to explain the "why" and "how" behind its occurrence. Interviews, by contrast, facilitate a sophisticated exploration of the complex, habitual, and emotional drivers that dictate supply chain behaviour.

In the specific context of the UK food retail sector, interviews allowed the study to uncover underlying causes of food waste that are often difficult to quantify, such as a localized lack of technical knowledge regarding "best-before" dates or an ingrained fear of food poisoning among the operatives. When investigating under-researched areas of FLW, the open-ended nature of interviews enabled the collection of rich, detailed insights without the constraints of pre-set, static answers. This flexibility allowed for real-time adjustments and follow-up questions, which were vital for clarifying ambiguous responses and exploring unanticipated, yet highly valuable, thematic directions.

Furthermore, surveys in waste management research often suffer from social desirability bias, where participants underreport waste to avoid appearing inefficient or environmentally irresponsible. Interviews mitigate this by fostering a comfortable, conversational environment that reduces stigma, leading to more authentic data. This qualitative approach also allowed the researcher to interpret non-verbal cues such as tone and body language which provide critical information regarding the emotional aspects of food management.

By focusing on a select group of stakeholders, including managers and operatives from five specific retail firms, the study gained a "nuanced understanding of participants' thoughts, experiences, and perspectives" (Bryman, 2016). This qualitative lens was essential for examining the internal decision-making processes, challenges, and motivations regarding waste reduction strategies. Ultimately, the case study methodology provided the depth required to understand how firms navigate financial and operational pressures to implement sustainability policies, a level of detail that a large-scale survey could not achieve (Creswell & Poth, 2018).

1.8.4 Justification for Combining Group and Personal Interview Methods.

The main purpose of the group interviews conducted in this research is to leverage group dynamics, interaction, and brainstorming of the Operatives to generate rich, detailed data on perceptions feelings, and experiences. It explores why behind questions, allowing participants to spark new ideas, debate issues, and provide deeper insights. This was used alongside personal interview with senior Managers which was used to elicit in-depth, detailed and nuanced information about a participant's personal experiences. Perspectives, beliefs, and feelings regarding a specific phenomenon. This allows for the understanding of the why and how behind human behaviour by providing a private, flexible, and confidential setting.

Also, in this study, management quotes are prioritized as critical because they dictate strategic direction, operational efficiency, and organizational culture. Managers act as the organizational "cornerstone," influencing the variance in team engagement, which fundamentally impacts operational performance and staff retention. While operatives focus on task execution, management responses provide the strategic rationale, explaining how daily activities align with high-level objectives such as inventory optimization, facility layout design, and technology implementation which impact FLW. Furthermore, managers carry the responsibility for risk definition, decision-making, and setting safety standards; their ability to navigate these scenarios is vital for preventing costly errors or safety incidents. Their responses reveal the capacity to foster high-performing cultures and motivate teams, which directly correlates with reduced staff turnover and mitigated Food Loss and Waste (FLW). As the primary gatekeepers of resources, managers are responsible for securing budgets and developing the actionable plans necessary for operatives to succeed.

However, the "voice" of the operative through the group interview remains indispensable to this research. As the individuals directly handling food products, operatives provide unique, first-hand data regarding the physical integrity of packaging and the real-world logistical pressures that lead to waste. By synthesizing these strategic management insights with the practical, ground-level experiences of operatives, this study achieves a holistic understanding of the internal dynamics driving FLW within the food retail sector.

1.8.5 Details of Coding Protocol.

To uphold rigorous academic standards, the study utilized a systematic coding protocol to ensure transparency, validity, and reliability while minimizing bias (Williams and Moser, 2019). This foundational qualitative approach facilitates the transformation of dense, unstructured data into a coherent, theoretically grounded narrative. The methodology was executed through three interconnected phases: open coding for concept identification, axial coding for refining thematic categories and connections, and selective coding to integrate these findings into overarching, meaningful constructs as shown in Fig. 2 below.

First-Order Coding: In this initial generative phase or the first stage, the study engaged in a line-by-line analysis of the raw data to identify distinct concepts and emerging themes (Williams and Moser, 2019). This stage is critical for breaking down raw data which includes interviews transcripts into small, discrete parts to identify early concepts and themes. (Bogdan and Biklen, 2007). The aim is to remain entirely open to the data without trying to fit it into pre-existing theories.

Second-Order Coding: The second stage in this grounded theory employed involves a more analytical and systematic sifting of the data. Here, it involves connecting, grouping, and reassembling data together after initial open coding to reveal patterns, categories and subcategories. By aligning data and discovering hidden connections between the initial open codes, researchers formed "core codes" supported by robust empirical evidence (Strauss and Corbin, 1990). This phase acts as a bridge, organizing fragmented data into a hierarchical structure that reflects the complexity of the phenomenon under study.

Third-Order Coding: As the concluding stage of this study, selective coding required a higher level of abstraction and discretion. At this level, the study systematically selects one core category or central theme to integrate all other categories, creating a cohesive theoretical framework. (Flick, 2009). By refining the central narrative and selecting the most significant themes, the study was able to synthesize the findings into a unified theoretical framework, directly influencing the study's ultimate contributions to the research.

Ultimately, the final codebook contained 38 codes organized into comprehensive themes such as Effective Inventory Practices, Environmental Preferable Purchasing, Corporate Environmental Management, Complaints Reporting, Time Consideration, Reverse Logistics, Back-order Management, and Facilities Layout. This detailed coding process ensured a thorough analysis and categorization of the data, followed by a comparative analysis of findings across all cases (King, 2012; Tranfield, Denyer and Smart, 2003).

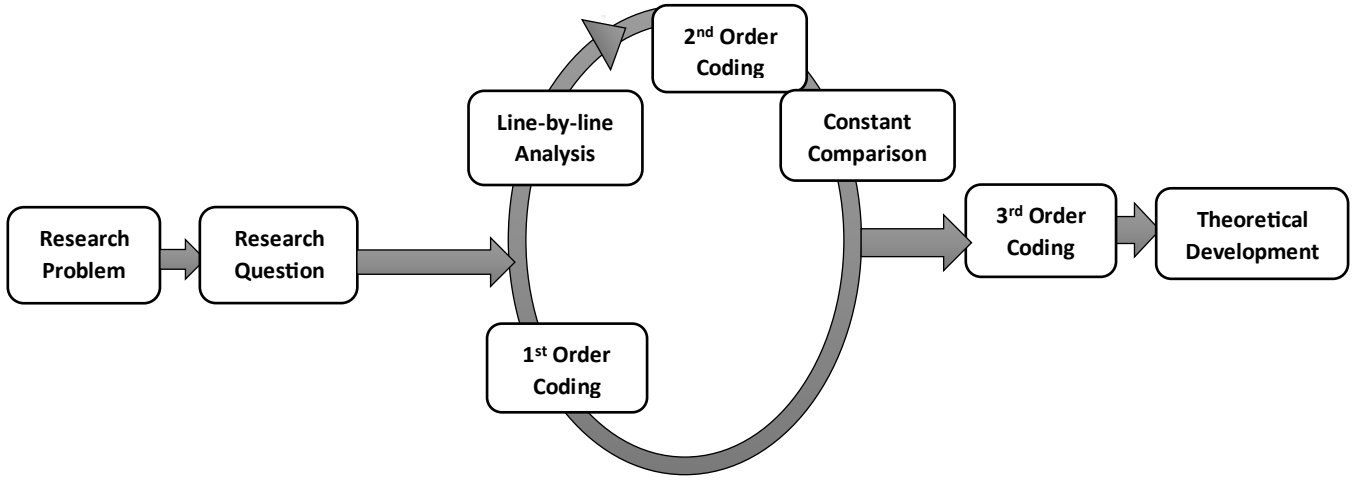

Figure 2: Manual Qualitative Data Coding (Adapted from Choi et al. 2018)

As illustrated and shown in Fig 2, the process is a deeply iterative. The study consistently moves back and forth between data collection and analysis, allowing emerging insights to refine subsequent inquiries, ensuring the analysis is rigorously rooted in real-world observations and empirical data.

1.8.6 Thematic Analysis.

This approach utilizes Microsoft Word to highlight, annotate, and reorganize data, combining manual interpretation with digital efficiency for rapid internal document searching. It also involves a meticulous, hands-on analysis of transcripts and field notes to identify emerging themes, balancing structural organization with deep qualitative immersion. It allows the study to interact with data in a tactile way that leads to deeper insights. The process includes:

Familiarisation: The study involves reading document on the screen to categorize text and write codes directly. This tactile approach involves sorting text snippets into thematic piles to visualize emerging relationships.

Generating Coding: Leveraging Microsoft Word to highlight, annotate, and reorganize data. This combines the benefits of manual interpretation with digital efficiency, enabling rapid internal document searching.

Developing Themes: The study ensures a rigorous process of comparing each new data point whether a line, paragraph, or incident against previously identified data. This iterative refinement ensures that codes and categories remain robust, consistent, and grounded in the evidence. It is a more analytical stage where the researcher group initial codes into broader categories or themes.

Reviewing Themes: The study rigorously evaluated the themes against coded extracts, iteratively merging, splitting, or discarding those with insufficient data to ensure the final thematic framework was both robust and empirically supported.

Defining Themes: The study formulated concise, distinct names for each theme, defining their core essence and drafting detailed descriptions to capture the specific scope and qualitative nuances inherent within every thematic category.

Writing-Up: The study conducted a comprehensive analysis of each theme, utilizing poignant illustrative quotes to substantiate and validate the findings.

Digital manual coding is utilized because it seamlessly combines human interpretative judgment with the organization and storage power of computer technology. Using software to manually tag text allows for rapid word categorization and fosters a deep familiarity with the data, all while eliminating the logistical mess of traditional paper and highlighters.

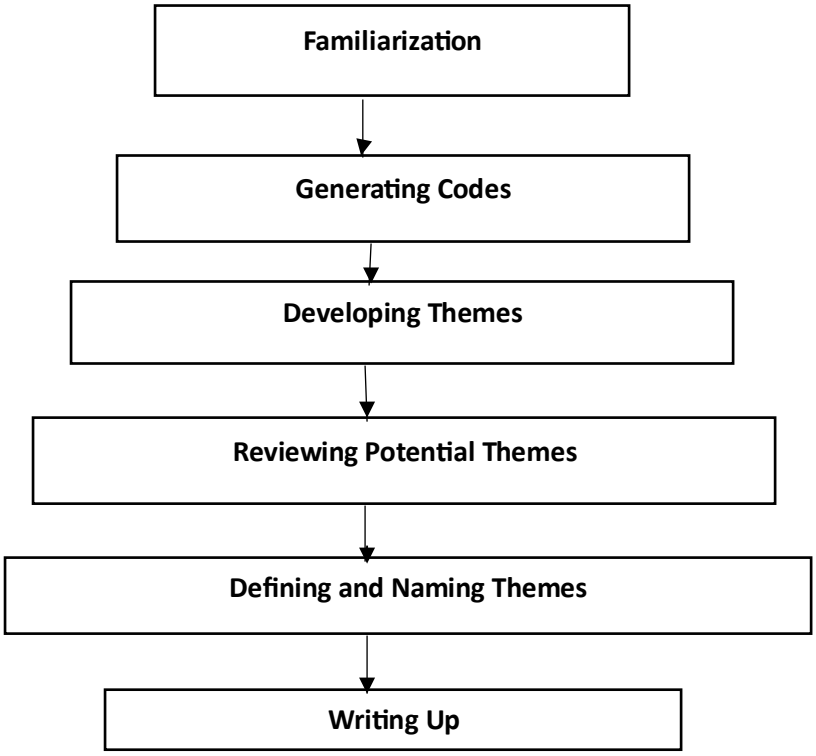

Fig 3: Coding Process. Source: (Khokhar et al., 2020).

1.9 Overview of the Thesis Structure.

Specifically, this thesis in a bid to address the sustainable food loss and waste management in the FSC of the UK retail firms, is structured as follows: Chapter 2 provides the systematic review of the empirical studies within the specific areas of this thesis with the aim to provide a comprehensive summary of existing evidence to inform future research. Chapter 3 aims to examine the impact of food packaging strategies and logistical efficiency strategies on Food Loss and Waste (FLW) generation. Furthermore, it seeks to study how management practices, such as utilizing food alternative uses, can mitigate FLW. Chapter 4 provides the detailed impact of inventory, Backorder and facilities layout management on FLW along the FSC. Chapter 5 provides the conclusion which contains the summary of the thesis, the academic and the practical contributions, the limitations and future research direction.

Chapter 2: Food Loss and Waste Management in the Retail Food Supply Chain: Methods and Framework to Achieve Environmental Sustainability

2.1 Abstract

Food loss and waste (FLW) represent a critical challenge to environmentally sustainable development, impacting food security, waste management, and climate change. One-third of the world's food is disposed of, with 13% lost between harvest and the supply chain and 17% wasted domestically and in food services. Food loss and waste (FLW) in retail supply chains is a critical issue that demands new frameworks due to its significant economic, social, and environmental impacts, including pollution, resource depletion, and contributions to climate change. Effective operational and inventory management practices to reduce FLW can yield significant cost savings and increased economic and environmental performance of the retail supply chain. A new framework is needed to combine all aspects related to logistics, packaging, and management practices to comprehensively address the FLW issue in the retail chain. This study critically analyses empirical research from 2009 to 2025 to identify key research gaps and to propose strategies for FLW reduction. The research identifies three primary gaps: limited focus on FLW due to inefficient packaging strategies, insufficient information on logistical inefficiencies that cause FLW, and scarce literature on how management practices affect the perishable food chain. By addressing these gaps, the study aims to enhance understanding of FLW reduction strategies, emphasising the need for integrated approaches and cooperation across the supply chain. By examining the impact of packaging, logistics, and management practices, this research provides insights into improving operational performance through the reduction of FLW and the development of sustainable waste management systems. The findings underscore the importance of proactive actions and innovation from both public authorities and the private sector in reducing FLW. Effective strategies for FLW reduction can lead to significant environmental, social, and economic benefits, contributing to a more sustainable and efficient food supply chain.

2.2 Introduction

Food loss and waste (FLW) generally refer to food not consumed, and become a waste. FAO (2019) defines FLW as the decrease in food quantity or quality along the supply chain, distinguishing between food loss and waste based on Food supply chain (FSC) stages. Food loss occurs at the upper part of FSC from post-harvest to retail, including storage, transportation, processing, and importing. Food waste arises at the lower part of FSC from retail to consumption.

Overall, about one-third of the world's food is disposed of. Globally, about 13 percent of food produced is lost between harvest and the supply chain and about 17 percent of food produced worldwide is wasted domestically, in the food service and the supply chain. (UNEP, 2022). It is also important to note that approximately 30% of food produced globally is lost or wasted along the retail food supply chain. These steps include production, handling, processing, distribution, and food consumption (Varese *et al.*, 2022). The causes of FLW are many and occurs throughout the supply chain. Packaging, logistics and management practices are central to FLW as they directly impact the efficiency, cost-effectiveness and customer satisfaction of the entire food supply chain, from production to customer delivery (Garcia-Arca *et al.*, 2022). As the food materials move from farm to consumer, the effective packaging practices keeps food safe, logistics moves it safely and quickly, and supportive management practices make sure the whole system runs smartly. Without effective packaging, more food gets damaged, spoils faster, and is wasted. Inefficient logistics and warehousing practices create more spoilage during distribution, generating huge food losses. Inappropriate management practices not aligning with reducing spoilage and wastes in food supply chain further contributes to degrading the environment.

Reducing FLW is an opportunity for both the Public Authority and Private sector to be proactive in actions and adopt innovation towards reducing FLW.

Globally, FLW challenge sustainable development, impacting food security, waste management, and climate change. FLW incurs high socioeconomic costs and leads to environmental degradation (Carter *et al.,* 2022). The moral implications are profound, with 12% of the global population suffering from hunger (Lohnes and Wilson, 2010). Despite efforts to minimize FLW, it remains high, with nearly half of all root crops, vegetables, and fruits wasted worldwide (Gustavsson *et al.,* 2011). Addressing FLW is crucial for a sustainable future, necessitating further research on the food supply chain.

Food safety, crucial for public health, is directly linked to food freshness, which dictates quality (Kucha and Ngadi, 2020; Baba and Esfandiari, 2023). Expired food fosters harmful germs,

increasing food poisoning risks. Accurate, continuous freshness monitoring is therefore crucial for consumer health (Zhang et al., 2024). Traditional subjective methods are unreliable, and lab testing is expensive and slow. Efficient, rapid, non-destructive techniques are key for meeting demand for safe, high-quality food (Zhao *et al.,* 2019). Chemometrics created a model linking food quality to spectral data for precise assessment, enabling real-time data acquisition and cloud-based visualization for enhanced monitoring and traceability helping to achieve accurate and continuous food freshness monitoring (Zhang *et al.,* 2024).

Reducing food waste is crucial for environmental sustainability and better nutrition. The Waste and Resources Action Program (WRAP) indicates that investing in food loss reduction can improve food security and sustainability. The COVID-19 pandemic highlighted the fragility of global food supply chains, resulting in the disposal of unsold goods. Food waste contributes to pollution, resource depletion, and undermines food security (Kummu *et al.,* 2021). Implementing food loss and waste (FLW) reduction offers significant economic benefits for food retailers and stakeholders. Research indicates that every dollar invested can yield up to $14 in operational savings through reduced procurement, handling, and disposal costs (Aramyan *et al.,* 2021). Minimizing FLW streamlines operations, providing a high return on investment, with many companies recovering their initial costs within one to two years (Dou *et al.,* 2018). Adopting FLW reduction practices also substantially enhances a food retail firm's brand reputation and customer loyalty by demonstrating a commitment to sustainability and ethical responsibility (Garcia-Garcia *et al.,* 2019).

Food retailers such as supermarkets contribute significantly to food waste due to purchasing problems and inventory miscalculations (Filimonau and Gherbin, 2017; Teller *et al.,* 2018).
While prior literature reviews provide a crucial foundation, three research limitations are evident. First, there has been an imbalanced focus on customer responsibility for food waste, neglecting the significant roles of other supply chain stakeholders. Second, many studies narrowly concentrate on specific points within the supply chain, offering a limited perspective on this complex issue, which cannot be attributed to a single factor. A singular viewpoint is insufficient for understanding FLW reduction strategies. Finally, some studies lack transparency and thoroughness, potentially introducing researcher bias in interpreting existing literature (Tranfield *et al.,* 2013). Consequently, more comprehensive research is necessary to adequately address food loss and waste across the entire supply chain (Chaboud and Daviron, 2017). This review addresses waste reduction throughout the supply chain, emphasizing technologies, innovative solutions, and good management practices. Reducing waste offers

environmental, social, and economic benefits. This study examines FLW sources, including perishables management, stakeholder attitudes, disruptions (Biuki *et al.,* 2020), and packaging impacts on waste generation (Cater et al., 2020; Centobelli *et al.,* 2020).

This research focuses on empirical studies conducted from 2009 to 2025 on FLW and its management strategies within the FSC. The findings of this study contribute to the existing literature by critically analysing previous sustainable food chain cases to identify the essential common aspects that drive companies to achieve environmental sustainability in the FSC (Giannetti *et al.,* 2020).

This paper will significantly enrich existing literature by offering a profound, multidimensional analysis of Food Loss and Waste (FLW). By synthesizing prior research and identifying critical operational gaps, it establishes a robust conceptual foundation designed to guide scholars and practitioners in promoting future empirical investigations.

The overarching aim of the Systematic Literature Review (SLR) in this paper is to critically analyse existing literature to understand strategies to reduce FLW in FSC.

The following research questions needs to be addressed:

1. How do different types of packaging strategies of Food products affect FLW generation?
2. What is the impact of logistical efficiency such as, material handling, Stacking of Food Products and Expected Targets in the supply chain on FLW?
3. To what extent could the Management Strategies/Practices solve or adversely affect the problem of FLW?
4. How does FLW reduction strategies influence the operational aspects of the FSC, such as efficiency, speed, quality, responsiveness, and inventory policy?

The research question was addressed through a systematic literature review of papers published between 2009 and 2025 in leading journals.

This study aims to deepen our understanding of food waste by examining the causes of food loss and waste throughout the supply chain. Previous research suggests that initial supply chain stages significantly contribute to food loss and waste (FLW) (Gustavsson *et al.*, 2011), but there is a growing need for a more holistic approach to identifying reduction strategies. Traditionally, FLW has focused on discarded or uneaten food (Huang *et al.,* 2021), with earlier studies not differentiating between "food loss" and "food waste." This study will focus on FLW within the supply chain, considering five dimensions: the supply chain stage, edibility, quality,

use, and destination. Recently, research has shifted from assessing loss to implementing environmentally focused recommendations, aiming to improve FLW management at every stage and establish benchmarks for the food industry (Beausang *et al.*, 2017; Salim *et al.*, 2021). This study contributes to that effort by providing a nuanced understanding of FLW causes to inform reduction strategies.

The paper is organized into six sections. Section 1 introduces the research topic. Section 2 details the methodology, focusing on the Systematic Literature Review (SLR) process, following Tranfield *et al*. (2003) framework. This includes planning the search strategy, identifying target journals, setting inclusion and exclusion criteria, conducting the review, and documenting findings. Section 3 categorizes the selected research papers for analysis. Section 4 discusses the analysis, findings and their interpretation. Section 5 explores potential avenues for future research. Finally, Section 6 concludes the study, summarizing the key insights and outcomes.

2.2.1 Methodology

A systematic review (SR) was conducted to address the research aims, utilizing a search strategy to identify relevant literature (Denyer and Transfield, 2009). Managing perishable FLW faces two main challenges: the high cost of sustainability limits facilities development for small businesses, and inadequate follow-up on employee training effectiveness impacts waste volumes despite increased training efforts (Jaji *et al.,* 2014).

This review utilized SCOPUS and Web of Science, two of the largest repositories of peer-reviewed journals (Centobelli *et al.,* 2020). These databases are ideal for comprehensive literature reviews in Operational Management and supply chains (Shashi *et al.,* 2018). Integrating both databases enhances the likelihood of finding all relevant contributions and ensures objectivity in selecting journals or articles for analysis. Table 1 below illustrates the steps involved in the literature selection process.

The search fields in Scopus included “Title, Author, Keywords, Abstract, Document Type, and Source Type,” while in WoS, they included “Title, Author Keywords, Keyword Plus, and Abstract.” Scopus returned 3628 papers, and WoS returned 837 on 'Food loss' or 'food waste.' For 'Food loss' or 'food waste' and ('Sustainable supply chain' or 'Circular supply chain' or 'Logistics'), Scopus returned 343 papers and WoS 286. After applying inclusion and exclusion criteria, the number was reduced to 194 articles, excluding 43 duplicates found in both databases.

The SLR is implemented in two stages. In the first stage, keywords were selected, inclusion and exclusion criteria were set, a database search was implemented, and documents were evaluated for quality. In the second stage, SLR results were reviewed (see Table 2 below). After removing duplicates, the full texts were read to eliminate unrelated papers, reducing the count to 87. Researchers reviewed titles, abstracts, and keywords, assessing them using screening criteria and conceptual boundaries.

2.2.2 Data extraction

The final list was made from the selected keywords (Refer Table 1) and transformed them into a search base by applying Boolean logic, using * along with ‘OR’ and ‘AND’ connectors. The researcher searched for title, abstract, and author keywords in the selected databases using a search base. The researcher conducted a search for all studies published in this domain until March 2025. The researcher initially found 343 Articles on the Scopus database, while the WoS document search resulted in 286 articles. First, 43 duplicate articles were removed from the

databases, leading to 586 articles. We further screened this pool by applying different inclusion and exclusion criteria, as explained below.

Table 1: Keywords used for searching literature.

Search Terms	Scopus	WoS
Food loss' and 'food waste'	594	72
Food loss' or 'food waste'	3628	837
Food loss' and 'food waste' and 'supply chain'	231	73
Food loss' and 'food waste' or 'supply chain'	180	712
('Food loss' or 'food waste') and 'supply chain'	350	25
('Food loss' or 'food waste') and 'sustainable supply chain'	172	7
('Food loss' or 'food waste') and 'sustainability'	485	29
('Food loss' or 'food waste') and 'circular supply chain'	141	77
('Food loss' or 'food waste') and 'circular economy'	575	107
('Food loss' or 'food waste') and 'operational performance'	24	16
('Food loss' or 'food waste') and 'logistics'	114	76
('Food loss' or 'food waste') and ('sustainable supply chain' or 'circular supply chain' or 'logistics')	343	286
('Food loss' or 'food waste') and ('sustainable supply chain' or 'circular supply chain' or 'logistics' or 'operational performance')	43	178
Year of Restriction:	2009 – 2025.	

Table 2: Literature Search Keywords.

FLW-Linked Keywords	FSC Linked Keywords	Search Documents
Food Loss Food Waste Food Security Food Wastage Food Reduction	Supply Chains, Food Supply Chain Food Shortage Management, Food Chain, Sustainable Supply Chain. Logistics, Supplier, Procurement, Food Production, Distribution, Transportation.	("Food loss or "food waste") and ("sustainable supply chain" or "circular supply chain" or "logistics")

2.2.3 Inclusion and exclusion criteria.

It is pertinent to note that only journal papers published in English are added, which is consistent with Fahimnia *et al.*, (2015). Conference papers, commercial magazine papers, and books are not included in the search to ensure strict adherence to research interest (as shown in

Table A3 below), only journal papers, reviews, and articles are included. The final shortlisted papers were published in the period 2009–2025.

Table 3: Inclusion and exclusion criteria

Inclusion Criteria	**Exclusion Criteria**
Journals, Articles & Reviews.	Conference papers, Discussions Articles &
Papers published from 2009 to March 2025 were finally shortlisted.	Editorials, Conceptual Studies, Data Articles, Notes, Papers in commerce.
Studies focussing on Business Management and Accounting, and Social Science. All Source Title considered. Initial source not restricted.	Magazines and book chapters

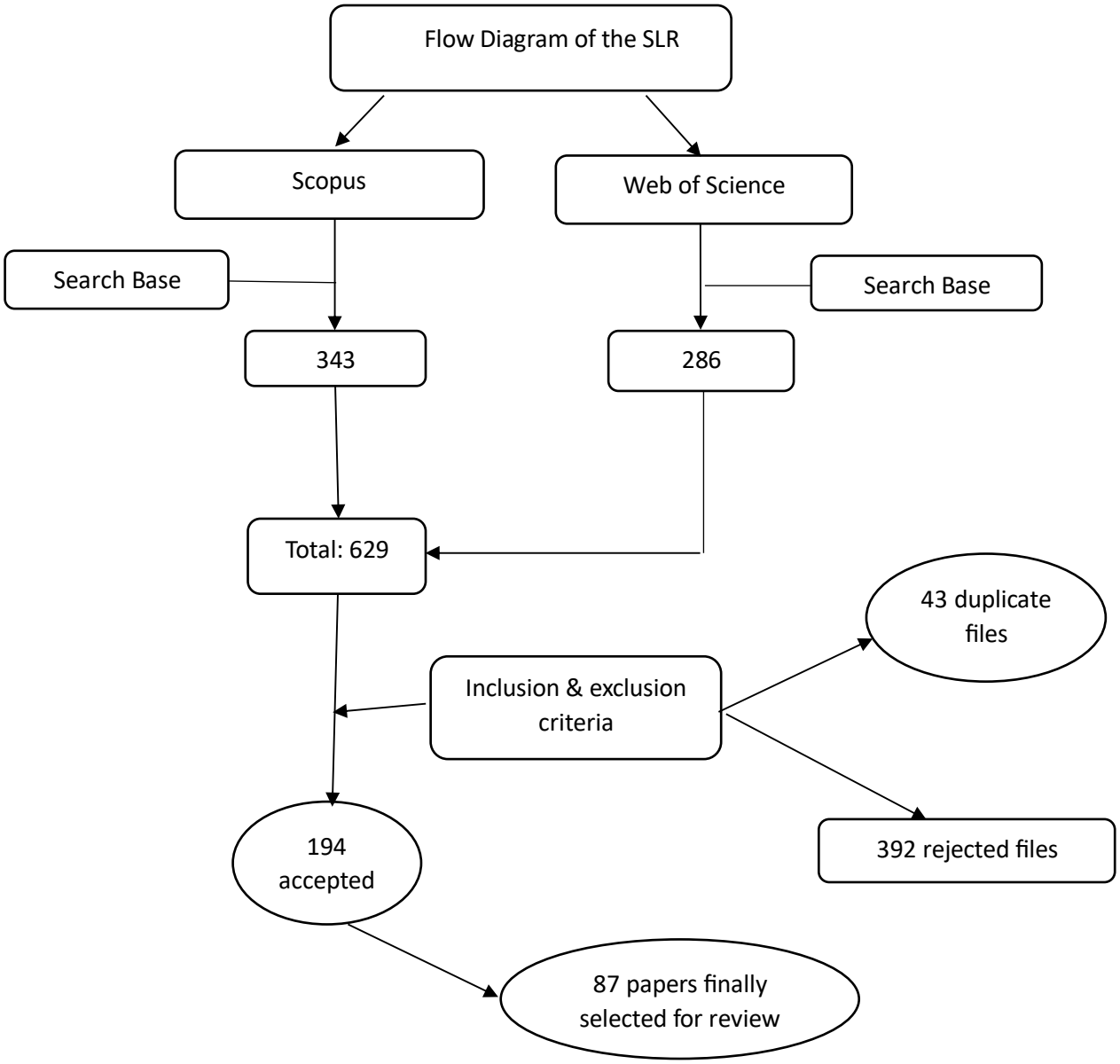

Figure 4: Steps taken to shortlist the papers for SLR. (Drawn by the Researcher)

In Figure 4 above, the first analysis, which includes the selection stage for articles, the inclusion or exclusion decision is made after reading the study title, abstract, and keywords (Wong and Hernandez, 2011). Of the 629 papers found, 392 were rejected, 43 were duplicated, and 194 met the criteria established in the protocol.

In the second stage, all previously shortlisted articles were read in full and included in the article extraction process. Studies that were not relevant to the research theme were excluded (Wong and Hernandez, 2011). This analysis ensured that the articles considered for the research fit the objectives of the study. Therefore, we read and evaluated 194 articles, accepted 87 articles, and rejected 107 articles for final review.

The final sample of 87 articles accepted in the extraction stage was analysed considering the publication year of each article in the scientific journal, geographical context, location of the country where each study was developed, and type of study.

2.2.4 Data performance: research outlining

Preliminary assessment seeks to observe the historical progress, the journals commonly targeted for publications, and the geographical distribution of the journals in the research topic. Prior to 2015, studies in this area were limited. Few papers were published between 2009 and 2013.

The research outlining the studies indicates that papers on FLW in FSCs are quite recent, as the number of journals has risen since 2015 (Refer Fig. A2)

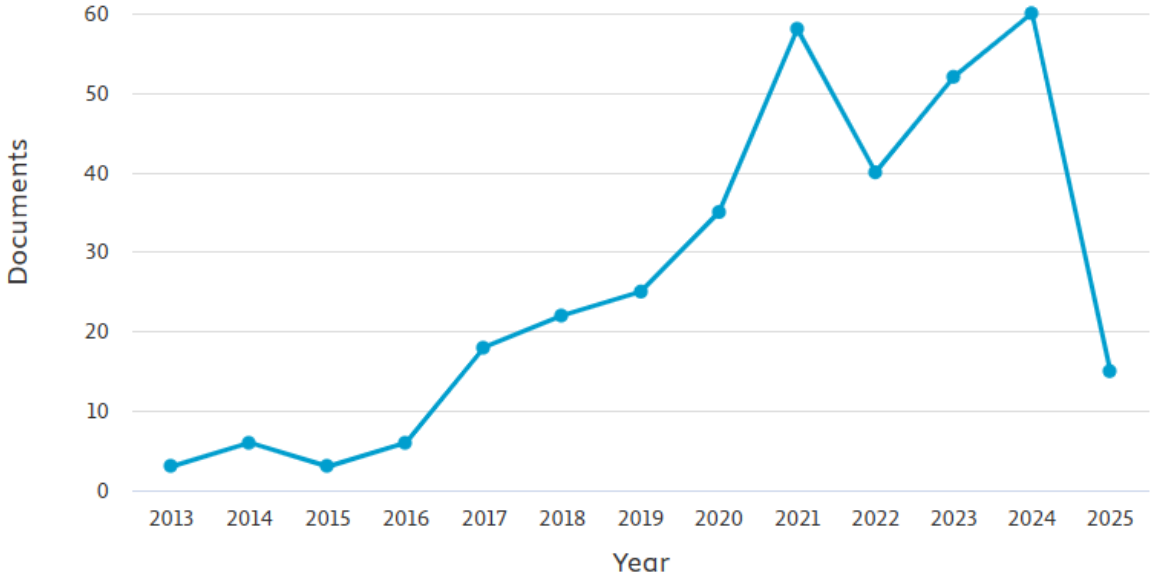

Figure 5: Trend of publications over the year (Adapted from Scopus 2025).

Table 4: Trend of Publication of Documents

Year of Publication	Number of Documents
2013	3
2014	6
2015	3
2016	6
2017	18
2018	22
2019	25
2020	35
2021	58
2022	40
2023	52
2024	60
2025	15

2.2.5 Distribution of Articles per year of publication

Figure 5 shows the distribution of 343 recognized articles by year of publication. It could be observed that publications on this research interest are growing. The first publication was in 2002, with one article published, and no article was published until 2008, which has one Article. The same applies to 2009 and 2010. It increased marginally to three articles in 2011 and dropped again in 2012. Furthermore, there were six publications in 2014, which showed more interest in this area of research. The number of publications, however, started increasing sharply from 2017 with 18 articles, followed by 2018 with 22 papers, 2019 with 25 papers. It reached its peak in 2021 when 58 papers were published, and it dropped in 2022 to 40 publications but picked up in the year 2023 and 2024 with 52 papers and 60 papers respectively. In the year 2025, only 10 papers were published till March. Fig. 6 indicates that 83% of the papers used for this research were articles, while 17% of Literature review papers were used.

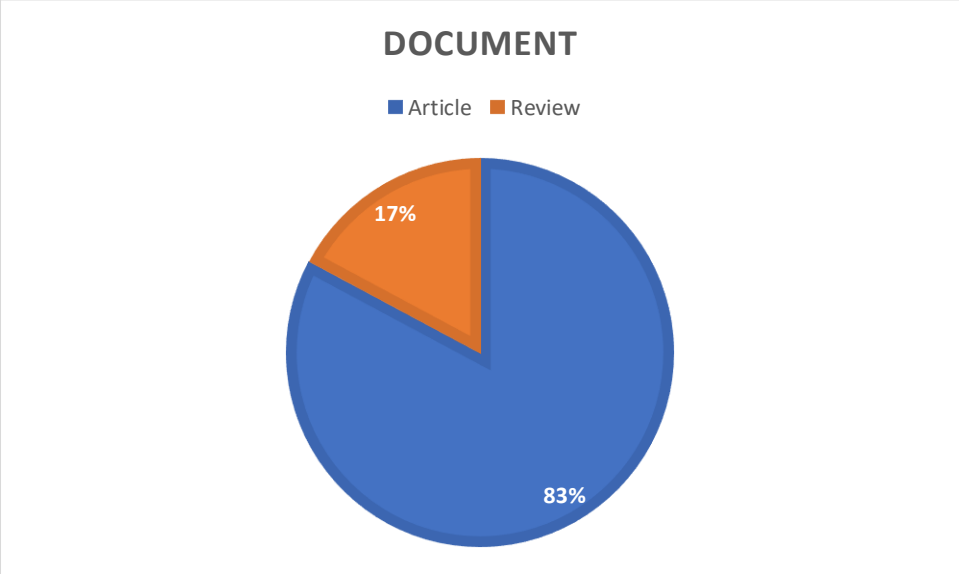

Figure 6: Types of Documents (Number of Papers: 343) (Adapted from Scopus 2025).

Table 5: Types of Documents

Document Type	Document
Article	284
Review	59

2.2.6 Geographic background

This geographical background shows the countries in which the designated papers were published. We made this decision because some journals do not specify the country where the study was conducted, or alternatively, they might refer to a broader geographical area, such as

the EU, instead of identifying a specific country. Table 6 describes the geographical background of the published articles and shows that Italy, the United Kingdom, and Germany constitute the combined greatest number of publications, all countries in the EU. India, China, and the USA are the only three countries outside Europe among the top ten countries with the highest number of affiliations. This shows European Countries' commitment to research on Food Loss and Waste Management in the Retail Food Supply Chain, targeting FLW among the priorities.

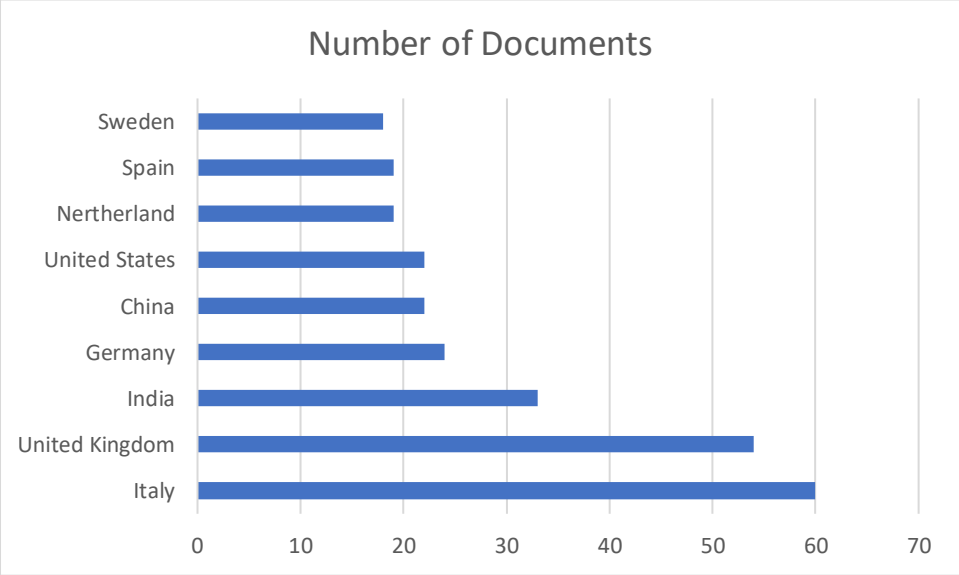

Figure 7: Documents by Country or Territory (Adapted from Scopus 2025).

Table 6: Documents by Country or Territory

Country/Territory	Number of Documents
Italy	60
United Kingdom	54
India	33
Germany	24
China	22
United State	22
Netherland	19
Spain	19
Sweden	18

It should be noted that 271 papers were published in the top nine countries (Refer Figure 6), and 70% of these studies were carried out in the EU, especially in Italy and the UK. 20% of the studies were conducted in developing countries. The recognition of publications in the EU

and the USA indicates a position with heightened interest from companies and policymakers in these countries.

It is also observed that out of 343 papers published, 52 papers were from countries other than European countries, representing interest from other parts of the world. However, there is worldwide interest in FLW researchers in the retail food supply chain. It is also worth noting that publications on the subject are being published, including in developing countries such as Brazil and India.

2.2.7 Type of Study

Nearly all the published papers are mainly Literature Reviews and case studies, and most of the case studies are new and published between 2021 and 2024. Literature Reviews were focused on 2020 and 2024. Furthermore, there has been an increase in literature reviews in recent years, and the number of case studies has also increased.

From the year of publication, geographical distribution, and type of study mentioned above, it is ideal to emphasize some important aspects. The first reveals academic interest represented by the surge in publications from 2020 to 2024. This meets the sustainable development goals and objectives of the United Nations (UN). These objectives reduce food loss and waste, as well as the generation of waste through prevention, reduction, recycling, and reuse (Oliveira *et al.*, 2021).

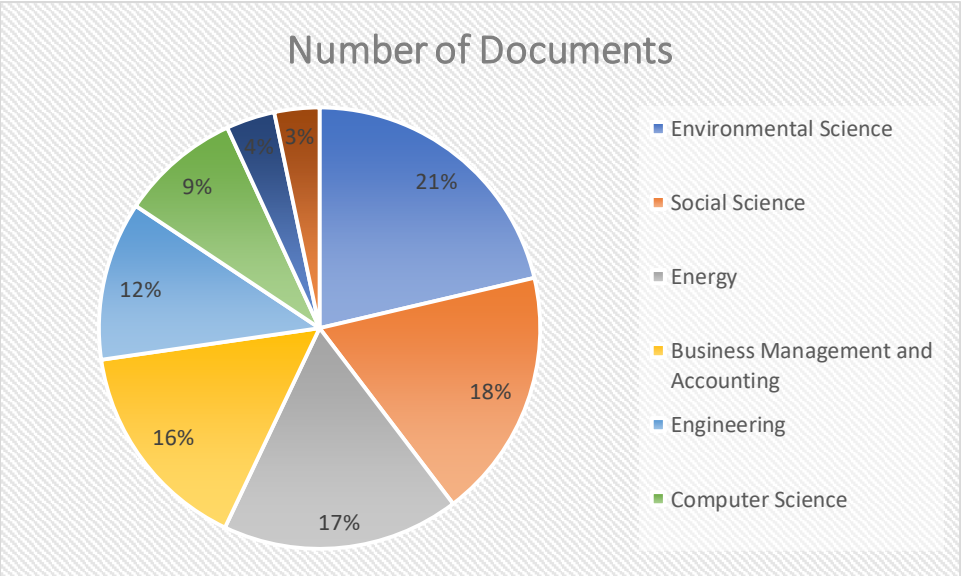

Figure 8: Documents by Subject Area (Adapted from Scopus 2025).

Table 7: Publication by Subject Area.

Subject Area	Number of Documents
Environmental Science	233
Social Science	200
Energy	190
Business Management and Accounting	171
Engineering	127
Computer Science	96
Economics, Econometrics and Finance	39
Agriculture and Biological Science	36

Figure 8 (Refer above) shows that Business Management and Accounting Journals are extensively used by approximately 16% of the research papers. In addition, energy (17%), engineering (12%), environmental science (21%) decision science and computers (3.6%), economics (3.6%), and other topics are also applied frequently. Figure. 9 (Refer below) shows the most productive authors. The most important publishing outlets were those focused on waste management and environmental issues.

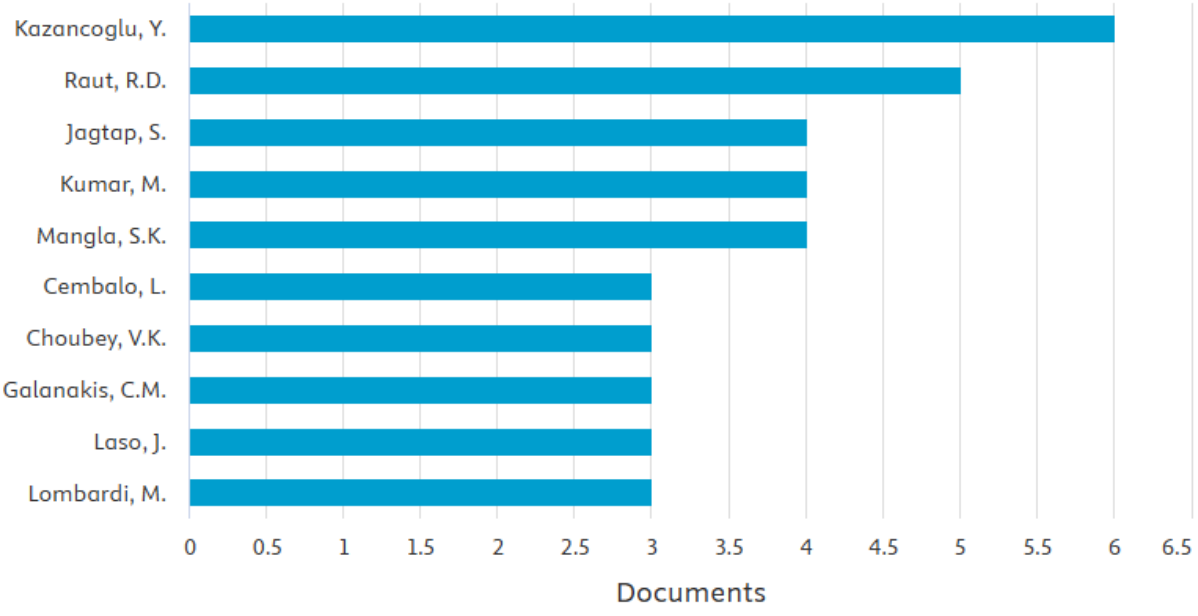

Figure 9: Documents by Author. (Adapted from Scopus 2025).

Table 8: Documents by Top Ten Authors.

Author Name	Number
Kazancoglu, Y	6
Raut, R. D.	5
Jagtap, S	4
Kumar, M.	4
Mangla, S.K.	4
Cembalo, L.	3
Choubey, V.T.	3
Galanakis, C. M.	3
Laso, J	3
Lomberdi, M.	3

Table 8 (Refer above) shows the authors of the most published papers. Ten authors published at least three studies. This is a long way to indicate how this research has generated interest in recent years. In Table 9 (Refer below), the Journal of Cleaner Production attracted the greatest number of publications, followed by Sustainability Switzerland, Foods, Food Policy, and the Journal of Enterprise Information Management. These journals jointly numbered over 30% of the total publications in the review sample (Refer Fig 10 below). Even though the FLW in the FSC could relate to multiple research areas, the field of review papers is appropriate within the scope of these journals, which exemplifies FSC management practices and the sustainability concept.

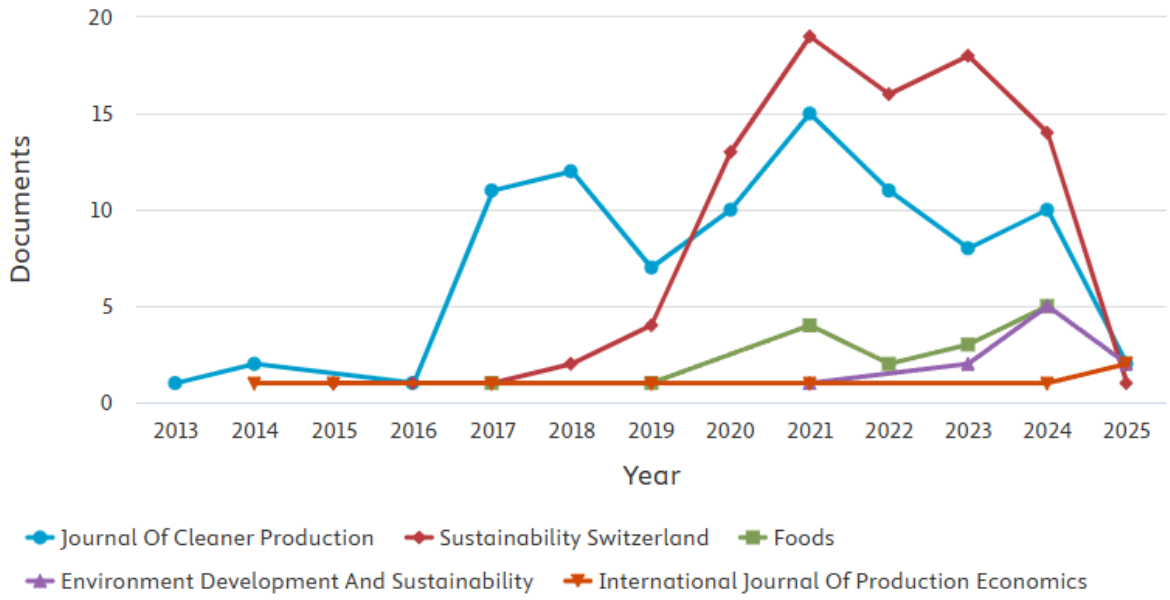

Figure 10: Documents per Year by Source. (Adapted from Scopus 2025**).**

Table 9: Number of Publications from Top Nine Journals.

Source Title	Number
Journal of cleaner Production	90
Sustainability Switzerland	90
Food	16
Environmental Development and Sustainability	6
International Journal of production economics	6
Journal of Industrial Ecology	6
Business Strategy & the Environment	6
International Journal of Production Economics	5
Production Planning and Control	5

2.3.0. Articles Categorization and Review.

In the 87 selected articles, information was extracted and organized into five categories explained in this study as 1, The concept of FLW to achieve sustainability, 2, Food Packaging strategies, 3, supply chain management process, 4, Firms Practices along the FSC and 5, Network design of Food redistribution.

2.3.1. The Concept of FLW to Achieve Sustainability.

Among the 87 selected articles, 18 defined FLW along the FSC, with eight using the FAO definition (Gustavsson *et al.,* 2011). The FAO states that food loss occurs at the initial stages (production to processing), while food waste happens at the final, retail, and consumption stages.

Based on the report from FAO regional conference for Europe in the year 2020, FLW denotes the reduction in the volume of food intended for human consumption at all stages of the food chain, from yield to consumption (Jocelyn *et al.,* 2023). Food loss refers to a decrease in the quantity or quality of food during production, post-harvest, and processing stages before retail. Food waste occurs when food is discarded in the FSC due to unsuitability for human consumption, damage, or expiry. These issues arise from consumers' financial capabilities, poor inventory management, and carelessness in food services and at home (Kayikci, 2019). Porter *et al.,* (2018) use "loss" for upstream FSC stages and "waste" for downstream stages. FLW is a general term used when the distinction between loss and waste is unnecessary, as seen in (Jocelyn *et al.,*2023) who consider "food losses" to cover both loss and waste at all FSC stages

and also propose "food loss" for food not counted as surplus, specifically referring to edible parts suitable for human consumption.

Food loss and waste (FLW) occur throughout the food supply chain (FSC), impacting quality from production to consumption (Koberg and Longoni, 2019). The FSC's complexity involves logistics, manufacturing, processing, distribution, and consumption, with a focus on quality, safety, sustainability, and efficiency (Baba and Esfandiari, 2023). Key challenges include security, waste, farming, public health, climate change, oil dependency, fair trade, and localism (Li *et al.,* 2014). Each FSC stage contributes to total waste, and reducing FLW and its environmental impact is essential for sustainability and long-term profitability (Wikström *et al.,* 2018). Waste at one stage can raise prices downstream, so improving sustainability benefits the entire supply chain.

Food companies should enhance sustainability throughout the chain for environmental and commercial benefits. Key steps include identifying areas for change, investing in modern technology, and improving management (Heard *et al.,* 2019). Failure to invest in new technology and strategies leads to environmental harm as food waste in landfills releases methane, affecting climate (Heard *et al.,* 2019). Irresponsible food wastage, especially meat, impacts land use significantly, with approximately 950 million hectares dedicated to meat production worldwide, adding urgency to addressing this issue globally (Li *et al.,* 2014).

2.3.2. Collaboration Between Private and Public Sectors to reduce FLW.

Effective food loss and waste (FLW) reduction requires collaboration between public and private sectors, from production to retail. This includes FLW reduction policies and mandatory targets. Collaboration involves developing technologies and infrastructure for better food storage, data sharing, and research to identify FLW hotspots in the supply chain. The EU Platform on FLW, established in 2016, unites key public and private stakeholders, ensuring representation from all supply chain actors, including international organizations like FAO and UN Environment, and EU agencies like the Economic and Social Committee. The platform guides the implementation of EU regulations and policies on FLW reduction along the supply chain. This multi-stakeholder approach facilitates coordinated efforts and knowledge exchange, incentivizing retailers towards sustainable practices (EU, 2021).

In Asia, countries like China address FLW through public-private partnerships, with initiatives like the 2021 Anti-Food Waste Law aimed at prevention and food security, moving towards green food production and processing laws. However, implementation challenges, particularly due to cost, exist for small food retail enterprises (Zhang and Huo, 2023).

2.3.3. Food Packaging strategies.

Twenty of the selected articles emphasize that food packaging functions are crucial for reducing FLW (Lindh *et al.,* 2016). Packaging plays a vital role in mitigating food loss and waste by safeguarding food products from damage and spoilage, extending shelf life, and ensuring food safety, thus minimizing waste throughout the retail and consumer supply chain stages (Zhang and Zhao 2012). Packaging serves in handling food products throughout the supply chain and communicating information in different parts of the system. Retail packaging must be durable to prevent damage and loss hence, optimizing sales. Consumer-friendly features like easy opening, resealing, and efficient use minimize spills and waste. Acknowledging and valuing diverse packaging functions can effectively mitigate FLW across various stages of the food supply chain.

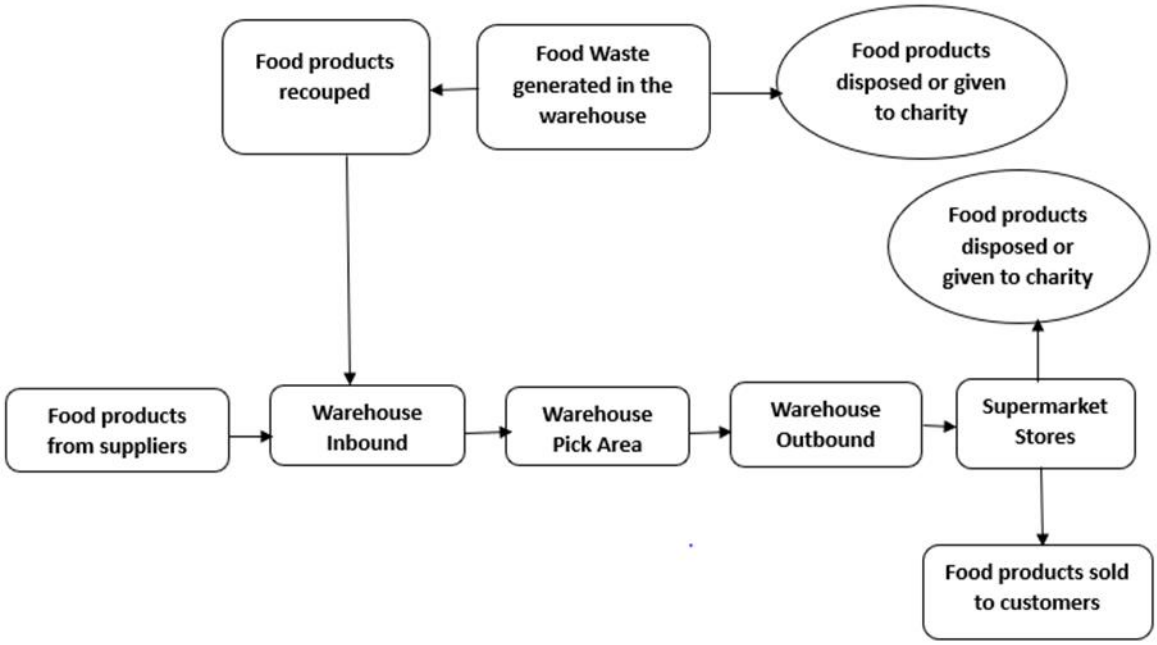

Figure. 11: Simplified Flow Sheet of Food Supply Chain (Designed by Researcher).

The Figure 11 shows the movement of Food Products along the FSC and how FLW is normally recouped back into the system. It also shows that FLW is generated along the supply chain mainly due to poor packaging. Poor packaging of Food Products amounts to 45% of the waste generated by the FSC.

Chaffee *et al.,* (2022) found that older adults frequently spill food when opening packages. Proper portioning can prevent overconsumption and waste. WRAP (Wikstrom *et al.,* 2018)

reported significant household food waste in original or partially used packaging. Packaging should cater to diverse needs with clear freshness and safety information, using standardized date labelling (eFED, 2016).

FLW in retail can increase due to slower turnover with multiple packaging sizes. There are trade-offs between FLW in retail, households, and packaging volume. For high-impact food products, smaller packaging sizes may reduce waste despite using more material. Packaging's communication functions, like RFID tags and temperature recording during distribution, also impact food waste (Aschemann-Witzel *et al.,* 2020).

Muangmala (2016) noted that food packaging contributes 0.3% of GHG emissions for resource-intensive foods like red meat but up to 20% for low-resource foods like blueberries. Heller *et al.,* (2018) reviewed GHG ratios across products, ranging from 0.06 to 700. Optimized packaging can reduce FLW, and NGOs, governments, and companies should integrate this into sustainability initiatives. Balancing product protection with minimal material use conserves resources and lowers environmental impact.

Prior studies have explored various packaging technologies impacting food loss and waste (FLW), from traditional materials like plastics, glass, and cardboard to innovations such as active and intelligent packaging. Results indicate a significant correlation between plastic and cardboard packaging and increased fresh food waste, alongside environmental impacts (Zhang and Zhao, 2012). Consequently, with the need to track and monitor food products, firms are recognizing the limitations of some packaging raw materials in significantly reducing FLW and are seeking greener alternatives. The adoption of flexible and intelligent packaging, which provides information and modifies the internal environment to extend shelf life, has increased. These include smart packaging which uses technology like RFID or QR codes for tracking and monitoring food product throughout the FSC and the active and sustainable packaging which uses biodegradable materials like the combined use of plastics, cardboard, and foil, offering space-saving, customer-friendly, and environmentally conscious advantages (Huang, 2017). Food retail firms implementing these packaging innovations are gaining a competitive edge over others (Dora *et al.,* 2022).

2.3.4 Barriers of Implementing Effective FLW reduction Strategies.

Implementing effective food loss and waste (FLW) reduction faces financial constraints, regulatory hurdles hindering innovation, and technological gaps affecting management practices. High facility upgrade costs and complex government policies are significant barriers.

Investing in storage, transport, and processing machinery is costly, disproportionately impacting smaller firms and developing nations (Montoli *et al.,* 2023). Modern technologies like cold chain systems are expensive and indirect costs like staff training add up. (Sundin *et al.,* 2023),

Despite their benefits in reducing FLW, smart and sustainable packaging face cost implications such as higher upfront cost of eco-friendly materials and cost of disposal. While flexible packaging's compactness is advantageous, justifying smart packaging for low-value food is often economically challenging, hindering wider adoption due to customer cost concerns. However, as smart packaging becomes more common, its cost has begun to decline. Selecting the appropriate type of smart and sustainable packaging is crucial but also challenging. While plastic packaging has offered a global, cheap, and safe solution, its current use is unsustainable due to environmental impacts. Food retail companies are increasingly adopting flexible and smart packaging strategies that are not only suitable for the food product but also economical and environmentally friendly (Brennan *et al.,* 2021; Sasaki *et al.,* 2022).

Furthermore, Government food packaging regulations aim for safety and environmental protection through sustainable practices (FSA, 2022). However, partial policy implementation hinders sustainable adoption by retailers, many prioritizing cost-cutting over full compliance.

Logistical management is a key competitive advantage for many firms in the food supply chain (Defra, 2022). However, managers struggle to devise strategies that simultaneously reduce logistical costs and enhance efficiency while minimizing food loss and waste (Muth *et al.,* 2019). The process improvement involves optimizing each supply chain stage using IoT and AI technologies, alongside investments in infrastructure and sustainable practices like effective inventory, storage, and transportation (Ciccullo *et al.,* 2021; Mandal *et al.,* 2021). Technological gap hinders FLW reduction in some regions of the world, with efforts to bridge it through investment and government intervention (Spring and Biddulph, 2020).

2.4 Supply Chain Management Process.

Several analysed articles have explored the management process of delivering food products from farms to consumers. This process involves planning operations across the supply chain and product planning. As part of the management philosophy aimed at reducing Food Loss and Waste (FLW), operations planning plays a crucial role. According to Parfitt *et al.,* (2010), waste is one of the major barriers to the sustainability of the Food Supply Chain (FSC). An efficient FSC aims to supply, distribute, and consume food in a more sustainable manner without

compromising costs. This involves setting standards and leveraging technology to enhance sustainable development, reduce operating costs, and minimize food waste (Li *et al.,* 2014). Companies are motivated to explore this area due to the incentives of using resources efficiently, reducing FLW, and saving money (Richter and Bokelmann, 2016).

2.4.1 The Effect of Logistical Efficiency.

Efficient logistics are crucial for minimizing food loss and waste (FLW) through optimized handling, inventory, and transportation, reducing spoilage and ensuring optimal food delivery (Bhatia *et al.,* 2021). For example, resource optimization enhances sustainability and minimizes environmental impact. Real-time inventory tracking allows precise stock level monitoring, enabling retailers to balance orders and avoid overstocking or stockouts.

Logistical inefficiencies from farm to supermarket significantly contribute to FLW, including inadequate storage, transportation delays, and ineffective inventory management. For example, at the farm production and harvesting stages, Poor harvesting and lack of cold storage cause farm-level spoilage. Post-harvest, inconsistent grading and insufficient infrastructure exacerbate the problem (Biuki *et al.,* 2020). High transportation costs, lack of cold storage in warehousing, and absent on-site processing increase waste. Addressing these cumulative inefficiencies across the supply chain is vital for minimizing FLW and enhancing sustainability.

Further, it is evident that temperature control is crucial in food logistics, especially for delicate items like fresh fruits and cucumbers requiring immediate cold storage transfer. Precise temperature-controlled transportation is essential. Smart sensors track and log critical environmental parameters (humidity, temperature, stock, light, air pressure) for each shipment, providing real-time data. This empowers retail managers to monitor each product's journey, enabling proactive spoilage prevention, ensuring optimal condition upon arrival, minimizing waste, and maintaining quality (Filimonau and Gherbin, 2017; Teller *et al.,* 2018). This data also supports traceability and accountability.

Maintaining temperature control is vital in the cold chain logistics of fruits like table grapes to minimize spoilage, prolong storage, and preserve economic value (Kim *et al.,* 2015). Implementing Wireless Sensor Networks (WSN) is a highly effective solution for real-time monitoring in food cold chains (Aung and Chang, 2014), and agriculture (Correa *et al.,* 2014).

This measurement enhances the traceability, sustainable performance, and transparency of the fruit products, ultimately ensuring their quality and safety (Xiao *et al.,* 2013).

2.4.2 Environmentally Sustainable Practices.

Retail firms' environmentally sustainability practices in the management Planning of food waste reduction are business strategies within the Food Supply Chain (FSC) successfully implemented in countries like China, South Korea, and Japan. Its core values focus on continually reducing Food Loss and Waste (FLW) to enhance customer service and achieve sustainability, helping these countries reduce food waste by about 30%. Everyone in the FSC, from top management to workers and suppliers, participates in reducing food waste across all operations (Krishnan *et al.,* 2020).

However, current supply chain practices often accelerate food waste due to reliance on overproduction and surplus-creating processes. Without altering these fundamental characteristics, systemic overproduction will continue, posing a significant challenge (Messner *et al.,* 2021). Thapa-Karki *et al.,* (2021) outline five key principles for organizations to achieve continuous order fulfilment and reduce food waste (Figure 12):

1. **Food Waste Reduction at First Contact:** Integrates waste reduction into operational processes with ongoing improvements. Training pickers enhances their skills in achieving these goals.
2. **Strategic Improvement of Picking Processes:** Focuses on improving the picking of food products and minimizing spills during dispatch. Strategic plans should integrate food waste reduction, ensuring suppliers provide quality products with functional packaging. Monitoring by SKU helps identify poorly packaged items, fostering continuous improvement through supplier communication (Brennan *et al.,* 2021).
3. **Continuous Improvement Throughout the FSC:** Involves evaluating and implementing more effective methods across the supply chain. Qualified and trained employees facilitate information flow between suppliers, retail stores, customers, and distribution centers, optimizing data management and resolving operational obstacles (Abbasi and Nilsson, 2022).
4. **Teamwork and Mutual Respect:** Promotes a culture of waste reduction and cost savings. This principle is embraced by many organizations in the UK and France, encouraging workforce feedback and recognizing significant achievements (Albizzati *et al.,* 2019).

5. **Customer-Focused Approach:** Ensures food products meet and exceed customer needs, emphasizing quality and packaging on store shelves. Warehouses require a systematic approach involving the entire FSC workforce.

While these principles address key FSC challenges, they often overlook outsourcing, integration, and strategic alignment. Further research should develop principles incorporating management operations, external suppliers, and retail stores.

Figure 12: Principles of Environmentally Sustainable Practices in FSC
(Designed by Researcher).

2.4.3 Conflicts Between Efficiency Improvements and Environmental sustainability Goals.

The conflict between efficiency and sustainability emerges when aiming for greater supply chain output unintentionally causes resource depletion and increased food loss and waste (FLW), leading to environmental degradation and hindering long-term sustainability (Baumgartner and Quaas, 2010). Efficiency-driven increases in food product volume, if poorly managed, can exacerbate FLW. Sustainability, in terms of consistency, fundamentally differs from efficiency (Huber, 2000). Performance targets for retail workers significantly contribute to food waste, causing pollution and undermining environmental sustainability.

Technological advancements, while boosting output efficiency, can inadvertently increase waste generation, posing environmental challenges. For instance, highly automated supply chains in major UK supermarkets, despite operational efficiency gains, lead to substantial

waste. UK supermarkets waste approximately 270,000 tonnes of food annually, with 100,000 tonnes being edible (BWA, 2024), raising concerns for retail management and the government. In November 2021, the UK's five largest supermarkets pledged to halve the environmental impact of weekly food shopping by the end of the decade (COP 26 Summit).

2.4.4 The Impact of Research and Development.

Research and Development (R&D) support is a crucial innovation model in the food supply chain, fostering new product development and jointly reducing supply disruption risks, thereby enhancing environmental performance (Yang *et al.,* 2024). A supply chain is an intricate network of interconnected supply and demand relationships, encompassing various processes delivering value to consumers (Jahani *et al.,* 2024).

Given the food industry's rapid expansion and consumers' growing focus on material safety and environmental sustainability, proactive innovation is vital for firms to remain competitive. R&D collaboration within the supply chain occurs as horizontal cooperation among similar-level firms and vertical cooperation between upstream and downstream entities (Solaimani and van der Veen, 2022).

These collaborations offer significant benefits, including lower production costs and fostered joint innovation with suppliers. Identifying suitable R&D partners within the complex supply chain network, based on their specific technical strengths, is critical for target firms. Determining the most appropriate partners is essential (Wu *et al.,* 2023). Thus, enhancing R&D cooperation and innovation in the food supply chain is increasingly vital for firms seeking sustained growth and competitive success in a dynamic market.

2.5.0. Evaluating Performance.

Sixteen analysed articles examined firms' practices along the Food Supply Chain (FSC). One important practice involves evaluating performance categories within the FSC to identify areas for corrective action. This approach assesses strengths, weaknesses, and critical variables influencing the chain's efficiency. While external metrics like stock turnover, fill rate, and back-order rate are commonly emphasized to enhance customer satisfaction and reduce food waste, internal variables are critical for determining FSC success and food loss and waste (FLW) reduction (Guo *et al.,* 2019). Effective management practices are critical to the reduction of food loss and waste as they enable the tracking, and monitoring of food product with optimisation of the food supply chain which leads to increase efficiency, resource conservation and reduced environmental impact. By analysing data on food handling by pickers, inventory,

backorder, and transportation, food retail firms can identify inefficiencies and implement strategies to minimise food loss and waste (Filimonau and Gherbin, 2017*)*

Handfield *et al.,* (2020) highlights the importance of broadening performance measures in the FSC to meet diverse objectives across industries. A key internal variable is the control system within food retail firms, particularly in the UK. This system plays a significant role in managing the FSC by maintaining data reliability, managing paperwork, meeting store requests promptly, and using computer systems effectively (Carter, 2020). Real-time online order-entry systems allow for batch orders and provide timely instructions, enhancing operational trust and efficiency. However, data reliability remains a challenge due to unpredictable purchase trends and economic uncertainty, which impacts consumer behaviour and contributes to FLW (Munson and Rosenblatt, 2017). As such, robust control systems and accurate data management are crucial to reducing FLW and optimizing supply chain operations.

Inventory accuracy is another vital factor in preventing FLW. Effective inventory management and lot sizing strategies help reduce FLW by extending planning horizons, while individual portion sizes in hospitality can mitigate waste (Alvarez *et al.,* 2020). Accurate inventory management is essential for smooth supply chain operations, impacting vendor supplies, labour efficiency, and customer service. Inadequate forecasting can lead to excess or shortages in inventory, thus affecting customer satisfaction and operational efficiency. Proactive inventory management systems enhance accuracy, reliability, and overall performance, reducing FLW risks.

Another significant practice is fulfilling the Outbound Warehouse Request (OWR), a key workload-planning tool for warehouse managers (Lebersorger and Schneider, 2014). This helps streamline transportation planning by offering insights into completed orders, package carriers, and other indicators. Conducted quarterly, OWR supports effective outbound request management in food supply chains.

The design and use of facility layouts also impact supply chain efficiency. Effective facility layouts optimize space usage, material handling, and product storage, minimizing damage to food products and reducing FLW (Carter *et al.,* 2020). Similarly, prioritizing health and safety, including fire safety and hazardous materials handling, is crucial for minimizing accidents that lead to food loss.

Large EU retail firms focus on key performance indicators (KPIs) such as order-picking accuracy to minimize food waste (Priefer *et al.,* 2016). Inaccurate orders increase returns, transport time, and error rates. KPIs like orders per hour and order cycle times help streamline these processes.

Finally, supportive leadership plays a key role in motivating employees to reduce FLW and promote sustainable food management (Akkas and Gaur, 2022). Leadership fosters a culture of collaboration and flexibility, enhancing information sharing and driving sustainability across the supply chain (Belavina, 2021).

2.5.1 The impact of data-driven strategy and AI on Inventory Management.

EU food retailers are increasingly using AI-driven inventory control and predictive analytics to enhance decision-making and optimize operations. Both methodologies use data and algorithms to forecast future outcomes by identifying patterns in historical data (Gayam *et al.,* 2021). While both aim to optimize inventory, AI-driven systems autonomously learn and adapt, offering an advantage over traditional predictive analytics that rely on manual processes (Eyo-Udo, 2024). AI-driven systems use sophisticated algorithms to analyse patterns, predict demand fluctuations, monitor inventory in real-time, and dynamically optimize stock levels (Nimmagadda, 2021).

These systems integrate data points like sales trends, supplier performance, customer behaviour, and external factors, providing a holistic supply chain view. For instance, AI can proactively predict demand spikes, ensure sufficient inventory and improve customer satisfaction, contrasting with reactive stockout responses. Firms use AI to gain data-driven insights, maintaining optimal inventory levels instead of overstocking (Muthukalyani, 2023).

Implementing AI-driven inventory control offers benefits like reduced operational costs, increased profitability by minimizing food loss and waste, improved customer experiences through timely availability and automated replenishment, reduced manual errors, and enhanced environmental sustainability by reducing unnecessary inventory and waste. This dynamic solution empowers firms to navigate modern retail complexities and achieve sustainable growth.

Adopting AI inventory management poses challenges for small businesses with legacy systems. Incompatibility with modern AI requires costly modifications. Aligning manual processes with predictive analytics is very difficult. Synchronizing data between AI and outdated systems present hurdles. Outdated inventory records undermine AI accuracy and effectiveness (Eyo-Udo, 2024).

2.5.2 Greenhouse Facilities Management and Digital Transformation in Agriculture.

Digital transformation is revolutionizing agriculture, enhancing efficiency and environmental performance through data-driven insights that improve decision-making and reduce waste

(Abedrabboh *et al.,* 2022). Effective financial management, considering upfront costs, operating expenditures, revenues, financing, and government support (Durmanov *et al.,* 2024), is crucial for adoption, particularly in greenhouse operations.

While the EU and Asia invest in digital agriculture, a lack of supply chain coordination hinders small to mid-sized operations (Choi and Kang, 2022). This review reveals that integrating digital platforms with supply chain coordination significantly boosts productivity and financial sustainability. Participation in digital platforms notably increases profitability, reduces expenses, enhances yields and technical efficiency, and improves environmental performance (Durmanov *et al.,* 2024). This provides quantifiable evidence of synergistic gains from combining infrastructure upgrades with enhanced data visibility and supply network integration, effectively addressing challenges for smallholder agriculture.

2.5.3 Ecosystem Dynamics and Environmental Impact.

Food chains are environmentally crucial, involving management, ecology, mathematics, engineering, and economics. A food chain model shows a single path of organism, energy, and resource flow. Interconnected food chains form complex food webs. Food chains exhibit various trophic levels. Organisms in different stages, including producers, consumers, and decomposers, are categorized within these levels. The movement of organisms, energy, and resources in a food chain model is found to bilinear and these impact the environment (Arif *et al.,* 2024). A food web's formation uses a framework. Mathematical analysis and modelling can represent food chains (Naji, 2012). Ecologically, food chains are species sequences where each serve as food for the next. Interconnected food chains form complex food webs (Nath and Das, 2018). Various methods integrate cannibalism and harvesting to understand ecosystem dynamics and environmental impacts. Methods include connecting ANNs to computational proficiency for model behaviour insights over time. Findings demonstrate that system boundedness, computed fixed points, and stability characteristics exists among the organisms, (Arif *et al.,* 2024).

2.5.4 Circular Economy influence on operational efficiency and sustainability.

Implementing circular economy frameworks in the food supply chain provides significant environmental, economic, and social benefits, such as reduced waste, improved resource efficiency, and new business models, despite challenges like high initial investment. For example, implementing reuseable packaging by opting for reusable or returnable containers of food products and also finding alternative use for food that are not perfect but are still edible

(Vegter *et al.,* 2020). Focusing on minimizing waste and maximizing resource use from production to consumption can lead to substantial cost savings for businesses and consumers. By adopting circular economy principles, food retailers can achieve greater operational efficiency and more sustainable economic development, gaining strategic advantages by reducing environmental impacts and enhancing economic performance (Yang *et al.,* 2024). For example, this framework helps prioritize waste reduction, resource efficiency, and closed-loop systems, including optimized inventory management (Bocken *et al.,* 2016). However, substantial initial investments, uncertain long-term financial returns, and the difficulty of changing consumer behaviour toward sustainable practices can hinder widespread adoption (Todeschini *et al.,* 2017).

2.5.5. Network design of Food redistribution.

Eleven of the reviewed papers considered the Food redistribution practices of Food retail firms and highlighted the multifaceted causes of FLW in food retail firms. External factors like weather, natural variability, and regulatory constraints impact FLW (Kummu *et al.,* 2021). Strategic-level causes include inadequate infrastructure, logistical challenges, and limited market access (FAO, 2013). Interfaces within the food value chain are significant contributors (Gobel *et al.,* 2015). In the fruit and vegetable industry, high trading standards and retail regulations drive FLW (Richter and Bokelmann, 2016). Donating unsold products is a viable solution, offering social and ecological benefits, enhancing corporate image, reducing costs, and providing tax deductions (Whelan, 2014). However, economic, infrastructural, and legal barriers persist (Priefer *et al.,* 2016). Legal concerns also pose barriers to food redistribution; UK retailers fear litigation and administrative burdens (Gruber *et al.,* 2016). Conversely, legal protections like Italy's "Good Samaritan Act" and similar US legislation mitigate donor liability (Priefer *et al.,* 2016). Vlaholias *et al.,* (2015) highlight the importance of awareness in charitable contributions, advocating for better communication between distributors and retailers regarding recipient needs. Addressing barriers like legal concerns, logistical challenges, and societal stigma is crucial. Enhancing awareness and fostering collaboration among stakeholders are essential steps toward reducing FLW through effective food donation practices in the retail sector. Preventing donated food waste requires retailers to maximize distribution via charities, ensure food quality, and implement surplus management strategies like repurposing or donating to local food banks. Utilizing a first-in-first-out system and clear date labelling of “best before”, and "use by” is crucial for food quality and safety. Retailers should promptly remove damaged or expired items and communicate with food aid

organizations about low-quality donations (Bajzelj *et al.,* 2020). Partnering with local food banks and charities is vital for effective distribution, including repackaging surplus food and simplifying donation pickups. Exploring alternative uses like animal feed or shelter donations is also important. Cultivating a waste reduction culture necessitates trained staff collaborating with charities and food banks. Regular communication, clear donation quality guidelines, and efficient logistics are key to successful, waste-minimizing food donation programs supporting local communities (Kummu *et al.,* 2021).

Food redistribution addresses food insecurity and reduces waste but has environmental and social trade-offs. Potential impacts on food quality and nutritional value exist, along with logistical demands for infrastructure, transport, and storage. Increased consumption could offset environmental gains (Midgley, 2019), and transportation can increase emissions. Food quality concerns, especially near expiry, may lead to spoilage and health issues. Extra packaging can add to landfill waste, and recipients might have limited food choice. Redistribution can also shift waste management burdens to charities and food banks (Schanes *et al.,* 2018). Careful consideration of these trade-offs is vital for optimising the effectiveness and sustainability of food redistribution. Determining the most appropriate partners is essential (Wu *et al.*, 2023).

2.6. Discussion.

This research proposes that achieving a sustainable food supply chain requires boost in management techniques focusing on logistical efficiency and effective packaging strategies. Organizational readiness for change is crucial for sustainability, supported by proactive management practices addressing detrimental factors in the food supply chain (FSC). Integrating environmental and social sustainability into the corporate model guides FSC decision-making. Embedding sustainability effectively demands that all employees engage in practices aligned with business targets, fostering sustainability as a routine discourse. This inclusive approach necessitates widespread communication and engagement on the non-economic aspects of sustainability throughout the organization, transcending individual roles.

Proposition 1: A Food Supply Chain that recognizes that the type of food product must be considered in the packaging designs.

Insufficient attention has been given to diverse packaging functions influencing food loss and waste (FLW), critical for sustainable product and package design. Each product, like yogurt, dry pasta, and bread, faces unique waste challenges (Humbert *et al.,* 2009; Lindh *et al.,* 2016; Verghese *et al.,* 2015). Understanding and integrating these specific packaging purposes into design and development processes are essential to mitigate FLW across the food supply chain (FSC).

Proposition 1(i): Identifying and obtaining specific data on packaging design that impact food waste for different products. (Morashti *et al.,* 2022; Ada *et al.,* 2022).

Proposition 1(ii): Developing reusable design methods to improve packaging with regards to FLW. (Wikström *et al.,* 2019; Beitzen-Heineke *et al.,* 2017; Verghese *et al.,* 2015).

Proposition 2: A clear management focus toward the logistics efficiency of the Food Supply Chain is necessary to reduce food losses and waste.

Evidence has shown that financial considerations influence firms' decisions regarding investments in facilities for food product stacking, potentially affecting FLW generation (Beausang *et al.,* 2017). Additionally, integrating health and safety strategies into logistics training enhances management practices that impact FLW (Derqui *et al.,* 2018). . Worker productivity and meeting of targets also influence FLW in the food supply chain, necessitating further study on their environmental implications.

Proposition 2(i): Logistics efficiency is supported or adversely affected by product display and stacking (Pietzsch *et al.,* 2017).

Proposition 2(ii): The management focus on Health and Safety Strategies demonstrated by the sustainable training of workers, as part of logistics efficiency, could impact FLW. (Silvestri *et al.,* 2021).

Proposition 2(iii): Product handling is an important issue in logistics efficiency, which deserves firms' attention. (Bates and Phillips, 1999).

Management focus is supported by Company's values which drives corporate decisions.

Proposition 2(iv): Workers' productivity and expected targets demonstrate and impact the FLW generated along the FSC, which could lead to environmental concerns (Gokarn and Kuthambalayan, 2019).

Proposition 3: Management Practices along the Food Supply Chain impact the generation of FLW.

Proposition 3(i): Managers of sustainable Food Supply Chains treat buyer-supplier contracts as an important outcome that affects FLW. (Janousek *et al.,* 2018). Janousek *et al.,* 2018).

Proposition 3(ii): Management Practices such as Inventory strategies, back-order rate, facility layout, and overproduction of food items by suppliers that could impact FLW must be examined. (Silvestri *et al.,* 2021).

Proposition 4: Operations planning along the supply chain and product planning affect FLW along the Food Supply Chain.

Evidence has shown that operational planning along the supply chain and food product planning affect FLW along the Food Supply Chain (Pietzsch *et al.,* 2017). Employee involvement in operational planning has a major impact on the generation of FLW along the FSC. In addition, the management's strategic operational style has a tremendous impact on FLW.

Proposition 4(i): Employee involvement in operational planning impacts the generation of FLW along the FSC. (Krishnan *et al.,* 2020).

Proposition 4(ii): Dynamic Teamwork Approaches and Tactics affect FLW generation along the FSC. (Kharola *et al.,* 2022).

Proposition 4(iii): Management's focus on customer orientation has a long-term impact on FLW. (Colicchia *et al.,* 2022)

Proposition 4(iv): Management Operational strategic style has tremendous impact on FLW. (Luo *et al.,* 2022).

Proposition 5: A Food Redistribution policy that aims to donate unsold products to needy people is a possible solution to reduce FLW.

Evidence suggests that food redistribution which has been put into practice by many firms in the Western world that aim to donate unsold products to needy people is a possible solution to reduce FLW. (Gerstberger and Yaneva, 2013).
The Administrative and Logistical structure of firms could impact their Food Redistribution policy and, hence, impact FLW. (Varese *et al.,* 2023).
Proposition 5(i): Infrastructure and legal issues impact Food Redistribution, and hence, the generation of FLW along the Supply Chain. (Abbade, 2020; Kumar *et al.,* 2020).
Proposition 5(ii): The Administrative and Logistical structure of firms could impact their Food Redistribution policy and, hence, impact FLW. (Belavina 2021).
Proposition 5(iii): There is impact of 'in store donation' on the costs and quantities of FLW. (Varese *et al.,* 2023; Thapa Karki *et al.,* 2021).

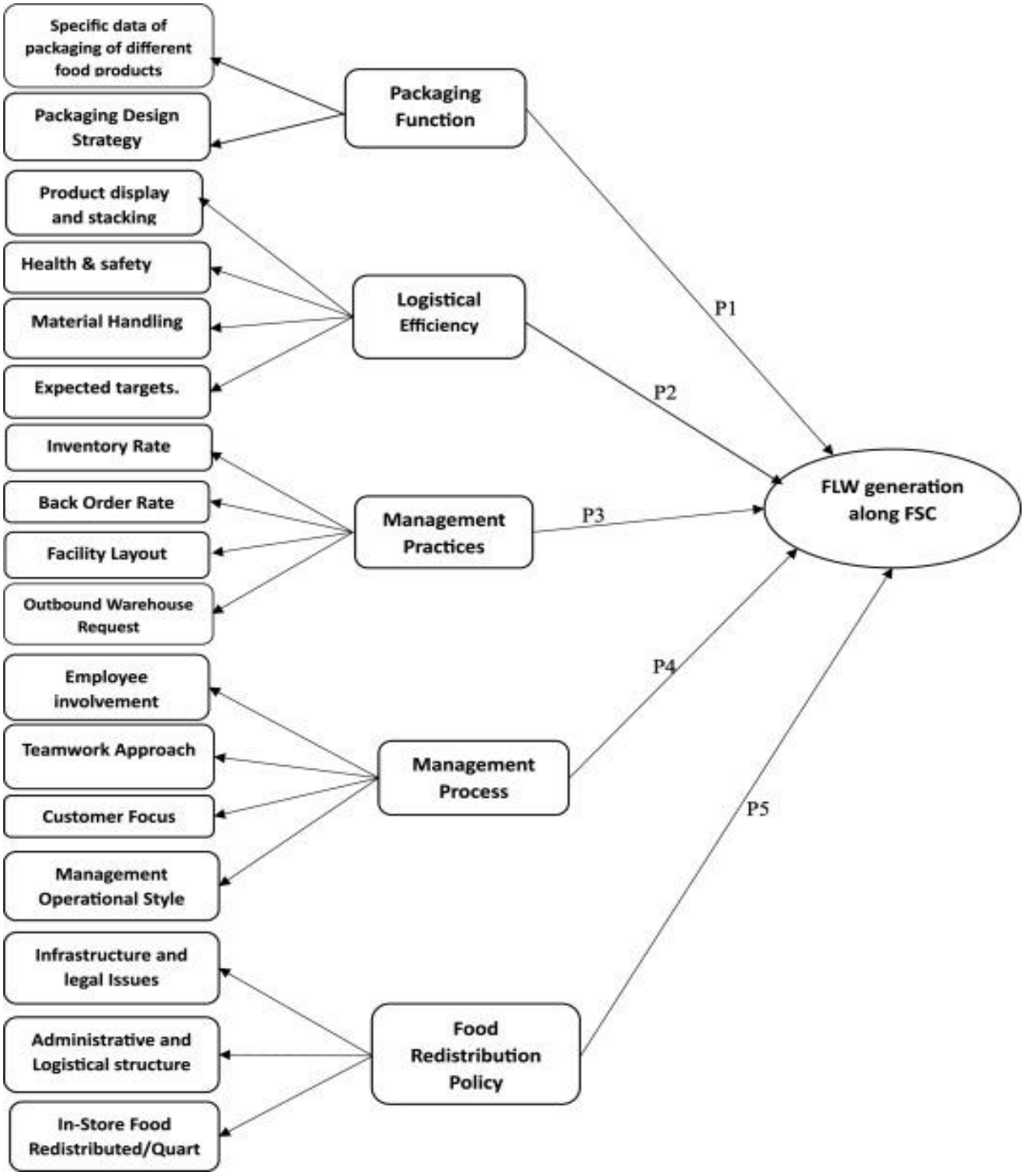

Figure 13: Proposed Framework. (Designed by Researcher)

The proposed framework emerged from the SLR is shown above in Figure 13. This reveals different elements that contributes to the generation of FLW along the FSC. Evidence has shown that financial considerations significantly influence firms' decisions on investing in facilities to optimize food stacking, potentially reducing FLW (Beausang *et al.,* 2017). Integrating health and safety strategies through sustainable worker training enhances logistics efficiency, impacting FLW (Derqui *et al.,* 2018). Workers' productivity and meeting targets

also influence FLW in the FSC, posing environmental concerns (Pietzsch *et al.,* 2017). The buyer-supplier contract's impact on food overproduction affects inventory levels, back-order rates, and facility layouts, contributing to potential waste (Jamani, 2018). Balancing food production with consumption needs careful consideration, often overshadowed by financial incentives.

Also, packaging strategies influencing FLW have received insufficient attention but are crucial for sustainable product/package design and development. Gathering product-specific data on packaging's influence on food waste (e.g., yogurt, dry pasta, bread) is essential (Lindh *et al.,* 2016). Exploring the impact of packaging design strategies on FLW across the FSC is necessary. In addition, operational planning and food product management significantly influence FLW (Pietzsch *et al.,* 2017). Employee engagement in operational planning and strategic management styles profoundly affect FLW generation in the FSC.

Food redistribution, implemented widely in the Western world to donate unsold products to those in need, offers a potential solution for reducing FLW. Infrastructure and legal considerations significantly affect its effectiveness along the supply chain. Analysing the concept of "awareness of the need" in redistribution and the impact of in-store donation on FW costs, quantities, and store image is crucial. Additionally, understanding who benefits—needy individuals or regular clients—impacts ecological and social outcomes. The administrative and logistical structure of firms plays a critical role in shaping their food redistribution policies and influencing FLW.

2.6.1. The Coherence of Propositions with Papers Reviewed.

There are 87 papers reviewed and there are strong correlations between those papers reviewed and the proposals identified in the conceptual framework.

It should be noted that eighteen (18) of the eighty-seven (87) papers discussed Logistical Efficiency with about 80% of the identified papers which consists of the following variables, (i) stacking of food products, (ii) Material Handling and (iii) Expected Targets as indices of Logistical Efficiency and close to 20% identified also, Health and Safety as one of the indices.

Sixteen (16) of the eighty-seven (87) papers considered Management Practices with mostly all these papers indicated that all the variables listed are linked to Management Practices. Twenty (20) of the eighty-seven (87) papers examined Packaging Functions and all the papers identified, highlighting packaging design strategy and specific data of packaging of different food products as indices of Packaging function. Fourteen (14) of the eighty-seven (87) papers discussed Management Processes and all the papers indicated that all the variables listed are

associated with Management Processes. Eleven (11) of the eighty-seven (87) papers examined Food Redistribution Policies as a factor affecting FLW. All the papers assessed the variable listed in the conceptual framework as being associated with Food Redistribution Process.

Table 10: Key literature supporting the propositions

FLW generation along FSC	**Key elements**	**Key references**
Logistical Efficiency	*Stacking of Food Products*	*Quynh et al., (2021). Sánchez-Teba et al., (2021)*
	Material Handling	*Bates and Phillips (1999). Kaipia et al., (2013)*
	Health & safety	*Mithun (2021). Amicarelli and Bux (2020). Wu, and Huang (2018).*
	Expected targets.	*Gokarn and Kuthambalayan. (2019). Manzini et al., 2014.*
Management Practices	*Back Order Rate*	*Somlai (2022). Silvestri et al., (2021). Janousek et al., (2018).*
	Inventory Rate	*Wang et a., (2019) Luo et al., (2021).*
	Facility Layout	*Akkaş and Gaur (2022). Pakseresht et al., (2022). Azadivar and Wang. (2000). and Cancellara. (2019).*
	Outbound Warehouse Request	*Voldrich et al., (2017). Genovese et al., (2017).*
Packaging Function	*Specific data of packaging of different food products*	*Morashti et al., (2022). Ada et al., (2022). Dora et al., (2022). Brennan et al. (2021).*
	Packaging Design Strategy	*Wikström et al., (2019). Beitzen-Heineke et al.,2017. Verghese et al., (2015). Sasaki et al., (2022).*
Management Process	*Strategic Style*	*Luo et al., (2022) Pullman and Wikoff (2017). Aschemann-Witzel et al., (2017). Da Silva et al., (2025).*
	Teamwork Approach	*Kharola et al., (2022), Lemaire, and Limbourg (2019).*
	Employee involvement	*Jones et al., (2008). Krishnan et al., (2020). Strotmann et al., (2017).*
	Customer Focus	*Colicchia et al., (2022). Gokarn, and Kuthambalayan (2017)*
Food Redistribution Policy	*In-Store Food Redistributed Per Quarter*	*Varese et al., (2023). Thapa Karki et al., (2021). Lemaire, and Limbourg (2019).*
	Environmental, Infrastructure and legal Issues	*Jones et al. (2008) Carter et al. (2020), Abbade (2020). Kumar et al., (2020).*
	Administrative and Logistical structure	*Belavina, E. (2021), Salim et al., (2021). Amicarelli and Bux (2020)*

2.7. Scope of Future Research.

These research findings have implications for future studies and practice. First, the agri-food industry supply chain is the area where work should be conducted to effectively reduce FLW. Therefore, future research should identify company practices that impact FLW. This includes poor management of perishable food items along the FSC, stakeholder attitudes, buyer-supplier agreements, and supply chain interruptions. Further research should also focus on how to identify and overcome weaknesses in communication structures between company leadership and employees, as it affects food waste in FSC (Kharola *et al.*, 2022).

Further research is required to address the need for a comprehensive approach to the packaging of food supply chains. This includes whether better packaging strategies could contribute to FLW minimization in logistics (Wikstrom *et al.*, 2019). Therefore, future research needs to understand and collect data on how various packaging purposes affect food wastes along the FSC for different food products. In addition, it is important to develop purposeful design methods to improve packaging with regards to FLW.

Furthermore, it is vital that future research examines how supply chain operational processes affect FLW. We propose that future research should apply the findings of this study to real-world trials to measure the actual improvement caused by changes in supply chain operations.

Studying the "awareness of need" concept in redistribution and the impact of in-store donations on FW costs, quantities, and store image is crucial. This approach could simplify food products redistribution network design. Additionally, examining whether FW benefits needy people or regular clients reveals different ecological and social impacts. Finally, infrastructure and legal issues significantly influence food redistribution and FLW generation along the supply chain.

The study provides a critical analysis of the existing literature to provide the propositions. This study can be used by the practitioners and researchers to understand the role of strategies on FLW.

2.8 Conclusion

This literature review critically analyses existing literature to examine environmentally friendly strategies in Food Loss and Waste (FLW) Management within the Retail Food Supply Chain (FSC). It aims to assess how different packaging strategies for food products affect FLW generation, evaluate the influence of logistical efficiency factors like material handling, stacking, and target expectations on FLW, determine the management strategies and practices' role in FLW issues, and investigate how FLW reduction strategies impact operational aspects of the FSC, including efficiency, speed, quality, responsiveness, and inventory policy.

The main findings indicate that FLW occurs at all stages of the supply chain and faces several stage-dependent variables, identified as food packaging strategies, supply chain management processes, firm practices along the FSC, and network design of food redistribution.

Evidence shows that packaging systems play a critical role in reducing FLW. NGOs, governments, and firms must ensure improved packaging practices are part of their circular economies and sustainability agendas.

Small changes in food packaging can significantly affect sustainable development. Balancing product protection and packaging material use can lead to resource savings, reduced environmental impact, and increased overall system efficiency.

This research proposes that environmental sustainability supply chains are best achieved with pragmatic management techniques involving logistical efficiency and good packaging strategies. The capacity for change and transformation is directly related to sustainability.

The articles suggest firms need to address management practices adversely affecting the FSC. Proactivity and dedication can be effective if the corporate model and sustainability elements are closely integrated.

Company involvement in charity impacts FW costs, quantities, and store image, potentially addressing FLW along the FSC. One could study whether FW benefits needy people or regular clients, as this has different ecological and social impacts.

Mixed outcomes in some studies create opportunities for further research. The UK government's collaboration with major supermarkets highlights the importance of research in Sustainable Chain Management Practices and focusing on FLW along the FSC.

Recent organizational interest in the environmental impact of supply chain activities provides evidence to examine how these activities impact the environment and how FSC management could significantly reduce FLW.

However, there are limitations, including the inability of some organizations to release essential data and the research's restriction to specific subjects, impacting the number of papers reviewed.

Researchers can overcome challenges in obtaining primary data from food retailers through strategic planning, ethical communication, and technology. Utilizing secondary data and ensuring robust data quality and security are also key. Formulating clear research questions, establishing protocols, and building strong relationships with managers are crucial. Transparency about research goals, methods, benefits, and risks is paramount. Researchers must also be aware of any limitations imposed by the food retail firms.

Chapter 3: Understanding the Environmental Impact of Packaging, Logistical Efficiency and Food Alternative Uses on FLW in the UK Food Retail Firms

3.1. Abstract

The food supply chain (FSC) in the retail sector faces complex sustainability challenges. Mishandling resources generates significant food waste, leading to environmental pollution. To identify the causes of food loss and waste (FLW) and methods for minimization, this study adopts a case study methodology, conducting 32 semi-structured interviews across five major UK food supply chain companies. Both in-case and cross-case analyses were performed to evaluate how pollution prevention practices improve operational and managerial performance. The theoretical bedrock of this research is the Natural Resource-Based View (NRBV), which posits that integrating environmental capabilities specifically pollution prevention and sustainable development produce a strategic competitive advantage. Opportunities for reducing FLW stem from sustainable practices, including optimized product packaging and enhanced logistical efficiency.

However, the findings indicate a critical barrier: while most food retailers recognize the importance of pollution prevention, they often possess limited knowledge or exhibit an unwillingness to integrate these practices due to immediate financial pressures and ingrained cultures of overproduction. Despite these hurdles, the research highlights that adopting flexible, intelligent, active, and sustainable packaging made from biodegradable materials offers significant advantages. These packaging innovations are space-saving, customer-friendly, and environmentally conscious.

The insights from this study provide a practical roadmap to assist UK practitioners in making tactical and strategic decisions to implement sustainable FSC practices. It emphasizes that incorporating and repositioning pollution prevention alongside operational and management improvements are critical factors for developing an efficient supply chain and significantly reducing FLW. Theoretically, this research extends the retail sustainability discourse by exploring smart packaging and logistical practices that extend shelf life actively modifying the food's internal environment and providing vital data in support of NRBV. Ultimately, these findings offer a fresh perspective on leveraging information and operational shifts to combat FLW.

Keywords: sustainability; food loss and waste; sustainable Practices; food supply chain.

3.2 Introduction.

Food waste is anything that provide no value for the customer, contribute nothing to the bottom line, but absolutely has a cost (Browning, 2016). It occurs in every level of the food supply chain and within every activity that takes place. The ultimate lean target is the total elimination of food wastes. While this is practically impossible to achieve, it should still be the ultimate goal. When a firm can change its policy away from "that is just how we do it mentality" the firm can start developing lean business process by identifying and eliminating key areas of food product waste (Omolayo, 2021).

One-third of the yearly food produced in the world for human consumption (which is estimated to be around 1.3 billion tons) is either wasted at consumption or lost along the food supply chain (FSC) (FAO, 2011; 2014). Globally, about 13 percent of food produced is lost between harvest and the supply chain and about 17 percent of food produced worldwide is wasted domestically, in the food service and the supply chain (United Nation, 2022). Food loss and waste (FLW) accounts for 24% of freshwater use, 28% of total global cropland area, 23% of global fertiliser use (Kummu *et al.,* 2012) and about 12% of perishable food products are wasted globally (FAO, 2013). Reducing the amount of FLW into halve have been the concern of major retail firms in the UK and could ensure the reduction of emission from food production by 20–30% (Bajˇzelj *et al.,* 2014). Although about 15.8% of the world population (nearly 815 million) is malnourished (FAO *et al.,* 2022) and by 2050 9.6 billion people will need to be sufficiently fed (United Nations, 2017), wasting foods characterises a modern environmental, economic, social and moral challenge on a universal scale, which requires urgent political attention (FAO, 2013; Teigiserova *et al.,* 2020).

One of the new actions taken in tackling and managing FLW is the adoption of the sustainable supply chain management that has been reinforced by the EU policies (European Commission, 2022). FLW prevention is identified as the top priority and an integral part of an EU Action Plan (Gitton, 2025). The Sustainable Practices Action Plan not only puts forward a series of actions to promote more workable production and patterns in EU food system, e.g. food donation, food alternative use, improved packaging and labelling awareness, but also promotes the use of bio-technologies and practices to convert FLW into different types of valuable bio-based products for long-term socio-economic and environmental benefits (Maina et al., 2017; Zabaniotou and Kamaterou, 2019). Furthermore, EU procedure for FLW quantification is also intended to ensure the steady and dependable measurement, monitoring, and analysis of FLW data. These measures ensure that the EU meets the United Nations' Sustainable Development

Goal. Also, the company executives of five big supermarkets in the UK have agreed to halve environmental impact of weekly food shops by 2030 during COP26 summit in Glasgow in November 2021. (COP 26)

As playing an instrumental role in the transition towards the sustainable practices, FLW has attained recognition in the academic discourse with exponential growth in related publications over the last five years. (Jaswani, 2021). Sustainable operations within the food supply chain aim to minimize environmental impact, guarantee economic viability, and promote social responsibility across the entire process, from production to consumption. This comprehensive approach encompasses key elements such as reducing food waste generation, optimizing resource utilization, and diligently implementing ethical and fair practices for employees and their relationships. Fundamentally, sustainable food supply chain operations are dedicated to ensuring the long-term viability and resilience of food production and distribution systems, while simultaneously striving to minimize their overall negative environmental footprint on a global scale. (Accorsi and Manzini, 2019; Center, 2024). Sustainable operations performance in the food supply chain signifies the ability to produce and distribute food while minimizing environmental impact, fostering social responsibility, and ensuring economic viability, all while maintaining or enhancing operational efficiency. This crucial balance involves adept resource management and diligent food waste reduction. Concurrently, it encompasses upholding social responsibility through positive employee relationships, active community engagement, and contributing to overall food security. This holistic approach ensures long-term system health and broad stakeholder benefits. (Leon-Bravo and Caniato. 2023).

Sustainable practices are significantly enhanced by efficient product packaging, logistical efficiency, and the adoption of food alternative uses. Sustainable packaging minimizes food waste, lowers carbon footprint, improves brand image, and reduces resource depletion. The use of cellulose-based, dry fibre materials in food packaging, for instance, represents a major step towards eco-friendly solutions, particularly ideal for perishable food products. (Dora et al., 2022). Logistical efficiency plays a crucial role in reducing food waste by optimizing routing through technology and real-time data, ensuring efficient handling and storage, and reducing environmental impact by minimizing transportation distances and optimizing delivery schedules. Furthermore, effective food alternative use practices such as repurposing or donating surplus food can further lessen the overall environmental impact associated with food waste, creating a more circular and sustainable system.

This research significantly advances the theoretical propositions (1, 2, and 5) established in paper one, which could be found in chapter two which highlighted a critical research gap: the insufficient attention paid to how diverse packaging functions influence Food Loss and Waste (FLW). Recognizing that products such as yogurt, dry pasta, and bread face distinct waste challenges, this study emphasizes that sustainable design must be product-specific. Furthermore, it argues that a rigorous management focus on logistical efficiency is paramount for waste mitigation. Beyond structural improvements, the research identifies food redistribution policies specifically donating unsold goods to those in need as a potential strategic solution. By integrating packaging strategies, logistical optimization, and food alternative practices, this study addresses the urgent need for empirical investigation within the UK food retail sector, providing a holistic framework to align operational performance with environmental sustainability goals.

Although the systematic literature review (discussed in chapter 2), signify the central preparatory step for our study, two research limitations are identified. First, studies are constrained to specific topic areas, predominantly focused on food waste reduction at a specific point in the supply chain. However, Since FLW is a complex issue that cannot be credited to a single variable (Hussain, 2021; Kyriakopoulos *et al.,* 2019), a singular viewpoint is not enough. Secondly, the studies carried out in many cases are generally repetitive of previous studies and at times devoid of transparency and thoroughness and thus can be influenced by the researchers in making sense of present literatures (Tranfield *et al.,* 2013). We, therefore, attempt to overcome these limitations by extending its scope to the Product Packaging, Logistical Efficiency, and food alternative use adopted by food retail companies in the UK, putting into consideration their massive impact on the environment. Specifically, 3 research gaps emerged:

3.2.1. Research Gaps

1. Limited studies have been conducted to understand the FLW that occurs due to the packaging strategies of food products along the FSC in the major retail firms in the UK. (Lindh *et al.,* 2022).
2. Although a sustainable supply chain has been suggested as a mean of improving competitiveness, little evidence has been found regarding the FLW caused by logistical efficiency, such as technology, material handling, and stacking of food products and expected targets (Priefer *et al.,* 2016; Pietzsch *et al.,* 2017).

3. Particularly in the case of food retail companies, limited research has been found to support how the concept of sustainable management practices, such as Food alternative uses, could ensure FLW reduction and better operational performance (Bamber,2019).

In this regard, this study focusses on understanding the sustainable practices adopted by food retail companies in the UK and considers the challenges and barriers they face in relation to FLW improvement.

3.2.2 Research aims, and questions:

The research aims are:

1. To examine the impact of Food packaging strategies on FLW and how to reduce it.
2. To examine the logistical efficiency strategies on how it impacts the FLW.
3. To study how Management practices such as food alternative uses could impact FLW and Operational Performance.

This research bridges the gap identified by addressing the following research questions:

1. What are the impacts of various food product packaging strategies on food loss and waste (FLW) within the food supply chain (FSC)?
2. How does logistical practices, such as material handling, stacking techniques, and performance targets, contribute to or mitigate food loss and waste (FLW) in the food supply chain (FSC)?
3. How do sustainable management practices such as food alternative uses, solve or adversely affect FLW.

In this paper, an inductive research approach is used to address the research questions, making it possible to conduct a detailed investigation of the sustainable operational practices of food supply chain of retail companies. Data are collected from five case companies operating in the food supply chain through semi-structured interviews. In-case and cross-case analysis approaches are used to find out the current practices and prospect of sustainable strategies and implementation. Based on the pragmatic analysis of the data collected from case companies, this study evaluates the effect of sustainable FLW reduction practices on operational performance and discusses the challenges of integrating sustainable practices with food supply chain operational performance. Furthermore, this paper offers the procedures that can be used

by food supply chain to boost their operational efficiency while implementing sustainable practices. This paper addresses these logistical challenges through the lens of the Natural Resource-Based View (NRBV) (Hart, 1995), a framework incorporating corporate social responsibility (CSR), entrepreneurship, and environmental commitment (Johnsen *et al.*, 2014). CSR aligns with pollution prevention, entrepreneurship with product stewardship, and environmental commitment with sustainable development, including clean technologies (Menguc and Ozanne, 2005).

The remaining part of this paper is planned as follows: Section 2 shows the review of literatures in food supply chain of the retail companies operating in the UK, critically analyses the relationship that exist between them and provides a compact theoretical foundation for this research. Section 3 examines the conceptual framework and comprehensive discussion of the research methodology adopted in this study. Section 4 analyses the data collected and discusses the findings of both in-case and cross-case analyses. Section 5 discusses the suggestions made in this study and offers the recommendations to practitioners. The last section 6 concludes the paper with directions for future research.

3.3 Literature Review

3.3.1. Food Loss and Waste Defined

It is very pertinent to evaluate the scope of topic due to a lack of consensus to a precise definition of food loss and waste resulting in a interchangeable use of the concepts of loss and waste (FAO, 2019). The existence of multiple FLW definitions makes the data collection and comparison of FLW levels very complicated (Corrado and Sala, 2018), challenges the measure of the distance towards the SDG target (Jeswani HK, 2021), and hinders the analysis of FLW (FAO, 2019). There are two different parts of FLW definitions: the types of food waste (edible and inedible aspect of foods) and the boundaries in the FSC to be included (Corrado and Sala, 2018). For instance, FAO (2019) define FLW as "the decrease in quantity or quality of food along the food supply chain", and also differentiate food loss from food waste based on the stages of the food supply chain. Food loss is described as the amount of the edible parts of perishable food like crops, livestock and fish leaving the upper part of the FSC – from the post-harvesting, slaughtering, and catching stage up to but not including the retail stage – by being discarded or disposed of or incinerated (FAO, 2019). These stages typically consist of storage, transportation, processing and importing activities. Food waste arises at the downstream stages from retail to the consumption points. It refers to food not ultimately consumed and is discarded or recycled such as, food served but not eaten. Of note, the FLW's scope under the FAO's theoretical framework excludes not only inedible parts of foods but also the edible foods that are destined to an economically productive non-food use, such as animal feeds or industrial use. It therefore shows that FAO definition is not a wholistic consideration of what FLW encompass as it needs to be broadened to include categories of FLW. It is interesting to know that Fusions (2014), on the other hand, includes all parts of foods, both edible and inedible in its proposed FLW definition, but it does not distinguish food loss and food waste. Fusions (2014) also highlighted the difference between food surplus and food waste. Although food surplus is still a part of FSC and fit for human consumption, it would end up as food waste if no prevention or alternative use is carried out. As a result, prevention, finding food alternative use, and redistribution to humans are only applicable to food surplus (Ng *et al.,* 2019). While the paper acknowledges differences between various concepts, the scope of FLW terminology used hereafter in this paper will encompass perishable FLW as defined by FAO (2019) as well as food surplus that arise from all stages of the FSC as defined by Fusions (2014). The perishable foods referred to in this study includes, fruits and vegetables, dairy, fish and meat products which have limited shelf life after harvest or production.

3.3.2 An overview of Food packaging strategies

Food packaging is a comprehensive system evolving rapidly to meet sustainability goals, with the primary objective of ensuring the safe and cost-effective delivery of food from suppliers through retailers to consumers, all while minimizing environmental impact (Zhang and Zhao, 2012). Its critical functions are multifaceted: it shields food products from physical damage, biological threats (like microbes), and environmental factors (such as oxygen and moisture). Furthermore, effective packaging significantly serves to extend the shelf life of food, which is key to reducing spoilage and, consequently, Food Loss and Waste (FLW) (Zailani *et al.,* 2012). Packaging also consists of granular materials crucial for efficient handling and transportation. Finally, it utilizes labels to communicate essential product information, including ingredients, nutritional facts, storage instructions, and critical expiration dates.

Previous studies have examined different factors such as the shelf life of perishable food, consumer behaviour and environmental repercussions of food packaging. The result of these studies shows an important correlation between plastic packaging and the surge in fresh food waste (WRAP, 2022). Therefore, firms across the globe are gradually looking to reduce the negative environmental impacts of perishable food loss as a result of poor packaging. The food packaging design involves the use of a lot of natural resources and energy sources. Firms have started noticing the limits of currently available raw materials for packaging of fresh food products and the difficulties encountered in ensuring significant reduction in FLW through better packaging and therefore in search for greener raw materials for packaging (Gislam, 2022). A new system for packaging is needed in the food supply chain in which the raw materials that contribute significantly to FLW could be reduced and also the packaging materials could be reused and recycled. Firms are increasingly recognizing that conventional packaging limits FLW reduction and are seeking greener alternatives. Consequently, the adoption of flexible and intelligent packaging has grown. This includes smart packaging, using RFID or QR codes for product tracking, and active and sustainable packaging, employing biodegradable materials (like combined plastics, cardboard, and foil) for internal environment modification and extended shelf life (Huang, 2017). These innovations offer space-saving, customer-friendly, and environmentally conscious advantages, granting implementing food retail firms a competitive edge (Dora *et al.,* 2022). To device an effective packaging strategy, it is pertinent to reduce the FLW by ensuring good packaging food products, to save limited resources, to protect the environment, and to apply the sustainability concept in material selection, processing, producing, storage, transport, reusing and recycle (Xueyan, 2015). Early

studies on companies operating in the food supply chain stressed the characteristics like shape and size while role and appearance of the food packaging were the most evaluated factors and the environmental issues have not drawn much attention (Roper and Parker, 2006).

From the middle of the 20th century, the firms have been under increasing pressure from media and consumers around the world because of its negative impact of food packaging on the environment. Zhang and Zhao (2012) concluded that food packaging can generate both solid wastes as well as liquid and gaseous pollution. Most of the criticisms particularly concentrate on the use of plastic as the major part of food packaging. Meikle (1995) stressed the threats of use of plastic, saying that plastic packages have occupied every part of life and it will damage the balance between human force and nature's power.

Past literatures have focused on reducing the environmental impacts related to sourcing and producing food packaging materials, and salvaging of the materials at the end of use. However, they have neglected how the packaging design fits into the automated system of each retail firm and how this could affect the logistical efficiency of the firms concerned. They have also not focused on the sustainable strategies adopted in the retail firms which include the selection of more renewable materials, using flexible materials in replace of consistent use of plastics, supporting the effective energy consumption relating to sourcing, producing and converting packaging materials (European Council 1994). Zailani *et al*. (2012) stressed the importance of sustainable food packaging by stating that it has direct effect on a firm's economic and social outcomes. Svanes et al. (2010) also described a holistic methodology for food packaging design with the Norwegian food industry as a case study. Huang (2017) argued that in order to increase the value of the food products, multi-layer packaging or expensive materials are used without consideration of its cost and resulting in the packaging costs even higher than the value of the food products. Such packaging not only result in more cost to the consumers, but also wastes more resources, increase production costs and recovery difficulties, and are not in support of the development direction of sustainable packaging. Therefore, the packaging strategy should be simplified on the principle of ensuring the safety of perishable food products. Williams and Wikstrom (2010) explored the environmental impact of the food-packaging system with a life-cycle view. Their study identified six stages of the food-packaging system: Production, Processing & Packaging, Handling & Storage, Distribution, Retail/Consumption and End of Life Waste Management. However, little research on the causes of food waste generated along the FSC as a result of food packaging has been published.

Although packaging is identified as an important stage in the food supply chain to keep and protect the food content from being wasted during, wholesale, retail, transport and final consumption, the environmental impact of different types of food packaging waste is progressively being deliberated upon in the literature (Wikstrom *et al.,* 2014; Accrosi *et al.,* 2014). In fact, the packaging strategies can play a crucial role in developing a sustainable food supply chain. Sustainable packaging is one of the importance and critical stages in improving not only the environmental progress of the companies operating in the food supply chain, but also the economic progress. Furthermore, the environmental impact of food packaging is also attracting increased attention in the literature. Verghese and Lewis (2007) suggested the need for cooperation between food supply chain approaches and environmental innovation in reducing food product costs and enhancing efficiency in food packaging. An increasing number of studies have discussed environmental issues in the use of plastics as major component of food packaging. Pohlen and Farris (1992) examined the reverse logistics channels for recycling in plastics packaging. Brown (1993) also examined the recovery stage of product life cycle in plastic packaging of food with the case of polypropylene-based snack food packaging. Packaging features can impact the distribution stages, as moderate and effective packaging can reduce material used thus making the food supply chain environmentally friendly (Sarkis, 2003). Diabat and Govindan (2011) discovered that one of the most important environmentally friendly practices in the packaging of food products is to reduce packaging materials and food waste while still meeting the needs of consumers.

Previous studies discuss the reasons why firms are not buying environmentally friendly packaging materials for the packaging of food products. One direct and simple explanation is the cost. (Bech-Larsen, 1996). Lewis (2005) pointed that another cause is the lack of knowledge about the relationship between their decisions and the costs of such decisions. Globally, companies operating in the food supply chain are consistently designing new packaging formats and materials that can fit into their automation system and easy to transport and handled. Zhang and Zhao (2012) stated that the pollution caused by packaging waste ranks the fourth largest source of pollution. Poor packaging design by firms were directly responsible for this result, but other possible reasons may include failure to meet the environmental requirements. The UK government has in place, new regulations to better manage the environmental issues caused by the poor packaging of food. (OEP, 2021) Specific measures include reduced use of plastics in food packaging, advanced quality standards in food packaging, standardised labelling in food packaging, etc. The packaging of food products has

undergone high continuous regulatory procedures that are environmentally friendly not limited to the use of the good packaging material but aiming to make the food supply chain more efficient.

3.3.3 Logistical Management and Efficiency

The logistical management and efficiency of food supply chain have suddenly come to the attention not only of scholars but business executives in the UK in recent years (Pasparage, 2016). They have become a core competence and tactical weapon that many firms are using to boost their competitive positions (Defra, 2022). However, the food supply chain managers are experiencing difficulties in devising management strategies that not only result in reduction of operational cost of the supply chain but which also leads to logistical efficiency and FLW reduction (Muth *et al.,* 2019). Few studies have paid attention to these difficulties wholistically. Some of the challenges like food product waste, constant request to reduce inventory, integration of every level of the food supply chain, challenges in logistics thinking from push and pull setting, and management ever increasing request to develop measurement and operational responsibilities are becoming very challenging to overcome which demand that managers of food supply chain device methods to improve their operational process (Filimonau and Gherbin, 2017; Teller *et al.,* 2018).

The planning, management and enhancement of the operations of the food supply chain demand a much more pragmatic approach in order to significantly reduce food product wastes. The questions constantly before the food chain managers are, what area of the operation process needs attention and improvement which could lead to FLW reduction. What is the effect of material handling in the generation of food products, what are the effects of meeting late orders vis-à-vis the expected demand from pickers to meet targets and what aspect of management strategies in the warehouse needs to be changed? According to Joann Brumsey (2014), a simple but often overlooked tools are preventive measures which are part of operations schedules. An important systematic approach to the successful running of the food supply chain is the consciousness and acceptance supply chain requirements for success (Muth *et al.,* 2019; Centobelli *et al.,* 2020; Wiener *et al.,* 2020). A successful operational food supply chain will have high regards for customers by identifying their requirements and providing a means of meeting the requirements constantly (Pagotto and Halog, 2016). In addition, approach to success means that standard will be established, performance such as FLW generated quarterly, Health and safety, inventory accuracy, and labour Efficiency/Absenteeism will be measured

against standard using the Key performance Index (KPI) and prompt action taken to correct the deviation. (da Costa Maynard *et al.,* 2020).

Furthermore, Boiteau and Pingali (2023) indicated that system and techniques ought to be continuously examined by tools such as the Value Steam Mapping which allows supply chain managers to proactively plan their operations and monitor activities and performance of each section of the supply chain operations. This invariably would help managers in identifying where attentions are needed in order to meet the company's set standard. The Value Stream Mapping is a supply chain technique used to document, investigate and develop flow of information or level of inventory required to meet the demands of customers (Porter et al., 2016). This tool is very useful when devising a plan to reduce food product waste in the supply chain. It takes into consideration the management and information flow techniques that sustain the basic operational process and are closely used in monitoring the activities of pickers in the automation system. The mapping device is built into the system in such a way that it becomes very easy to monitor the activities of pickers.

3.3.4 The Importance of Sustainable Practices

Sustainability is contributing significantly in the role in planning and management within organizations and across food supply chains (Kleindorfer *et al.,* 2015; Linton, Klassen and Jayaraman, 2017; Srivastava, 2017). In its widest idea, sustainability has been defined as meeting existing needs without compromising the ability of future generations to meet their own needs (UN Documents, 1987). In management research and withing the context of food supply chain, it has been included within the framework of corporate social responsibility (CSR) and commonly assessed through a range of social, cultural, legal, political, economic and natural environmental dimensions (Wood, 2010).

Implementing sustainable practices in food retail faces several challenges. These include high initial costs, the inherent complexity of supply chains, and difficulties in measuring impact. A significant hurdle is the necessary cultural shift within firms. Additionally, balancing economic considerations with environmental goals, navigating evolving regulations, and managing diverse customer expectations further complicate adoption. There is a concept of sustainable practice that shows that firms can realise competitive reward via the prioritisation of sustainability amongst companies operating in the food supply chain. This concept was offered by (Stuart Hart,1995). it is pertinent to know that food waste is a major contemporary issue (Pagotto and Halog, 2016), and one in which supermarkets are the major contributors. Analysis

of the related literature indicates ways in which retailers can also reduce food waste. Information about varieties of such problems in the retail sector and potential reduction strategies are offered below.

In the food retail sector, the principal causes of food waste can be credited to problems in the management of supply chain operations and store supplies. Problems related to the former could be linked with the size of the food retail organisation. The literature shows that large companies operating in the food supply chain, with their many varieties and quantity of food items, tend to have higher levels of food waste (Filimonau and Gherbin, 2017; Teller et al., 2018). Food waste could also come from problems food handling, supply chain infrastructure and hygiene, such as in the refrigeration, processing, transport, and receipt of products (Jagtap and Rahimifard, 2019; Kumar *et al.,* 2020; Santos et al., 2020). These problems can be aggravated by the particular store manager's lack of autonomy (Filimonau and Gherbin, 2017), a scarcity of skilled personnel or effective leadership (Mithun Ali *et al.,* 2019), and the non-adherence to the best management practices used among other, similarly-structured organisations (Lebersorger and Schneider, 2014).

3.3.5 Theoretical background

As management theorists, we identify the Natural Resource-Based View (NRBV) as most suitable for theorising on FLW reduction. The NRBV of the firm was offered by Stuart Hart in 1995 as a means by which to realise competitive reward via the prioritisation of sustainability. The theory still features with importance in current literature as an innovative and competitive approach to sustainable operations (Shi *et al.,* 2012; Matapolous *et al.,* 2014; Johnson *et al.,* 2014; Miemczyk *et al.,* 2016).

The NRBV covers resource-based theories of the firm by clearly recognising the natural environment as a resource limitation, suggesting that, to pursue competitive advantage, firms must develop strategic capabilities in the areas of pollution prevention along the food supply chain, and maintain product, and sustainable development (Hart and Dowell, 2011). Pollution prevention includes the substitution of processes and materials to reduce the environmental impact of food products through continuous improvement. The NRBV, studies the environmental impact of firms' resources and of the processes emanating from these resources (Hart, 1995; Hart and Dowell, 2010). Effective Food Products Reduction innovation from a NRBV should both enable a firm to gain a competitive advantage and be favourable for the natural environment. The research area of Green Supply Chain Management (GSCM) has

received an upward interest. Green supply chain management (GSCM) involves sustainable environmental processes built into conventional supply chains from manufacturing or suppliers through the warehouse and retail shops to end-of-life management with the aim of achieving significant reduction in Food Waste Gilbert (2001).

3.3.6 The Natural-Resource-Based View & Sustainable Food Supply Chain Management

It is not just Shi *et al.,* (2012) who argue links between the NRBV and the Food supply chain, but rather an inherent reliance on supply chain management is implied throughout NRBV literature (e.g. Hart, 1995; Johnsen *et al.,* 2014; Matopoulos *et al.,* 2014). This is perhaps linked to the argument that sustainability falls into supply chain jurisdiction (Faisal, 2010) on account of the broadly accepted assumption that sustainability is dependent on a contribution from each player in a supply chain (Seuring & Müller, 2008; Abbasi and Nilsson, 2012 Giminez and Tachizawa, 2012; Miemczyk *et al.,* 2012; Jensen et al., 2013). More specifically, it has been argued that supply chain management should be maximised to support the protection and conservation of natural resources (Matopoulos *et al.,* 2014). The same too can be said of competitiveness, in that it is not derived from a firm in isolation but rather from the Food supply chain (Markley and Davis, 2007; Prajogo and Sohal, 2013). Thus, links between the NRBV and supply chain management emerge with logic.

Of particular interest is the growing school of sustainable supply chain management (SSCM), which as a result of its focus on competitiveness and sustainability (Faisal, 2010; Ashby *et al.,* 2012; Walker and Jones, 2012; Svensson and Wagner, 2012; Golicic and Smith, 2013; Prajogo and Sohal, 2013; Wu, 2013), bears considerable parallels the NRBV, and interestingly profound connections with corporate social responsibility and the triple-bottom-line concept (Boken *et al.,* 2013; Berger-Walliser and Shrivasta, 2015). As well as benefitting from extensive research surrounding its successful application (Abbasi and Nilsson, 2012; Giminez and Tachizawa, 2012; Miemczyk *et al.,* 2012; Johnsen *et al.,* 2014; Fahimnia *et al.,* 2015), SSCM is also argued to benefit from widespread industry acceptance (Johnsen *et al.,* 2014). Thus, linking the NRBV with SSCM is of great value: the latter offering practical applicability for the former and both benefiting from refinement and definition.

NRBV theory has been used in numerous environmental and sustainability studies (Ashby *et al.,* 2012; Pagel and Shevchenko, 2014). It has been widely accepted that NRBV initiate a form of resolve for firm to acknowledge that sustainability presents one of the most prominent

opportunities for business in the 21st century (Ashby *et al.,* 2012; Pagel and Shevchenko, 2014). From a resource-based theory perspective, resource array can be realised via diverse approaches to sustainability that support Food loss and waste management (McWilliams and Siegel, 2001; Ashby *et al.,* 2012; Pagel and Shevchenko, 2014).

This paper addresses these logistical challenges through the lens of the Natural Resource-Based View (NRBV) (Hart, 1995), a framework incorporating corporate social responsibility (CSR), entrepreneurship, and environmental commitment (Johnsen *et al.,* 2014). CSR aligns with pollution prevention, entrepreneurship with product stewardship, and environmental commitment with sustainable development, including clean technologies (Menguc and Ozanne, 2005).

(a) Pollution Prevention.

Pollution prevention Hart's (1995), which in line of growing concerns of ecological degradation, promotes the minimisation of Food Products Waste and emissions throughout the supply chain. The focus is shifted away from traditional management or disposal of food waste and emissions, to instead prevent their initial occurrence (Aragon-Correa and Sharma, 2003). In doing so, pollution prevention is intended to reduce costs associated with food waste and emissions and maximise efficiency (Hart, 1995; Russo and Fouts, 1997), encouraging its presentation as a competitive cost cutting strategy (Hart, 1997; Christmann, 2000; Hart and Dowell, 2011.

More specifically, Pollution prevention seeks to promote environmental sustainability whilst simultaneously cutting costs and maximising efficiency throughout internal operations (Hart and Dowell, 2011). In preventing internal food waste and emissions (Aragon-Correa and Sharma, 2003) costs associated with disposal are avoided and internal operations streamlined (Russo and Fouts, 1997; Christmann, 2000).

(b) Product Stewardship

Product stewardship, encourages the prioritisation of the natural environment throughout each stage of the food product supply chain (Hart, 1995). That is, assuming a lifecycle perspective of production and presenting the natural environment as a key stakeholder, environmentally damaging processes are minimised, and conservation and avoidance of harmful productions maximised. Attention is also turned to environmental end of-life practices, with Hart (1995) discussing the value of recyclability or take-back as opposed to traditional disposal methods which pose environmental threat.

Product stewardship extends environmental sustainability towards external operations, seeking conservation, avoidance of harmful substances and recyclability from a lifecycle perspective (Hart, 1995).

In product stewardship, the shift towards a lifecycle perspective of environmentalism (Hart, 1995) forces consideration of the food supply chain (Miemczyk *et al.,* 2016). As such, it is generally accepted that product stewardship places a dependency on supply chain FLW reduction strategies (Vachon and Klassen, 2008; Ashby *et al.,* 2012; Shi *et al.,* 2012; Wu, 2013). Comparisons to product stewardship emerge out of paralleled motives of sustainability and competitiveness via the creation of innovative and holistic operations (Soosay *et al.,* 2008; Vachon and Klassen, 2008, Ashby *et al.,* 2012; Golicic and Smith, 2013; Jensen *et al.,* 2013; Prajogo and Sohal, 2013; Wu, 2013)

(c) Sustainable Product Development

Sustainable product development aims to promote the consideration of economic, environmental, and social issues on a global scale (Hart, 1995). Sustainable development links economic, environmental, and social issues together to 'seek ecologically sustainable and socially-just development world-wide' (Shrivastava and Hart, 1995). As such, firms are expected to go beyond the environmental alleviation intentions of pollution prevention and product stewardship in pursuit of positive impact operations (Hart, 1997). The fundamental role of business in sustainable development is needed, in that to overcome FLE issues, and meet the demands of growing populations with industrial and economic activity substantially multiplying, further adding to environmental degradation, A consistent environmentally friendly strategy is necessary in the FSC. More specifically, such increased activity intensifies pressures on the earth's natural resources, which are already mismanaged via traditional business processes, contributing to degradation of eco-systems which human life is dependent (Song *et al.,* 2015). Thus, sustainable development encourages both the creation of new manufacturing and logistical processes in support of environmental advancement and new business markets in the south in support of economic and societal advancement (Hart, 1995). Opportunities for competitive gain arise in the creation of such processes ahead of competitors and access to new, unsaturated markets of the future (Prahalad and Hammel, 1994). Firms who successfully identify and respond opportunities in the natural environment may benefit from sustainable and competitive gains, delivering competitive sustainability (Li and Lui, 2014). This inspired initial conceptualisation of three sustainability resources aimed at both sustainable advancement and firm gain: pollution prevention, product stewardship and

sustainable development. Such resources are made up of internal organisational capabilities and routines and exploitation of external issues of environmental and social degradation (Hart, 1995; Hart and Dowell, 2011).

3.3.7 Implications of NRBV for Firm Performance on FLW Reduction

Food firms possess a significant opportunity to achieve competitive advantage by leveraging the inherent links between the Natural Resource-Based View (NRBV) and Sustainable Food Supply Chain (FSC) management. While existing literature touches upon this connection to some extent (e.g., Ashby *et al.,* 2012; Johnson et al., 2014; Miemczyk *et al.,* 2016), the synergistic relationship between NRBV principles and sustainable FSC management strategies, particularly its direct impact on Food Loss and Waste (FLW) reduction, has yet to be comprehensively investigated. Such an in-depth investigation holds immense value for the practical realization of the NRBV, especially given sustainable FSC management's extensive academic study and its widespread practical appeal and acceptance within the industry (Johnsen *et al.,* 2014; Pagel and Shevchenko, 2014). Furthermore, this exploration offers a clearer definition to the multifaceted and often complex management of sustainable supply chains (Miemczyk *et al.,* 2016). Notably, the theme of innovation consistently emerges as a crucial element in both NRBV scholarship (Hart, 1995; Aragon-Correa and Sharma, 2003; Hart and Christensen, 2002; Hart and Dowell, 2011) and effective sustainable FLW management strategies (Yam *et al.,* 2010; Ageron *et al.,* 2013). The literature affirms the strong presence and modern relevance of the Natural Resource-Based View (NRBV) in food retail firms. However, it also exposes the NRBV's limitations, including issues of impracticality, challenges in incorporating dynamic capabilities, and a disregard for its evolution beyond three core resources.

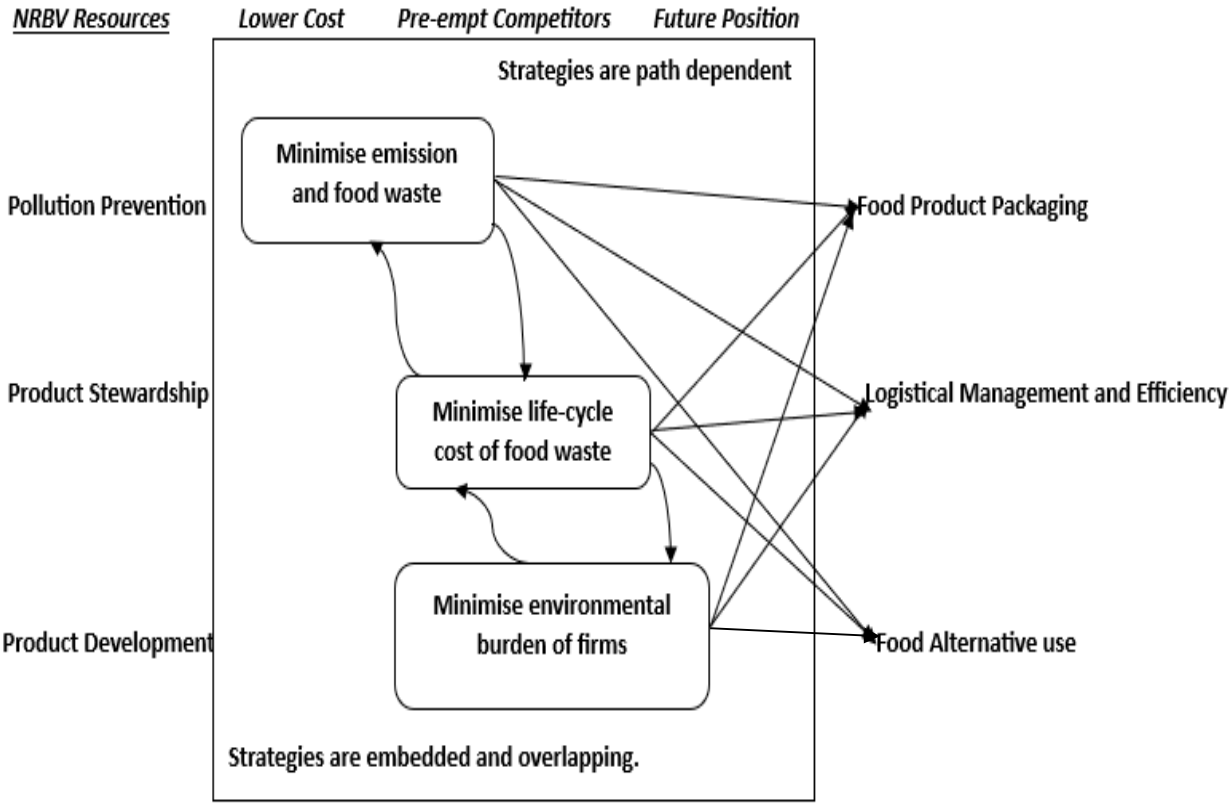

Figure 14: Research Framework (Adapted from Mollaoglu et al., 2024)

Strategic Capability	Environmental Driver	Key Organisational process	Competitive Advantage
Pollution Prevention	Minimise emissions effluent and food waste through effective packaging strategies of food products and logistical efficiency. Minimise resource use.	Continuous improvement of supply chain management	Lower costs of running the food Supply chain increase profitability.
Product Stewardship	Minimise the cost of food waste through effective use of firm recourses to manage the supply chain	Stakeholder integration Resources in food supply chain assessed. Sustainable Business Ethics	A move to prevent competitors through exclusive food waste management and/or environmental management
Sustainable Development	Minimise environmental weight of firm growth and development.	Shared vision of FLW strategies withing the organisation	Securing future position of firm.

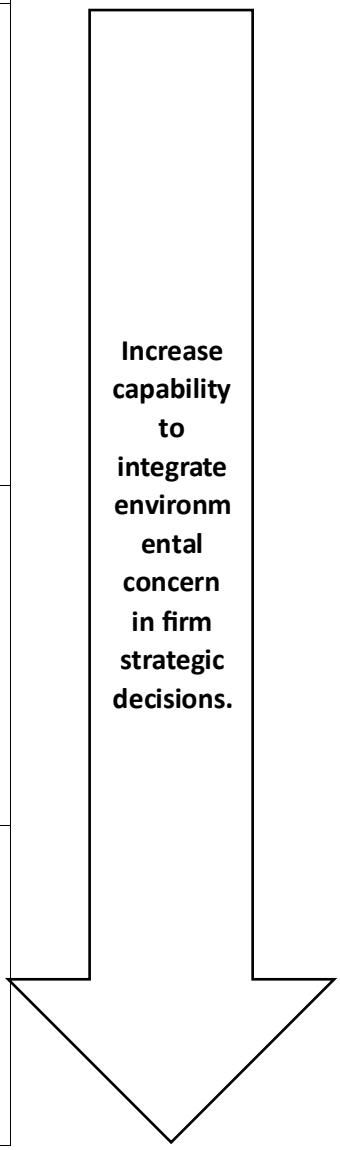

Figure 15: The Impact of NRBV Resources on Firms' Capabilities and Strategies. (Adapted from Hart, 1995).

3.4. Theoretical Framework.

The above figure 14 shows the research framework that integrate the NRBV theory to account for Environmental drivers for firms' commitments to reduction of FLW along the supply chain. In the framework, the strategic capabilities of the firm include Pollution prevention, product stewardship and sustainable development which could impact the organisation process and the environmental drivers. Fig 15 also shows the environmental driving force for key organizational strategies, conferring competitive advantages when effectively managed.

In-depth interviews permit the explication of tacit phenomena via analysis of discursive data (Saunders *et al.,* 2012). Such interviews facilitate interactive engagement between phenomena (NRBV) and real-life (practice along the supply chain) (Ackroyd, 2004), with researchers and interviewees playing fundamental roles in the creation of knowledge (Edwards *et al.,* 2012).

Also, building on the core principles of NRBV capabilities related to packaging and logistics management could be crucial for sustainable competitive advantage. It was carried out to understand how different types of packaging strategies of Food products affect FLW generation and what is the impact of logistical efficiency such as, material handling, Stacking of Food Products and Expected Targets in the supply chain on FLW.

Companies adopt different packaging strategies, and several packaging materials have distinct qualities which affects the generation of Food waste. For example, paper and cardboard-based packaging can be cheaper to produce and have some added benefits of easy to recycle. However, it also has weaknesses of not water-resilient and could be easily damaged or impacted by material handling. The use of plastic packaging has become very acceptable in currently due to adaptable uses of flexible and rigid plastics which could be moulded into different shapes. Its weight is light and cheaper to produce in bulk. However, one of the major challenges with most of the use of plastic packaging is it is difficult to dispose of in environment friendly ways and it creates vast problems for the environment. The warehouse is a cost generating part of the supply chain and companies have been adopting different logistical policies to increase efficiency in their organisation. However, these policies have impacted the generation of Food product waste. All these form part of the investigation of this research.

3.5 Research Methodology.

This study implements a qualitative research design, an approach particularly well-suited for investigating emerging and innovative fields (Fields, 2015; Markard et al., 2012; Truffer, 2022; Zhang et al., 2022). In this paper, an inductive research approach is used, which allow us to conduct a detailed investigation of the Food Loss and Waste management along the supply chain in major retail companies. This research implements the case study-based research methodology (Yin, 2017) to understand the challenges of Food loss and waste management at various stages of the food supply chain and to explore these challenges in integrating these practices to improve operational performance.

3.5.1 **Data Collection.**

Data are collected from five firms in the retail sector through semi-structured interviews and group discussions to balance consistency with depth, providing a guided yet flexible format that allows for exploration of the research while ensuring comparability across participants. This approach is designed to collect detailed, rich qualitative data on the participants' experiences, attitudes, and beliefs. In-case and cross-case analysis approaches are adopted to explore the current practices of food packaging, logistics and food alternative use management among firms and prospect of implementation.

In this study, we have conducted 32 semi-structured interviews with senior managers and group interviews with operatives of 5 firm operating in the food retail sector (Table 12). The sample selection followed a strategy of quotas according to the type of the firm (Commercial Food retailers and supplier that most commonly experience significant food loss and waste in their organisation). The retail companies involved have sales revenue between 800 million to 30 billion pounds and the number of employees between 200 and 1200.

This research helped us to obtain a great amount of information about the firms' activities, the products they provide, and the profile of the firms or customers they serve. Two of the firms (denoted as firms A and D) operating in the food supply chain are leading UK retailers with long history, known for their supermarkets, big distribution centres, convenient stores and online presence, prioritize diverse sourcing, procuring food from both UK and international suppliers. They maintain a steadfast commitment to high quality, rigorous safety standards, and ethical considerations. These firms cultivate long-term relationships with their suppliers, actively collaborating to address evolving sustainability challenges, ensuring responsible practices, diligent food waste reduction, and upholding ethical considerations across their supply chains. Two firms (Firms B and E), are one of the largest groceries stores in the UK holding significant market shares and they are significant players in the food supply chain, source food products extensively from over 70 countries globally. Domestically, they partner with thousands of UK farmers. Central to these firms' values is a commitment to maintaining stringent food safety, excellent hygiene, and robust logistical practices throughout their entire

supply chain. They actively conduct regular audits and collaborate with their diverse network of suppliers on continuous improvement initiatives. Firm C is one of the largest suppliers of groceries in the UK. They are known for supplying groceries like fruits, vegetable and other farm produce to major food retail firms in the UK. The firm strives to maintain hygienic food products and food management system. They also maintain good sourcing, storage, transportation, and delivery processes.

The interviewees included senior management representatives from all the food retail firms, and in firms D and E, group discussions were conducted with four and five operatives respectively. These group interviews were also semi-structured to balance consistency with depth, specifically aimed at discovering the operatives' perceptions on how daily logistical operations directly impact FLW. Due to the complexity of an analysis of this kind of process, we developed a procedure as a viable and practical guide on collection of data during interviews. The procedure proposes a semi-structured interview design with open questions and unlimited time in order to obtain possible unexpected results and redirect the interview according to the responses of the interviewee. The interviews lasted an average of 60 min and all of them were conducted in places suggested by the interviewees within their company's premises to maintain their comfort and privacy. In addition, the interviews were recorded using an audio recorder. The protocol also suggests the observation of interviewees' reactions (e.g., behaviours or non-verbal communication) when they are responding to questions. The transcript of the interviews was conducted by means of the Transcriber software, Cockatoo (O'Hara *et al.,* 2021). The transcript generated was then cross checked by researcher for authenticity check. The organisations were assured of protection of sensitive from unauthorised access, use or disclosure, while also adhering to legal and ethical guidelines. This includes obtaining information consent, ensuring secured data storage, and being transparent about data handling practices. Transcriptions of the interviews were done using Cockatoo's Transcriber software.

3.5.2 Coding Process for interviews and Group Discussions

To ensure the highest standards of academic rigor, the study strictly adhered to a systematic, multi-phase coding protocol, thereby safeguarding the validity, reliability, and transparency of the qualitative findings (Williams and Moser, 2019). The analysis was executed through three distinct stages: First Order coding, which involved deconstructing raw data into preliminary concepts; Second Order coding, used to systematically refine themes and uncover significant interconnections between categories (Strauss and Corbin, 1990); and finally, Third Order coding. This concluding phase integrated identified categories into coherent, high-level constructs, ultimately shaping a meaningful, theoretically grounded narrative that effectively addresses the study's research objectives while minimizing researcher bias (Flick, 1992).

The study did codification of the interviews through the methodological proposals of Bogdan and Biklen (2007) (refers to appendix C1, C2 and C4) and the group discussion (refers C3). The first step of the interview coding was to identify the blocks or paragraphs where the interviewees spoke about one of the essentials suggested by Bogdan and Biklen, 2007, such as Setting, Definition, Process, and Method. This first coding allowed defining the starting point from which we would analyse the structure of each interview. The second step of coding consisted in assigning to paragraphs (or a part of them) a list of preconceived codes from the theoretical framework of the research to answer each research question. The third and final step consisted in coding the paragraphs with a more inductive approach, recoding some of the interviews as new codes emerged. The final code book contains a total of 38 codes that classify data into the following Themes: Packaging Strategies, Environmental Consideration, Cost of Repackaging, Complaints Reporting, Time Consideration, Factors Affecting Repackaging, Performance Target, Pickers Efficiency, Training Needs, Role of Teamwork, and Equipment Maintenance for the interviews conducted and three codes classified into one theme, the operative contributions for the group interview.

To ensure a comprehensive analysis, separate coding structures were developed for the senior manager interviews and operative group discussions, specifically targeting food packaging challenges and logistical efficiencies within the five retail firms. Despite their distinct sources, these parallel coding streams converge on a unified front to evaluate the impact of packaging on food loss and waste (FLW), performance targets, and product stacking.

This dual approach captures holistic supply chain data by juxtaposing different organizational tiers. For instance, themes like performance targets and workforce training needs were analysed independently across both sets of transcripts. This deliberate design allows the study to address identical research questions through a dual lens, contrasting managerial strategic intent with the ground-level operational realities experienced by operatives, ultimately providing a complete picture of FLW generation across the firms.

Table 11 shows the profile of the case firms, interviewee, group discussions and data sources. The interviewee has an average working experience of 9.6 years in management in the food retail sector and the operatives have average working experience of 12.5 years. We were able to gain access to these organisations because the researcher works in one of the companies. Furthermore, getting access to these senior managers is challenging because of limited availability. However, we were able to get the number of interviews needed for the robustness of the research.

3.5.3 Data Validity and Reliability

To ensure robust external validity and rigorous scholarly standards, the researchers strategically employed a multi-case study design and purposive sampling techniques, strictly adhering to established qualitative field practices. While some scholars argue that traditional notions of

"validity" are rooted in quantitative paradigms, there is a clear consensus that qualitative research requires specific criteria to verify the quality and integrity of its findings (Golafshani, 2003). To validate the findings, the study utilized member checking, a process where initial interpretations of interview data were presented back to the participants for confirmation, clarification, or correction. This iterative process was supported by the significant time spent building rapport with participants, which allowed for a deeper familiarization with their perspectives and organizational cultures.

Furthermore, the study ensured contextual reliability by providing "thick descriptions" of the research environment. This transparency minimizes the risk of misinterpretation and bolsters the overall trustworthiness and transferability of the data. Meticulous records were maintained throughout the research lifecycle, documenting every stage of data collection and the subsequent analytical and interpretive steps. To guard against personal bias and ensure robustness, the study also engaged in peer debriefing, seeking critical feedback from fellow academics. As McMillan and Schumacher (2006) suggest, validity in this context is the extent of consistency between the scholarly explanation of a phenomenon and the reality it represents, ensuring that these findings truly reflect the lived situation within the UK food supply chain.

Table 11: Profile of companies, Interviewees, and data 1.

Firm	Country	Industry sector & business activities	Number of Interviews	Interviewee designation & years of experience	Data Source & Time (Mins)	Number of Employees
A	UK	Supermarket Store	6	Store Manager (15)	Interview (56)	420
				Shift Manager 1 (8)	Interview (52}	
				Shift Manager 2 (7)	Interview (58)	
				Shift Manager 3 (10)	Interview (49)	
				Team Manager 1 (5)	Interview (54)	
				Team Manager 2 (5)	Interview (42)	
B	UK	Supermarket Store	7	Store Manager (18)	Interview (55)	446
				Shift Manager 1 (12)	Interview (51)	
				Shift Manager 2 (9)	Interview (48)	
				Shift Manager 3 (9)	Interview (59)	
				Team Manager 1 (6)	Interview (45)	
				Team Manager 2 (5)	Interview (47)	
				Team Manager 3 (6)	Interview (57)	
C	UK	Agro-Allied	3	General Manager (22)	Interview (59)	128
				Farm Manager 1 (15)	Interview (46)	
				Farm Manager 2 (7)	Interview (44)	
D	UK	Warehouse	8	General Manager (21)	Interview (58)	978
				Operations Manager (18)	Interview (52)	
				Shift Manager 1 (8)	Interview (54)	
				Shift Manager 2 (6)	Interview (46)	
				Shift Manager 3 (8)	Interview (52)	
				Team Manager 1 (5)	Interview (50)	
				Team Manager 2 (4)	Interview (43)	
				Team Manager 3 (7)	Interview (42)	
			4	Pickers (>5)	Group Discussions (45)	
E	UK	Warehouse	8	Operations Manager (18)	Interview (56)	754
				Shift Manager (16)	Interview (48)	
				Shift Manager (10)	Interview (46)	
				Shift Manager (13)	Interview (55)	
				Team Manager (6)	Interview (52)	
				Team Manager (8)	Interview (56)	
				Team Manager (4)	Interview (59)	
				Team Manager (8)		
			5	Pickers	Group Discussions (52)	

3.6. Analysis

3.6.1 Sustainable Food Waste Reduction Practices

The 32 in-depth interviews with senior managers and group discussions with operatives from the five food retail firms provide the initial empirical foundation for this research. As depicted in the research framework above and discussed throughout this section, pollution prevention, product stewardship and sustainable development featured conspicuously in interviews, and demonstrating their existence in UK Food Loss and Waste along the supply chain.

To address the research questions with the necessary depth, the researcher conducted a robust analysis of responses from both management and frontline operatives, ensuring a multi-level perspective on operational challenges. For instance, in the research question 1, to evaluate the specific impacts of product packaging strategies on Food Loss and Waste (FLW) reduction within the UK food retail sector, participants across five firms were systematically interviewed regarding the integration of food waste reduction sustainability principles into their core packaging design strategies and the operatives were asked how packaging contribute to FLW and the procedure provided to inform the management about poor packaging. This inquiry extended to the environmental implications of material selection for various food categories. Furthermore, the researcher investigated the proactive measures and logistical protocols these firms employ to repackage products that arrive damaged or poorly protected, identifying these interventions as critical touchpoints for preventing avoidable food waste and maintaining supply chain integrity.

Also, in this section, the responses from senior managers of each of the five firms are analysed to understand the key sustainable food waste reduction practices adopted. The qualitative data collected is analysed in three phases, Description, Analysis, and Interpretation (Wolcott, 1994). The analysis of the qualitative data is completed to appreciate the key themes emerged from the interviews. The practices across these cases are compared to analyse the common practices among other firms. Furthermore, the motivations and challenges to implement these strategic practices along the supply chain are analysed to explore common themes and issues to provide a more generalized view of the barriers facing the retail firms in the UK to implement sustainable practices and to improve their operational performance. The analysis of interviews was focussed on four key processes: product packaging, logistical efficiency, management practices and FLW strategies.

Interviewee discussion of sustainable operations and FLW strategies corresponded with literature's description of NRBV resources and associated sustainability and competitive benefits and the coding framework. The presence of such sustainability and competitive benefits in interviews demonstrates the effect of each resource, which the critical realist considers evidence of existence (Sayer, 2004). Pertinently, this is not to say that the NRBV in practice exactly mirrors its conceptualisation, but that based on the results of qualitative content analysis and intercoder reliability assessments, pollution prevention, product stewardship and sustainable development play some role in competitive sustainable operations in UK Food retail firm as it is discovered in this research

3.6.2 The Impact of Product Packaging on FLW reduction.

The impact of FLW reduction is a critical issue, identified as a major reason for significant food product waste generation along the supply chain, a concern consistently raised by various interviewed senior managers in the five firms. This indicates an organizational awareness of environmentally-minded product packaging strategies that actively promote recycling, reuse, and food waste reduction directly at the source (Carter and Ellram, 1998; Min and Galle, 2001). To gain a deeper understanding of the Impact of Product Packaging on FLW reduction in in the food retail sector, five retail firms were specifically questioned about their consideration of sustainability principles in packaging design and the environmental implications of the materials used for their food products

(i) The impact of Product Design.

The senior managers were asked questions regarding their consideration of packaging materials' environmental impact on FLW. They were asked if they are actively improving package design by adopting the good packaging materials and rectifying poor packaging to enhance environmental friendliness and reduce FLW. Additionally, inquiries focused on their adoption of innovative technological approaches to make packaging more compact, thereby improving its resilience during material handling and transportation.

Company A General Manager of firm D highlighted:

"In an effort to reduce food waste and improve food package design, suppliers introduced a recyclable pouch as an alternative to larger plastic bowls. However, this lighter-weight solution inadvertently caused new problems: our standard boxes proved unable to handle the altered weight distribution, leading to damage to the fragile fruits it was intended to protect. This attempt to reduce the plastic content in packaging has, unfortunately, resulted in product shrinkage. The prevailing environmental requirement to use less plastic in food packaging is

making products inherently less sturdy, creating a dilemma between sustainability goals and product integrity in our supply chain".

It is evident from the above quote that providing a temporary solution to the problem of food packaging by using recyclable materials plastics or cardboard materials in packaging of food product always result in FLW. Evidence also indicates that utilizing temporary packaging solutions specifically composite materials blending plastics and cardboard frequently backfires. While intended for recyclability, these hybrid designs often compromise structural integrity and food preservation. Consequently, such material combinations lead to unintended increases in Food Loss and Waste (FLW) across the retail supply chain. Also, product packaging cost, adherence to government regulations on materials, and compatibility with existing automation systems were identified as the most crucial factors influencing all firms' food product packaging strategies. These considerations collectively drive decisions on design and material selection, ensuring both legal compliance and operational efficiency within the supply chain.

Company E Operations Manager highlighted:

"We adopt flexible and intelligent packaging, which offers features that provide vital information and modify internal environments to extend food product shelf life. This includes smart packaging, leveraging technologies like RFID and QR codes for real-time tracking and monitoring throughout our Food Supply Chain (FSC). Additionally, we make use of active and sustainable packaging that utilizes biodegradable materials, often combining plastics, cardboard, and foil which offers space-saving benefits, enhances user-friendliness for our customers, and provides environmentally friendly advantages".

The quote above reveals that adopting flexible, intelligent type of packaging significantly extends shelf life and mitigates Food Loss and Waste (FLW). Respondents emphasized smart packaging integrating RFID and QR technologies to enable real-time tracking and monitoring across the Food Supply Chain (FSC). Furthermore, the strategic use of active and sustainable packaging utilizing biodegradable materials provides a multifaceted advantage. These designs combine plastics, cardboard, and foil to optimize warehouse and storefront space, enhancing logistical efficiency while offering superior user-friendliness for consumers. Ultimately, these innovations provide critical environmental benefits, aligning operational product protection with the strategic goal of minimizing food surplus and waste through superior resource management.

Most interviewees consistently highlighted cost as the paramount priority when determining their food product smart packaging design. This financial consideration was closely followed by the selection of packaging materials that generate minimal food waste and the critical requirement from retail firms for designs compatible with their automation systems. Across all five firms surveyed, the cost of raw materials, the potential overall packaging cost, and the

resultant amount of food product wastage were universally recognized as highly significant factors influencing their decisions. While some of these adopted practices undeniably support FLW reduction by promoting more compact packaging and the use of environmentally friendly materials, a notable inconsistency was observed. In certain food product brands supplied, the beneficial combination of cardboard and plastic, which strengthens packaging to withstand rigorous material handling and transportation—thus implicitly making it more environmentally friendly by preventing damage and subsequent food loss—was conspicuously absent. Furthermore, some suppliers preferred using predominantly cardboard and gums. Although these materials are inherently eco-friendly, this approach often resulted in loose packaging and ultimately contributed to increased food loss and waste (FLW) down the supply chain, revealing a complex trade-off between material choice and product integrity.

Most of the company executives agreed that there is need for the suppliers to take steps to improve environmental performance and a senior manager of firm A highlighted that:

"Supply managers are also culprit in poor packaging issues, not just the depot. The food product category supply manager, owning the contract, is the primary contact. We provide feedback, and they often acknowledge the problem. However, the critical questions are profitability for their business and whether other supermarkets are raising similar complaints. Consequently, issues are not always resolved accurately. I cannot definitively say how suppliers will respond consistently."

It was evident across all interviewed companies that each maintains significant control over their food brand's packaging design. Consequently, most products were exceptionally well-packaged, rigorously conforming to all environmental regulations. The companies themselves bear the cost of this packaging, which empowers them to design highly robust product packaging. This ensures not only compliance with legal requirements but also superior protection, contributing to product integrity throughout the supply chain.

(ii) Repackaging of Food Products.

Significant costs are incurred in the packaging and repackaging of food product, and expenses frequently passed on to the consumer. Furthermore, the materials chosen for packaging must stringently conform to current environmentally sustainable standards. Crucially, the response to complaints regarding poor packaging is often contingent upon the specific food product brand and whether similar concerns are being raised by other food retailers, influencing the priority and speed of corrective action.

Firm A faced prolonged challenges with poor food product packaging, usually taking over five months to resolve issues. Complaints were compiled centrally and forwarded to the head office, which then contacted relevant suppliers. Suppliers, in turn, often prioritized the cost of repackaging and considered whether other retail companies were raising similar complaints about the same product. The repackaging process typically necessitated suppliers visiting the depot or retail store. There, they would observe and test the optimal number of food products per package, utilizing the retailer's facilities. An agreement would then be reached with the depot manager on the best repackage design. This identical method is applied by retail firms B and C, though, for these firms, the resolution of poor packaging issues with suppliers averages a significantly shorter period of less than three months. These highlights varying response times and possibly negotiation leverage across companies.

A senior manager of firm B interviewed highlighted the reasons why there are many reported cases of poor packaging as follows:

"A supplier might claim to be prioritizing environmental savings by reducing plastic, even if it draws supermarket complaints. However, this often involves weakening the box's structural integrity, inadvertently creating more food waste due to damaged goods. Believing they've contributed positively to the environment by causing shrink, they might then opt for less plastic and cardboard, substituting with more tape and gum to secure packaging. This approach, while seemingly eco-conscious, consistently proves problematic. The resulting package is frequently not robust enough, leading to product damage and a greater overall generation of food waste, counteracting the initial environmental intent. The bottom line is the supplier is, trying to dodge away from the cost of re-packaging".

Table 12 presents the case companies' food product packaging practices. Some of the specific sustainable practices adopted by case companies are highlighted in the following quotes from the senior managers of the case companies.

Table 12 Summary of Food Products Packaging practices Among Retail firms.

Firm	Prioritisation of Sustainable FLW Reduction Practices
A	Increased adoption of smart, compact packaging is crucial for food products, designed to withstand material handling and transportation pressures. This involves prioritizing environmentally friendly materials and minimizing plastics to prevent serious pollution, aligning with sustainable brand practices.
B	Implementing smart packaging is key, as exemplified by Company A's proactive approach in identifying and repackaging loose products, while also ensuring suppliers resolve poor packaging issues. Collaborative efforts with suppliers are essential to guarantee high-quality, environmentally compliant raw materials are used, meeting national requirements. Furthermore, establishing an active monitoring system is vital to continually assess the environmental and FLW impact of these raw materials and supplier environmental practices, fostering continuous improvement.
C	Environmental packaging factors are crucial for food products supplied to retail firms, though not uniformly across all food products. Raw materials for packaging must strictly comply with national environmental requirements. Adherence to these standards significantly reduces poor packaging instances for food products, which directly contributes to a measurable decrease in food loss and waste (FLW) within the supply chain.
D	Firm often prioritize smart packaging materials and environmentally friendly factors leveraging technologies like RFID and QR codes. This leads to selecting smart and strong options. Packaging design must withstand rigorous material handling and transportation to prevent damage. Maintaining proactive communication with suppliers is crucial to address and overcome challenges posed by inadequate or loose food product packaging.
E	Prioritizing environmental impact over cost is crucial for food product packaging. This involves diligently selecting and purchasing food products from suppliers who consistently provide high-quality packaging materials. These materials must rigorously satisfy all relevant environmental standards, ensuring sustainable practices throughout the supply chain.

3.6.3 The impact of Firms' Logistical management Efficiency on FLW reduction.

It is crucial to evaluate all logistics aspects within each firm's supply chain. Achieving sustainable logistical efficiency is vital for reducing food loss and waste (FLW), and mitigating the environmental impact of manufacturing processes, fostering a more responsible operation.

To understand firms' sustainable logistical efficiency practices, executives were questioned on their integration of sustainability principles into developing logistics strategy, and how these principles are adapted to reduce food loss and waste (FLW) and address pollution prevention. Inquiries also focused on the monitoring processes and training initiatives implemented to enhance overall logistical efficiency.

(i) Capacity Building and Training of Employees.

Capacity building and training of workers are crucial for reduction of FLW as the workers are equipped with the knowledge and skills to handle food products more effectively, minimising spoilage and food waste at each stage of the supply chain. All the executives highlighted the importance of training and retraining of workers to improve handling techniques, understand food safety, enhance efficiency, empowering workers and fostering commitment thereby building a sustainable FLW reduction system. The company executive of firm A highlighted; *"We are committed to training and retraining to increase motivation and sense of ownership of the process amongst our workers in order to equip them with the ability about food safety standards and practices that minimise damage and soilage"*

Moreover, despite the firms' commitment to the training of their workers, most executives at the firms consistently highlighted bad stacking of food products and a high turnover of workers as significant operational problems. These issues, they explained, directly contribute to the generation of food waste within their food supply chains, underscoring critical areas for improvement. For example, a senior manager at one of the firm D highlighted: *Most of the reported cases of bad stacking experienced in the firm are mainly from new workers although steps have been taken to reduce this through training and retraining of the new workers*.

All the five firms experience significant number of food waste as a result of their workers turnover which directly impact on the number of already trained and skilled workers available. The need to constantly train workers therefore is apparent.

(ii) Performance Targets and Safety Measures.

Performance targets and safety measures influence both the extent of the food waste reduction efforts and the overall effectiveness of those efforts, Well-defined targets can drive focus action, while robust safety measures ensure that strategies to reduce FLW do not inadvertently create new hazards or compromise quality (Willett *et al.,* 2019)

It was also evident that performance targets set for workers by all the firms under consideration contribute significantly to food waste. However, The Store Manager of firm A highlighted: *We employed random monitoring of our pickers on a weekly basis to ensure that pickers are working as trained and we identify the training needs of the workers through personal interaction and engagements.* The Store Manager of firm B went further to emphasise: *Our company's performance targets are always reviewed to prevent food waste generation and to guide against Health and Safety issues. He stressed the important of training and retraining of workers on picking and Health and Safety.* A senior Manager of firm E highlighted the adoption of what they called "*Total food waste reduction strategy*" in their logistics system in which everybody working in the firm is conscious of the need to reduce food waste and are expected to also participate actively in food waste reduction. All the firms highlighted the importance of teamwork and constant engagement and monitoring by Team managers to ensure that pickers are working as trained. Firm D stressed the importance of maintaining the raw cages the company use in stacking of food products. A lot of food wastes and accidents are experienced through broken raw cages."

Table 13 delineates the logistical efficiency practices across the investigated case food retail firms. To provide empirical context, the subsequent selection of quotes from senior management highlights the distinct sustainable strategies and operational practices currently being adopted.

Table 13 Summary of Logistical Efficiency practices Among Retail firms.

Firm	Prioritisation of Sustainability Practices
A	Maximise random weekly monitoring of pickers to verify adherence to training. This also helps identify worker training needs through personal interaction and engagement. Such oversight ensures consistent performance, addresses skill gaps proactively, and maintains high operational standards within the facility.
B	To significantly reduce food waste, the company consistently reviews performance targets, aiming to prevent food waste generation and mitigate Health and Safety issues. Emphasizing continuous training and retraining, the company stresses the critical importance of proper stacking techniques and strict adherence to Health and Safety protocols for all workers.
C	Employee performance in production is now directly linked to food waste generated, serving as a key efficiency metric. The firm employs appropriate technology and processes to significantly reduce the environmental impact of food waste. This includes improving the overall production process and adopting advanced technologies to minimize pollution output.
D	The company emphasized teamwork, alongside continuous engagement and monitoring by Team Managers, to ensure pickers consistently work as trained. They also underscored the critical importance of maintaining the raw cages used for stacking food products. Significant food waste and accidents frequently occur due to damaged or broken raw cages, highlighting a crucial area for operational improvement.
E	Improved sustainability practices are evident through their "Total Food Waste Reduction Strategy" within the logistics system. This approach ensures every employee, from executives to pickers, is highly conscious of the need to reduce food waste. All staff are expected to actively participate in food waste reduction efforts, fostering a collective responsibility towards environmental goals.

3.6.4 The Impact of Food Alternative use and In-Store Donation on FLW Reduction.

Our research identifies a crucial classification of sustainable practices in the food supply chain, differentiating between types of food waste. Firstly, avoidable food waste at the source of production refers to food that, with robust management practices, could have been prevented from becoming waste. Secondly, partly avoidable food waste encompasses food that, though not fit for human consumption, is successfully diverted for alternative uses, such as animal feeds. Lastly, unavoidable food waste includes items like peels, food skin, or animal bones, which are inherent by-products. Fresh food products, both plant and animal-based, are

particularly susceptible to becoming waste due to their inherently short shelf lives or economic considerations. For instance, a significant statistic reveals that approximately 35% of bananas and oranges sold in UK supermarkets ultimately end up discarded. Such facts highlight the undeniable challenge. Moreover, the category of partly avoidable food waste, effectively repurposed as animal feed, presents a valuable avenue for resource recovery.

The Store Manager of Firm A highlighted that: "*To reduce food waste significantly, we usually do not throw away certain plant produce such as potatoes, yams, and maize etc. We could sell it as animal feed, but then we need to remove the packaging from the food products, and this could cost us more than what you can get from it. However, most often it helps to reduce food waste which is the ultimate goal."* Under this context, waste that has a further usefulness would be included under the concept of avoided food waste and could include for example food donations, recycled food or food sent to secondary markets and sold as animal feeds. This concept would include food that, although not having received the use for which it was produced, does not end up discarded. This concept is what many of the retail company are presently practising to reduce food product to a minimum level. Some of the companies contacted are involve in minimising food waste through what they called strategic pricing of food products in which the price of food products is reduced at a particular time every day to attract customers to buy more of the products and through food bank hence reduce food waste.

One of the senior managers of firm B said, "*We are always looking out for opportunities to reduce food product waste and one of our practices is to reduce prices of certain food products at a particular time every day with the aim of reducing the volume of those food products from the shelves. Some of our customers have become used to this pricing practice."*

Food banks play a pivotal role in reducing food loss and waste (FLW) for all five firms examined. This is achieved through the crucial redistribution of surplus, unsold food to individuals and families experiencing food insecurity. This practice simultaneously prevents perfectly edible food from being needlessly discarded and ending up in landfills, while directly addressing pressing societal needs. All five firms are actively engaged in these initiatives and have collectively highlighted their significant contributions to their overall food waste reduction efforts.

Table 14 below outlines the case firms' sustainable practices through Alternative use and food charity. The subsequent senior management quotes provide empirical context, highlighting the distinct sustainable strategies and operational practices currently adopted.

Table 14. Summary of sustainable practices through Alternative use and food charity.

Firm	Prioritisation of Sustainability Practices
A	To reduce food waste, the firm collaborates with food banks for charitable distribution and reduces prices on products nearing shelf-life expiry. They actively prevent avoidable food waste by diverting suitable food products for uses like animal feeds, thereby maximizing resource utilization and minimizing disposal.
B	The firm strategically minimizes food waste through a "strategic pricing" approach. This involves reducing food product prices at specific times daily, effectively incentivizing customers to purchase more. This proactive method helps clear stock, reducing the likelihood of products becoming food waste.
C	Environmental considerations are crucial for determining the volume of food donated to charity, which actively prevents avoidable waste. This principle equally applies to food products diverted for uses like animal feeds, underscoring a holistic approach to sustainable resource management.
D	Collaborating closely with suppliers ensures the consistent supply of high-quality food products, fostering strong customer patronage. The firm strategically reduces prices for items nearing their shelf lives, offering value to consumers, and simultaneously donates surplus food to charity, effectively minimizing food waste across operations.
E	Greater attention is placed on preventing food waste by identifying alternative uses for products unsuitable for human consumption. This encompasses diverting food for sale as animal feeds, utilizing it as organic manure, and generously donating surplus items to charity. These strategies collectively enhance resource recovery and reduce environmental impact.

3.6.5. Comparing the Sustainability FLW Reduction Practices of Case Firms.

Firms generally adopt sustainable Food Loss and Waste (FLW) reduction practices, often for competitive advantage, like firm B's disposable cardboard packaging. However, for many, these are mainly for regulatory risk mitigation. Only firm A proactively integrates sustainable initiatives beyond legal mandates with operational improvements. Firms A, B, D, and E significantly control their own-brand food packaging design by adopting environmentally friendly packaging using non-hazardous, biodegradable materials, ensuring products are well-packaged, environmentally compliant, and robust, bearing the costs. Firm A, for instance, implements extensive environmental practices across its logistics, including weekly random picker monitoring for training and health/safety compliance. Conversely, Firms A, B, D, and E individually lack sufficient influence over their suppliers' food packaging practices. This hinders their ability to enforce environmentally friendly processes aimed at FLW reduction. Retailers' limited control means repackaging poorly packaged items often depends on collective complaints from other retailers, highlighting a systemic challenge in supply chain sustainability.

Sustainable FLW reduction practices in logistical management are observed to be limited, with four retail companies are not strongly committed to improving logistical efficiency, primarily due to increased warehouse costs. Only two retail firms have adopted a total food waste reduction strategy. Executives at firms A, B, D, E highlighted that "*difference in packaging needs and costs*" are major obstacles to implementing sustainable packaging practices.

3.6.6 Major Drives for adopting Sustainable FLW reduction practices.

Interviews with senior managers from five retail firms revealed key motivations for adopting sustainable FLW reduction practices: competitive advantage through sustainability, environmental regulations, customer reaction, and the cost of FLW. Managers confirmed that prioritizing sustainability and adhering to environmental regulations significantly influenced their decisions to implement sustainable FLW reduction across packaging strategies, logistical efficiency, and food alternative uses. These practices helped mitigate environmental regulatory risks and avert negative customer reactions. Environmental regulation, in particular, proved highly influential in shaping packaging strategies. Furthermore, ensuring pickers worked as trained, thereby avoiding Health and Safety issues, was identified as the second most popular motivating factor

The firms adopt these practices for various reasons. Senior Managers of firm C expressed that "*if the government work more with the retail companies in regulating the design of product packaging, the suppliers would be forced to comply and hence implement sustainable supply chain practices."* Customers' reactions on environmental compliance products and the aim to reduce cost of running the warehouses of the retail companies were equally considered influential in adopting sustainable practices. The executives of firm A highlighted that *"our customers. want the packages to be environmentally friendly, recyclable, and reusable and therefore we need to keep improving to conform with the customers' wants"*. Moreover, Senior managers at firm B stated that "*the main drivers that may contribute to the company's implementing the Sustainable practices include favoured policies like Cost reduction, and customer's reaction".* However, Senior Managers of firm A highlighted: *"Competition from other retail companies is the main driver"* in the sector is also a crucial driver." All the retail companies' senior managers clearly mentioned that they adopted sustainable practices to reduce cost and hence, improve their profits. It is important to know that all the retail companies were influenced by external factors to ensure implementation of sustainable FLW reduction practices in their supply chain operations. They all recognise the importance of these practices in improving their environmental and operational performance.

3.6.7. Difficulties Encountered in Implementing Sustainable FLW reduction Practices.

Firms C, D, *and* E identify cost of packaging and running their companies as their main challenge for implementing sustainable practices. The cost of packaging is very enormous and might lead to higher price of food products. The warehouses of the retail companies are cost generating and the companies are devising a lot of methods to minimise the cost of running them. Although all the companies' executives feel obvious pressure of implementation due to an increase in the cost of packaging raw materials, they enjoy the economy of scale that gives them advantages over smaller retail companies. Partial implementation of appropriate company policy and regulations is another barrier for implementing sustainable practices by the retail companies. The senior manager of firm D highlighted partial compliance with relevant policies and regulations by the Team Managers are responsible for the ineffective implementation of sustainable FLW reduction practices in the company and steps have been taken to correct this. High turnover of workers is another difficulty encountered by companies B and E affecting the implementation of sustainable practices because it takes time and money to train workers. The time taken in repackaging of food products is a major challenge faced by most of the retail companies, A chief executive of firm D said that *"it takes an average of six months for some*

of our food suppliers to address the problem of poor packaging". Another challenge faced by retail firm D compared to others is lack of adequate recycling infrastructures and underdeveloped means of recouping food products which drops out of the conveyor belt back into the system.

3.6.8 Focus Group Discussion.

Focus Group discussions with warehouse operatives in firms D and E revealed a disparity of views, often linked to work experience. In firm D, operatives with over five years' experience prioritized good product stacking, enhancing food safety. In contrast, those with less than two years' experience focused more on performance metrics than meticulous stacking, inadvertently contributing to FLW issues. All operatives in firm D stated that while health and safety are emphasized, the primary focus remains on the sheer volume of food products picked, directly linking this performance emphasis to the high volume of Food Loss and Waste (FLW) generated. Unanimously, firm D's operatives stressed the need for training and retraining, especially for new hires, to improve stacking and reduce food waste. They also contended that the company must address high operative turnover to seriously tackle FLW reduction.

One of the firm E operatives highlighted; *Company's operatives who are well experienced on the work are constantly feeling dissatisfied with their wages and the condition of their contracts and are leaving in considerable large numbers which lead to high turnover of workers and hence, the need to employ and train new workers who are major contributors of high volume of food waste generated in the company.* They also agreed that the company needs to set performance targets that are not only achievable but could make the workers to work as trained and lead to food waste reduction. Of particular interest was Warehouse operatives' discussions about Food products packaging. One of the Operatives of firm D said; *Some of the food products are wrapped together with loose or oversized materials which makes the products to shift and spill over. We have been experiencing a lot of food wastes because of poor packaging and we have made complaints concerning this to the managers.*

3.7. Discussion.

3.7.1. The Impact of Environmentally Friendly Policies.

It is obvious that the retail companies in the UK are facing challenges of FLW and improvement of their environmental performance in boosting sustainable practices. Nevertheless, the retail companies are in an even more tough situation. They are struggling to comply with government's environmental regulation on FLW reduction while also being criticized by their customers over environmental compliance both nationally and internationally. Based on the realistic findings of this research, the existing situation of FLW and the strategies adopted by retail firms on FLW reduction, and its effect on the environment can be drawn. This study found out that the retail companies in the UK show awareness of the importance of FLW reduction to realise competitive reward in their businesses. They were aware of the impact of FLW along the FSC on firms' performance. However, the cost and the willingness of maintaining this are major factors which plays a significant role in broader implementation of the sustainable FLW reduction practices. Lack of adequate communication and cooperation between the retail companies and some of their suppliers contributed immensely to the poor approach to implement sustainable FLW reduction practices. Darkow *et al.,* (2015) analysis of capabilities required to support FLW reduction practices in the food supply. Customers' enthusiasm for environmentally friendly packaging of products and absence of definite company's environmental policies is some of the other important challenges identified. This is in line with the established knowledge that Customers who want ecologically friendly goods and services, are ready to pay more to satisfy their requirement. Food retail firms risk client boycotts if they do not adhere to this particular demand (Ageron *et al.,* 2012). Also, food retail firms can cultivate a "good citizen" brand by supporting environmental and social initiatives throughout their supply chain. This brand will enhance the access to important resources and the credibility (Mastos and Gotzamani, 2022). (Saeed and Kersten, 2019)

Firms utilize automated crane systems, significantly easing food product location and picking. This technological innovation greatly enhances their environmental performance compared to companies relying on traditional tractors. Firms with clear environmental policies generally outperform competitors in operational sustainability. While all retail companies in this study meet minimum environmental legal standards, some deliberately exploit this by using weak packaging materials that fail to withstand product handling and transportation, leading to food waste. Only actively evaluates its operational processes beyond minimum compliance to reduce negative environmental impacts.

Firm E primarily focuses on executing FLW reduction strategies within one part, with only partial extension to other parts of its supply chain, where sustainability practices show limited evidence. It's also observed that most executives do not leverage sustainable FLW reduction practices to drive broader operational improvements. This suggests a gap between awareness and comprehensive integration of sustainable FLW reduction practices into core business strategies, particularly concerning packaging robustness and supply chain-wide environmental responsibility beyond immediate operational boundaries.

Different fundamental causes for not leveraging FLW reduction strategies with the operational performance could be classified under following themes:

3.7.2 Partial implementation of Environmentally Friendly logistical practices.

Good stacking unequivocally enhances product safety within the food supply chain. Furthermore, the implementation of a comprehensive logistical evaluation system, designed to assess internal eco-performance and utilize environmental reports for internal review (Zaid *et al.,* 2018; Zhu *et al.,* 2013), is crucial for sustainable operations. However, this rigorous approach was not consistently followed by firms D and E, whose logistical practices appeared to contrast with such guidelines.

It was observed that the types and quantities of food products stacked into raw cages for transportation were heavily dictated by demand from retail stores. Critically, the cost of transportation emerged as a key factor influencing the stacking of varying weights within each roll cage. This often led to a detrimental tendency where lightweight food products were damaged under the pressure of heavier items placed above them. This prevalent issue routinely results in an increase in food product waste across most of the retail companies examined in this study. Evidently, the economic consideration of reducing transportation costs currently outweighs the financial impact of food loss and waste for all these retail companies.

There is an operational policy of setting performance targets for pickers in all the companies under this study which if not reviewed from time to time could lead to FLW. The commitment and unwavering support from senior management are consistently considered the most critical firm-level factor for successfully implementing environmentally friendly logistical policies (Walker and Jones, 2012; Faisal, 2010; Wittstruck and Teuteberg, 2012). Anderson and Bateman (2000) specifically emphasize that top management bears the ultimate responsibility for overseeing all FLW reduction initiatives within an organization. Furthermore, Klassen (2001) highlighted that the perspective and dedication of top corporate management are

essential for ensuring effective environmental management even at the plant level. Ultimately, environmental activities and comprehensive Food Supply Chain (FSC) management are largely driven by directives and priorities set by top management (Giunipero *et al.,* 2012). Conversely, numerous studies have identified that a poor or inadequate commitment from top management serves as a significant obstacle, hindering the successful application and sustained effectiveness of FLW reduction strategies (Ansari and Kant, 2017; Walker *et al.,* 2008). The policy of setting these targets with the aim of getting as much as possible number of picks without due consideration of how it could affect health and safety, always leads to increase in FLW. In addition, three of the retail companies under this case experience high number of workers turn over which impact on the number of inexperience pickers that need to be trained and retrained. This leads to high volume of food waste generated in the companies.

Total Quality Environmental Management (TQEM) is crucial for food loss and waste (FLW) reduction within the food retail sector. Its application drives efficiency and sustainability, as supported by various studies (Diabat *et al.,* 2014; Zaid *et al.,* 2018; Zhu *et al.,* 2013). Firms A and D that practices total food waste reduction policy in its organisation in which all the staff of the company irrespective of their position are required to be conscious of FLW reduction and also participate actively in reducing the waste normally record lower FLW compared to the other companies that are not practicing this.

3.7.3 Information sharing with suppliers.

Giving out and sharing information within supply chain of each food retail firm is important to improve the sustainable FLW reduction performance. Information sharing significantly facilitates supply chain cooperation and the development of innovative environmental concepts (Saeed and Kersten, 2019). In the food retail sector, this exchange between participants acts as a new form of traceability, directly correlating with improved supply chain performance (Pagell and Wu, 2009). Enhanced communication is crucial for fostering more efficient, transparent, and environmentally sound practices across the entire food value chain. However, interviews revealed that information sharing regarding packaging is inadequate between four of the case firms and their suppliers. This deficiency frequently leads to significant delays in the necessary repackaging of identified poorly packaged food products, hindering overall operational and environmental goals. In firm A, the extensive five to six-month period required for information processing significantly contributes to a high volume of FLW. This considerable delay in acting on crucial data is, critically, a factor entirely within the retail firm's control. Expediting such processes is essential for companies genuinely committed to effectively implementing

sustainable practices throughout their supply chain and minimizing environmental impact. This supports an established theory that environmental cooperation will help in the mitigation of the FSC risks that may affect the environmental health. (Radmehr, 2023)

3.7.4 Lack of coordination in implementing packaging strategies.

There is an apparent lack of coordination among retailers and their suppliers regarding the implementation of food product packaging strategies. Environmentally friendly packaging design is crucial for mitigating Food Contact Material (FCM) risks, benefiting environmental health, and ultimately leading to Food Loss and Waste (FLW) reduction. Utilizing reused or recycled materials, such as recyclable plastics and glass for food product packaging, significantly contributes to food waste reduction (Abdullah and Yaakub, 2014; Tritos *et al.,* 2013; Laosirihongthong *et al.,* 2013; Zailani *et al.,* 2012). In addition, adopting environmentally friendly packaging, specifically non-hazardous and biodegradable materials, is essential for mitigating the overall environmental risks posed by food product packaging. This approach strongly supports a circular economy and minimizes ecological impact. However, a challenge arises because two of the five retail firms D and E operate automated crane systems for picking food products. Their packaging is most often designed primarily to fit seamlessly into these automation systems. This functional requirement can, ironically, lead to a high volume of food waste generated, as some packaging may not adequately withstand the pressures of subsequent handling and transportation. Furthermore, products not bearing a specific firm's label are generally designed with a standardized shape and size for all retail firms in this study. Consequently, complaints about packaging from any single firm in isolation might not be honoured by suppliers if the same complaints are not concurrently made by the majority of companies purchasing that particular food product, highlighting a systemic issue in influencing supplier practices. However, some suppliers have become aware of this problem and have been working directly with the retail companies involve with the aim of solving the problem.

3.7.5 The Impact of Employees Capacity Building.

Specialized training for food retail firms' employees on environmental issues is evident in this study to be paramount to FLW reduction. Companies can significantly facilitate the adoption of Food Loss and Waste (FLW) reduction practices by investing in human capital equipped with specialized knowledge and skills concerning environmental concerns (Saeed and Kersten, 2019) as Conversely, the growth of such initiatives is often hampered by a lack of awareness regarding critical sustainability issues (Chkanikova and Mont, 2015). Indeed, it was found that,

one of the most important firm-level critical factors directly tied to environmental performance is the capacity building of employees. It was evident in this study that continuous learning and capacity building in sustainability not only enhance job performance in environmental matters but also effectively aid businesses in reducing food waste and minimizing costly errors and hence given them competitive advantage over other food retail firms. Conversely, a weakness in learning and training presents a significant risk, preventing the effective application of FLW reduction principles (Ansari and Kant, 2017). Integrating environmental considerations into daily operations is crucial: every decision-making process should involve regular discussions on FLW reduction practices, ensuring employees consider the social and environmental effects of their actions (Mastos and Gotzamani, 2022). Such consistent, daily discourse on environmental issues is a clear indicator of sound management orientation (Pagell and Wu, 2009). This was found to be the case in all the firms under this study as they have invested heavily on the training and retraining of their staff and this has significantly impacted on the FLW generated. It is mandatory in all the firms that all their staff undergo retraining at least once in a year depending on the staff immediate training needs. It was evident that the firm's performance in its FLW reduction strategies is directly tied to their investment in human capacity building and training to meet their environmentally friendly practices.

3.7.6. Government support for Environmentally Friendly practices.

Improved government involvement is crucial for significantly reducing FLW in retail firms. Governments have a duty to establish clear standards and regulations, perfect supervising mechanisms, and provide expert guidance to encourage environmentally friendly practices among retailers. The UK government, for instance, has notably bolstered its efforts, recently allocating £6 million in funding to FLW reduction schemes (GOV.UK, 2020). This commitment has spurred a landmark pledge from all of the UK's major supermarkets, who have collectively agreed to halve their FLW generated across the supply chain by 2030. Beyond financial incentives, the UK government is actively implementing a combination of regulatory and non-regulatory actions and policies specifically designed to address FLW (GOV.UK, 2021). However, the adoption of these measures by many firms, including those in this study, has largely remained at a minimum level. This cautious implementation is primarily driven by the associated costs, indicating a persistent barrier despite governmental initiatives and industry pledges.

Moreover, enhanced motivation and supportive financial policies could effectively accelerate the implementation of such sustainable practices. For example, the government could establish

a dedicated agency tasked with monitoring compliance by all retail companies, ensuring accountability. Additionally, creating a specialized information network for retail companies would be invaluable. This network could provide detailed information about environmental standards and best practices, empowering retail companies to easily study, evaluate their current approaches, and consequently improve their environmental performance in FLW reduction.

3.8 Conclusion.

This study evaluates how firms' strategies impact Food Loss and Waste (FLW) reduction within the food retail sector. It delves into the inherent challenges of integrating sustainable practices with food supply chain operational performance. Furthermore, the research outlines specific procedures that food supply chains can implement to significantly boost their operational efficiency and, consequently, reduce FLW.

The research findings explain how five case companies operating in the food supply chain in the UK generates food wastes through misapplication of resources which contributes to environmental pollution. It shows in context how their operational mechanisms, and related management processes, leads to generation of food wastes. The implementation of strategic capabilities in the area of pollution prevention along the food supply chain and sustainable developments are well implemented in the UK food supply chain. It relies mostly on secluded sustainable practices of different units in the supply chain rather than a coordinated effort among all the players to achieve the sustainable objectives (Lee, 2018).

3.8.1 Academic Contribution.

The theoretical standpoint identified suggests that any program to reduce food waste will be met with high levels of resistance within the organisations because they either have limited knowledge or are often unwilling to integrate these practices to improve operational performance due to financial considerations and the overproduction of food products. This corresponds with additional studies linking pollution prevention with continuous innovation within the food firms (Vachon and Klassen, 2008; Golicic and Smith, 2013) and emphasising the specific importance of process innovation in line with NRBV principles (Aragon-Correa and Sharma, 2003). The realistic insights provided in this study have the potential to further enhance the understanding of implementing sustainable practices in the food supply chains. Different processes, which could lead to a reduction in food waste along the supply chain from packaging design strategies to logistical efficiency practices considered in this study, intend to

investigate whether the sustainable practices are proactively adopted by the five case companies. It is evident that the essential practices for mitigating environmental health risks include the eco-labelling of products (Zhu, Sarkis and Lai, 2007) and active cooperation with both suppliers and customers. This collaboration is vital for promoting the use of environmentally friendly packaging, specifically materials that are non-hazardous and biodegradable, thereby reducing the overall environmental risk posed by packaging in support of the NRBV principle (Younis *et al.,* 2016; Zaid *et al.,* 2018; Zhu, Sarkis and Lai, 2013). Also, environmentally friendly packaging design is vital for reducing food contact risks, substantially improving environmental health, and is a key strategy directly leading to the reduction of Food Loss and Waste (FLW). Collectively, these activities significantly increase the level of environmental health by addressing and reducing the risks associated with FLW.

The current business practices and the general perceptions regarding the quality of food products not only promote overproduction and surplus but also lead to reliance on these features for the supply chain to function. Moreover, the Natural Resource-Based View (NRBV) fails to define how food firms can overcome these challenges associated with predicting the ecological and societal environments caused by overproduction and surplus of food products, which arguably intensifies competitive impermanency (Chakrabarty and Wang, 2012; Li and Liu, 2014). This oversight, according to Butler and Priem (2001), contributes to the clumsiness and ineffectiveness typical of resource-based theories. The drives and barriers to applying these practices, as discussed in this paper, could assist in appreciating the challenges in their implementation in the UK. The findings also suggest that, without altering the essential characteristics of current food supply chains, systemic food waste will continue, which means large volumes of food will be wasted. Branco and Rodrigues (2006) stated that by investing in environmental protection and product stewardship strategies, a corporation can profit on both internal and external levels.

Limited studies in past have focused on retail food firms in the UK. Therefore, this study makes significant contributions in providing insights into how to improve the environmental performance of the Supermarkets. Analysing and comparing the sustainable capability of the case companies offers useful evidence about the factors responsible for promoting sustainable practices in the food supply chain. Implementing sustainable practices in the packaging design strategies and logistical efficiency practices would be more effective in reducing FLW across the food supply chain. However, the Government could play an important role through improvements in various aspects to create the right conditions for encouraging environmentally

friendly practices along the supply chain. The research findings indicate that monitoring the sustainability practices along the supply chain is a contributing method of food waste prevention.

3.8.2 Practical Implications.

The findings of this study may assist practitioners in making both tactical and strategic conclusions concerning the effective implementation of food supply chain practices in the UK, which could significantly affect their sustainability performance. It is pertinent to note that sustainable operations require implementing a comprehensive logistical evaluation system. This system assesses internal eco-performance and uses environmental reports for internal review, driving continuous improvement, which helps practitioners to reduce FLW significantly. (Zaid *et al.,* 2018; Zhu *et al.,* 2013). Also, adopting environmentally friendly packaging, specifically non-hazardous and biodegradable materials, will help practitioners in mitigating the overall environmental risks posed by food product packaging. Furthermore, this study could help practitioners in dealing with the possible challenges highlighted in executing sustainable practices through food alternative uses and charity. We believe that these research findings will encourage the food retailers to become proactive in implementing sustainable ideas with the operational performance to remain competitive.

3.8.3 Limitations and Future Research Direction.

This study, while offering important insights into implementing sustainable FLW reduction practices in the food supply chain, also highlights significant opportunities for future research. A key limitation is its reliance on only five case companies, which, despite being a recognized aspect of case study methodology, may restrict the generalizability of findings.

To achieve a deeper and more comprehensive understanding of the UK food supply chain's environmental performance, future studies could significantly increase the sample size by engaging more case companies. The current findings might present an optimistic view of the food retail sector. A larger sample in future investigations could offer a more nuanced and potentially challenging perspective.

Additionally, no single best method exists for qualifying FLW. Each method has drawbacks. Employing diverse methodologies, such as large-scale survey research and mixed methods approaches, could provide a richer appreciation of the complex dynamics at play. Also, the NRBV theory in this research is limited by its static nature, failing to fully address the contextual, institutional, and dynamic factors influencing management in the FSC. While it

links resources to competitive advantage, the theory offers little prescriptive guidance for managers on how to effectively build or leverage those resources to minimize FLW. The theory underemphasizes the role of external market conditions. It focusses mainly on internal resources which ignored the important external pressures and opportunities. Given these limitations, future researchers should be cautious when relying on NRBV to study firm approaches on reducing FLW.

Chapter 4. Understanding the Environmental Impact of Inventory, Backorder Management and Flexible Facilities Layout of the UK Food Retail Firms.

4.1 Abstract.

Significant Food Loss and Waste (FLW) within the UK food retail sector poses severe economic and environmental challenges, costing the UK economy 21.8 billion annually. Despite increasing regulatory and public pressure, systemic FLW persists, highlighting a critical knowledge gap concerning the practical operationalization of strategic environmental capabilities. This study addresses this gap by examining how the Natural Resource-Based View (NRBV) capabilities like Pollution Prevention, Product Stewardship, and Sustainable Development, are implemented through core operational management practices within perishable food supply chains.

Employing a Critical Realist paradigm and a Multi-Case Study design, the research analysed data from 32 semi-structured interviews and group discussions across five major UK food retail and supply chain firms. The analysis reveals that the full potential of NRBV is often undermined by operational inhibitors related to inventory control, demand forecasting, and facility design. Specifically, a Policy Misalignment Mechanism is identified, where operational policies remain primarily focused on short-term cost minimization, failing to structurally integrate environmental outcomes. A key finding of this study indicate that systemic food waste will persist without significant changes to inventory and backorder policies that align with environmentally sustainable outcomes and more effective use of facility layout that prevents overcrowding in the firms operating in the food supply chain and also, managerial reliance on post-waste mitigation (e.g., donation) often substitutes for systemic pollution prevention efforts.

The contributions of this research are both theoretical and managerial. Theoretically, this paper extends NRBV by defining its micro-operational capabilities in perishable supply chains and develops the NRBV-Aligned framework. Managerially, it demonstrates how integrated information sharing and flexible operational strategies can resolve inherent tensions between efficiency and environmental outcomes, providing a strategic roadmap for retail executives to achieve systemic FLW reduction and secure sustained competitive advantage.

Keyword: Food Loss and Waste (FLW), Supply Chain Management, Inventory Control, UK Food Retail, Natural Resource-Based View (NRBV).

4.2 Introduction.

Despite technological advances globally, managing perishable products remains a significant challenge in industries such as, food (Kumar et al., 2020) and agri-food (Weerabahu *et al.,* 2022). In supply chains, key logistical drivers include inventory management, backorders, and facility layout (Chopra and Meindl, 2015). These factors have attracted considerable research interests (Bonyadi *et al.,* 2014). This paper addresses these logistical challenges in managing perishable food products through the lens of the Natural Resource-Based View (NRBV) (Hart, 1995). The NRBV, which has received substantial academic attention (Johnsen *et al.,* 2014), incorporates three core components: corporate social responsibility (CSR), entrepreneurship, and environmental commitment. CSR aligns with pollution prevention, entrepreneurship with product stewardship, and environmental commitment with sustainable development, including the adoption of clean technologies (Menguc and Ozanne, 2005).

Integrating environmental practices into supply chain operations is essential for coordinating firms' activities efficiently. For instance, simultaneously addressing inventory, backorders, and facility layout leads to complex operational management issues (Jemai *et al.,* 2022). Perishable food products are particularly sensitive to transportation delays (Yakavenka *et al.,* 2020), temperature fluctuations (Aung and Chang, 2014), storage conditions (Liu *et al.,* 2021), and time lags (Yakavenka *et al.,* 2020). These vulnerabilities necessitate a holistic, environmentally conscious strategy that promotes pollution prevention and sustainable development within the food supply chain.

Inventory management is a critical factor contributing to food wastes in supply chains. When perishable products remain in upstream supply chain stages for extended periods and arrive at retail shelves with limited shelf life, the risk of expiration before sale increases. As a result, retailers often discard expired or soon-to-expire items, contributing to an estimated $15 billion in annual food wastes in the grocery industry (GMA, 2008). Additionally, aging products can diminish perceived quality, negatively affecting consumer experience and future demand. Thus, managing inventory age is crucial for minimising food wastes, preserving product quality, and thereby enhancing consumer satisfaction and stabilizing consumer demand (Wan and Sanders, 2017).

Operational inefficiencies—such as overstocking, poor product launch planning, and labour cost-driven batching policies—contribute significantly to inventory problems in food supply chains (Akkas and Honhon, 2022). These issues are widespread. For instance, one food retail

firm found that the average remaining shelf life of items selected for shipment was 74%, with 1.05% of inventory falling below the required six-week threshold for retail delivery (Wan *et al.,* 2019) Another retailer reported receiving products with just one month of shelf life after spending eight months circulating within the distribution network (Prak and Teunter, 2019). Such inefficiencies frustrate retailers, increase food losses and wastes (FLW), and strain relationships among supply chain partners.

To address these issues, producers and retailers often implement rules governing minimum shelf-life requirements—commonly mandating at least 15 remaining days. Products not meeting these criteria are frequently rejected to maintain freshness and minimize FLW (Acar and Gardner, 2012). Resolving inventory-related challenges is therefore essential not only for improving environmental outcomes and supply chain efficiency but also for fostering stronger partnerships across the food supply chain.

When customers discover that a particular food product is out of stock in a retail store, they may choose to wait until it becomes available, resulting in a backorder. If backorders are not handled promptly, they can significantly impact a firm's revenue, market share, and customer trust, potentially leading to customer loss (Mohebalizadehgashti *et al.,* 2020) Conversely, swift action to fulfil backorders exerts immense pressure on various stages of the supply chain, potentially overloading processes and incurring additional costs related to production, labour, and shipping (Yu *et al.,* 2020). This pressure often leads to food losses and wastes throughout the supply chain. Managing backorders effectively is essential to maintaining operational efficiency and minimizing negative impacts on both the business and its supply chain (Rodger, 2014).

Uncertainty in customer demand complicates forecasting for various food products, rendering traditional supply chain strategies less effective due to inaccurate demand projections and misclassification of backordered items. This uncertainty adds pressure on supply chains to respond rapidly to fluctuating demand when needed (Guo *et al.,* 2019). Backorders typically arise when demand exceeds available inventory, creating logistical and inventory control challenges – particularly when multiple orders are received within a short timeframe. Food retail firms must manage out-of-stock items sourced from various suppliers, requiring meticulous record-keeping and timely order placement. Frequent backorders necessitate a critical evaluation of inventory control practices to prevent excessive inventories that can lead to significant food losses and wastes (Rodger, 2014). Predicting backorders is feasible in the

food retail sector, where lead time, unit price, product quantity, and current stock levels are key influencing factors (Xu *et al.,* 2017). However, sudden shifts in store-level demand can introduce new risks into the supply chain and significantly increase food loss and waste.

This study also examines the impact of process and facility layouts on food loss and waste (FLW) within the supply chain. Both layout types have gained prominence in supply chain research (Thi *et al.,* 2015). Process layouts, and functional layouts, have similar activities in food retail supply chain based on the functions they perform (Martdianty *et al.,* 2020). Process layouts offer flexibility, allowing workers to perform a variety of tasks within a single department, positively impacting FLW reduction (Kristensen and Mosgaard, 2020). However, they may also lead to inefficiencies such as long queues and excessive work-in-process inventory. Techniques like block diagramming can improve process layouts by minimizing non-adjacent loads and movements between departments (Russell and Taylor, 2003).

On the other hand, facility layouts combine the flexibility of process layouts with the efficiency of product layouts by arranging activities in a sequential manner for specific food products processing. Using group technology (GT), dissimilar machines are grouped into work centers to process parts with similar requirements (Jurgilevich *et al.,* 2016). This one-piece flow enhances efficiency by simplifying routing and streamlining logistical process, making it ideal for food product processing or picking. Facility layouts thus offer strategic advantages within food supply chains by improving operational efficiency while maintaining flexibility, which also contribute to reducing FLW (Kher and Jensen, 2021).

4.2.1. Research Gaps:

Building upon the proposition 3 established in paper one of chapter two, this research addresses a significant academic void regarding how diverse management practices influence Food Loss and Waste (FLW). While structural factors are often cited, the systematic literature review identified an urgent requirement for empirical investigation into specific operational variables: inventory strategies, back-order rates, facility layout, and supplier-driven overproduction. By synthesizing these overlooked management practices with the structural improvements detailed in paper 3 in this chapter, this study constructs a robust, holistic framework designed to align internal operational performance with sustainable waste reduction goals across the food supply chain.

Furthermore, previous studies have examined the impact of Supply Chain Management on sustainable inventory practices (Rajabion *et al.,* 2019; Bhatia and Gangwani, 2021; Beske *et al.,* 2022). However, research on food loss and waste (FLW) due to inventory strategies in major UK retail food supply chains remains limited (Yang *et al.,* 2023; Jeswani *et al.,* 2021; Rao, 2020; Mastos and Gotzamani, 2022).

Minimal emphasis has been devoted in past to back-order rate issues such as transportation delay, unpredictable demands, unreliable suppliers, inadequate safety stock, and excessive lead times in the reduction of FLW (Rodger, 2014; Hofmann *et al.,* 2014; Dancho, 2017; Kumar *et al.,* 2020; Madarász *et al.,* 2022).

While prior studies suggest effective Supply Chain Management can enhance sustainability in operations (Shi *et al.,* 2018; Jia *et al.,* 2018), current literature has not drawn enough attention to how facility layout, such as equipment, technology, machines, and Workers' arrangement, impacts the food supply chain. This results in unclear explanations of its impact on food loss and waste (FLW) and operational performance (Jackson and Drougas, 2002; Russell and Taylor, 2022).

Although many studies have previously highlighted these gaps in operational and management strategies that exacerbate FLW, this study demonstrates that effective inventory management, backorder handling, and flexible layout design are essential for reducing food loss and waste. By adopting practices such as efficient inventory control, optimized warehouse layouts, and improved demand forecasting, food retailers can significantly mitigate food waste and enhance sustainability across their operations.

This study primarily focusses on examining the impact of inventory management, back-order rate issues, and facility layout arrangement on FLW and operational performance of retail supply chain.

4.2.2. Research Questions:

Key research questions this study attempts to address are:

1. How do inventory management practices of food retailers affect generation of FLW in the supply chain?
2. How do back-order related issues impact the FLW in FSC?
3. To what extent could facility layout arrangement solve or adversely affect FLW?

4.3 Literature Review.

4.3.1. Food Classification and Complexity of Food Supply Chain.

For decades, efforts to classify and quantify global food waste (FLW**)** have aimed to highlight its significant types and amounts in relation to global hunger. These assessments, relying on limited datasets extrapolated to larger scales, often cite the estimate that up to half of all food produced is lost or wasted before reaching consumers (Lundqvist *et al.,* 2008). Classifying FLW involves identifying its type, quality, and potential for reuse or recycling, which helps develop effective reduction and management strategies (Bellemare *et al.,* 2017; FAO, 2019). Fresh foods, including fruits, vegetables, meats, seafood, dairy, nuts, berries, beans, and starchy foods, must be kept safe, nutritious, and appealing by retailers (Gobel *et al.,* 2015). The food supply chain (FSC) differs from other supply chains due to its unique complexities: the perishable nature of food, interactions with numerous stakeholders, and inter-sectoral influences (Mithun-Ali *et al.,* 2019). The FSC's complexity is linked to concerns about safety, sustainability, quality, and efficiency (Gobel *et al.,* 2015). Scholars identify key FSC stages: (i) farm production, (ii) handling and storage, (iii) processing, (iv) distribution, and (v) consumption (Porter *et al.,* 2016). Inefficiencies leading to FLW occur across all these stages (Hartikainen et al., 2018), and the reason for FLW at one stage might be concealed in another (Raak *et al.,* 2017).

The globally recognized approach to reducing food loss and waste (FLW) addresses inefficiencies across the entire Food Supply Chain (FSC) (Hartikainen et al., 2018). The FSC's length and the significance of each stage depend heavily on facility layout (Porter et al., 2016). Prior studies indicate initial FSC stages contribute most to FLW generation (Gustavsson et al., 2011). In developing countries, FLW often stems from poor harvesting, inadequate storage, and insufficient transportation infrastructure (Gustavsson *et al.,* 2011). Despite this, developed nations are also falling short in FLW management; European countries generate over 59 million tonnes annually (Eurostat, 2024). This underscores the need to focus on FLW generation in the initial stages of the FSC—from farm to distribution, including firms' management of inventory, backorder, and facilities layout. In the UK, seven major supermarkets, covering 85% of the retail market, produce around 0.2 million tonnes of food waste, approximately 2% of the national total. Food waste costs the UK economy £21.8 billion yearly, with a government goal of halving it by 2030 (British Retail Consortium-BRC, 2022; WRAP, 2024).

Globally, approximately 1.3 billion tonnes of food are lost or wasted annually, representing about one-third of all food produced for human consumption. Perishable foods, especially fruits

and vegetables, are highly susceptible, with over 40% of produce lost or wasted worldwide each year by weight (Ishangulyyev *et al.,* 2019). The breakdown of FLW by food type varies by measurement. In terms of calories, cereals account for the largest share (53%), followed by roots/tubers (14%), and fruits/vegetables (13%). Meat comprises a smaller caloric share (7%), but its environmental impact is substantial. On a weight basis (Fig 16), roots and tubers, and vegetables each contribute 21% of FLW. Fruits, fish, and seafood combine for 16%, cereals 14%, dairy 10%, meat 9%, and oilseeds/pulses 9% (FAO, 2018). Estimating FLW per commodity production, 20-22% of cereals are lost, compared to 39-44% of fruits and vegetables, 33% of roots and tubers, and 24% of seafood (Irina et al., 2023).

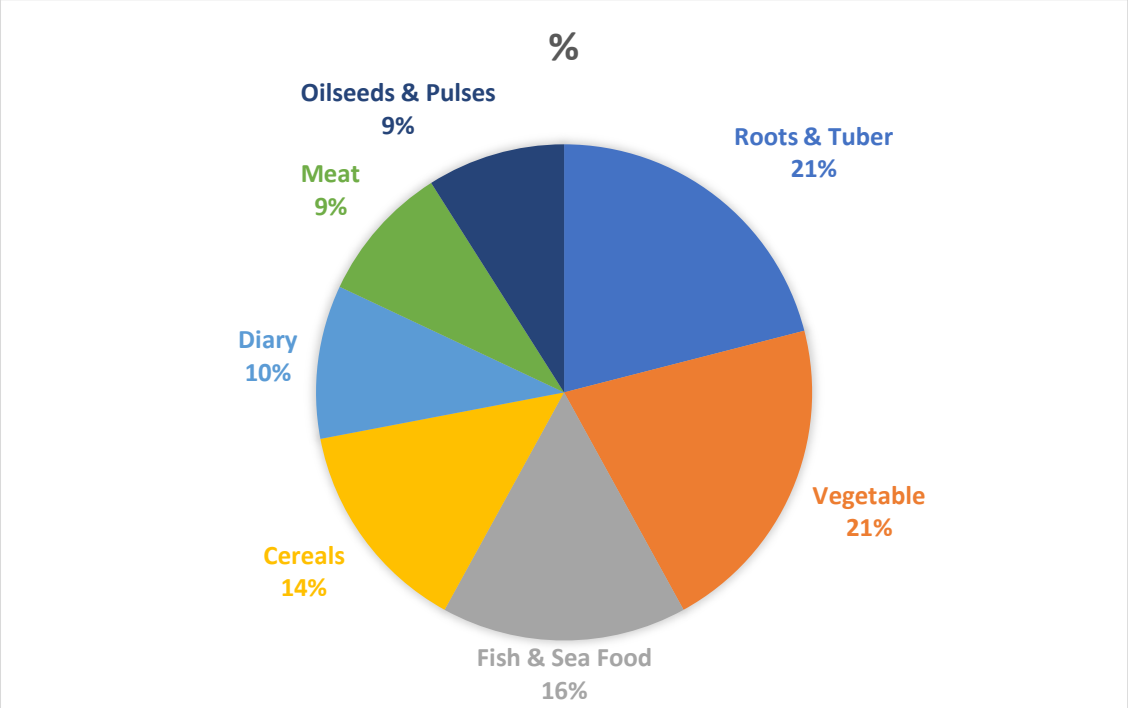

Figure 16 Different types of Perishable Food loss in Percentage (FAO 2018).

4.3.2. Environmentally Friendly Supply chain.

Sustainable development emphasizes harmony between human activities and nature, aligning with the principles of Natural Resource-Base View in the supply chain. The UK, grappling with severe ecological issues, has prioritized environmentally friendly practices as a national strategy. Natural resource base principles play a crucial role in achieving this goal.

Research on environmentally friendly supply chains has been focused on the UK food retail sectors, as they dominate global retailing. These retailers face increasing pressure from

customers, government and organizations, such as the European Union, with stricter environmental regulations and increased monitoring. Some researchers considered important measures and capabilities for effectively implementing environmentally sustainable chains practices. For instance, Darnall *et al.,* (2008) compared capabilities for implementing environmental management system. Handfield *et al.,* (2001) emphasized dynamic interdepartmental cooperation as crucial for successful environmentally friendly practices and improved performance.

However, the impact of these factors on sustainable supply chain practices varies significantly across countries, industries, and organizational strategies. To gain in-depth insights, some research focuses on understanding the impact of these factors on operational performance within specific contexts. Tseng *et al.,* (2014) discussed a difficult method for comparing business performance of eco-efficiency in environmentally friendly supply chains under uncertainty, comparing gain and loss functions as performance tools for environmentally friendly practices. The study further discovered that customers and government pressures and implementation of environmentally sustainable supply chain are also fully mediated by internal pressures. Jabbour *et al.,* (2017) examined the connection between important achievement factors and the adoption of environmental practices for Brazil based manufacturing firms. They argued that firms using environmental technique in employee training, recruitment, performance evaluation and employee rewards will record more success in environmental technique implementation.

Moreover, Yu *et al.,* (2017) stressed the need for harnessing both procurement workers and environmentally friendly supplier choices as these have a significant impact on supplier partnership, and that securing teamwork with suppliers is very important and positively related to both environmental and operational performance. Lee *et al.,* (2015) discussed that a firm's environmental performance can impact its competitive advantage. GarzaReyes *et al.,* (2016) and Cherrafi *et al.,* (2017) studied the application of environmental practices methods in the supply chain setting to advance the operational performance in the supply chain. Likewise, in the previous studies, such as Chaabane *et al.,* (2011), Kumar *et al.,* (2015) and Marshall *et al.,* (2015), it was revealed that there are multiple factors to be considered while implementing sustainable supply chains.

Although some food retail firms have appreciated the importance of environmentally friendly practices, they are held back by lack of information and organisational skill and shortage of

financial budget to implement these practices. Additionally, Zhu *et al.,* (2005) also stated that some food retail firms cannot implement environmentally friendly supply chain effectively as they lack recouping systems. Thus, they are inevitably ineffective in the food product recouping practices and therefore fall short in reducing FLW in the whole supply chain. Clark (2000) and Hall (2000) suggested that human resource is also one of the important influences of the operation of the environmentally friendly supply chain. Zhang *et al.,* (1999) studied this matter from the view of organizational values. They concluded that weaker organisational values prevent the application of environmentally friendly practices in the supply chain.

In addition, when we are considering Environmentally friendly initiatives, a food retail firm centred approach is insufficient. Instead, a supply chain perspective is necessary. This is because competition is no longer solely between individual firms, but rather between entire supply chains of each firm. (Paksoy *et al.,* 2020). To maintain and enhance supply chain competitiveness, initiatives like using the natural environment friendly strategies and thinking must be embraced by the entire supply chain and coordinated by the lead company. (Nath *et al.,* 2010; Walker *et al.,* 2012; Hitt *et al.,* 2015). The level of incorporation controls the environmental performance, because greater supply chain integration leads to better environmental performance (Vachon and Klassen, 2006). Adopting environmental practices thus affects environmentally conscious consumers' perception of the firm (H'Mida, 2009; Maineri *et al.,* 1997), which becomes an advantage for the firms and in turn, their supply chains. Environmentally conscious consumers leverage their influence through their choice of the retail firms that they patronise and thus increasing firm and supply chains' competitiveness and economic performance (Kumar and Malegeant, 2006; Rao and Holt, 2005)

4.3.3. The inventory Management Challenges of perishable Food

Despite extensive research, the competitive landscape and increasing customer demand for quality necessitate careful inventory management in the perishable food supply chain. Advanced systems providing real-time insights into inventory levels, expiration dates, and storage conditions are crucial for minimizing spoilage, meeting demand, and ensuring customer satisfaction (Mohebalizadehgashti *et al.,* 2020). This enables accurate tracking of each product's lifecycle, prioritizing older stock to minimize expired goods.

However, maintaining quality and safety presents significant challenges. Perishable foods have diverse temperature requirements, making it difficult to ensure optimal conditions throughout the supply chain, especially during long transportation or unexpected delays. Studies show

approximately one-third of food losses result from transportation time, handling issues, and factors impacting perishable shelf life (Sahin *et al.,* 2007). Coelho and Laporte (2014) used a mixed-integer programming model to assess inventory and transportation robustness for perishables under unpredictable demand (weather, seasonality, customer preferences). Their objective was effective inventory management, optimizing routing and transportation while considering inventory levels and customer satisfaction. The findings highlighted challenges in maintaining food quality and freshness, particularly temperature control during long-distance transport, and emphasized the importance of accurate forecasting to prevent stockouts or overstocking.

Furthermore, Kumar and Kumar (2023) analysed challenges in co-transporting perishable products to cut costs, discovering that certain commodities absorb odours from others. For example, bell peppers can affect raspberries or strawberries, deterring customers. Wang (2024) emphasized collaboration between retail firms and suppliers for quality and timely delivery of perishable food products. Berlin *et al.,* (2022) incorporated optimal timing and volume for delivery and sales of products with varying production times, aiming to minimize costs and ensure timely delivery. The optimization system for perishable goods supply chain management can be single-objective or multi-objective, depending on specific problem requirements (Kiaghadi and Hoseinpour, 2023).

Research indicates that integrated production and distribution strategies within a multi-objective framework can lead to lower costs for perishable goods compared to separate models for products with indefinite lifespans (Amorim *et al.,* 2012). Pratap *et al.,* (2022) addressed challenges in the perishable food supply chain, focusing on balancing production, inventory, and routing amidst rapid deterioration. They introduced an integrated production-inventory-routing problem incorporating environmental concerns like carbon emissions and pollution prevention, and a sustainable pricing-production-workforce-routing model for perishable products. Majidi *et al.,* (2022) optimized supply chain decisions by balancing operational, social, and environmental concerns, providing insights for effective planning. Li *et al.,* (2023) merged production and distribution planning to determine fleet size and optimal distribution paths before shelf-life expiry. Pan *et al.,* (2023) tackled multi-product production routing under uncertainty, proposing two-stage stochastic strategies and introducing a novel metaheuristic algorithm, highlighting the negative impact of increasing demand and supply uncertainties on overall supply chain performance. Zhang *et al.,* (2024) introduced a non-deterministic multi-period location-routing-inventory problem for a three-tiered supply chain, optimizing location,

routing, and inventory for efficient perishable goods management. Kumar and Kumar (2023) addressed sustainable supply chain location-routing-inventory, identifying environmentally friendly suppliers and developing a model for environmental, social, and economic sustainability.

4.3.4. The Impact of Data-Driven Strategy and AI on Inventory Management.

EU food retailers are increasingly leveraging AI-driven inventory control and predictive analytics to enhance decision-making and optimize operations. Both methodologies utilize data and statistical algorithms to forecast future outcomes by identifying patterns in historical data (Gayam *et al.,* 2021). While both aim to optimize inventory, AI-driven systems offer a significant advantage by autonomously learning and adapting (Eyo-Udo, 2024).

Traditional predictive analytics relies on manual processes, historical data analysis, and rule-based systems for stock tracking and demand forecasting. In contrast, AI-driven inventory systems leverage sophisticated data-driven algorithms to analyse patterns, predict demand fluctuations, monitor inventory levels in real-time, and dynamically optimize stock levels (Nimmagadda, 2021). These systems integrate diverse data points, including sales trends, supplier performance, customer behaviour, and external factors, providing a holistic view of the supply chain. For example, an AI-driven system can proactively predict demand spikes, ensuring sufficient inventory, preventing stockouts, and improving customer satisfaction, a distinct advantage over reactive methods. Firms also gain data-driven insights to maintain optimal inventory levels, avoiding overstocking (Muthukalyani, 2023).

Implementing AI-driven inventory control offers numerous benefits: reduced operational costs through optimized stock levels, increased profitability by minimizing food loss and waste, and improved customer experiences via timely product availability. It also leads to the elimination of manual errors through automated replenishment and enhances environmental sustainability by reducing unnecessary inventory and food waste. This dynamic solution empowers firms to navigate modern retail complexities and achieve sustainable growth.

However, adopting AI inventory management presents challenges, particularly for small businesses with legacy systems. Incompatibility with modern AI often necessitates costly modifications. Aligning manual or partially automated procedures with predictive analytics can be very difficult. Furthermore, synchronizing data between AI and outdated systems creates hurdles. Outdated or incomplete inventory records can severely undermine the accuracy and

effectiveness of AI algorithms, hindering their ability to provide reliable insights and optimize inventory management (Eyo-Udo, 2024).

4.3.5. Connections between Backorder Management and Environmental Practices.

Supply chains strive to maintain environmental practices by adapting to consumer demands for shorter lead times, lower costs, and higher product availability, while remaining cost-competitive. Food retailers aim to eliminate food waste, including hidden processing costs, labour, and unsold seasonal products (DeHoratius and Raman, 2008). To boost food product availability, retailers endeavour to provide accurate inventory data across their systems, minimizing stockouts or excess stock (Xu *et al.,* 2017). A backorder occurs when a customer orders or seeks a food product that is unavailable, and they choose to wait for its replenishment (Carter and Rogers, 2018). If not handled promptly, backorders can severely impact a firm's environmental practices, revenue, market share, and customer trust, potentially leading to lost sales or customers entirely. Conversely, rapidly satisfying backorders places immense pressure on the supply chain, potentially causing inefficiencies, leading to food loss and waste (FLW), extra labour/production costs, and increased shipment expenses (Mohebalizadebgashti *et al.,* 2020). Furthermore, uncertainty in customer demands makes accurate forecasting difficult, rendering conventional supply chain management less effective. This can result in inaccurate demand forecasts or misclassification of back-ordered products, contributing to environmental challenges and increased FLW (Wan and Sanders, 2017). To mitigate the tangible and intangible costs of backorders, some companies now predict them using machine-adapted forecasting processes. Backorder forecasting is more achievable in markets with stable demand, where lead time, price per unit, order quantity, and stock level are primary drivers (Roger, 2014). However, sudden demand changes can flag new risks within the supply chain, potentially leading to food product loss (Wan *et al.,* 2019). While forecasting partial backorders based on periodic stock counts shows promise for unpredictable demand challenges, it might negatively impact the local inventory system (Xu *et al.,* 2017).

Given the rapidly changing market dynamics driven by customer demands and expectations, flexibility in inventory control is essential for maximizing profit. Additionally, early prediction of diverse customer buying behaviour can help organizations proactively retain profit and goodwill. This also enhances effective environmental practices, fostering a more responsive and sustainable supply chain.

4.3.6. Facility layout Challenges in the Food Supply Chain.

The core objective of planning facility layout in the food supply chain (FSC) is to create an environmentally friendly operational system that reduces food loss and waste (FLW) and generates savings. Facility layouts can be process-oriented, arranging machines by task order, or product-oriented, grouping machines for similar products (Azadivar and Wang, 2000). A primary optimization problem is the location of facility devices, which, when arranged around products, introduces challenges like balancing processing lines (Zwierzyński, 2018). In food retail, the appropriate distribution of food processing departments is paramount, ensuring essential departments are proximate while separating those that shouldn't be (Kikolski, 2018). Effective logistical optimization hinges on proper planning and scheduling of tasks and workstation deployment, with logistical and processing efficiency heavily dependent on facility location and available space (John and Jenson, 2013). Incorrect workplace layouts can directly lead to food losses (Piskrzyńska and Cieślar, 2015).

Numerous factors influence processing line design and operation, including the number of shifts, food product batch volume (variable or constant), and types of transport and storage (Vilariño *et al.,* 2017). Due to the complexity of inter-position connections, optimization problems are often solved using one or several criteria: Minimizing distance between inbound, and outbound facilities and transport operations, minimizing difficulty in loading and discharging food products, minimizing transport routes and the number of transport operations, minimizing logistical costs and the costs of locating facility positions., minimizing total transport costs and stand locations (Lis and Santarek, 1980). However, current approaches have created challenges for retail firms, contributing to increased FLW within the supply chain. Optimally placed workplaces should shorten the logistical cycle, reduce logistical costs, or improve logistics resource utilization (Hu *et al.,* 2011; Vergara and Kim, 2019).

4.3.7 Theoretical background.

This study applies the NRBV theoretical perspective to food waste minimization. NRBV emphasizes building competitive advantages through environmental strategies in organizations and their supply chains (Hart, 1995; Hart and Dowell, 2011). Key NRBV capabilities include pollution prevention, product stewardship, and clean technology initiatives, which offer good advantages. A central focus of the study is examining effective inventory practices of food products, back-order management and flexible use of facility layout as it affects FLW through the lens of these NRBV capabilities.

NRBV suggests that investing in environmental and product stewardship can benefit corporations internally and externally (Branco and Rodrigues 2006). This aligns with environmentally friendly practices, creating a mutually beneficial relationship between the two.

Pollution prevention initiatives within NRBV are key strategies for minimizing food surpluses and avoidable food waste in the FSC (Graham *et al.,* 2018; Islam *et al.,* 2019). Product stewardship relates to minimising life cycle cost of food products through efficient use of firm resources to manage inventory, and food products back-order through corporate environmental strategies (Jensen and Remmen, 2017), while sustainable development practices involve Minimise environmental burden of firm growth and development with strategic FLW management policies that involves Environmental preferable purchasing, consumer buying behaviour and facilities maintenance (Mourad, 2016).

While the NRBV is typically seen as a strategic theory, it also informs operational strategies for managing supply chain food waste. A key operational aspect is information sharing, crucial in online environments. In fresh food supply chains (FSCs), sharing demand and shelf-life data among supply chain actors can significantly reduce food waste and enhance sustainability (Kaipia *et al.,* 2013). Effective transformation to minimal FSC food waste requires parallel changes in information management and material flow (Lusiantoro *et al.,* 2018). Information management also supports NRBV's product stewardship in food waste management (Perey et al., 2018). Additionally, clean technology—evident in green information systems plays a key role in managing FSC food waste (Miranda *et al.,* 2019). These NRBV capabilities provide crucial operational support for the online case study.

The natural resource-based view (NRBV) highlights businesses' reliance on the environment, food waste reduction and natural capabilities for a competitive edge (Çankaya and Sezen, 2019; Li *et al.,* 2015). NRBV posit that environmental and food waste reduction initiatives strengthen green supply chain capacities (Li *et al.,* 2015). Branco and Rodrigues (2006) argue that investing in environmental protection, food waste reduction strategies and product stewardship benefits corporations internally and externally. NRBV components and environmentally friendly supply chain practices are interconnected.

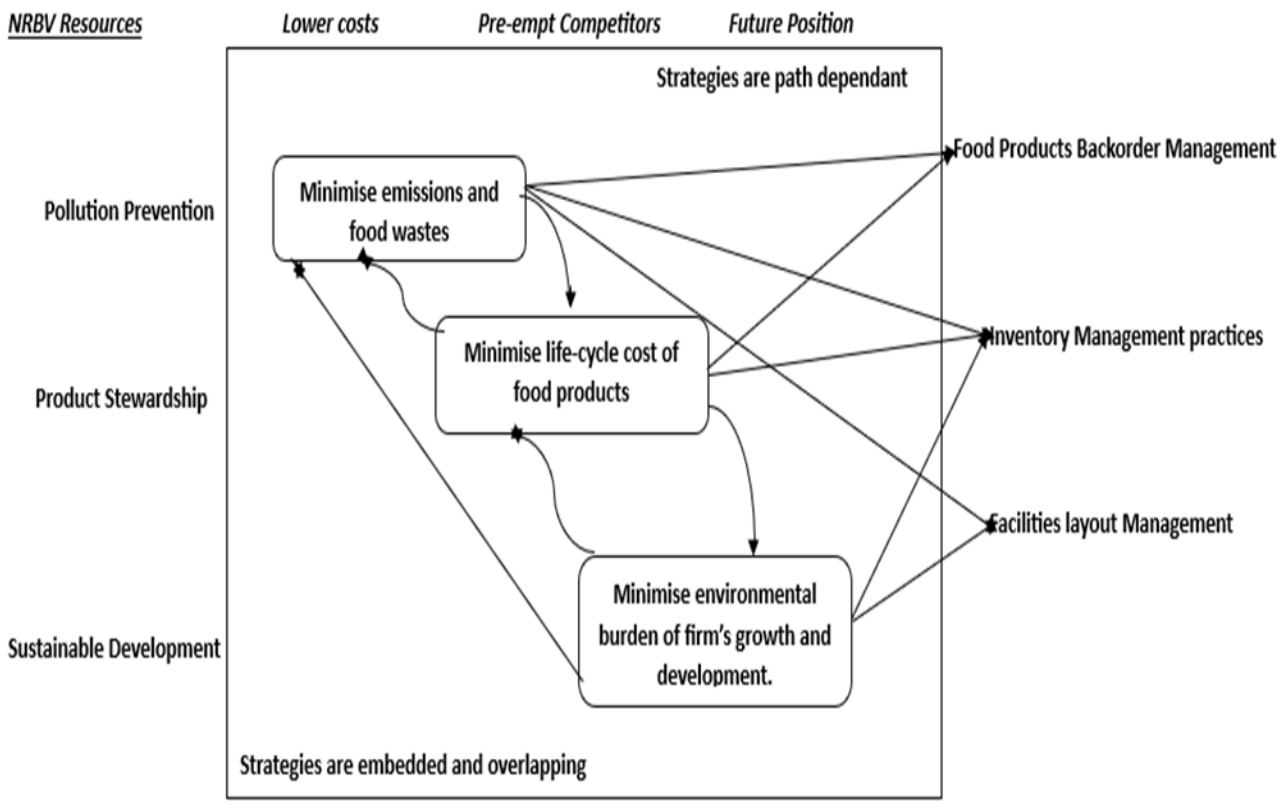

Figure 17: Research Framework 2 (Adapted from (Mollaoglu *et al*., 2024).

NRBV Resources	Environmental Driving Force	Key Organisational Capabilities and Strategies	Competitive Advantages
Pollution Prevention	Prevent discharges of effluent and food waste through effective inventory practices of food products, back-order management and flexible use of facility layout.	Promotes the minimisation of food waste and emissions throughout operations through Continuous improvement of firm's inventory practices, back-order management and facilities layout strategies.	Lower costs of running the food Supply chain increase profitability.
Product Stewardship	Minimise life cycle cost of food products through efficient use of firm resources to manage inventory, and food products back-order through corporate environmental strategies	Encourage the prioritisation of the natural environment through continuous assessment of food supply chain, Sustainable Business Values and Ethics tailored towards sustainable FLW reduction	A move to be more competitive in the food retail sector through exclusive food waste management and/or environmental management that involves active inventory practices and backorder management
Sustainable Development	Promote the consideration of economic, environmental and social issues through FLW management policies that involves Environmental preferable purchasing and facilities maintenance.	As the market features are changing rapidly based on the customers' demands and expectations, flexibility in inventory control and the facilities layout are essential to reduce FLW.	Securing future position of firm through a well-organized inventory practice of food products, back-order management and flexible use of facility layout.

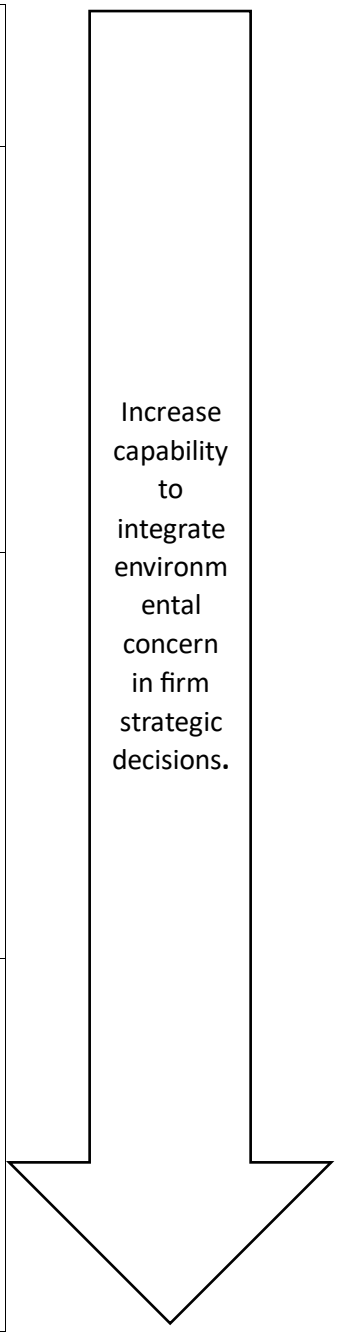

Figure 18: The Impact of NRBV Resources on Firms' Capabilities and Strategies (Adapted from Hart, 1995).

4.4. The Research Framework

This research framework (Fig 17) integrates the Natural Resource-Based View (NRBV) theory to account for the crucial environmental drivers that lead to firms' commitment to Food Loss and Waste (FLW) reduction along the supply chain. It highlights the link between NRBV resources and firms' innovation capabilities. These hard-to-imitate capabilities strengthen strategic activities like lowering retail costs and reducing FLW (Hooley *et al.*, 2004). (Fig.18) illustrates the environmental driving force for key organizational strategies, which confer competitive advantages when effectively managed.

NRBV resources, encompassing pollution prevention, product stewardship, and sustainable development, impact operational processes and environmental motivations. The strategies derived from these resources are embedded in and overlap with firms' innovation capabilities. For instance, effective inventory management minimizes emissions, food waste, life-cycle costs, and environmental burdens, aligning perfectly with NRBV strategies and guiding this study. These NRBV resources also provide an environmental driving force for key organizational strategies, conferring competitive advantages when effectively managed.

The resource-based approach in strategy emphasizes understanding the relationship between resources, capabilities, competitive advantage, and sustained profitability, which is crucial for effective strategy formulation (Song *et al.*, 2015). This study applied NRBV to explore capabilities in minimizing FLW through specific practices: effective inventory management of food products, back-order management, and flexible utilization of facility layout. It examined how these various inventory practices impact FLW generation, the specific influence of back-order management on FLW, and how facility layout management contributes to overall FLW reduction within the supply chain.

Ultimately, the NRBV framework provides a robust theoretical foundation for understanding how firms leverage environmental capabilities to gain competitive advantages in supply chain management. By integrating pollution prevention into inventory control and backorder processes, and by adopting sustainable development principles in facility layout, this study demonstrates how NRBV can significantly enhance operational efficiency while simultaneously reducing food loss and waste.

4.4.1 Research Methodology and Data Collection

4.4.1.1 Inductive Research Approach. This research starts with observations and data collection and thereafter, we seek pattern and relationships between the data collected to generate new theories. As there is little existing knowledge of using NRBV resources to explore capabilities in form of inventory, back-order management and facility layout in minimising FLW, the inductive method approach is appropriate for this research (Vijayamohan, 2025).

The research employs a case study methodology (Patton, 2002; Yin, 2017) to examine inventory practices, back-order management, and the impact of facility layouts on food loss and waste (FLW) across various supply chain stages. It also explores the challenges of integrating these practices to enhance operational performance. Semi-structured interviews are used to gather rich qualitative data with some consistency, balancing structured surveys and flexible unstructured interviews. This allows for both in-depth exploration and comparison of responses across participants (George, 2022). We conducted 32 semi-structured interviews with senior managers from five firms operating in food supply chain (refers to Appendix A). These includes two supermarkets, their warehouses and one supplier. They are selected for their common experiences with significant FLW. We also conducted group discussions with the operatives from two of the firms (refers to appendix B). These firms' sale revenues ranges from £800 million to £30 billion and have between 200 to 1,200 employees. The In-depth interviews enable the exploration of tacit phenomena through discursive data analysis (Saunders *et al.,* 2012). These interviews foster interactive engagement between theory (NRBV) and real-life food supply chain practices (Ackroyd, 2004), with researchers and interviewees co-creating valuable information (Edwards *et al.,* 2012).

The selection criteria focused on firms most likely to experience significant FLW. This research provided valuable insights into the firms' operations, the food products they offer, and the profiles of their customers and partners.

The interviewees were management-level representatives from the firms. Given the complexity of this analysis, a structured procedure was developed as a practical guide for data collection during interviews. This procedure recommended a semi-structured interview format and no time limits, allowing for unexpected insights and flexibility based on interviewee responses. Each interview lasted an average of 60 minutes and took place at the interviewees' chosen locations within their company premises to ensure comfort and privacy. The interviews were audio recorded, and interviewees' reactions, including non-verbal communication, were observed. Data confidentiality and ethical considerations are crucial in this study. The organisations were assured of protection of sensitive from unauthorised access, use or disclosure, while also adhering to legal and ethical guidelines. This includes obtaining information consent, ensuring secured data storage, and being transparent about data handling practices. Transcriptions of the interviews were done using Cockatoo's Transcriber software.

4.4.1.2 Transcription and Coding

To ensure the highest standards of academic rigor, the researcher strictly adhered to a systematic coding protocol, safeguarding the validity and reliability of the qualitative findings (Williams and Moser, 2019). This process involved first order coding to extract preliminary concepts from raw data, followed by second order coding to systematically refine these themes and identify significant interconnections (Strauss and Corbin, 1990). Finally, third order coding was employed to integrate these categories into coherent, high-level constructs, ultimately shaping a meaningful and theoretically grounded narrative (Flick, 1992).

The next step involved coding of the interviews following Bogdan and Biklen's (2007) approach. (refers to appendix C5 – C7) The first coding step identified blocks or paragraphs where interviewees discussed key elements like Setting, Definition, Process, and Method, as suggested by Bogdan & Biklen. This initial coding established a foundation for analysing the interview structure. The second step involved assigning paragraphs (or parts) preconceived codes from the theoretical framework to address each research question. The final step used a more inductive approach, recoding interviews as new codes emerged. Ultimately, the final codebook contained 38 codes organized into themes such as Effective Inventory Practices, Environmental Preferable Purchasing, Corporate Environmental Management, Complaints Reporting, Time Consideration, Reverse logistics and recoup, Back-order management and Facilities Layout This comprehensive coding process ensured thorough analysis and categorization of the data for the study. We then compared our findings across cases (King, 2012; Tranfield, Denyer, and Smart, 2003).

The digital manual coding involves the use of Microsoft Word and Excel to highlight, annotate, and reorganize data. This method combines the benefits of manual interpretation with digital efficiency, enabling rapid internal document searching. It also involved a meticulous, hands-on analysis of transcripts and field notes to identify emerging themes. The researcher utilized a hybrid approach, leveraging word processors for digital commenting and highlighting, alongside spreadsheets to construct structured codebooks for comparing data points. Additionally, traditional low-tech methods including physical printouts, color-coded highlighters, and sticky notes were employed to visually brainstorm and organize codes. This rigorous process allowed for the physical sorting and categorizing of text, ensuring a deep, immersive engagement with the data that facilitated the systematic identification of complex patterns within the food supply chain.

4.4.1.3 Data validity and Reliability:

To ensure robust external validity and adhere to rigorous scholarly standards, the researchers strategically employed a multi-case study design coupled with purposive sampling techniques, strictly following established qualitative field practices to ensure the sample was both relevant and representative of the industry’s complexity. While some scholars argue that traditional notions of "validity" are primarily rooted in quantitative, positivist paradigms, there is a clear

consensus within the social sciences that qualitative research requires its own specific criteria—often referred to as trustworthiness or credibility—to verify the quality and integrity of its findings (Golafshani, 2003).

To rigorously validate the findings, the researchers utilized member checking, a critical reflexive process where initial interpretations and transcribed data were presented back to the participants for formal confirmation, clarification, or correction. This iterative process was underpinned by the significant time the researchers invested in building rapport with participants, which facilitated a deeper, more authentic familiarization with their unique perspectives and organizational cultures.

Furthermore, the study bolstered contextual reliability and transferability by providing "thick descriptions" of the research environment. This transparency provides a rich narrative of the specific settings, minimizing the risk of misinterpretation and allowing future researchers to assess the applicability of the findings to other contexts. Meticulous records, or an "audit trail," were maintained throughout the research lifecycle, documenting every decision-making stage of data collection and the subsequent analytical steps. To further guard against personal bias, the researchers engaged in peer debriefing, seeking critical feedback from fellow academics to challenge assumptions. Ultimately, as McMillan and Schumacher (2006) suggest, validity is the extent of consistency between the scholarly explanation of a phenomenon and the reality it represents, ensuring these findings accurately reflect the lived situation within the UK food supply chain.

4.4.1.4 Significance of the Quotes Used

Direct quotes from respondents in this paper serve as the authentic, firsthand "voice" of the participants, providing indispensable empirical evidence that grounds theoretical interpretations in lived reality. By preserving the unique tone and emotional nuances of the data, these verbatims allow participants to represent themselves, ensuring that the analysis is not merely a reflection of the researcher’s perspective. This practice significantly enhances the credibility and trustworthiness of the study, as it demonstrates exactly how abstract themes and codes were derived from raw data.

Furthermore, the quotes act as powerful illustrative tools, transforming general phenomena into vivid, relatable instances that enhance the readability and engagement of the research report. They illuminate complex experiences and validate the study's findings by providing a transparent audit trail of the analytical process. Ultimately, the strategic use of verbatims bridges the gap between raw data and synthesized narrative, offering a more nuanced, accessible, and defensible account of food loss and waste management.

Table 15 details the case firms, interviewees, and data sources. The interviewees averaged 9.6 years of management experience, ranging from middle to senior levels.

Table 15: Profile of companies, Interviewees, and data 2.

Firm	Country	Industry sector & business activities	Number of Interviews	Interviewee designation & years of experience	Data Source & Time (Mins)	Number of Employees
A	UK	Supermarket Store	6	Store Manager (15)	Interview (56)	420
				Shift Manager 1 (8)	Interview (52}	
				Shift Manager 2 (7)	Interview (58)	
				Shift Manager 3 (10)	Interview (49)	
				Team Manager 1 (5)	Interview (54)	
				Team Manager 2 (5)	Interview (42)	
B	UK	Supermarket Store	7	Store Manager (18)	Interview (55)	446
				Shift Manager 1 (12)	Interview (51)	
				Shift Manager 2 (9)	Interview (48)	
				Shift Manager 3 (9)	Interview (59)	
				Team Manager 1 (6)	Interview (45)	
				Team Manager 2 (5)	Interview (47)	
				Team Manager 3 (6)	Interview (57)	
C	UK	Agro-Allied	3	General Manager (22)	Interview (59)	128
				Farm Manager 1 (15)	Interview (46)	
				Farm Manager 2 (7)	Interview (44)	
D	UK	Warehouse	8	General Manager (21)	Interview (58)	978
				Operations Manager (18)	Interview (52)	
				Shift Manager 1 (8)	Interview (54)	
				Shift Manager 2 (6)	Interview (46)	
				Shift Manager 3 (8)	Interview (52)	
				Team Manager 1 (5)	Interview (50)	
				Team Manager 2 (4)	Interview (43)	
				Team Manager 3 (7)	Interview (42)	
			4	Pickers (>5)	Group Discussions (45)	
E	UK	Warehouse	8	Operations Manager (18)	Interview (56)	754
				Shift Manager (16)	Interview (48)	
				Shift Manager (10)	Interview (46)	
				Shift Manager (13)	Interview (55)	
				Team Manager (6)	Interview (52)	
				Team Manager (8)	Interview (56)	
				Team Manager (4)	Interview (59)	
				Team Manager (8)		
			5	Pickers	Group Discussions (52)	

4.5. Analysis

The data collected for this study offer the first empirical insights into pollution prevention, product stewardship, and sustainable development in relation to FLW in the UK food supply chain. Senior managers from five firms operating in food supply chain shared key sustainable food waste reduction practices and these are analysed (Wolcott, 1994). This qualitative analysis identified major themes emerging from the interviews and compared practices across the cases to uncover common strategies among retail firms. Additionally, the study explored motivations and challenges in implementing these strategic capabilities to highlight recurring themes and barriers faced by UK retailers in adopting sustainable practices and improving operational performance. The analysis focused on three key processes: Inventory Practices, Back-Order management, and the flexible use of facility layouts. This comprehensive approach provides a broader understanding of the obstacles and best practices associated with sustainable food waste reduction in the UK retail sector. Inefficient inventory and backorder management, along with poor utilization of facility layouts, particularly those that fail to prevent overcrowding, can lead to significant food waste. Simultaneously, there is increasing pressure to incorporate sustainable practices across the supply chain to mitigate environmental impacts.

Interviewee discussions of sustainable operations and FLW strategies were consistent with the literature on NRBV and their associated sustainability and competitive benefits, as well as the coding framework used in this study. The identification of these benefits in the interviews provides empirical evidence of their presence, aligning with the ontological position of critical realism (Sayer, 2004). While the NRBV may not be fully realized in practice, the qualitative content analysis and intercoder reliability assessments suggest that pollution prevention, product stewardship, and sustainable development play a meaningful role in the competitive and sustainable operations of UK food supply chain.

4.5.1. Environmentally Friendly Practices Adopted by the Food Retail Firms (In-Case Analysis).

Each case is individually analysed to understand the implementation and impact of environmentally friendly practices on the generation of FLW along the supply chain in the retail firms and to explore the impact of these practices on improving the operational performance. The food retailers successfully adopted eco-friendly practices by effectively managing inventory and backorders to minimize waste. They optimized facility layouts to streamline operations, using advanced systems and data analytics for accurate demand forecasting, thus preventing overstocking (which causes FLW) and understocking (which impacts the supply

chain). Furthermore, the design of their warehouses and stores reduces unnecessary product movement, prevents cross-contamination, and ensures a seamless, hygienic process flow.

4.5.2. Impact of Back-Order Rate on FLW.

Backorders arise when orders exceed available inventory, leading to logistical and inventory control issues, especially if multiple orders are received or a lot of purchases are made of certain food products in a particular week (Guo *et al.,* 2019). The number of food products on backorder and how long it takes to fulfil these customer orders could provide insight into how well a firm operating in the food retail sector manages its inventory and reduce FLW. A relatively manageable number of orders and a short turnaround time to fulfil the orders to the retail stores generally means the firm is performing well (Simchi-levi *et al.,* 2018). However, this could have significant impact on the FLW and hence, pollution prevention strategies as more pressure are on the supply chain to meet with demands. This shows clear links between the NRBV resources and the back-order management strategies in the supply chain, (Shi *et al.,* 2012) and also, an inherent reliance on supply chain management is implied throughout NRBV literature (e.g. Hart, 1995; Johnsen *et al.,* 2014; Matopoulos *et al.,* 2014.

Interviews from the five different firms shows similar challenges. It indicates the awareness of the impact of backorder of food products on FLW and the cost of inventory. To appreciate the pollution prevention practices adopted in the management of Backorder of food products, five retail companies were asked questions related to whether they consider the environmental concerns of backorder management and how it affects FLW.

4.5.2.1 The Challenge of Forecasting Customers' Demand.

The senior managers were asked how they manage backorder and keep FLW low when a sudden increase in sales means that products are getting sold faster than they can be stocked. and whether they consider pragmatic approaches of keeping track of trends of sales of food products.

Firm D General Manager highlighted:

"*We average 2.6 million food products picked weekly, adjusting for seasonal and store demand, which dictates assembly volume. Our AI-driven inventory control provides a forecast and informs our annual budget, reviewed mid-year based on purchase trends. We also receive a "latest view" forecast, updated weekly, looking 12 weeks out. For example, we're assembling 2.16 million food products this week and requested an additional 20,000 for tomorrow's release. We analyse shopper trends, which are somewhat weather-dependent. Unmanaged*

demand spikes could lead to backorders and potential food wastage. We're already seeing Christmas product activity. Our whole milk sales are currently strong due to promotional efforts. Tracking seasonal purchase trends helps us maintain optimal stock levels, placing excess on backorder, which prevents overstocking and effectively reduces both food waste and costs.

Interviewees prioritized storage space and inventory cost in backorder management. Holding excess perishable food risks FLW and financial losses if supply outstrips demand. Tracking seasonal sales trends enables firms to maintain optimal stock levels and place the rest on backorder, preventing excess inventory, reducing FLW, and cutting costs. Food retail firms are now shifting from traditional waste disposal to preventing food waste at its source. (Aragon-Correa and Sharma, 2003). In doing so, pollution prevention is achieved which is intended to reduce costs associated with food waste and emissions and maximise efficiency (Hart, 1995; Russo and Fouts, 1997), encouraging its presentation as a competitive cost cutting strategy (Hart, 1997; Christmann, 2000; Hart and Dowell, 2011).

Interviews highlight the challenge of managing unexpected demand spikes, as competing firms strive to meet customer needs to avoid losses. While some practices support pollution prevention by making backorder management more compact and eco-friendlier, consistent backorders can signal overly lean operations. This means the firm is missing out on sales, potentially frustrating loyal customers and driving them to competitors.

The challenges of backorder management can ultimately lead to a loss of market share as customers grow frustrated by product unavailability. Firms A and B consistently face backorder issues, impacting food loss and waste (FLW) generation. Executives at these firms agreed on the critical need for weekly review of food product supply, emphasizing continuous monitoring of purchase trends and using forecasts to manage inventory quantities effectively.

The Operations Manager of Firm A highlighted that,

"We engage in extensive event planning, including Christmas preparations. Forecasts guide our stock levels, using backorders to minimize excess inventory, thereby reducing food loss and waste and associated costs. Currently, we have 2.25 million food products with a 2.6 million capacity, nearing full inventory. We're actively managing this volume to prevent food waste during the Christmas ramp-up, increasing capacity over the next 14 weeks until the holiday.".

It was discovered in firms A, B, D and E where interviews were carried out that each firm has significant control over their backorder management. The firms manage their food stocks through reliable forecasting figures and can minimise excess inventory, reduce FLW and inventory cost. This align with product stewardship which is a concept that seek

environmentally maximised food supply chain systems. Hart's (1995) proposition that product stewardship is rooted in food supply chain operations from internal cross-functional processes to external stakeholder orientated processes, are aligned with our findings. Not only is this demonstrative of Hart's exemplification of the internal and external characteristics of resource-based theory, but it is here that opportunities for competitiveness arise.

4.5.2.2 The Impact of Strategic Data on FLW Reduction.

Backorder often require addition human and financial resources in managing the excess demands for food products, so instead of simply carrying stocks in inventory and selling them to customers, the firms keep strategic data and provide information to their customers about the availability of certain food products which helps to reduce FLW significantly.

A chief executive of firm B highlighted that:

"We normally incorporate data of trends in purchases of food products, manage obligations and responsibilities, coordinate logistics and communicate the availability of food products to our customers through public communication and advertisement. This help to reduce anxiety about the availability of food products in the stores, reduce pressure on the supply chain, reduce FLW and also help in maintaining our market share".

Effective backorder management furthermore supports the NRBV principle of product stewardship, where firms minimize food loss by using predictive analytics and dynamic inventory controls. Firms that integrate sustainability into backorder policies enhance both supply chain resilience and customer trust, reinforcing their market position. These systems integrate various data points, including sales trends, supplier performance, customer behaviour, and external factors, into a unified system, providing a holistic view of the supply chain

Table 16 presents the case companies' Backorder Management Practices. Some of the specific sustainable practices adopted by case companies are highlighted in the following quotes from the senior managers of the case companies.

Table 16. Summary Environmental Backorder Management Practices.

Firm	Backorder Management Practices
A	Increased monitoring and keeping track of trends of purchases of food products depending on the season of the year helps the firm to keep the required number of stocks in supply and the rest on backorder which alleviates the need for excess or extra inventory and therefore reduce FLW and costs. It also Consider environmental factors when there is need for extra inventory The firms keep strategic data about each food product and provide information to their customers about the availability of certain food products which helps to increase purchases and hence, reduce FLW significantly.
B	Maintain the same sustainability Backorder practices as company A but often goes further in identifying relatively number of food products that are in high demand and device a short turnaround time to fulfil the orders to the retail stores which help reduce the number of food products tied down in inventory and leads to FLW reduction. Put in place active monitoring system to assess the environmental and FLW impact of the backorder of food products and suppliers' environmental practices.
C	Environmental factors of Backorder management of food products are very important and are considered by monitoring trends of purchasing food products in the stores but not on all food products were closely monitored as some of the products are not frequently purchased. Based on this, the firm often experience backorder on some food products when demand of such products suddenly goes up which impact FLW.
D	Pays more consideration to the impact of backorder on the firm in terms of incurring extra production costs, labour, food waste generation and shipment expenses. This at times leads to loss of sales as customers patronise other food retail firms for such food products. Managing backorders effectively is crucial to the firm in order to maintain operational efficiency and minimise the negative impacts on both the business and the supply chain. Have a reputation of lacking behind in supplying some ranges of products in order to reduce the impact of Backorder.
E	Pays good attention to environmental impact of Backorder than to the cost in terms of extra retail costs, labour, waste generation and shipment expenses. Purchase food products from the with suppliers who provide are always meeting orders at short notice and are also supplying high quality products that satisfies relevant environmental standard

4.5.3. The effect of inventory management on FLW.

An effective food inventory management system helps Food Retail Firms to track stock levels, orders, and sales, optimizing order sizes to reduce food waste and save money. Commonly used by food retailers, it enhances operational efficiency for effective business management. A key aspect of food inventory management is staying organized to ensure all products are accounted for, preventing food waste from expired or unused items. It helps forecast future needs based on consumption patterns, identifies trends, and addresses issues like backorders, ultimately enhancing business efficiency and reducing food waste. However, poor inventory practices are the major reasons why a lot of food product waste is generated along the supply chain.

Interviews from the five firms show similar concern. It indicates the challenges encountered by the food retail firms to find an inventory system that works for them and to manage the system effectively to reduce FLW and the cost of inventory. More specifically, it can be argued that inventory management could be maximised to support the protection and conservation of natural resources (Matopoulos *et al.,* 2014). The same too can be said of competitiveness, in that it is not derived from a firm in isolation but rather from the supply chain (Markley and Davis, 2007; Prajogo and Sohal, 2013).

4.5.3.1 Cohesion between Inventory and Service Level.

To appreciate the NRBV concepts adopted in the inventory management of food products, five retail companies were asked questions focus on whether management considers appropriate safety stock levels or stock in excess of what is required, what factors influence this consideration, if they have an inventory management system suited to their market position, and how often they face challenges balancing inventory and service levels. These factors are explored to understand their impact on food loss and waste (FLW).

Firm E Senior Manager interviewed highlighted:

"Our automated inventory system meticulously marks incoming food products with arrival dates and SKU numbers before dispatching them to stores. A critical aspect of our inventory management is the minimum life on receipt rule, which dictates the minimum remaining shelf life a product must have to be sent to stores. Products failing this, or those with a short minimum life of issue, are prioritized for immediate processing and dispatch, sometimes via "dummy orders" placed by supply managers to ensure rapid movement. The number of stocks we maintain depends on our service level. While we aim to keep stock levels slightly above this, occasionally leading to product waste, this is infrequent due to continuous information flow and regular updates among all involved teams.".

All the managers interviewed stressed on the importance of appropriate level of safety stock of perishable food products which must be maintained. Additional inventory volume will increase products availability but with an increase in inventory holding cost and increase possibilities of FLW if the products are not moving in the stores. However, the appropriate level of safety stock depends on the firm's policy which defers from one firm to the other. Firm A has a policy of maintaining additional inventory that could serve for at most four days in excess of demand for some types of food products. The same goes for firm B that has one to three days in excess of demand depending on the type of food products. Other remaining firms are more conscious of the inventory holding cost and have limited additional inventory that could meet demands from the stores to two days. The study of NRBV exposes some reliance upon technology and resource management. Hart and Dowell (2011) define continuous improvement of inventory management as the key strategic capability of pollution prevention. This corresponds with additional studies in which continuous innovation (Vachon and Klassen, 2008; Golicic and Smith, 2013), and process innovation (Aragon-Correa and Sharma, 2003) are linked with pollution prevention.

4.5.3.2 Management of Optimal Inventory Level.

Also, decisions about optimal inventory levels of food products are very important for the entire supply chain to minimise logistics costs, which include ordering cost, receiving cost, and holding cost. It is evident that there is a correlation between the optimal inventory level that must be maintained by each firm and the service level (which is a measure expressed as a percentage of satisfying demand through inventory in time to meet the customer's requested purchases and delivery dates). It was discovered that each of the five firms is conscious of this, and it was evident from the interviews conducted that the optimal inventory level depends on the size of the firm and the volume of food products sold each day. It should be noted, however, that perishable fresh food items in stock for daily consumption, such as dairy products, vegetables and fruits, need to be reordered constantly before stocks are exhausted. This creates challenges for the management, especially in determining the optimal level of stocks to keep to reduce FLW. Therefore, continuous improvement of inventory management is the key strategic capability of FLW reduction, which aligns with the pollution prevention resource of the NRBV theory. Interviews conducted amongst the five firms show that they are experiencing challenges in determining the optimal inventory level of perishable food products that must be maintained to prevent FLW.

Firm D's General Manager highlighted that

"If a food product has a short minimum life of issue, we expedite its dispatch to stores, prompting category supply managers to place "dummy orders" for quick movement. A key challenge arises when receiving many food products with short shelf lives, especially those that don't sell quickly in stores, like perishable fruits, vegetables, dairy, fish, and meat. This leads to accumulating stock, full storage, and significant food waste. To combat this, my team regularly updates category supply managers on slow-moving items, triggering promotional sales to reduce food waste.

All the firms highlighted that the challenges face in managing perishable food products are enormous and adopted effective inventory management of FIFO for their food products. In addition, firm A rely on real and accurate information for the service of supply chain. Firm B rely more on the trend of purchases and consumer behaviors over a period of time. Firm C Operate without a backroom with the aim of reducing inventory record inaccuracies (IRI) and food waste. Firm E stressed the importance of supplying a manageable number of foods to the stores for effective service of their supply chain.

Table 17 shows the key sustainable inventory management practices of the five firms under this case study. Some of the specific sustainable practices adopted by case companies are highlighted in the following quotes from the senior managers of the case companies

Table 17. Summary of Environmental Inventory Management Practices.

Firm	Inventory Management Practices.
A	Minimized the tension between inventory and customer service level by relying on real and accurate information across the supply chain for the supply of perishable food products thereby reducing ordering cost, receiving cost, holding cost and food waste through random monitoring, and implementation of the information received and also through interaction and engagements amongst the management teams.
B	Reduced food wastes significantly through company's policy of maintaining additional inventory that could serve for at most two days in excess of demand for some types of food products thereby ensuring products availability but with a manageable increase in inventory holding cost. The optimal level of inventory is always reviewed to prevent food waste generation and to guide against increase in logistical cost.
C	Operate without a backroom with the aim of reducing inventory record inaccuracies (IRI) and waste. Improved inventory environmental practices by highlighting the adoption of what they called "Total food waste reduction strategy" in their inventory system. This has formed the firm's policy
D	The company highlighted the importance of sharing information such as demand sales orders and inventory status using collaborative information sharing approaches such as collaborative planning, forecasting and replenishment in order to reduce inventory costs, improve decision making, improve customer service level and reduce FLW along the entire supply chain.
E	Stressed on the importance of identifying optimal inventory level in order to satisfy the desired service level. They highlighted on the importance of maintaining high service level with low inventory which help the firm to minimise logistics cost and reduce FLW

4.5.4. Facilities Layout effect on FLW.

Facility layout is critical for supply chain efficiency in storing, picking and distributing perishable foods. Addressing this complex challenge requires complementary approaches at various collection levels to accommodate the key features of layout determinants. Facility layout is crucial for the smooth, safe, and efficient operation of the food supply chain. It directly impacts the flow of food products, worker safety, and overall logistics, contributing significantly to the retail firm's competitiveness and its aims to reduce FLW. Effective facilities layout allows for optimal utilization of space, ensuring that, picking areas, storage and other essential areas are organised and used effectively. It helps to maintain strict hygiene and sanitation standards which are very essential in perishable food retail firms to prevent FLW and ensure safety. It supports compliance with food safety regulations requirements. (Zielecki *et al.,* 2014; Kowalski *et al.,* 2016)

Food retail firms must improve the reliability of facility layout without significantly increasing operating and logistical costs or contributing to food loss and waste (FLW). This has created some challenges to the food retail firms under this study. Facility layout affects costs, and operating expenses are directly proportional to the volume of food products processed by the firm. Thus, sustainable development encourages both the creation of effective facilities layout in support of environmental advancement and competitive edge which could lead to economic and societal advancement (Hart, 1995). Opportunities for such competitive gain arise in the creation of such processes ahead of competitors and access to new, unsaturated markets of the future (Prahalad and Hammel, 1994)

4.5.4.1 Utilisation of Space, Food Safety and Hygiene Compliance.

To appreciate the FLW reduction practices adopted by the food retail firms on their facilities layout, five retail companies were asked questions focus on what steps the management considers on the optimal utilisation of space by ensuring that picking, marshalling, and storage areas are organised and used effectively. What has the management put in place to ensure their facilities layout support the safety and ergonomics of their workers and also keep the food hygienic and safe. In what way has the facilities layout helped the firm in the compliance of the food safety regulatory requirements and what steps does the management take regularly to accommodate changes due to market demands, food products varieties and technological advancements.

The Operations Manager of Firm D highlighted:

"Peak periods, like Christmas, significantly challenge facility layout, with this year's picks at 3.4 million. Maximizing space utilization in both picking and marshalling areas for food products is crucial, as exceeding this capacity is difficult. To manage this, the business can shift fast-moving ambient lines to a release side. Other strategies include reducing the food product range and increasing the hit rate, which involves optimizing transportation and pick rates to efficiently manage existing space. While Christmas peaks always stretch capacity, alternative solutions like a Christmas relief site for processing overflow food products could offer support.".

It is evident from the interviews conducted that all the firms experienced the problem of space especially during the seasonal periods. It was found that flexible use of facilities which can ensure a smooth and effective movement of food products, food safety and hygiene, compliance with food safety regulation requirement, cost saving by reducing food waste, and improve resource utilisation, were most important factors considered in all the firm's management strategies. It has become increasingly clear that firms must play a central role in achieving the goals of sustainable development strategies both corporate social responsibility (McWilliams and Sigel, 2001; Li and Liu, 2014) and the bottom-line approach (Wilson, 2015) warrant links with competitive gain through effective facilities layout. Most interviewees mentioned space which helps in optimizing workflow and efficiency as priority in deciding their facilities layout for food products. Firm B and C emphasised cost saving measures which they said generate low food waste, helps in the requirements to comply with food regulation, and also helps in food safety and hygiene. In the firms' grocery store, all the fruits and vegetables are located together, while all the freezer items are located together to ensure easy access by the customers which ultimately leads to pollution prevention.

4.5.4.2 Facilities Layout and Maintenance.

Most company executives concurred on the critical need to maintain facilities for keeping perishable food products fresh and safe. Firms D and E highlighted their similar facility layouts, which they assert enable a smooth-running supply chain. This optimized arrangement significantly contributes to reducing food loss by enhancing operational flow and preserving product quality. One of the senior managers of firm E highlighted:

We use what we call Functional Facility Layout in which the facilities are organised based on their functions into different departments as certain types of facilities and skills can only be used to process some particular types of food products and are shared in each unit. In our organisation, we have four units and the facilities and skills needed in each of the department are unique and different from the other departments. This layout has the right features that

allows for smooth and effective management of our supply chain and also helps in reducing FLW and the cost.

It was discovered that firms strategically design their retail shelves to accommodate ample food products. This allows for newly supplied items to be placed at the back, while older stock is positioned at the front. This "first-in, first-out" (FIFO) method ensures older food products are sold before newer ones, a practice observed in Firms A and B. This approach ultimately helps save costs and significantly reduces food loss and waste (FLW) by minimizing product expiration. An executive of firm A highlighted that.

For the company, the policy of first in first out is very important and our stores facilities were designed to ensure that this is done. our stores operatives have been trained to always place new or freshly supplied products at the back of the shelves and older ones at the front in particular, perishable foods like fish, meat and dairy products. Although this method has its flaws, it has helped reduce FLW significantly I can assure you.

Table 18 presents the key sustainable facilities layout plans of each of the five firms under this case study. Some of the specific sustainable plans adopted by case companies are highlighted in the following quotes from the senior managers of the case companies.

Table 18. Summary of Environmental Facilities layout Management Practices.

Firm	Facilities Layout Plans
A	Ensure effective and flexible facilities layout which allows for optimal utilization of space, ensuring that, picking areas, storage, marshalling and other essential areas are organised and used efficiently. The firms make use of automated facilities and position them in different units within the supply chain in order to keep up with customers' huge requirements and hence ensure food products availability while minimising holding cost and FLW.
B	Maintain effective facility layout management which ensures the seamless coordination of various processes such as, inventory management, Backorder fulfilment, transportation and facility maintenance to enable efficient logistical operation. Put in place active monitoring system to assess facilities readiness, optimizing space utilization, safety and security measures, and ensure compliance to regulation requirements. The effective space management of the firm, minimises congestion, improve operational efficiency, reduce cost and FLW.
C	Consider the environmental impacts in the facilities management plans also and ensure optimizing logistics operations, smooth and efficient supply chain management. Focuses more on maintenance, operation, and optimisation of logistical facilities which ultimately helps to keep food products hygienic, safe and hence, reduce FLW. Ensure optimal utilisation of space by reducing their food products range and increasing the hit rate which includes the transportation and the pick rate on their food products for the effective management of the space available.
D	Pays attention to the sanitary impact of the facilities which can lead to food products contamination and impact FLW. The firm pays great attention to flooring and drainage in the facility layout plan by making sure the floor is smooth with no cracks and by selecting a food-safe system to prevent and eliminate bacteria and contamination. They also ensure optimal utilization of space in order to maintaining operational efficiency and minimizing the negative impacts of food waste on both the business and the supply chain.

E	They choose what they considered the right facilities layout to their food processing plant design to provide safe and economical flow for the production line and employees by focusing on a single product in a given production line with raw material entering at one end and making their way through the line with minimum work-in-progress and product handling thereby ensuring reduction in terms of extra costs, labour, and food waste generation.

4.5.5. Comparing the Environmental Practices of Case Companies (Cross Analysis).

All food firms have adopted some level of environmental practices in their operations. However, some engage primarily to lessen domestic market regulatory risks, with only a few proactively linking NRBV resources beyond legal requirements to operational improvements. Firm A has implemented many effective environmental practices in its inventory and facilities layout management. Firm B's executives emphasized concentrating on making their environmental practices more efficient, specifically by using FIFO for stock rotation and leveraging consumer behaviour and forecasting in their backorder management. Four of the firms have effective monitoring systems for suppliers' commitments to environmental practices, making it easy to confirm eco-friendly processing methods. However, Firm D's environmental practices in inventory and backorder policies fall short compared to Firm E. Firm D often purchases more food products than necessary, especially in anticipation of unexpected demand surges, which frequently leads to waste. It is evident from the interviews conducted that the aim of maintaining competitive advantage is a major motivation for implementing environmental practices as one of the senior managers of firm E highlighted, *"We always strive to maintain loyalty and enlarge our customer base by implementing environmentally friendly plans which is our core value".*

4.5.5.1 Reasons for adopting Environmentally Friendly practices.

The interviews conducted among the executives reveals different reasons why the five firms have adopted environmentally friendly practices in their inventory, backorder and facilities layout management. One of the main motivations for of adopting the practices is identified as brand reputation. Firms that prioritise sustainability are seen as ethical and responsible which can lead to customer loyalty and normally gives them competitive advantages over other firms. The executives of firm C highlighted that *"our customers want the food products to be kept fresh and under hygienic condition and thereby we have adopted effective inventory management practices, such as FIFO/LIFO, consumer behaviour, and demand forecasting*

which are vital for reducing food waste" One of the senior managers of firm D said that: *Customer buying behaviour is a significant barrier. Customers often reject fruit products that are not visually appealing, even if they are safe to consume. For instance, slightly imperfect fruits like orange are often discarded, highlighting a lack of awareness about fruit products.* It is therefore evident why the firm want to display fruit products that are very appealing to their customers in hygienic condition in order to have competitive advantages over other firms

Moreover, Senior managers at firm A stated *that "Possible motives that may inspire the firm to implement environmentally friendly practices include preferential policies like Government regulation as well as customer's requirement".* In addition, executives of firm B mentioned that *"Competition from other firms in the food retail sector is also a crucial motivating factor in using firm's resources and capabilities".* Another key driver for FLW reduction is the potential for significant cost savings through various operational management strategies. Interestingly, executives didn't explicitly cite direct profit improvement as a primary motive for adopting environmentally friendly practices. Instead, external factors largely influenced their implementation of environmental operations. However, firms seem to realize these practices enhance both environmental and operational performance. A critical finding also revealed that some floor managers lack the necessary knowledge and skills to effectively implement sustainable FLW reduction practices at the supply chain level, presenting a significant hurdle to broader adoption and effectiveness. Parfitt *et al.,* (2010) stated that it is difficult to quantify the exact amount of food wasted in food retail through inventory and backorder management as multiple variables affect the estimates. Eriksson (2015) adds that there is always a significant amount of unrecorded food waste in supermarkets which is laborious or even impossible to track. However, being on the ground and focusing on the day-to-day operations of their business ventures using firm's resources and capabilities (Wagner *et al.,* 2005), managers could normally be able to keep record of the food waste so that steps could be taken to reduce it.

4.5.5.2 Difficulties in Adopting Environmentally Friendly Practices.

One of the challenges encountered by all the five food retail firms to reduce FLW is the pressure on the supply chain to meet unanticipated significant surge in number of orders and a short turnaround time to fulfil the orders to the retail stores. This could have significant impact on the generation of food waste as more pressure is on the supply chain to meet with demands. Even firms that have economic scale advantage feel overt pressure due to sudden increase in the number of orders and the short time to meet the orders as customer behaviour are at times

difficult to predict. Most of the senior managers interviewed stressed that *lack of relevant firms' policies and regulations is responsible for messy competition and ineffective implementation of environmental practices in the industry*. It is important to note that, linking the NRBV with innovation inventory policies is not without complexity as the trends in demand of certain food products are unpredictable (Heimonen, 2012; Boons *et al.,* 2013; Szekely and Strebel, 2013) and may even act detrimentally on the firm (Christensen, 1997), placing a strain on costs, time and skills (Crossan and Apaydin, 2010). However, each firm is expected to maintain sustainable development which encourages both the creation of new operational inventory processes both in support of environmental advancement and effective business opportunities in the country in support of economic and societal advancement (Hart, 1995). Opportunities for competitive gain arise in the creation of such processes ahead of competitors and access to new, saturated food products market of the future (Prahalad and Hammel, 1994).

4.5.5.3 Storage Space and Cost of Inventory

Other factors contributing to FLW are the storage space and the cost of inventory. Exploring the most common effects of the inventory management issues that directly impact the five food retail firms' performance and profitability under this case study reveals high storage cost in order to meet the demands of customers. As stocks level grows, the likelihood of damage and food waste increases leading to financial losses. This challenge is common with Firm A compared to what is obtained in Firm B. One of the senior managers in firm A highlighted*: "Our company struggles with forecasting demand for perishable food products like fresh produce, vegetables, milk, bread, and bakery items. Factors like weather, customer behaviour, and current inventory complicate accurate predictions, leading to potential food waste".*

Holding excess inventory increases storage costs, while insufficient stock or understocking leads to lost sales and customer dissatisfaction leading to potential harm to their business status. Balancing inventory levels across seasons is a challenge for businesses to optimize costs and customer satisfaction. Rashidirad *et al.,* (2015) offer a strong argument for the need to examine the complex relationships between firms' capabilities and resources. As such, this study supports the basic definition of natural resource-based view capabilities with the specific relationship between a given inventory capability and the corresponding resources available. Although firms' policies support the use of resources in formulating their management strategies, it is evident that there is need to promote the minimisation of food waste and emissions in the supply chain through Continuous improvement of firm's inventory management.

One of the most significant practices of environmental supply chain management in the food retail firms is Facilities Layout Management. The executives of Firm A shared that, "*Effective warehouse and stores facilities layout design is essential for optimizing inventory performance and reducing food waste in the company as Poor layout can lead to inefficiencies and increased food loss*". Executives of firm A agreed and added that: *The firm adopt consistent application of warehouse and in-store policies and adequate training for employees on the use of the facilities which improves the effectiveness of food waste reduction strategies"*. One of the key challenges of Environmental practices is to manage the firms' facilities in line with what can deliver an effective operational management within the space available for use." A senior manager of firm B stressed that: *Individualized food waste decisions and misinterpreting quality as safety can hinder consistent food waste prevention efforts and we always guide against this in making good use our facilities with the available space*.

4.5.5.4 Dealing with Technical Constraints.

The five firms highlighted the technical constraints they experience in their facilities layout policies differently. General managers from firms B, C, and E identified several barriers to adopting environmental practices. Firm B discussed that "*technical constraints and, high cost of spare parts, cost of facilities maintenance and skilled human resources were some of the key barriers for adopting environmental practices in the organisation*". Firm C faced difficulties such as cost of installation of modern facilities, lethargic food waste disposal channels, financial constraints and lack of favourable government policies and regulations to effectively implement environmentally friendly practices. For Firm D, high implementation cost and insufficient resources were the two main barriers of developing Environmental supply chain. Executives of firm E prioritized cost over environmental factors and cited high material costs and limited technical knowledge as major barriers in the food retail firm.

4.6. Discussion.

The UK food retail sector faces a dual challenge of FLW reduction while making effort to increase profits in the domestic and global marketplace. Also, food retail firms face intense competition and criticism for their environmental performance. This study examines the current state of environmentally friendly practices of the five firms operating in the food supply chain and their impact on operational performance within this sector.

This study investigated the environmentally friendly practices developed within firm's strategic management of their inventory, backorder, and facilities layout. The objective of the research is to investigate the impact of the environmental practices of the firms' Inventory strategies on FLW, how back-order rate issues in the food supply chain impact FLW and how facilities layout management in food retail firms could impact FLW and Operational Performance. The NRBV provided a theoretical foundation for this research, building on Hart's (1995) concept of integrating sustainability into a business's strategic advantage through environmental capabilities.

Our paper presents an ideal academic case for eliminating Food wastes through retail firms' relationship with the natural environment that helps them identify and use resources to gain competitive advantages and positive environmental outcome. While we highlight the benefits and some level implementations in the firms under this research, we acknowledge that not all the retailers have fully adopted this lean approach due to size or operational constraints. Despite these challenges, a growing number of retailers are constantly exploring the use of firm's capabilities for pollution prevention and sustainable development in recent years.

Food retail firms are aware of the importance of environmental sustainability and its impact on food loss and waste (FLW) reduction in the supply chain. However, logistics costs—including ordering, receiving, and holding—significantly hinder the broader implementation of environmental sustainability efforts and, consequently, FLW reduction. A key challenge lies in firms' inability to determine the optimal inventory level needed to maintain service levels. This often leads to FLW, negatively impacting environmental sustainability, which aligns with the theoretical lens of this research on single or multi-objective optimal levels for perishable goods (Kiaghadi and Hoseinpour, 2023). Another inhibitor identified, especially in firms B and E, is a lack of knowledge regarding the correct approach to implement environmental practices in their backorder and inventory management. These firms often purchase more food products than they can sell due to economies of scale, leading to FLW. This is compounded by a lack of constant review of food product trends and insufficient use of forecasts to manage inventory quantities effectively. Furthermore, while most managers acknowledge the significant problem of food waste, some disagree on its severity regarding operational logistics and sustainability, believing it's less of an issue if mitigation plans are in place and adhered to.

While all the food retail firms under this case study met legal environmental standards, few actively sought to exceed these minimum requirements or consider supply chain impacts

through the NRBV capabilities available to the firms. Most focused on internal policies rather than broader environmental responsibility. Despite the advantages of integrating NRBV-based inventory strategies, the firms encounter significant barriers, including high implementation costs, effective use of advanced forecasting technology, and unpredictable consumer demand. These obstacles highlight the need for tailored NRBV resources applications that align with each firm's operational capabilities and financial constraints.

Different underlying causes of how inventory management practices of food retailers affect generation of FLW in the supply chain, the impact of back-order related issues on FLW, and the extent facilities layout arrangement could solve or adversely affect the FLW along the FSC can be categorized into the following themes:

4.6.1. Difficulties in Determination of the Optimal Level of Inventory to Maintain the Service Level in Inventory Management.

Optimal inventory levels in food firms are determined by factors like sales trends, market conditions, and supply chain dynamics. This precise balancing act directly manages the service level, which is critically assessed by the frequency of customer requests for unavailable food products or by the number of product references held in stock when items are out. The goal of each of the food retail firms is to meet customers' demand without incurring high carrying costs. Food retail firms are overly depended on the effective inventory management practices by adoption of FIFO (First-In, First-Out) in inventory management, and this aligns with the NRBV concept of pollution prevention, as it minimizes food spoilage and excess inventory accumulation chains (Hart, 1995; Hart and Dowell, 2011). By improving forecasting accuracy and reducing stock obsolescence, firms can enhance their environmental capabilities and strengthen their competitive advantage.

Moreover, it was evident that the firms face many challenges in their efforts to determine the optimize level of stock. The most difficult one is data accuracy which is used to make informed inventory decision. Firms B, C. and E are cut up with this difficulty. There is need for constant review of food products in the supply chain every week by monitoring trends of purchases and the use of the data to keep in check the quantity of food products in inventory. In addition, the firms also experience forecasting errors because of sudden and unexpected changes in customers' behaviour and often results in excess inventory. It is evident that keeping accurate inventory balance is very challenging and the firms struggles with these challenges. There is therefore the need for continuous inventory innovation (Russo and Fouts, 1997), and

Operational process innovation (Aragon-Correa and Sharma, 2003) are linked with FLW reduction for the firms to maintain competitive advantages.

4.6.2. Information Sharing and Sustainable Agreements with Suppliers.

Sharing and integrating information across the supply chain is essential for improving environmental performance. (Lin and Ho, 2008). The firms work with food product suppliers who are conscious of their desire for sustainability. They are in the practice of working with suppliers to ensure sustainable delivery of food products to meet the demands of their customers. They engage with suppliers willing to ensure sustainable supply timelines with often adequate deliveries to meet the optimal level of inventory. The five large food retail firms have abundant information resources and extend contacts with suppliers as well as customers. They make use of automated inventory which ensure that their inventory management are more sustainable and provides the information needed to share with their suppliers for adequate purchase of food products when needed. All the food retailers under this study use predictive analytics and supplier collaboration to minimize excess inventory and hence, reduce FLW and the environmental impact. They make use of trends of demands of previous three months to project and forecast what the demand for similar food product would be and also work with the suppliers to meet the customers' demand and that has helped to reduce the volume of FLW generated along the supply chain. This builds on previous study of Kaipia *et al.,* (2013) that, in fresh food supply chains (FSCs), sharing demand and shelf-life data among supply chain actors can significantly reduce food waste and enhance sustainability. Hart and Dowell (2011) define continuous information sharing with suppliers as the key strategic capability of pollution prevention, whilst innovative capabilities, commitment and proactivity also warrant attention. However, it was evident that some firms often want to take advantage of economies of scale in their purchasing practices from the supplier by buying high volume of food products at lower cost in excess of what is required without preference to NRBV resource of pollution prevention. The short-term benefits of lower food products cost from the suppliers becloud the decision to maintain the right optimal level of their inventory and this impact on the FLW. Some of the managers in two of the retail firms did not consider food waste as a major issue as long as there were corporate mitigation plans (which include food donation, food recycling, and regular price reduction) in place and these were closely adhered to by managers and staff alike. There is clear lack of supportive environmental policies in some of the firms as long as what they consider as mitigation plan is in place which they can use to reduce food wastes. This contradicts the use of managerial framework available to determine the strategic resources a firm can exploit

to achieve sustainable competitive advantage and the natural environmental practices that NRBV provides. (Vachon and Klassen, 2008; Golicic and Smith, 2013).

4.6.3. Lack of Upbeat Backorder Strategies Impacts FLW in Food Supply Chain.

The food retail firms often engage many suppliers that provides similar food products to manage backorders effectively. The firms can therefore sustain manageable number of orders within a short turnaround time to fulfil the orders to the retail stores. However, it was discovered that three of the food retail firms are often lacking behind in backorder strategies. The inability of the firms to accurately forecast customers' demands sometimes lead to overstocking or understocking which create backorder and generate food waste in the FSC. (Mastos and Gotzamani, 2022). Most of the firms' trends of food products demand are generated through their automated system on a quarterly bases and this sometimes does no give clear picture of the customers' buying behaviour. Not aligning the customers' demand at the supply chain level further creates challenges in the firms for effectively implementing the environmental practices and this contributes to high volume of FLW as experienced in many of the firms under this study. Some of the retail firms often does not have enough safety stock for some food products to meet their backorder which is based on lead time and demand variability. In addition, the food retailers also must do more to keep their customers informed about the availability of some food product at a reasonable price and adjust for potential sales increase as failure to do this adversely impact on their customers' loyalty.

4.6.4. Partial Implementation of Facilities Layout Strategies in Food Supply Chain.

Effective warehouse and store facilities layout optimize inventory performance and minimize food waste. Inefficient layouts can lead to increased food loss. It is apparent that Consistent application of in-store policies and adequate training for employees can improve the effectiveness of pollution prevention strategies and the firms' sustainable developments. Moreover, underutilization of facilities layout and overcrowding especially during the seasonal or peak periods as evident with the firms under this case study always led to ineffective use of space and impact on FLW generation. In addition, the firms often experienced inefficient workflows and excessive handling of food products and safety hazards. The firms are more interested in maximising their profits and reducing cost during the seasonal periods. However, during the normal period, the firms regularly analyse their space utilization, they often use techniques like batch picking to maximise travel distance between the pallets, clearly label shelves, bin, and sections to help pickers locate food products quickly which impact positively on the volume of FLW generated. They also design aisles that are wide enough for forklifts

and employee movement which are clear steps to ensure that food wates are minimised. Furthermore, the firms implement good racking system and ensure that food products flow smoothly in the system without any hindrance. By this there are clear steps by the firms under this study to manage their Facilities Layout effectively to reduce FLW along the FSC and gain competitive advantage (Sa'udach *et al.,* 2015; Aydinel *et al.,* 2008).

4.7 Conclusion.

The continuous pressure from competition, government, and customers for environmental protection significantly impacts how retail firms' strategic relationship with the natural environment can impact FLW and foster competitive advantage. Therefore, reducing food waste (FLW) in UK food retail firms is an urgent priority for achieving sustainability goals. Despite supply chain managers possessing valuable knowledge about food waste, research on FLW reduction within UK food retail firms is limited. This study investigates the current state of environmental practices in five food supply chain firms and their impact on FLW reduction. It specifically focuses on how these firms incorporate environmental considerations into their inventory, backorder, and facilities layout strategies. We use the Natural Resource-Based View (NRBV) as a theoretical foundation, building on Hart's (1995) concept of integrating sustainability for strategic business advantage through environmental capabilities.

4.7.1. Academic Contribution

This paper contributes to knowledge by exploring managerial attitudes towards reducing food loss and waste (FLW) using NRBV theory. It presents an academic case for how firms' relationships with the natural environment can lead to positive environmental outcomes.

This study found that some food retail firms are not fully utilising the resources available through the lens of NRBV theory, and food waste remains a major problem for them in the UK. The theoretical standpoint suggests that logistics costs (ordering, receiving, holding) significantly impact the implementation of environmental sustainability in inventory management, leading to high FLW volumes. The inability to determine optimal inventory levels to maintain service levels often contributes to FLW in some firms, supporting the NRBV principle that pollution prevention initiatives are key to minimising surpluses and avoidable waste in the food supply chain (Hart and Dowell, 2011; Graham *et al.,* 2018; Islam *et al.,* 2019). This also runs parallel with additional studies linking pollution prevention with continuous innovation (Vachon and Klassen, 2008; Golicic and Smith, 2013) and emphasising the specific importance of process innovation (Aragon-Correa and Sharma, 2003).

Additionally, a lack of stringent, environmentally friendly policies hinders progress, which largely impacts FLW. Furthermore, inconsistent review of food waste volume generated per quarter in the supply chain and overreliance on forecasts can contribute to excessive inventory. Underestimating the severity of food waste and believing that mitigation plans are sufficient for FLW reduction runs contrary to NRBV theory and adverse impact on the FLW. However, the NRBV faces claims that its operationalisation lacks clear guidance (Grant, 1991; Hitt *et al.,* 2015) and feasibility (Butler and Priem, 2001). Specifically, there remains a distinct lack of pragmatic evidence demonstrating the existence of viable resources and the capabilities required for their realisation (Newbert, 2007), or for achieving sustained competitiveness over time (Lockett et al., 2009). In addition, the empirical study of resources and capabilities remains troublesome (Hitt *et al.,* 2015). Butler and Priem (2001) also suggest this is due to their complex and tacit nature. Moreover, the overreliance of firms on forecasts without paying close attention to sales trends and consumer behaviour can lead to FLW. The findings of this study indicate that systemic FLW will persist without significant changes in the inventory and backorder policies to align with positive environmental outcomes, and also, effective utilisation of facilities layout that prevents overcrowding in the food supply chain. Furthermore, improving supply chain robustness and competitive advantage is influenced by a company's ability to quickly adapt to changing customer demand.

4.7.2. Practical Implications

The practical visions provided in this study can further enhance the understanding of implementing environmentally friendly practices not only inside the confines of the food retail firms, but also encompass their supply chains. Moreover, there are limited studies in the literature to understand the impact of environmental practices on FLW generation, particularly in the context of the food supply chain in the UK. Therefore, this research, one of the few focusing on environmental sustainability in UK food retail firms, contributes to supporting this crucial understanding by conducting an in-depth investigative study of different management practices.

The findings of this study may help practitioners in making strategic and pre-emptive decisions about the successful implementation of environmentally friendly supply chain practices in the UK food retail firms, which could significantly affect their sustainability performance, as evident by, and in support of the NRBV theory, as pollution prevention is intended to reduce costs associated with food waste, and maximising efficiency in the food firms (Hart, 1995; Russo and Fouts, 1997). This allows for a competitive, cost-cutting business strategy (Hart,

1997; Christmann, 2000; Hart and Dowell, 2011). The study could further help practitioners to deal with the current challenges faced by the food retail firms, as discussed in implementing environmental practices in the supply chain. We believe that the findings of this research will ensure that food retail firms in the UK become very involved in integrating environmentally friendly ideas to remain competitive and hence lead to a drastic reduction in the FLW along the FSC.

4.7.3. Limitation and Future Research Direction

While the focus of this study on five case companies may limit the generalizability of findings, this is a common limitation in case study research. Future studies could address this by increasing the sample size and employing diverse methodologies like surveys and mixed methods to gain a more comprehensive understanding of the UK food supply chain's environmental performance. Additionally, a larger sample size could provide a more nuanced view of the food retail sector, potentially revealing challenges not captured in this study.

While this study offers valuable insights of opportunities that the NRBV theory provides, future research could delve deeper into the implementation of sustainable food loss and waste (FLW) reduction practices by involving more food retail companies and analysing the dynamics of FLW reduction strategies that enhance competitive advantage and operational performance. opportunities for future research could be created based on the discussion offered in this paper. Comparative case studies could also explore the adaptation of sustainable FLW reduction strategies in similar industries across different developing and developed food retail contexts.

Chapter 5: Conclusion of This Research

5.1 Summary

This research examining sustainable FLW reduction in the supply chain of major UK food retail companies. It extends its scope to critically analyse the role of product packaging, logistical efficiency, food alternative use, Inventory, Backorder Management and Facilities Layout adopted by the firms operating in the food retail sector, given their substantial environmental impact. The research examined the impact of food packaging strategies on FLW generation and effective reduction methods. It analysed how logistical efficiency strategies (including product handling, stacking, and expected targets) affect FLW, and investigated the extent to which management practices (such as facility layout, inventory strategy, back-order rate management, and food alternative uses) could positively or adversely affect FLW and operational performance.

The research achieved significant advancements in understanding the scale and causes of FLW in the UK, developing mitigation strategies through the NRBV lens. It identified challenges and demonstrated how food retail management can develop reduction strategies focused on pragmatic packaging, logistics, and management practices. Crucially, the findings show that inconsistent food retail firm policies remain a core challenge in addressing the root causes of FLW along the Food Supply Chain (FSC)

Literature review was initially carried out to critically analyses existing literature to examine environmentally friendly strategies of FLW management within the Retail Food Supply Chain (FSC). Mixed research outcomes create avenues for this study. The research gaps identified underscores the critical importance of researching Sustainable Supply Chain Management Practices specifically focused on FLW across the Food Supply Chain FSC.

This research study critically evaluates the influence of firm-level strategies on FLW reduction within the dynamic food retail sector. It investigates the inherent challenges associated with integrating sustainable practices into complex food supply chain operational performance. Moreover, the research meticulously outlines specific, actionable procedures that food supply chains can adopt to significantly enhance their operational efficiency, thereby achieving a substantial reduction in FLW. This holistic approach offers valuable insights for industry improvement.

5.2 Theoretical Contribution.

Within the context of this research on sustainable practices for managing Food Loss and Waste (FLW), the Natural Resource-Based View (NRBV) serves as a pivotal theoretical framework

for understanding how firms secure a sustained competitive advantage through environmental sustainability (Mishra et al., 2021). By extending the traditional NRBV, this study asserts that a firm's strategic trajectory must be fundamentally informed by its relationship with the natural environment which impact on steps taken within the FSC to reduce food waste. This study utilizes the NRBV to bridge the existing gap between conventional business strategies and the specific goal of sustainable FLW reduction, identifying the internal pathway capabilities that food firms must cultivate to implement effective waste mitigation (Kusumowardani et al., 2022).

The research significantly advances the contribution of NRBV by shifting the academic focus from mere operational efficiency to strategic, environmentally sustainable capabilities as advanced by the theory. These are categorized into three core pillars: pollution prevention, product stewardship, and sustainable development, all of which are essential for addressing modern natural resource constraints. By treating food waste as a critical operational inefficiency rather than a mere environmental byproduct, this research demonstrates that FLW reduction investments yield high returns. This empirically supports the Natural Resource-Based View (NRBV) claim that pollution prevention drives a sustainable, cost-based competitive advantage. Furthermore, mitigating FLW demands intense collaboration between upstream suppliers and downstream retailers, aligning with NRBV's product stewardship pillar where firms develop rare, inimitable capabilities through complex, multi-echelon coordination. Furthermore, scholars like Saruchera and Asante-Darko (2021) have successfully integrated NRBV with reverse logistics to examine how firms manage product returns and systemic waste to improve holistic sustainability. This is supported by this research as it helps food system transition from resource wastage to reliance

Recent scholarly advancements have transitioned NRBV from a purely strategic abstraction to an operational imperative, linking specific green capabilities such as creative know-how for waste mitigation directly to social, environmental, and economic performance (Rodrigues et al., 2021). The research provides the rationale for why reducing FLW is a source of sustained financial advantage, offering a robust theoretical basis for food waste minimization even in complex sectors like online grocery retail by focusing on both direct and indirect waste outputs along the supply chain.in support of NRBV.

This paper contributes significantly to knowledge by exploring managerial attitudes toward reducing Food Loss and Waste (FLW) through the lens of Natural Resource-Based View (NRBV) theory. It constructs an academic case demonstrating how proactive food retail firms, by strategically managing their relationship with the natural environment, can achieve positive environmental outcomes and thereby gaining competitive advantage. The research offers crucial empirical evidence for improving the environmental performance of UK supermarkets, an area with limited previous focus. Key findings include identifying that, systemic FLW will persist without fundamental changes to inventory, backorder policies, and facility layout to align with positive environmental outcomes. The study underscores the importance of mitigating environmental health risks through eco-labelling of food packaging (Zhu-Sarkis and Lai, 2007) and active collaboration with both suppliers and customers. The findings of this study also emphasise that adopting environmentally friendly packaging (non-hazardous, biodegradable materials) and improving logistical efficiency (material handling, stacking) are highly effective strategies for reducing FLW. It suggests that monitoring sustainability practices is a key method for food waste prevention and that Government intervention is needed to create a supportive environment for environmentally friendly practices.

The study establishes that efforts to reduce FLW are met with significant organizational resistance, primarily due to a lack of knowledge and an unwillingness to integrate sustainable practices driven by overriding financial considerations and a systemic reliance on overproduction and surplus. This reluctance often hinders the utilization of resources available through the NRBV framework.

The findings reinforce the NRBV principle that pollution prevention initiatives, linked to continuous innovation (Vachon and Klassen, 2008; Golicic and Smith, 2013) and process innovation (Aragon-Correa and Sharma, 2003), are essential for minimizing food waste. Specifically, the paper theoretically contributes by:

(i) Demonstrating the impact of logistics costs on inventory management and subsequent high FLW volumes.

(ii) Highlighting that, the inability to determine optimal inventory levels to maintain service levels directly contributes to FLW.

Indicating that environmentally friendly packaging design is vital for reducing food contact risks, substantially improving environmental health, and is a key strategy directly leading to the reduction of Food Loss and Waste (FLW).

Critiquing the NRBV's static nature, the study argue that it fails to provide conventional guidance for managers to overcome the dynamic challenges of unpredictable ecological and societal environments caused in part by FLW, which adversely impact competitive durability among food retail firms (Chakrabarty & Wang, 2012; Li & Liu, 2023). This points to the recognized limitations of NRBV's operationalization (Grant, 1991; Saeed et al., 2019).

Revealing that a lack of stringent, environmentally friendly policies and an inconsistent review of food waste volume, coupled with an overreliance on forecasts, significantly contribute to excessive inventory and FLW.

5.3 Practical Contribution

This study offers significant practical guidance for UK food retail practitioners, aiding both tactical and strategic decisions concerning the effective implementation of sustainable supply chain practices to improve sustainability and operational performance.

This research guide practitioners in making strategic decisions to enhance sustainability and competitiveness through effective FLW reduction. Key actions include establishing a comprehensive logistical evaluation system to assess eco-performance, and adopting environmentally friendly packaging (non-hazardous, biodegradable materials) to mitigate risks. Furthermore, the study assists with practical challenges by detailing pragmatic management of inventory and backorders, flexible facility layout arrangement, and optimizing food alternative uses and charity redistribution. By integrating these ideas, firms can achieve a drastic and sustained reduction in Food Loss and Waste (FLW) across the Food Supply Chain (FSC).

The research furnishes policymakers with crucial evidence and robust frameworks to design effective, evidence-based policies aimed at enhancing food security, environmental sustainability, and economic efficiency. It provides a clear basis for assessing and prioritizing strategies based on their environmental impact and social gain.

The research's core practical visions, which are supported by the Natural Resource-Based View (NRBV), emphasize that:

- Cost Reduction and Efficiency: By adopting practices focused on pollution prevention (intended to reduce food waste-associated costs and maximize efficiency (Hart, 1995;

Russo and Fouts, 1997)) firms can implement a powerful, competitive, cost-cutting business strategy (Hart, 1997; Hart and Dowell, 2011).

- Systemic Evaluation: Practitioners should implement a comprehensive logistical evaluation system to assess internal eco-performance and utilize environmental reports for continuous improvement and significant FLW reduction (Zaid *et al.,* 2018; Zhu *et al.,* 2018).

By providing one of the few in-depth investigations into environmental sustainability in UK food retail, this research aims to encourage firms to become proactive and deeply involved in integrating environmentally friendly ideas across their supply chains to maintain competitiveness and achieve a drastic, sustained reduction in FLW.

5.4 Limitations and Future Research Directions

While this study offers valuable insights, its focus on five case companies is a recognized limitation of case study research, restricting the generalizability of findings. Future research should address this by increasing the sample size and employing diverse methodologies, such as large-scale surveys and mixed methods, to gain a more comprehensive appreciation of the UK food supply chain's environmental performance. A larger sample could also provide a more nuanced view of the food retail sector, potentially revealing practical challenges and less optimistic perspectives not fully captured here.

The study focussed on limited functions like packaging, logistical efficiency, food alternative uses, inventory, backorder and facility layouts but in future, the impact of other functions like post-harvest handling, transportation of food products, Food services and Household consumption etc could also be studied.

At the supply chain level, the study was limited to retailers' stores, warehouses and the supplier, but this has not discussed the complete supply chain including farmers and customers and their role in FLW. This should also be discussed to be considered in future to appreciate their impact in the generation of FLW. Also, a survey research approach covering all entities in supply chain could be useful for generalising the findings.

Institutional constraints limited operative participation to only two of the five participating food retail firms, inevitably resulting in a reduced volume of verbatim quotes from the operatives compared to management. This disparity in data representation is formally acknowledged as a methodological limitation. Future researchers may encourage more firms to make available

their operatives where their potential impact on the breadth of the findings is critically discussed and addressed more.

Building on the opportunities provided by the Natural Resource-Based View (NRBV) theory, future work could delve deeper into the implementation of sustainable Food Loss and Waste (FLW) reduction practices by involving a broader range of food retail companies. This should specifically analyse the dynamics of FLW reduction strategies that enhance both competitive advantage and operational performance. Furthermore, comparative case studies are recommended to explore how sustainable FLW reduction strategies are adapted and implemented in similar industries across different developing and developed food retail contexts. Moreover, the NRBV theory in this research is limited by its static nature, failing to fully address the contextual, institutional, and dynamic factors influencing management in the FSC. While it links resources to competitive advantage, the theory offers little prescriptive guidance for managers on how to effectively build or leverage those resources to minimize FLW (Hart and Dowell, 2011; Shi *et al.,* 2012). The theory underemphasizes the role of external market conditions. It focusses mainly on internal resources which ignored the important external pressures and opportunities. Given these limitations, future researchers should be cautious when relying mainly on NRBV to study firm approaches on reducing FLW.

References

References cited in Chapter 1

Aramyan, L., Grainger, M., Logatcheva, K., Piras, S., Setti, M., Stewart, G., and Vittuari, M. (2021), "Food waste reduction in supply chains through innovations: a review" Measuring Business Excellence, vol. 25 No 4, pp 475-492, Doi: 10.1108/mbe-11-2019-0105.

Ashby, A. Leat, M. Hudson-Smith, M. (2012). Making connections: a review of supply chain management and sustainability literature. School of Business Management, University of Plymouth, UK https://www.emeraldinsight.com/1359-8546.htm

Baba, F. V., Esfandiari, Z. (2023). Theoretical and practical aspects of risk communication in food safety: a review study. Heliyon, 9 (2023), p. e18141. https://doi.org/10.1016/j.hellyon.2023.e18141

Bamber, C. (2019). Exploring Enterprise-Wide Risk Management System in Higher Education. Journal Abbreviation: Managing Dynamic Knowledge Economy11(3), 267-285. Doi.10.2478/mdke-2023-0017

Beske-Janssen, Philip., Johnson, Thomas, Constant, Francois Constant. Wieland Andreas Wieland. (2022). New competences enhancing procurement's contribution to Innovation and sustainability. Journal of Purchasing and supply management. Vol 29, Issue 3, https://doi.org/10.1016/j.pursup.2023.100847

Bhatia, M.S & Gangwani, K. K (2021). Green supply chain management: Scientometric review and analysis of empirical research. Journal of cleaner production, 284, 124722. https://doi.org/10.1016/j.jclepro.2020.124722

Bhattacharya, A, and Fayezi, S. (2021) Ameliorating food loss and waste in the supply chain through multi-stakeholder collaboration. Industrial Marketing Management. Vol 93 Pp 328-343. https://doi.org/10.1016/j.indmarman.2021.01.009

Biuki, M., Kazemi, A., Alinezhad, A., (2020). An integrated location-routing-inventory model for sustainable design of a perishable products supply chain network. J. Clean. Prod. 260, 120842. https://doi.org/10.1016/jclepro.2020.120842

Campbell, C.G. and Feldpausch, G.L., (2022). Invited view. The consumer and dairy food waste: An individual plus policy, system, and environmental perspective. Journal of dairy Science vol. 105, issue 5 Pp 3736-3745. http://doi.org/10.3168/jds.2021.20994

Carter, A.B., Collier, C. Coles, R. Lawrence, E. Rasheed, M.A. (2022) Community-Specific desire states for seagrasses through cycles of loss and recovery. Journal of Environmental Management. Vol.314. 115059. https://doi.org/10.1016/j.jenviron.2022.115059

Chauhan, C. Dhir, A. Akram, M and Salo, J. (2021). Food Loss and Waste in Food Supply Chains: A Systematic Literature Review and Framework Development Approach. Journal of Cleaner Production vol 295,126438 https://doi.org/10.1016/j.jclepro.2021.126438

Chauhan, C., et al. (2021). Food loss and waste management for sustainable development: A systematic review and future research points. Journal of Cleaner Production.

Chaboud, G, and Daviron, B. (2017). Food losses and waste: navigating the inconsistencies. Global Food Security vol. 12. Pp 1-7. https://doi.org/10.1016/j.gfs.2016.11.004

Choi, Y. J., Choi, H. B., & O'Donnell, M. (2018). Disaster reintegration model: a qualitative analysis on developing Korean disaster mental health support model. International Journal of Environmental Research and Public Health, 15(2), 362

Coelho, P M., Corona, B., Klooster, R., Worrell, E. (2020). Sustainability of reusable packaging-current situation and trends. Resource, conservation & Recycling vol 6, may 2020, https://doi.org/10.1016/j.rcrx.2020.1000037.

Fahimnia B, Sarkis J and Davarzani H (2015). Green chain management: A review of bibliometric Analysis. International Journal of Production Economics, vol 162, Pg 101 – 104. https://doi.org/10.1016/j.ijpe.2015.01.003

FAO (2019) The State of Food and Agriculture 2019. Moving forward on food loss and waste reduction. Licence: CC BY-NC-SA 3.0 IGO. Available at: https://www.fao.org/3/ca6030en/ca6030en.pdf (accessed 26 October 2023).

Farahani, R Z., Rezapour S and Kardar L. (2011) Logistics Operations and Management: Concept and Models. Journal of Manufacturing Science and Technology. https://doi.org/10.1016/C2010-0-67008-8.

Filimonau V, & Gherbin, A. (2017). An exploratory study of food waste management practices in the UK grocery retail sector. Journal of Cleaner Production, 167, 1184-1194. https://doi.org/10.1016/j.jcleoro.2017.07.229

Francesco, V., et al. (2023). Circular economy models in the food supply chain: A management perspective on loss and waste reduction. International Journal of Logistics Management

Garcia-Garcia, G., Stone, J., & Rahimifard, S. (2019). Opportunities for waste valorisation in the food industry – A case study with four UK food manufacturers. Journal of Cleaner Production, 211, 1339–1356. https://doi.org/10.1016/j.jclepro.2018.11.269.

Golicic, S. and Smith, C.D. (2013) 'A meta-analysis of environmentally sustainable supply chain management practices and firm performance'. Journal of Supply Chain Management, 49 (2). pp 78-95. Doi:10.1111/iscm.12006

Hofmann, H. Busse, C. Bode, C. Henke, M. (2014) Sustainability-Related Supply Chain Risks: Conceptualization and Management. Business Strategy and the Environment. 23(3): 160-172 Doi: 10.1002/bse.1778

Isangula K G, Kelly S. Wamiyi J, (2024) Manuakl Qualitative Data Coding Using Word for Students and Career Researchers in Resource-Controlled Setting. International Journal of Qualitative Methods. https://doi.org/10.1177/16094069241299223

Janssens K, Lambrechts W, van Osch A. (2019) How consumer behaviour in daily food provisioning affects food waste at household level in The Netherlands. Foods 8: 428. https://doi.org/10.3390/foods8100428

Jeswani, K Harish, Figueroa-Torres, Gonzalo, Azapagic, Adisa (2020). The extent of food waste generation in the UK and Its environmental Impact. Journal of sustainable production and consumption. 12. 021. https://doi.org/10.1016/j.spc.2020.12.021

Khokhar, S., Pathan, H., Raheem, A., and Abbasi, A. M. (2020) Theory Development in Thematic Analysis: Procedure and Practice. The Journal of Management and Social Sciences. Doi.10.47067/ramss.v313.79

Kucha, C. T., Ngadi, M.O. (2020). Rapid assessment of pork freshness using miniaturized NIR spectroscopy. J. Food Meas. Charact., 14 (2020), pp. 1105-1115. Doi:10.1007/s11694-019-00360-9.

Kumar, A., Mangla, S. K., Kumar, P., & Karamperidis, S. (2020). Challenges in perishable food supply chains for sustainability management: A developing economy perspective. Business Strategy and the Environment, 29(5), 1809–1831. https://doi.org/10.1002/bse.2470.

Kusumowardani, N., Tjahjono, B., Lazell, J., Bek, D., Theodorakopoulos, N., Andrikopoulos, P., & Priadi, C. R. (2022). A circular capability framework to address food waste and losses in the agri-food supply chain: The antecedents, principles and outcomes of circular economy. Journal of Business Research, 142, 17–31. https://doi.org/10.1016/j.jbusres.2021.12.020";

Lindh, L. Olsson, A., Williams, H. (2016) Consumer Perceptions of Food Packaging: Contributing to or Counteracting Environmentally Sustainable Development? Packaging Technology and Science 29(1):n/a-n/a DOI: 10.1002/pts.2184.

Madarasz, L. Meszaros, L.A. Kote, A. Farkas, A, Krstof, N. (2023). AI- based analysis of inline process endoscope images for real-time particle size measurement in a continuous pharmaceutical mailing process. Vol 641 123060 https://doi.org/10.1016/j.ijpharm.2023.123060

Malacina, I and Teplov, R. (2022). Supply chain innovation research: A bibliometric network analysis and literature review. International Journal of Production Economics vol 251. 108540. https://doi.org/10.1016/j.ijpe.2022.108540

Malik, A., Lafortune, G. Mora, C.J. Carter, S. Lenzen, M. (2024). Carbon and social impacts in the EU's Consumption of fossil and mineral raw materials vol. 369 122291. Journal of environmental management. https://dou.org/10.1016/j.jenvman.2024.122291

Markley, M.J. and Davis, L. 2007. 'Exploring Future Competitive Advantage Through Sustainable Supply Chain Management'. International Journal of Physical Distribution and Logistics Management, 37 (9). pp763-774.

Mishra, S; Page, S. E; Cobb, A. R; Lee, J. S. H; Jovani-Sancho, A. J; Sjogersten, S; Aswandi, D. A. W. (2021) Degradation of Southeast Asian Tropical Peatlands and Integrated Strategies for thei Better Management and Restoration. Journal of applied ecology. Vol. 58, issue 7 pp 1370-1387 https://doi.org/10.1111/1365-2664.13905

Mastos, T.; Gotzamani, K. Sustainable Supply Chain Management in the Food Industry: A Conceptual Model from a Literature Review and a Case Study. Foods 2022, 11, 2295. https://doi.org/10.3390/foods11152295.

Matopoulus, A. Barros, A.C. Vorst, J.V. (2015). Resource-efficient supply chains: Ac research framework, literature review and research agenda. Supply chain management An International Journal 20(2):218-236 Doi:10.1108/scm-03-2014-0090

Nilsson. M. Zamparutti, T. Petersen, J.E. Nykvist, B. Rudberg, P. McGuinn, J. (2012). Understanding policy coherence: Analytical Framework and Examples of Sector-Environmental Policy Interactions in the EU. Environmental Policy and Governance/ vol.22, issue 6 Pp 395-423 https://doi.org/10.1002/eet.1589

Perez-Gosende, P. Mula, J, Diaz-Madronero, M. (2021). Facilities layout planning: An Extended literature review. International Journal of Production Research vol 59, 2021. https://doi.org/10.1080/00207543.2021.1897176

Pietzsch, N., Ribeiro, Jose Luis Duarte., Fleith de Medeiros, Janine. (2017) Benefits, Challenges and Critical Factors of Success for Zero Waste: A systematic Literature Review. Journal of waste Management. Vol 67 September 2017, pp 324-353 https://doi.org/10.1016/j.wasman.2017.05.004

Pourvaziri, H. Pierreval, H. Marian. H. (2021). Integrating facility layout design and aisle structure in manufacturing system. Formulation and exact solution vol 290, issue 2, Pg 499-513 https://doi.org/10.1016/j.ejor.2020.08.012

Prajogo, D. and Sohal, A. 2013. 'Supply Chain Professionals: A Study of Competencies, Use of Technologies and Future Challenges'. International Journal of Operations and Production Management, 33 (11/12). pp1532-1554

Priefer C, Jörissen J, Bräutigam KR (2016) Food waste prevention in Europe–a cause-driven approach to identify the most relevant leverage points for action. Resour Conserv Recycl 109:155–165. https://doi.org/10.1016/j.resconrec.2016.03.004

Rajabion Lila, Khorraminia Marieh, Andjomshoaa & Ghafouri-Azar Mona. A new model for assessing the impact of business processes on the success of green supply chain mgt syst. Jour of retailg & cus services. 2019. https://www.elsevier.com/locate/jretconser

Rao P, Holt D. Do green supply chains lead to competitiveness and economic performance? Int J Oper Prod Manag 2005;25(9):898–916. Doi:10.1108/01443570510613956.

Rodger J.A. (2014). Application of a fuzzy feasibility Bayesian probabilistic estimation of supply chain backorder aging, unfilled backorders, and customer wait time using stochastic simulation with Markov blankets. Expert System Appl. 2014;41(16):7005–222.

Russell, R.S. and Taylor, B.W (2003). Information-intensive operations-based service process classification. Journal of service science and management vol 15 nos 3 June 28, 2022 htpps://www.scirp.org

Shi, P. Yan, B. Shi, S (2014). A decision support system to select suppliers for a sustainable supply chain based on a systematic DEA approach. Inf. Techno management. 16: 39-49. Doi.org/Bogdan10.1007/s10799-014-0193-1

Saruchera, F. and Asante-Darko, D. (2021), “Reverse logistics, organizational culture and firm operational performance: some empirical evidence”, Business Strategy & Development, Vol. 4 No. 3, pp. 326-342.

Teller, C., Holweg, C., Reiner, G., Kotzab, H. (2018) Retail Store Operations and Food Waste. Journal of Cleaner Production, vol 185. Pp 981-997 https://doi.org/10.1016/j.jclepro.2018.02.280.

Transfield D, Denyer, D and Smart P. (2003) Towards a methodology for developing evidence-informed management knowledge by means of systematic review. (2003). British journal of management 14(3);207 – 222. Doi: 10.1111/1467-8551.00375

UNEP (2022) United Nation Environmental Programme. (2022). The UN climate Change Conference on Sustainable Development Goals to Protect and Restore Ecosystems and Reduce the Burden of Pollution. Stockholms+50 Conference UNEP Annual Report. https://share.google/FBoMTz7tUirsoVP6T

Walker, H., L. Di Sisto, and D. McBain. 2012. “Drivers and Barriers to Environmental Supply Chain Management Practices: lessons from the Public and Private Sectors.” Journal of Purchasing and Supply Management 14 (1): 69–85. doi: 10.1016/j.pursup.2008.01.00.

Weerabahu, S., Samaranayake, P. Nakandala, D. (2022) Digital supply chain research trend: a systematic review and a maturity model for adoption. Benchmarking An international Journal. Doi: 10.1108/BIJ-12-2021-0782

Wikstrom, F., H. Williams, K. Verghese, and S. Clune. 2014. “The Influence of Packaging Attributes on Consumer Behaviour in Food-Packaging Life Cycle Assessment Studies – A Neglected Topic.” Journal of Cleaner Production 73:100–108. doi:10.1016/j.jclepro.2013.10.042

Williams, H., and F. Wikstrom. 2010. “Environmental Impact of Packaging and Food Losses in a Life Cycle Perspective: A Comparative Analysis of Five Food Items.” Journal of Cleaner Production 19 (1): 43–48. https://doi.org/10.1016/j.jclepro.2010.08.008

Yang, Ying, Hattie Barnes, Biao yang, George, Onofrei & Hung Nguyen (2023). Food Management for the Uk grocery retail sector- Supply Chain Collaboratory Perspective. Production Planning & control journal 8, 1096. https://doi.org/10.1080/09537287.2023.2226622.

References cited in Chapter 2.

Abbade, E. B. (2020). Estimating the nutritional loss and the feeding potential derived from food losses worldwide. World Development, 134, 105038.

Abedrabboh, O., Koç, M., & Biçer, Y. (2022). Modelling and analysis of a renewable energy-driven climate-controlled sustainable greenhouse for hot and arid climates. Energy Conversion and Management, 273, 116412. doi:10.1016/j.enconman.2022.116412.

Ada, E., Kazancoglu, Y., Gozacan-Chase, N., & Altin, O. (2023). Challenges for circular food packaging: Circular resources utilization. Applied Food Research, 3(2), 100310.

Akkaş, A., Gaur, V. (2022). Reducing Food Waste: An Operations Management Research Agenda. Manufacturing and Service Operations Management, 24(3), pp. 1261–1275.

Albizzati, P.F., Tonini, D., Chammard, C.B., Astrup, T.F., 2019. Valorisation of surplus food in the French retail sector: environmental and economic impacts. Waste Manag. 90, 141–151. https://doi.org/10.1016/j.wasman.2019.04.034.

Alvarez, A., Cordeau, J.-F., Jans, R., Munari, P., Morabito, R., 2020. Formulations, branch-and-cut and a hybrid heuristic algorithm for an inventory routing problem with perishable products. Eur. J. Oper. Res. 283 (2), 511–529.

Amicarelli, V., Lagioia, G., Sampietro, S. and Bux, C. (2021). Has the COVID-19 pandemic changed food waste perception and behavior? Evidence from Italian consumers", Socio-Economic Planning Sciences, 101095, in press, available online 11 June 2021.

Aung, M., Chang, Y. (2014). Temperature management for the quality assurance of a perishable food supply chain. Food Control, 40 (2014), pp. 198-207.

Aramyan, L., Grainger, M., Logatcheva, K., Piras, S., Setti, M., Stewart, G., and Vittuari, M. (2021), "Food waste reduction in supply chains through innovations: a review" Measuring Business Excellence, vol. 25 No 4, pp 475-492, doi: 10.1108/mbe-11-2019-0105.

Arif, M. S., Mukheimer, A., Asad Ejaz, A. (2024). Cannibalism and Harvesting in Tritrophic Chains: Insights from Mathematical and Artificial Neural Network Analysis. Licensee ESJ, Italy. (https://creativecommons.org/licenses/by/4.0/).

Baba, F. V., Esfandiari, Z. (2023). Theoretical and practical aspects of risk communication in food safety: a review study. Heliyon, 9 (2023), p. e18141.

Belavina, E. (2021). Grocery store density and food waste. Manufacturing and Service Operations Management, 23(1), pp. 1–18.

Bajzeli, B., Quested, T.E., Roos, E., Swannell, R.P. (2020) The Role of Reducing Food Waste for Resilient Food System. Ecosyst Serv, 2020 Oct:45:101140.

Baumgartner, S., and Quass, M. (2010) What is Sustainability Economics. Ecological Economics, 2010, vol 69, issue 3, 445-450.

Bates, M.P., Phillips, P.S. (1999). Sustainable waste management in the food and drink industry. British Food Journal, 101(8), pp. 580–589.

Beausang, C., Hall, C., Toma, L. (2017). Food waste and losses in primary production: Qualitative insights from horticulture. *Resources, Conservation and Recycling*, *126*, pp.177-185.

Beitzen-Heineke, E.F., Balta-Ozkan, N., Reefke, H. (2017). Article. The prospects of zero-packaging grocery stores to improve the social and environmental impacts of the food supply chain. Journal of Cleaner Production, 140, pp. 1528–1541

Belavina, E. (2021). Grocery store density and food waste. Manufacturing and Service Operations Management, 23(1), pp. 1–18.

Bhatia, M.S & Gangwani, K. K (2021). Green supply chain management: Scientometric review and analysis of empirical research. Journal of cleaner production, 284, 124722. https://doi.org/10.1016/j.jclepro.2020.124722.

Biuki, M., Kazemi, A., Alinezhad, A., (2020). An integrated location-routing-inventory model for sustainable design of a perishable products supply chain network. J. Clean. Prod. 260, 120842.

Bocken, N.M., de Pauw, I., Bakker, C., van der Grinten B. (2016) Product design and business model strategies for a circular economy Journal of Industrial and Production Engineering, 33 (5) (2016), pp. 308-320, 10.1080/21681015.2016.1172124.

Brennan L., Langley S., Verghese K. (2021) The role of packaging in fighting food waste: A systematised review of consumer perceptions of packaging. *Journal of Cleaner Production* 281: 125276.

Carter, C.R., Hatton, M.R., Wu, C., Chen, X. (2020). Sustainable supply chain management: continuing evolution and future directions. International Journal of Physical Distribution and Logistics Management, 50(1), pp. 122–146.

Centobelli P., Cerchione R., and Chiaroni D. (2020). Designing business model in circular economy: A systematic review and research agenda. Vol 29 issue 4 pp 1734 – 1749.

Chaboud, G., and Daviron. (2017). Food losses and waste: Navigation the Inconsistencies. Glob. Food Sec (2017) pp 1-7.

Chaffe O, McGillivray A, Duizer L, Carolyn F. (2022) Identifying elements of a ready-to-eat meal desired by older adults. Food research international. Vol 157 111353. https://doi.org/10.1016/j.foodres.2022.111353.

Choi, W., & Kang, S. (2022). Greenhouse Gas Reduction and Economic Cost of Green Hydrogen-Using Technologies in the Steel Industry. SSRN Electronic Journal, 335, 117569. doi:10.2139/ssrn.4286238.

Ciccullo F, Cagliano R, Bartezzaghi G, et al. (2021) Implementing the circular economy paradigm in the agri-food supply chain: The role of food waste prevention technologies. *Resources, Conservation and Recycling* 164: 105114. Web of Science.

Colicchia, C., Creazza, A., Perotti, S. (2022) Better sustainability in the food supply chain through technology: a consumer perspective. International Journal of Logistics Research and Applications. Pp 1 – 25.

Correa, E.C., Jimenez-Ariza, T., Diaz-Barcos, V., Barreiro, P., Diezma, B., Oteros, R. (2014). Advanced characterisation of a coffee fermenting tank by multi-distributed wireless sensors: Spatial interpolation and phase space graphs. Food and Bioprocess Technology, 7 (11) (2014), pp. 3166-3174.

Da Silva, A.D.S., da Silva, W.V., da Silva, L.S.C.V., Su, Z., da Veiga, C.P. (2025). Interdependence between supply chains and sustainable development: global insights from a systematic review. Review of Managerial Science, 19(3), pp. 931–962.

De Corato, U., & Cancellara, F. A. (2019). Measures, technologies, and incentives for cleaning the minimally processed fruits and vegetables supply chain in the Italian food industry. Journal of Cleaner Production, 237, 117735.

Denyer, D., and Transfield, D. (2009) Producing a Systematic Review. The Sage Handbook of Organisational Research Methods pp 671-689. Sage publication Ltd.

Derqui, B., Fernandez, V., & Fayos, T. (2018). Towards more sustainable food systems: Addressing food waste at school canteens. Appetite, 129, 1-11.

Dora, M., Biswas, S., Choudhary, S., Nayak, R., & Irani, Z. (2021). A system-wide interdisciplinary conceptual framework for food loss and waste mitigation strategies in the supply chain. Industrial Marketing Management, 93, 492-508.

Dou, Z., Cochran, C., Finn, S.M., Galligan, D., Goldstein, N., & O'Donnell, T. (2018). Food loss and waste: a paper in the series on the need for agricultural innovation to sustainably feed the world by 2050. Council for Agricultural Science and Technology (CAST) Issue Paper No. 62. Ames, IA: CAST.

Durmanov, A., Farmanov, T., Nazarova, F., Khasanov, B., Karakulov, F., Saidaxmedova, N., Mamatkulov, M., Madumarov, T., Kurbanova, K., Mamasadikov, A. and Kholmatov, Z., (2024). Effective economic model for greenhouse facilities management and digitalization. *Journal of Human, Earth, and Future*, *5*(2), pp.187-204.

EU (2021) Action plan for circular Economy. Retrieved from https://eur-lex.europa.eu/legaL.content/EN/TXT/?uri=CELEX:5201DC0614.

EU. (2020). Food waste measurement. Retrieved from https://ec.europa.eu/food/safety/food-waste/eu-actions-against-food-waste/food-waste-measurement_

Eyo-Udo. N., (2024) Leveraging artificial intelligent for enhanced supply chain optimisation, Open Access research journal of multidisciplinary studies. 2024;7(2):001-15.

Fahimnia B, Sarkis J and Davarzani H (2015). Green chain management: A review of bibliometric Analysis. International Journal of Production Economics, vol 162, Pg 101 - 104

FAO. (2019). The State of Food and Agriculture 2019. Moving forward on food loss and waste reduction. Food and Agriculture Organization of the United Nations, Rome.

Filimonau V, & Gherbin, A. (2017). An exploratory study of food waste management practices in the UK grocery retail sector. Journal of Cleaner Production, 167, 1184-1194.

Garcia-Arca, J., Garrido, A. T. G., Prade, P., Gonzalez-Boubeta, I. (2022) Packaging Design for Competitiveness. Contextualizing the Search and Adaption of Changes from a Sustainable Supply Chain Perspective. International Journal of Production Management. 10(2):115-130.

Gayam, S.R. Yellu, R.R, Thuniki, P. (2021). Optimising supply chain management through artificial intelligence: techniques for predictive maintenance, demand forecasting, and inventory optimisation. Journal of AI-Assisted Scientific Discovery. Mar4;1(1);129-44.

Gerstberger, C., & Yaneva, D. (2013). Analysis of EU-27 household final consumption expenditure: Baltic countries and Greece still suffering most from the economic and financial crisis. Eurostat Statistics in Focus, 2, 2013
Gokarn, S., & Kuthambalayan, T. S. (2019). Analysis of challenges inhibiting the reduction of waste in food supply chain. Journal of Cleaner Production, 168, 595–604.

Gokarn, S., & Kuthambalayan, T. S. (2019). Analysis of challenges inhibiting the reduction of waste in food supply chain. Journal of Cleaner Production, 168, 595–604.

Gruber, V., Holweg, C., & Teller, C. (2016). What a waste! Exploring the human reality of food waste from the store manager's perspective. Journal of Public Policy & Marketing, 35(3), 3-25.

Guo L, Wang Y, Kong D, Zhang Z, Yang Y. (2019) Decisions on spare parts allocation for repairable isolated system with dependent backorders. Comput Ind Eng. 2019;127:8–20.

Gustavsson, J., Cederberg, C., Sonesson, U., van Otterdijk, R., & Meybeck, A. (2011). Global food losses and food waste. Save Food. from https://www.fao.org/3/mb060e/mb060e.pdf.

Handfield R, Sun H, Rothenberg L, (2020) Assessing supply chain risk for apparel production in low-cost countries Using newsfeed analysis. Doi: 10.1108/SCM-11-2019-0423

Heard B, Bandekar M, Vassar B, Shalie A. (2019). Comparison of life cycle environmental impacts from meal kits and grocery store meals. Resources, conservation and recycling. Vol 147, pp 189-200

Heller, M. C., Willits-Smith, A., Meyer, R., Keoleian, G.A., and Rose, D. (2018). Greenhouse Gas Emissions and Energy Use Associated with Production of individual Self-Selected US Diets. Environmental Research Letters, vol 13, Number 4
Doi 10.1088/1748-9326/aab0ac.

Huang, I. Y., Manning, L., James, K. L., Grigoriadis, V., Millington, A., Wood, V., & Ward, S. (2021). Food waste management: a review of retailers' business practices and their implications for sustainable value. Journal of Cleaner Production, 285, 125484.

Huber, J. (2000). Towards Industrial Ecology: Sustainable Development as a Concept of Ecological Modernisation. Journal of Environmental Pokicy and Planning. 2(4):269-285. Doi:10.1080/714038561.

Humbert S. (2009) Life cycle assessment of two baby food packaging alternatives: Glass jars vs. plastic pots. The international journal of life cycle assessment. Vol 14 pp 95 – 106.

Jahani, H., Abbasi, B., Sheu, J.-B., and Klibi, W. (2024) Supply chain network design with financial considerations: A comprehensive review. European Journal of Operational Research, 312 (3) (2024), pp. 799-839.

Jaji M, Adegbuyi B, and Yusuf-Oshoala M. (2014). Assessment of constraints of women in fish processing and accessibility to extension activities in Lagos, Nigeria. SSRN Electronic Journal 7(05):61-70.

Jones, P., Comfort, D., & Hillier, D. (2008). Moving towards sustainable food retailing? International Journal of Retail and Distribution Management, 36(12), 995–1001.

Janousek A, Sean M, Roseland M. (2018) Exploring the relationship between on-farm food waste and farm characteristics. ResearchGate DOI:10.1080/21683565.2018.1468381.

Jocelyn, M., Boiteau, Pingoli, P. (2023). Can we agree on a food loss and waste definition? An Assessment of Definitional Elements for a Global Application Framework. Global Food Security, vol 37, June 2023, 100677.

Kaipia, R., Dukovska-Popovska, I., & Loikkanen, L. (2013). Creating sustainable fresh food supply chains through waste reduction. International Journal of Physical Distribution & Logistics Management, 43(3), 262–276

Kayikci Y. (2019) Sustainable impact of digitalization in Logistics. Science Direct. Vol 21 pp 782 – 789.

Kharola, S., Ram, M., Kumar Mangla, S., & Pant, D. (2022). Exploring the green waste management problem in food supply chains: A circular economy context. Journal of Cleaner Production, 351, 131355.

Kim, W.R., Aung, M.M., Chang, Y.S., Makatsoris, C. 2015). Freshness gauge based cold storage management: A method for adjusting temperature and humidity levels for food quality Food Control, 47 (2015), pp. 510-519

Koberg, E., Longoni, A., 2019. A systematic review of sustainable supply chain management in global supply chains. J. Clean. Prod. 207, 1084–1098.

Krishnan, R., Agarwal, R., Bajada, C., & Arshinder, K. (2020). Redesigning a food supply chain for environmental sustainability – An analysis of resource use and recovery. Journal of Cleaner Production, 242, 118374.

Kucha, C. T., Ngadi, (2020) M.O. Rapid assessment of pork freshness using miniaturized NIR spectroscopy. J. Food Meas. Charact., 14 (2020), pp. 1105-1115.

Kummu, M., Heino, M., Taka. M., Varis, O., Viviroli, D. (2021) Climate Change Risks Pushing One-Third of Global Food Production Outside the safe Climatic Space. One Earth, vol 4 Issue 5. https//doi.org/10.1016/j.oneear.2021.04.017.

Lebersorger, S., & Schneider, F. (2014). Food loss rates at the food retail, influencing factors and reasons as a basis for waste prevention measures. Waste Management, 34, 1911-1919.

Li J., Zhao H., Huang W. (2014). Mechanism of proanthocyanidins-induced alcohol fermentation enhancement in saccharomyces cerevisiae. J ind Microbiol Biotechnol 41(12):1793-802.

Lindh, L. Olsson, A., Williams, H. (2016) Consumer Perceptions of Food Packaging: Contributing to or Counteracting Environmentally Sustainable Development? Packaging Technology and Science 29(1):n/a-n/a DOI: 10.1002/pts.2184.

Liu, Z., Wang, Y., & Feng, J. (2025). Identifying supply chain R&D partners via multilayer institutional cooperation network and tailored link prediction. Computers & Industrial Engineering, 201, 110887. doi: https://doi.org/10.1016/j.cie.2025.110887

Lohnes, J., Wilson, B. (2018) Bailing Out the Food Bank? Hunger Relief, Food Waste, and Crisis in Central Appalachia. Environmental and Planning: Economy and Space. https://doi.org/10.1177/0308518x17742154.

Luo, N., Olsen, T., Liu, Y., & Zhang, A. (2022). Reducing food loss and waste in supply chain operations. Transportation Research Part E: Logistics and Transportation Review, 162, 102730.

Mandal J, Mitra R, Gupta VK, et al. (2021) Optimal allocation of near-expiry food in a retailer-foodbank supply network with economic and environmental considerations: An aggregator's perspective. *Journal of Cleaner Production* 318: 128481.

Markard, J., Raven, R. and Truffer, B., 2012. Sustainability transitions: An emerging field of research and its prospects. Research policy, 41(6), pp.955-967.

Messner, R., Johnson, H., & Richards, C. (2021). From surplus-to-waste: A study of systemic overproduction, surplus and food waste in horticultural supply chains. Journal of Cleaner Production, 278, 123952. https://doi.org/10.1016/j.jclepro.2020.123952.

Midgley, J.L. (2019) Anticapacity practice and the making of surplus food. Geoforum, 99 (2019) pp 181 -189, 10.1016/j.geoforum.2018.09.013.

Mithun Ali, S., Moktadir, M.A., Kabir, G., ...Rumi, M.J.U., Islam, M.T. (2019). Framework for evaluating risks in food supply chain: Implications in food wastage reduction. Journal of Cleaner Production, 228, pp. 786–800.

Montoli P, Ares G, Aschemann-Witzel J, et al. (2023) Food donation as a strategy to reduce food waste in an emerging Latin American country: A case study in Uruguay. *Nutrire* 48: 22.

Morashti, J. A., An, Y., & Jang, H. (2022). A systematic literature review of sustainable packaging in supply chain management. Sustainability Switzerland, 14(9), 4921.

Munson C and Rosenblatt. (1998) Theories and Realities of Quality Discount. An exploratory study, production and operational management, vol 7, No 4, 1998, pp 352 – 369.

Muthukalyani, A.R. (2023). Unlocking Accurate Demand Forecasting in Retail Supply Chains with AI-driven Predictive Analytics. Information Technology Management. 2023;14(2):48-57.

Naji R.K. (2012). Global stability and persistence of three species food web involving omnivore. Iraqi Journal of Sciences, 53(4), 866–876.

Nath, B., & Das, K. P. (2018). Density Dependent Mortality of Intermediate Predator Controls Chaos-Conclusion Drawn from A Tri-Trophic Food Chain. J. Ksiam, 22(3), 179–199. doi:10.12941/jksiam.2018.22.179.

Nimmagadda, V.S. (2021) Artificial Intelligence for Real-Time Logistics and Transportation Optimisation in Retail Supply Chains: Techniques, Models, and Applications. Journal of Machine Learning for Healthcare Decision Support. Jun8;1(1):88-126.

Pakseresht, A., Yavari, A., Kaliji, S. A., & Hakelius, K. (2021). The intersection of blockchain technology and circular economy in the agri-food sector. Sustainable Production and Consumption, 35, 260–274.

Pietzsch, N., Ribeiro, Jose Luis Duarte., Fleith de Medeiros, Janine. (2017) Benefits, Challenges and Critical Factors of Success for Zero Waste: A systematic Literature Review. Journal of waste Management. Vol 67 September 2017, pp 324-353.

Porter, S. D., Reay, D. S., Bomberg, E., & Higgins, P. (2018). Production-phase greenhouse gas emissions arising from deliberate withdrawal and destruction of fresh fruit and vegetables under the EU's Common Agricultural Policy. Science of the Total Environment, 631-632, 1544-1552.

Pfeiffer, B. E., Sundar, A., & Deval, H. (2021). Not too ugly to be tasty: Guiding consumer food inferences for the greater good. Food Quality and Preference, 92, 104218.

Quynh D, Ramudhin A, Colicchia C, Creazza A, and Dong L. (2021). A systematic review of research on food loss and waste prevention and management for circular economy. International Journal of Production Economics. Vol 239. 108209. Https://doi.org/10.1016/j.ijpe.2021.108209.

Richter, B., & Bokelmann, W. (2016). Approaches of the German food industry for addressing the issue of food losses. Waste Management, 48, 423-4 29.

Salim, O. O., Guarnieri, P., & Leitão, F. (2021). Food waste from the view of circular economy: A systematic review of international literature. Revista de Gestao Social e Ambiental, 15, e2579.

Sánchez-Teba, E. M., Gemar, G., & Soler, I. P. (2021). From quantifying to managing food loss in the agri-food industry supply chain. Foods, 10(9), 2163.

Sasaki Y, Orikasa T, Shinozaki R, et al. (2022) Ideal packaging for ripened peaches determined through modeling the relationship between food loss reduction and life cycle environmental impacts. *Packaging Technology and Science* 36: 1–11.

Schanes, K., Dobernig, K., & Gözet, B. (2018). Food waste matters – A systematic review of household food waste practices and their policy implications. Journal of Cleaner Production, 182, 978-991.

Shashi, Singh, R., Centobelli, P. (2018) Evaluating Partnership in Sustainable-Oriented Food Supply Chain: AA Five Stage Performance Measurement Model. Energies.2018, 11(12), 3473.

Silvestri, B., Facchini, F., Mossa, G., & Mummolo, G. (2021). A systematic literature review on strategies to reduce the food loss and waste. Proceedings of the Summer School Francesco Turco, 18, 1-20.

Solaimani, S., and van der Veen., J. (2022). Open supply chain innovation: An extended view on supply chain collaboration Supply Chain Management: An International Journal, 27 (5) (2022), pp. 597-610.

Spring. C.A., and Biddulph, R. (2020) Capturing Waste or Capturing Innovation? Comparing Self-Organising Potentials of Surplus Food Redistribution Initiatives to Prevent Food Waste. Sustainability, MDPI, vol. 12(10) pp 1-19.

Somlai, R. (2022). Integrating decision support tools into businesses for sustainable development: A paradoxical approach to address the food waste challenge. Business Strategy and the Environment, 31(4), 1607–1622.

Strotmann, C., Gibel, C., Friedrich, S., Kreyenschmidt, J., Ritter, G., & Teitscheid, P. (2017). A participatory approach to minimizing food waste in the food industry—A manual for managers. Sustainability, 9(1), Article 66. https://doi.org/10.3390/su9010066.

Sundin N, Bartek L, Persson Osowski C, et al. (2023) Sustainability assessment of surplus food donation: A transfer system generating environmental, economic, and social values. *Sustainable Production and Consumption* 38: 41–54.

Taoumi, H., Elouahbi, K., Adnane, I., & Lahrech, K. (2024). Sustainable crop production: Highlights on economic, environmental and social life cycle thinking. Science of the Total Environment, 916, 170267. doi:10.1016/j.scitotenv.2024.170267.

Teller, C., Holweg, C., Reiner, G., Kotzab, H. (2018) Retail Store Operations and Food Waste. Journal of Cleaner Production, vol 185. Pp 981-997
https://doi.org/10.1016/j.jclepro.2018.02.280.

Tian, S. Wu, L. Pawar, K.S. (2025). Achieving food supply chain sustainability through digital sharing platforms: prospects in China Industrial Management and Data Systems, 125(3), pp. 1023–1051.

Thapa-Karki, S., Bennett, A. C. T., & Mishra, J. L. (2021). Reducing food waste and food insecurity in the UK: The architecture of surplus food distribution supply chain in addressing the sustainable development goals (Goal 2 and Goal 12.3) at a city level. Industrial Marketing Management, 93, 563-577.

Tian, S. Wu, L. Pawar, K.S. (2025). Achieving food supply chain sustainability through digital sharing platforms: prospects in China Industrial Management and Data Systems, 125(3), pp. 1023–1051.

Todeschini, B.V. Cortimiglia, M.N. Callegaro-de-Menezes, D. Ghezzi, A. (2017) Innovative and sustainable business models in the fashion industry: entrepreneurial drivers, opportunities, and challenges. Bus. Horiz., 60 (6) (2017), pp. 759-770, 10.1016/j.bushor.2017.07.003.

Transfield D, Denyer, D and Smart P. (2003) Towards a methodology for developing evidence-informed management knowledge by means of systematic review. (2003). British journal of management 14(3);207 – 222.

United Nation Environmental Programme. (2022). The UN climate Change Conference on Sustainable Development Goals to Protect and Restore Ecosystems and Reduce the Burden of Pollution. Stockholms+50 Conference.

Varese, E., Cesarani, M. C., & Wojnarowska, M. (2023). Consumers' perception of suboptimal food: Strategies to reduce food waste. British Food Journal, 125(1), 361-378.

Verghese, K., Lewis, H., Lockrey, S., Williams, H. (2015). Packaging's role in minimizing food loss and waste across the supply chain. Packaging Technology and Science, 28, 603-620.

Vegter, D. Hillegersberg, J. V. Olthaar M. (2020). Supply chain in circular business models: Process and performance objectives. Resources, conservation and recycling, vol 162, November, 2020, 105046.

Vlaholias E, Thompson K, Every D, Dawson D. (2015). Reducing food waste through charity: Exploring the giving and receiving of redistributed food. Conference at Central Queenland University, Appleton Institute, Wayville SA 5034 Australia. Doi:10.3920/978-90-8686-820-9_33.

Wang, J., Liu, L., Zhao, K., & Wen, Q. (2023). Farmers' adoption intentions of water-saving agriculture under the risks of frequent irrigation-induced landslides. Climate Risk Management, 39, 100484. doi:10.1016/j.crm.2023.100484.

Whelan, K. (2014) Ireland's Economic Crisis. The good, the bad and the ugly. Journal of Macroeconomics, 2014, vol 39, issue PB, 424-440.

Wikstrom, F., Verghese, K., Auras, R., Olsson, A., Williams, H., Wever, R., Gronman, K., Kvalvåg Pettersen, M., Møller, H., & Soukka, R. (2019). Packaging strategies that save food: A research agenda for 2030. Journal of Industrial Ecology.

Wong K and Hernandez A. (2012) A review of Additive Manufacturing, ISRN Mechanical Engineering, vol 2012 (2012) Article ID 208760, 10 pages.

Wu, Y. W., Ji, Y. J., and Gu, F. (2023) Identifying firm-specific technology opportunities in a supply chain: Link prediction analysis in multilayer networks
Expert Systems with Applications, 213 (2023), Article 119053.

Xiao, X., He, Q., Li, Z., Antoce, A. O., & Zhang, X. (2017). Improving traceability and transparency of table grapes cold chain logistics by integrating WSN and correlation analysis. Food Control, 73(Part B), 1556-1563. doi: https://doi.org/10.1016/j.foodcont.2016.11.019.

Xiao, X., Qi, L., Fu, Z., Zhang, X. 2013). Monitoring method for cold chain logistics of table grape based on compressive sensing
Transactions of the Chinese Society of Agricultural Engineering, 29 (22) (2013), pp. 259-266

Yang, J., Zhang, W., and Zhao, X. (2024) How can suppliers strategically involve downstream manufacturers in research and development collaboration? A knowledge spillover perspective European Journal of Operational Research, 314 (1) (2024), pp. 122-135.

Zhang, G., and Zhao, Z. (2012). Green Packaging Management of Logistics Enterprises. Physics Procedia, vol 24, part B, 2012, pp 900-905.

Zhang, M., Wang, L., Wang, Q., Chen, D., & Liang, X. (2024). The environmental and socioeconomic benefits of optimized fertilization for greenhouse vegetables. Science of the Total Environment, 908, 168252. doi:10.1016/j.scitotenv.2023.168252.

Zhang, R., Wang, M., Zhu, T., Wan, Z., Chen, X., Xiao, X. (2024). Wireless charging flexible in-situ optical sensing for food monitoring. Chemical Engineering Journal, 488, 150808. doi: https://doi.org/10.1016/j.cej.2024.150808.

Zhang, Y; Huo, J. (2023). Foreign experience and China's path in Food waste governance. J. Hefei Univ. Technol (Soc.Sci ed) 37, 112-119.
Zhao, X., & Manning, L. (2019). Food plate waste: Factors influencing insinuated intention in a university food service setting. British Food Journal, 121(7), 1536-1549.

References cited in Chapter 3.

Abbasi, M. and Nilsson, F. (2012) 'Themes and challenges in making supply chains environmentally sustainable'. Supply Chain Management: An International Journal, 17 (5). pp517-530. Doi:10.1108/13598541211258582.

Accorsi, R., A. Cascini, S. Cholette, R. Manzini, and C. Mora. 2014. "Economic and Environmental Assessment of Reusable Plastic containers: A food catering supply chain study. International Journal of Production Economics. Vol 152, Pp 88-101. https://doi.org/10.1016/j.ijpe.2013.12.014.

Accorsi, R and Manzini, R, (2019). Sustainable Food Supply Chains: Planning, design, and control through interdisciplinary methodologies. https://doi.org/10.1016/C2016-0-05053-2

Acedo, F.J; Barroso, C. and Galan, J.L. (2006) 'The resource-based theory: dissemination and main trends. Strategic Management Journal, 27 (7). pp621-636.

Astill, J.; Dara, R.A.; Campbell, M.; Farber, J.M.; Fraser, E.D.G.; Sharif, S.; Yada, R.Y. Transparency in food supply chains: A review of enabling technology solutions. Trends Food Sci. Technol. 2019, 91, 240–247.

Ackroyd, S. (2014) 'Methodology for management and organisation studies: some implications for critical realism'. In: Fleetwood, S., Ackroyd., S. Critical Realist Applications in Organisation and Management Studies. London: Routledge. pp127- 150.

Adamides, E.D., Papachristos, G. & Pomonis, N., (2021) 'Critical realism in supply chain research: Understanding the dynamics of a seasonal goods supply chain'. International Journal of Physical Distribution and Logistics Management, 42 (10). pp906-930.

Ageron, B., Lavastre, O. and Spallanzani, A. (2013) 'Innovative supply chain practices: the state of French companies. Supply Chain Management: An International Journal, 18 (2). pp265-276.

Akhtar, P., Tse, Y.K., Khan, Z., Rao-Nicholson, R., 2016. Data-driven and adaptive leadership contributing to sustainability: global agri-food supply chains connected with emerging markets. Int. J. Prod. Econ. 181, 392–401

Albizzati, P.F., Tonini, D., Chammard, C.B., Astrup, T.F., 2019. Valorisation of surplus food in the French retail sector: environmental and economic impacts. Waste Manag. 90, 141–151. https://doi.org/10.1016/j.wasman.2019.04.034. Alfaro, J., Miller, S., 2014. Applying industrial symbiosis to smallholder farms. J. Ind. Ecol. 18 (1), 145–154. https://doi.org/10.1111/jiec.12077.

Amicarelli, V., Bux, C., Lagioia, G., 2020. How to measure food loss and waste? A material flow analysis application. Br. Food J. https://doi.org/10.1108/bfj-03-2020-0241.

Andersson, C., Stage, J., 2018. Direct and indirect effects of waste management policies on household waste behaviour: the case of Sweden. Waste Manag. 76, 19–27. https://doi.org/10.1016/j.wasman.2018.03.038.

Amit, R. and Schoemaker, P.J.H. (1993) “Strategic assets and organisational rents”. Strategic Management Journal, 14 (1). pp33-46

Antoniou, N., Monlau, F., Sambusiti, C., Ficara, E., Barakat, A., Zabaniotou, A., 2019. Contribution to Circular Economy options of mixed agricultural wastes management: coupling anaerobic digestion with gasification for enhanced energy and material.

Aschemann-Witzel, J., Ares, G., Thogersen, J., Monteleone, E., 2019a. A sense of sustainability? - how sensory consumer science can contribute to sustainable development of the food sector. Trends Food Sci. Technol. 90, 180–186. https://doi. org/10.1016/j.tifs.2019.02.021.

Atasoy, M., Eyice, O., Cetecioglu, Z., 2020. A comprehensive study of volatile fatty acids production from batch reactor to anaerobic sequencing batch reactor by using cheese processing wastewater. Bioresour. Technol. 311 https://doi.org/10.1016/j. biortech.2020.123529.

Awasthi, S.K., Sarsaiya, S., Awasthi, M.K., Liu, T., Zhao, J., Kumar, S., Zhang, Z., 2020. Changes in global trends in food waste composting: research challenges and opportunities.

Bahn, R.A.; Yehya, A.A.K.; Zurayk, R. Digitalization for Sustainable Agri-Food Systems: Potential, Status, and Risks for the MENA Region. Sustainability 2021, 13, 3223.

Bech-Larsen, T. 1996. “Danish Consumers’ Attitudes to the Functional and Environmental Characteristics of Food Packaging.” Journal of Consumer Policy 19 (3): 339–363. doi:10.1007/BF00411413.

Bhattacharya, A., and Fayezi, S (2021) Ameliorating food loss and waste in the supply chain through multi-stakeholder collaboration. Ind Market. Management, 93(2021), pp. 328-343.

Bioresour. Technol. 299, 122555. https://doi.org/10.1016/j. biortech.2019.122555. Baj˘zelj, B., Richards, K.S., Allwood, J.M., Smith, P., Dennis, J.S., Curmi, E., Gilligan, C.A., 2014. Importance of food-demand management for climate mitigation. Nat. Clim. Change 4 (10), 924–929.

Brown, D. 1993. “Plastics Packaging of Food Products: The Environmental Dimension.” Trends in Food Science & Technology 4 (9): 294–300. doi:10.1016/0924-2244(93)90073-J.

Carter, C. R., and L. M. Ellram. 1998. “Reverse Logistics: A Review of the Literature and Framework for Future Investigation.” Journal of Business Logistics 19:85–102.

Chaabane, A., A. Ramudhin, and M. Paquet. 2011. “Designing Supply Chains with Sustainability Considerations.” Production Planning & Control 22 (8): 727–741. doi:10.1080/09537287.2010.543554.

Canali M, Amani P, Aramyan L, Gheoldus M, Moates G, Östergren K, Silvennoinen K, Waldron K, Vittuari M (2016) Food waste drivers in Europe, from identification to possible interventions. Sustainability 9(1):37. https://doi.org/10.3390/su9010037

Corrado, S., Sala, S., 2018. Food waste accounting along global and European food supply chains: state of the art and outlook. Waste Manag. 79, 120–131. https://doi. org/10.1016/j.wasman.2018.07.032.

Carroll, A.B. (1979) ‘A three-dimensional conceptual model or corporate performance’. The Academy of Management Review, 4 (4). pp497-505.

Carroll, A.B. (1999) ‘Corporate Social Responsibility: evolution of definitional construct’. Business Society, 38 (3). pp268-295.

Carter, C.R. & Ellram, L.M. 2020 ‘Reverse logistics: a review of the literature and framework for future investigation’. Journal of Business Logistics, 19 (1). pp85-102.

Chakrabarty, S. and Wang, L. (2019) ‘The long-term sustenance of sustainability practices in MNCs: A dynamic capabilities perspective of the role of R&D and Internationalization’. Journal of Business Ethics, 110 (2). pp205-217.

Chen, C. (2011) ‘Design for the environment: a quality-based model for green product development’. Management Science, 4 (2). pp250-263.

COP26 (2021) Five big supermarkets to halve environmental impact of weekly food shop by 2030. https://news.sky.com/story/cop26

Cu´ellar, A.D., Webber, M.E., 2010. Wasted food, wasted energy: the embedded energy in food waste in the United Kingdom. Environ. Sci. Technol. 44 (16), 6464–6469. https:// doi.org/10.1021/es100310d. Davis, J., 2011.

Defra, 2022. UK horticulture statistics. Available online a. https://www.gov.uk/government/statistics/latest-horticulture-statistics. (Accessed 18 September 2023).

Diabat, A., and K. Govindan. 2011. “An Analysis of the Drivers Affecting the Implementation of Green Supply Chain Management.” Resources, Conservation and Recycling 55 (6): 659–667. doi:10.1016/j.resconrec. 2010.12.002

Dora, M.; Biswas, S.; Choudhary, S.; Nayak, R.; Irani, Z. (2022) A system-wide interdisciplinary conceptual framework for food loss and waste mitigation strategies in the supply chain. Ind. Mark. Manag. 2021, 93, 492–508.

Dora M, Wesana J, Gellynck X, Seth N, Dey B, De Steur H (2020) Importance of sustainable operations in food loss: evidence from the UK food processing industry. Ann Oper Res 290:47–72. https://doi.org/10.1007/s10479-019-03134-0

Echebarria, C., Barrutia, J.M., Eletxigerra, A., Hartmann, P. and Apolaza, V. (2017) ‘Local sustainability processes worldwide: a systematic review of the literature and research agenda’. Journal of Environmental Planning and Management. pp1-29.

Emissions of greenhouse gases from production of horticultural products: analysis of 17 products cultivated in Sweden. SIK Institutet for ¨ livsmedel och bioteknik, ISBN 978-91-7290-301-2. Defra, 2022. UK horticulture statistics. Available online a. https://www.gov.uk/government/statistics/latest-horticulture-statistics. (Accessed 18 September 2023).

Eriksson, M., Strid, I., Hansson, P.A., 2015. Carbon footprint of food waste management options in the waste hierarchy–a Swedish case study. J. Clean. Prod. 93, 115–125. https://doi.org/10.1016/j.jclepro.2015.01.026.

Edwards, P.K., O'Mahoney, J. and Vincent, S. (2020) Studying organizations using critical realism: a practical guide. Oxford: Oxford Scholarship.

Ehrgott, M., Reimann, F., Kaufmann, L. and Carter, C.R. (2011) 'Social sustainability in selecting emerging economy suppliers' Journal of Business Ethics, 99 (1). pp98-119.

Eisenhardt, K.M. (1989) "Making fast strategic decisions in high velocity environments". Academy of Management Journal, 32 (3). pp543-576.

Eisenhardt, K.M. and Martin, J.A. (2000) 'Dynamic capabilities: what are they?' Strategic Management Journal, 21 (10-11). pp1105-1121.

Fan, Y., de Kleuver, C., de Leeuw, S., Behdani, B., 2021. Trading off cost, emission, and quality in cold chain design: a simulation approach. 158, 107442 https://doi.org/10.1016/j.cie.2021.107442.

FAO (Food and Agriculture Organization of the United Nations). Global Food Losses and Food Waste: Extent, Causes and Prevention; FAO: Rome, Italy, 2011.

FAO G (2011) Global food losses and food waste–extent, causes and prevention. Save FOOD: Initiative Food Loss Waste Reduction 9:2011. FAOSTAT F (2020) Agriculture organization of the United Nations— statistics division. Available online: http://faostat3.fao.org/ browse/Q/QC.E. Accessed 18 Feb 2020.

Food and Agriculture Organization of the United Nations (2009) Declaration of the World Food Summit on Food Security. FAO, Rome

Foster, A., Evans, J., 2023. Projecting the carbon emissions from refrigeration used in the UK food industry to 2050. In: ICR2023 26th International Congress of Refrigeration. https://doi.org/10.18462/iir.icr.2023.0151, 10.18462/iir.

Gabler, C.B., Panagopoulos, N., Vlachos, P.A., Rapp, A., 2017. Developing an environmentally sustainable business plan: an international B2C case study. Corp. Soc. Responsib. Environ. Manag. 24 (4), 261–272.

Gbrich, C. (2007) Analysing Qualitative Data. Sage: London Gebauer, H. (2011) "Exploring the contribution of management innovation to the evolution of dynamic capabilities" Industrial Marketing Management, 40 (8). pp1238-1250.

Gimenez, C. and Tachizawa, E.M. (2012) 'Extending sustainability to suppliers: a systematic literature review'. Supply Chain Management: An International Journal, 17 (5). pp531-543.

Gitton, M., (2025) The European Commission's Strategic Priorities for 2025: Between Ambition and Structural Challenges. Available at https://buymeacoffee.com/euroscope

Global Food Security (GFS) (2010) 'Developing countries face a greater threat'. Available at http://www.foodsecurity.ac.uk/blog/2010/02/developing-countries-face-a-greater threat/ [Accessed 5th July 2016] Global Food Security (GFS) (2012).

Global food systems and UK food imports: resilience, security and safety. Available at http://www.foodsecurity.ac.uk/assets/pdfs/gfs-and uk-food-imports.pdf [Accessed 29th June 2016] Goffin, K, Lemke, F. and

Szwejczewki, M. (2006) "An 'exploratory' study of close supplier-manufacturer relationships". Journal of Operations Management, 24 (2). pp189-209.

Gislam, S. (2022) Plastic packaging increases pollution and food waste, research find. Industry Europe. www.industryeurope.com

Gold, S., Seuring, S. and Beske, P. (2010) 'Sustainable supply chain management and inter organisational resources: A literature review'. Corporate Social Responsibility and Environmental Management, 17 (4). pp230-245.

Golicic, S. and Smith, C.D. (2013) 'A meta-analysis of environmentally sustainable supply chain management practices and firm performance'. Journal of Supply Chain Management, 49 (2). pp 78-95.

Herszenhorn E, Quested T, Easteal S, Prowse G, Lomax J, Bucatariu C (2014) Prevention and reduction of food and drink waste in businesses and households-guidance for governments, local authorities, businesses and other organizations. U Nation Environ Program.

Hussain SM, Hussain K, Malik AA, Hussaini AM, Farwah S, Rashid M, Ahmad R (2021) Development of a novel in-vitro protocol for micro propagation of tomato male sterile line (Shalimar FMS-1) of Kashmir Valley India. Acta Sci Agric 5(4)

Hart, S.L. (1995) 'A natural-resourced-based view of the firm'. Academy of Management Review, 20 (4). Pp986-1014.

Hart, S.L. (1997) 'Beyond greening: strategies for a sustainable world. Harvard Business Review, 75 (1). Pp 68-75.

Hart, S.L. (2011) 'The clean tech economy at the base of the pyramid'. Harvard Business Review, May 31st [online] available at https://hbr.org/2011/05/how-to-save-the-us clean-tech.html [accessed].

Hart, S.L. and Dowell, G. (2011) 'A natural-resource-based view of the firm: fifteen years after'. Journal of Management, 37 (5). pp1464-1479.

Jeswani HK, Figueroa-Torres G, Azapagic A (2021) The extent of food waste generation in the UK and its environmental impacts. Sustain Prod Consum 26:532–547. https://doi.org/10.1016/j.spc. 2020.12.021.

Jiménez LM, Pérez-Vidal A, Torres-Lozada P (2022) Research trends and strategies for the improvement of anaerobic digestion of food waste in psychrophilic temperatures conditions. Heliyon 11174. https://doi.org/10.1016/j.heliyon.2022.e11174.

Jin, Q., Yang, L., Poe, N., Huang, H., 2018. Integrated processing of plant-derived waste to produce value-added products based on the biorefinery concept. Trends Food Sci. Technol. 74, 119–131. https://doi.org/10.1016/j.tifs.2018.02.014.

Johansson, N., Corvellec, H., 2018. Waste policies gone soft: an analysis of European and Swedish waste prevention plans. Waste Manag. 77, 322–332. https://doi.org/

Johnson LK, Dunning RD, Bloom JD, Gunter CC, Boyette MD, Creamer NG (2018) Estimating on-farm food loss at the field level: a methodology and applied case study on a North Carolina farm. Resour Conserv Recycl 137.

Kayikci Y, Demir S, Mangla SK, Subramanian N, Koc B (2022) Data driven optimal dynamic pricing strategy for reducing perishable food waste at retailers. J Clean P.

Kopyto, M., Lechler, S., von der Gracht, H.A., Hartmann, E., 2020. Potentials of blockchain technology in supply chain management: long-term judgments of an international expert panel. Technol. Forecast. Soc. Change 161, 120330. https://doi. org/10.1016/j.techfore.2020.120330.

Kosseva MR (2020) Sources, characteristics and treatment of plant-based food waste. In: Food Industry Wastes. Academic Press, pp 37–66 https://doi.org/10.1016/B978-0-12-817121-9.00003-6

Kour R, Singh S, Sharma HB, Naik TS, Shehata N, Pavithra N, Ali W, Kapoor D, Dhanjal DS, Singh J, Khan AH (2023) Persistence and remote sensing of agri-food wastes in the environment: current state and perspectives. Chemosphere 14:137822. https://doi.org/ 10.1016/j.chemosphere.2023.137822

Krishnan, R., Agarwal, R., Bajada, C., Arshinder, K., 2020. Redesigning a food supply chain for environmental sustainability – an analysis of resource use and recovery. J. Clean. Prod. 242, 118374 https://doi.org/10.1016/j.jclepro.2019.118374.

Kumar, A., Mangla, S.K., Kumar, P., Karamperidis, S., 2020. Challenges in perishable food supply chains for sustainability management: a developing economy perspective. Bus. Strateg. Environ. 29, 1809–1831. https://doi.org/10.1002/ bse.2470.

Kummu M, De Moel H, Porkka M, Siebert S, Varis O, Ward PJ (2012) Lost food, wasted resources: global food supply chain losses and their impacts on freshwater, cropland, and fertiliser use. Sci Total Environ 438:477–489. https://doi.org/10.1016/j.scitotenv.2012. 08.09.

Lewis, H. 2005. “Defining Product Stewardship and Sustainability in the Australian Packaging Industry.” Environmental Science & Policy 8 (1): 45–55. doi: 10.1016/j.envsci.2004.09.002.

Leon-Bravo, V. Caniato, F., (2024) Sustainability performance measurement in the food supply cain: Trade-offs, institutional pressures, and contextual factors. The European Management Journal. Vol 42, Issue 4. Pp 633-646 https://doi.org/10.1016/j.emj.2023.04.004

Lebersorger S, Schneider F (2014) Food loss rates at the food retail, influencing factors and reasons as a basis for waste prevention measures. Waste Manag 34(11):1911–9. https://doi.org/ 10.1016/j.wasman.2014.06.013

Manning L, Soon JM (2016) Food safety, food fraud, and food defence: a fast-evolving literature. J Food Sci 81(4):R823–R834. https:// doi.org/10.1111/1750-3841.13256

Marshall, D., L. McCarthy, C. Heavey, and P. McGrath. 2015. “Environmental and Social Supply Chain Management Sustainability Practices: construct Development and Measurement.” Production Planning & Control 26 (8): 673–690. doi:10.1080/09537287.2014. 963726.

Markley, M.J. and Davis, L. 2007. 'Exploring Future Competitive Advantage Through Sustainable Supply Chain Management'. International Journal of Physical Distribution and Logistics Management, 37 (9). pp763-774.

Matzembacher, D., Vieira, L., de-Barcellos, M, (2021). An analysis of multi-stakeholder initiatives to reduce food loss and waste in an emerging country-Brazil. Ind. Market. Management., 93 (2021), pp. 591-604.

Meikle, J. 1995. American Plastic: A Cultural History. New Brunswick: Rutgers University Press.

Mena, C.; Adenso-Diaz, B.; Yurt, O. (2018) The causes of food waste in the supplier–retailer interface: Evidences from the UK and Spain. Resour. Conserv. Recycl. 2011, 55, 648–658.

Mena C, Terry LA, Williams A, Ellram L (2014) Causes of waste across multi-tier supply networks: cases in the UK food sector. Int J Prod Econ 152:144–158. https://doi.org/10.1016/j.ijpe. 2014.03.012.

Mollaoglu. M, Okur, I, Gurturk, M. Doganer, B. (2024) Review on sustainable Development goals in maritime transportation: current research trends, applications, and future research opportunities. Environmental Science and pollution Research 32(4); 1-18. Doi:101007/s11356-023-31622-1

Muth, M.K., Birney, C., Cu´ellar, A., Finn, S.M., Freeman, M., Galloway, J.N., Zoubek, S., 2019. A systems approach to assessing environmental and economic effects of food loss and waste interventions in the United States. Sci. Total Environ. 685, 1240–1254. https://doi.org/10.1016/j.scitotenv.2019.06.230.

Newsome R, Balestrini CG, Baum MD, Corby J, Fisher W, Goodburn K, Labuza TP, Prince G, Thesmar HS, Yiannas F (2014) Applications and perceptions of date labelling of food. Compr Rev Food Sci Food Saf 13(4):745–769. https://doi.org/10.1111/ 1541-4337.12086.

Nicastro R, Carillo P (2021) Food loss and waste prevention strategies from farm to fork. Sustainability 13(10):5443. https://doi.org/ 10.3390/su13105443.

Ng, H.S., Kee, P.E., Yim, H.S., Chen, P.T., Wei, Y.H., Chi-Wei Lan, J., 2020. Recent advances on the sustainable approaches for conversion and reutilization of food wastes to valuable bioproducts. Bioresour. Technol. 302, 122889. https://doi.org/ 10.1016/j.biortech.2020.122889.

Ng, K.S., Yang, A., Yakovleva, N., 2019. Sustainable waste management through synergistic utilisation of commercial and domestic organic waste for efficient resource recovery and valorisation in the UK. J. Clean. Prod. 227, 248–262.

O'Hara, M., Mioduszewska, B., Yohanna, M. R., Haryoko, T., Rachmatika, R., Prawiradilaga, D.M., Huber, L., Auersperg, A.M.I., (2021). Wild Goffin's Cockatoos flexibility manufacture and use tool set. Current Biology. Vol. 31, Issue 20. Pgs. 4512 – 4520.e6 https://doi.org/10.1016/j.cub.2021.08.009

Omolayo, Y., Feingold, B.J., Neff, R.A., Romeiko, X.X., 2021. Life cycle assessment of food loss and waste in the food supply chain. Resour. Conserv. Recycl. 164 https:// doi.org/10.1016/j.resconrec.2020.105119.

Office of Environmental Protection, (OEP). The Environmental Act (2021). Environmental Legislation UK- What you need to know. https://www.sweep.net/bolg/environmental-legislation-uk-whatyou-need-to-know#:~

Papargyropoulou, E.; Lozano, R.; Steinberger, J.K.; Wright, N.; bin Ujang, Z. The food waste hierarchy as a framework for the management of food surplus and food waste. J. Clean. Prod. 2014, 76, 106–115

Pohlen, T. L., and M. T. Farris. 1992. "Reverse Logistics in Plastics Recycling." International Journal of Physical Distribution & Logistics Management 22 (7): 35–47. doi:10.1108/09600039210022051.

Porter, S.D., Reay, D.S., Higgins, P., Bomberg, E., 2016. A half-century of production phase greenhouse gas emissions from food loss and waste in the global food supply chain. Sci. Total Environ. 571, 721–729. https://doi.org/10.1016/j. scitotenv.2016.07.041

Prajogo, D. and Sohal, A. 2013. 'Supply Chain Professionals: A Study of Competencies, Use of Technologies and Future Challenges'. International Journal of Operations and Production Management, 33 (11/12). pp1532-1554

Priefer C, Jörissen J, Bräutigam KR (2016) Food waste prevention in Europe–a cause-driven approach to identify the most relevant leverage points for action. Resour Conserv Recycl 109:155–165. https://doi.org/10.1016/j.resconrec.2016.03.004

Roper, S., and C. Parker. 2006. "How (and Where) the Mighty Have Fallen: branded Litter." Journal of Marketing Management 22 (5–6): 473–487. doi:10.1362/026725706777978659.

Roy, R., and R. C. Whelan. 1992. "Successful Recycling through ValueChain Collaboration." Long Range Planning 25 (4): 62–71. doi:10.1016/ 0024-6301(92)90009-Q.

Shi, V.G.. Koh, L., Baldwin, J. and Cucchiella, F. 2012. 'Natural Resource Based Green Supply Chain Management' Supply Chain Management: An International Journal, 17 (1), pp54-67.

Srivastava, A. and Thomson, B.S. 2009. 'Framework Analysis: A Qualitative Methodology for Applied Research'. Journal of Administration & Governance, 4 (2). pp71-79.

Srivastava, P. and Hart, S.L. 1995. 'Creating Sustainable Corporations'. Business Strategy and the environment, 4. pp154-165.

Song, M., Cen, L., Zheng, Z., Fisher, R., Liang, X., Wang, Y. and Huisingh, D. 2015. 'Improving Natural Resource Management and Human Health to Ensure Sustainable Societal Development Based Upon Insights Gained from Working Within Big Data Environments'. Journal of Cleaner Production, 94. pp1-4

Statistica., 2022. Retail sales volume of potatoes in Great Britain. Available online at. https://www.statista.com/statistics/410340/potatoes-retail-sales-volume-great-brita in-uk-by-type/. (Accessed 21 June 2022).

Teigiserova DA, Hamelin L, Thomsen M (2020) Towards transparent valorisation of food surplus, waste and loss: clarifying defnitions, food waste hierarchy, and role in the circular economy. Sci Total Environ 706:136033. https://doi.org/10.1016/j.scito tenv.2019.136033

Terry, L.A., Mena, C., Williams, A., Jenney, N., Whitehead, P., 2011. Fruit and Vegetable Resource Maps: Mapping Fruit and Vegetable Waste through the Wholesale Supply Chain. WRAP, RC008.

Terry, L.A., Medina, A., Foukaraki, S., Whitehead, P., 2013. Review of factors affecting fruit and vegetable demand. Defra Final Report FO0438 96.

Trotter, P.A., Becker, T., Renaldi, R., Wang, X., Khosla, R., Walther, G., 2023. The role of supply chains for the sustainability transformation of global food systems: a large scale, systematic review of food cold chains. J. Ind. Econ. 27 (6), 1429–1446. https://doi.org/10.1111/jiec.13445.

Truffer, B., Rohracher, H., Kivimaa, P., Raven, R., Alkemade, F., Carvalho, L. and Feola, G., 2022. A perspective on the future of sustainability transitions research. Environmental Innovation and Societal Transitions, 42, pp.331-339.

United Nations System High Level Task Force on Global Food Security (2021) Food and nutrition security: comprehensive framework for action. Summary of the Updated Comprehensive Framework for Action (UCFA

Vachon, S., and R. D. Klassen. 2008. "Environmental Management and Manufacturing Performance: The Role of Collaboration in the Supply Chain." International Journal of Production Economics 111 (2): 299–315. doi: 10.1016/j.ijpe.2006.11.030.

Vagsholm I, Arzoomand NS, Boqvist S (2020) Food security, safety, and sustainability—getting the trade-off right. Front Sustain Food Syst 4:16. https://doi.org/10.3389/fsufs.2020.00016.

Verghese, K., and H. Lewis. 2007. "Environmental Innovation in Industrial Packaging: A Supply Chain Approach." International Journal of Production Research 45 (18–19): 4381–4401. doi:10.1080/00207 540701450211.

Waitt G, Phillips C (2016) Food waste and domestic refrigeration: a visceral and material approach. Soc Cult Geogr 17(3):359–379. https://doi.org/10.1080/14649365.2015.1075580

Wikstrom, F., H. Williams, K. Verghese, and S. Clune. 2014. "The Influence of Packaging Attributes on Consumer Behaviour in Food-Packaging Life Cycle Assessment Studies – A Neglected Topic." Journal of Cleaner Production 73:100–108. doi:10.1016/j.jclepro.2013.10.042

Williams, H., and F. Wikstrom. 2010. "Environmental Impact of Packaging and Food Losses in a Life Cycle Perspective: A Comparative Analysis of Five Food Items." Journal of Cleaner Production 19 (1): 43–48.

WRAP (2013) The impact of Love Food Hate Waste. Household food waste prevention case study: West London Waste Authority in partnership with Recycle for London. http://www.wrap.org.uk/sites/fles/wrap/West%20London%20LFHW%20Impact%20case%20study_0.pdf

WRAP (2022) Some plastic packaging can increase food waste. https://packagingeurope.com/news/wrap-some-plastic-packaging-can-increase-food-waste/7926.article#:~:text=Marcus%20Grover%2CEO%20of%20WRAP,food%20wate

Xueyan, Y. A. O. 2015. “Research on Green Strategies for Packaging Design.

Xu, X., Gou, X., Zhang, W., Zhao, Y., Xu, Z., 2023. A bibliometric analysis of carbon neutrality: research hotspots and future directions. Heliyon 9 (8), e18763. https://doi.org/10.1016/j.heliyon.2023.e18763.

Zailani, S., K. Jeyaraman, G. Vengadasan, and R. Premkumar. 2012. “Sustainable Supply Chain Management (SSCM) in Malaysia: A Survey.” International Journal of Production Economics 140 (1): 330–340. doi:10.1016/j.ijpe.2012.02.008.

Zhang, G., and Z. Zhao. 2012. “Green Packaging Management of Logistics Enterprises.” Physics Procedia 24:900–905. doi:10.1016/ j.phpro.2012.02.135

Zhang, A., Alvi, M.F., Gong, Y. and Wang, J.X., 2022. Overcoming barriers to supply chain decarbonization: Case studies of first movers. Resources, Conservation and Recycling, 186, p.106536. https://doi.org/10.1016/j.resconrec.2022.106536

Zhu, Z., Chu, F., Dolgui, A., Chu, C., Zhou, W., Piramuthu, S., 2018. Recent advances and opportunities in sustainable food supply chain: a model-oriented review. Int. J. Prod. Res. 56 (17), 5700–5722. https://doi.org/10.1080/00207543.2018.1425014.

Knowledge Center., (2024). Sustainable Supply Chain: Definition, Components, and Benefits - Inbound Logistics. https://www.inboundlogistics.com/article/sustainable-supply-chain/

References cited in Chapter 4.

Acar Y, Gardner ES Jr. (2012) Forecasting method selection in a global supply chain. Int J Forecast. 2012;28(4):842–8. https://doi.org/10.1016/j.iijforecast.2011.11,003

Akkas, Arzum., and Honhon, Dorothee. (2021). Shipment Policies for Products with Fixed Shelf lives: Impact on Profits and Waste. Manufacturing & Services Operations Management. Doi: 10.1287/msom.2021.1018

Amorim, P., Günther, H.-O., Almada-Lobo, B., 2012. Multi-objective integrated production and distribution planning of perishable products. Int. J. Prod. Econ. 138 (1), 89–101. DoI: 10.1007/s11750-012-0266-4

Amorim, P., Meyr, H., Almeder, C., Almada-Lobo, B., 2013. Managing perishability in production-distribution planning: a discussion and review. Flex. Serv. Manuf. J. 25, 389–413. DoI:10.1007/s10696-011-9122-3.

Alvarez, A., Cordeau, J.-F., Jans, R., Munari, P., Morabito, R., 2020. Formulations, branch-and-cut and a hybrid heuristic algorithm for an inventory routing problem with perishable products. Eur. J. Oper. Res. vol 283 (2), 511–529. https://doi.org/10.1016/j.ejor.2019.11.015

Aydinel, M., Sowlati, T. Cerda, X. Cope, E. Gerschman, M. (2008). Optimization of production allocation and transportation of customer orders for a leading forest products company. Mathematical and Computer Modelling. Vol. 48. Issues 7-8. Pgs. 1158-1169. https://doi.org/10.1016/j.mcm.2007.12.025

Azadivar, F., & Wang, J. (2000). Facility layout optimization using simulation and genetic algorithms. International Journal of Production Research, 38(17), 4369-4383. https://dx.doi.org/10.1080/00207540050205154.

Bellemare, M.G. Dabney, W. Munos, R. (2017). A distributional Perspective on Reinforcement Learning. Machine learning. https://doi.org/10.48550/arXiv.1707.06887

Beske-Janssen, Philip., Johnson, Thomas, Constant, Francois Constant. Wieland Andreas Wieland. (2022). New competences enhancing procurement's contribution to Innovation and sustainability. Journal of Purchasing and supply management. Vol 29, Issue 3, https://doi.org/10.1016/j.pursup.2023.100847

Berlin, D., Feldmann, A., Nuur, C., 2022. The relatedness of open-and closed-loop supply chains in the context of the circular economy; framing a continuum. Cleaner Logistics and Supply Chain 4, 100048. Doi:10.1016/j.clscn.2022.100048.

Bhatia, M.S & Gangwani, K. K (2021). Green supply chain management: Scientometric review and analysis of empirical research. Journal of cleaner production, 284, 124722. https://doi.org/10.1016/j.jclepro.2020.124722

Biuki, M., Kazemi, A., Alinezhad, A., (2020). An integrated location-routing-inventory model for sustainable design of a perishable products supply chain network. J. Clean. Prod. 260, 120842.

Bonyadi, M., Esmaeilzadeh, F. Mowla, D. Nematollahi, M. (2014). Theoretical and experimental determination of initial reservoir fluid in a lean gas condenser reservoir. Journal

of Petroleum Science and Engineering. Vol. 114 Pgs. 74 81. https://doi.org/10.1016/j.petrol.2014.01.003

Branco, M. C., and L. L. Rodrigues. (2006). "Corporate Social Responsibility and Resource-based Perspectives." Journal of Business Ethics 69 (2): 111–132. https://doi.org/10.1007/s10551-006-9071-z

British retail consortium (2022). Reducing waste in the UK by halve in 2030. https://brc.org,uk/climate-roadmap.

Carter, C., and Roger, D. (2018). A framework of sustainable supply chain management: Moving Toward New Theory. International journal of physical distribution & logistics management. Vol. 38(5) Pgs. 360-387. Doi:10.1108/09600030810882816

Chaabane, A., A. Ramudhin, and M. Paquet. 2011. "Designing Supply Chains with Sustainability Considerations." Production Planning & Control 22 (8): 727–741. doi:10.1080/09537287.2010.543554

Cherrafi, A., S. Elfezazi, J. A. Garza-Reyes, K. Benhida, and A. Mokhlis. 2017. "Barriers in Green Lean Implementation: A Combined Systematic Literature Review and Interpretive Structural Modelling Approach." Production Planning & Control 28 (10): 829–842. doi:10.1080/09537287.2017.1324184

Christmann, P. (2000). Effects of "best practices" of environmental management on cost advantage: The role of complementary assets. Academy of Management Journal, 43: 663-680.

Clark, G. 2000. Developing better systems for communications: environmental best practice in small business. In Small and Medium-Sized Enterprises and the Environment, edited by R. Hillary. Sheffield, England: Greenleaf.

Crossan, M.M., and Apaydin. (2010) A Multi-Dimensional Framework of Organisational Innovation: A Systematic Review of the Literature. Journal of Management Studies. Vol. 47, issue 6. Pp. 1154-1191. https://doi.org/10.iiii/j.1467-6486.2009.00880.x

Dantas, H. T. A. (2024). The influence of shelf life on the integrated production scheduling and vehicle routing optimization for perishable products. https://doi.org/10.1504/EJIE.2024.141732.

Darnall, N., G. J. Jolley, and R. Handfield. 2008. "Environmental Management Systems and Green Supply Chain Management: complements for Sustainability." Business Strategy and the Environment 17 (1): 30–45. doi:10.1002/bse.557

Daroudi, S., Kazemipoor, H., Najafi, E., Fallah, M., 2021. The minimum latency in location routing fuzzy inventory problem for perishable multi-product materials. Appl. Soft Comput. 110, 107543.

Dehbari, S., Pourrousta, A., Nezhad, S., Tavakkoli-Moghaddam, R., Javanshir, H., 2012. A new supply chain management method with one-way time window: A hybrid PSOSA approach. Int. J. Ind. Eng. Comput. 3 (2), 241–252.

DeHoratius, N.; Raman, A. (2008). Inventory record inaccuracy: An empirical analysis. Manag. Sci. 2008, 54, 627–641. Doi:10.1287/mnsc.1070.0789.

Devapriya, P., Ferrell, W., Geismar, N., 2017. Integrated production and distribution scheduling with a perishable product. Eur. J. Oper. Res. 259 (3), 906–916.

Diabat, A., and K. Govindan. 2011. "An Analysis of the Drivers Affecting the Implementation of Green Supply Chain Management." Resources, Conservation and Recycling 55 (6): 659–667. Doi: 10.1016/j.resconrec. 2010.12.00.

Eriksson, L., (2015) social Norms Theory and Development Economics. World Bank Policy Research Working Paper No. 7450. 45 pages.

Eriksson, M., Strid, I., Hansson, P.-A., 2016. Food waste reduction in supermarkets – net costs and benefits of reduced storage temperature. Resour. Conserv. Recycl. 107, 73–81. https://doi.org/10.1016/j.resconrec.2015.11.022.

Etzion, D. 2007. Research on organizations and the natural environment, 1992-present: A review. Journal of Management, 33: 637-664. Vol 33. Issue 4. https://doi.org/10.1177/0149206307302553.

Eurostat, 2024, Food waste- European Commission. https://food.ec.europa.eu.

Eyo-Udo. N., (2024) Leveraging artificial intelligent for enhanced supply chain optimisation, Open Access research journal of multidisciplinary studies. 2024;7(2):001-15. https://doi.org/10.53022/oarjms.2024.7.2.0044

FAO (2018). Key facts on food loss and waste you should know. Retrieved from http//www.fao.org/save-food/resources/keyfindings/en/.

FAO (2019) The State of Food and Agriculture 2019. Moving forward on food loss and waste reduction. Licence: CC BY-NC-SA 3.0 IGO. Available at: https://www.fao.org/3/ca6030en/ca6030en.pdf (accessed 26 October 2023).

FAO (2022) Tackling food loss and waste: A triple win opportunity. Available at: https://www.fao.org/newsroom/detail/FAO-UNEP-agriculture-environment-food-loss-waste-day-2022/en (accessed 22 October 2023).

Fiol, C. M. 2001. Revisiting an identity-based view of sustainable competitive advantage. Journal of Management, 27: 691-699. https://doi.org/10.1016/S0149-2063(01)00119.2

Fowler, S. J., & Hope, C. 2007. Incorporating sustainable business practices into company strategy. Business Strategy and the Environment, 16: 26-38. Doi:10.1002/bse.462.

Garcia-Garcia, G., Stone, J., & Rahimifard, S. (2019). Opportunities for waste valorisation in the food industry – A case study with four UK food manufacturers. Journal of Cleaner Production, 211, 1339–1356. https://doi.org/10.1016/j.jclepro.2018.11.269.

Garza-Reyes, J. A., B. Villarreal, V. Kumar, and P. Molina Ruiz. 2016. "Lean and Green in the Transport and Logistics Sector – A Case Study of Simultaneous Deployment." Production Planning & Control 27 (15): 1221–1232. doi:10.1080/09537287.2016.1197436.

Gayam, S.R. Yellu, R.R, Thuniki, P. (2021). Optimising supply chain management through artificial intelligence: techniques for predictive maintenance, demand forecasting, and inventory optimisation. Journal of AI-Assisted Scientific Discovery. Mar4;1(1);129-44.

Ghisellini, P., Cialani, C., & Ulgiati, S. (2016). A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems. Journal of Cleaner Production, 114, 11–32. https://doi.org/10.1016/j.jclepro.2015.09.007.

Gobel Christine, Betz Alexandra et al., (2015) Food waste in the Swiss food service industry – Magnitude and potential for reduction. Waste Management. https://www.elsevier.com/locate/wasman.

Golicic, S. and Smith, C.D. (2013) 'A meta-analysis of environmentally sustainable supply chain management practices and firm performance'. Journal of Supply Chain Management, 49 (2). pp 78-95.

Govindan, K. (2018). Sustainable consumption and production in the food supply chain: A conceptual framework. International Journal of Production Economics, 195, 419–431. https://doi.org/10.1016/j.ijpe.2017.03.003

Guo L, Wang Y, Kong D, Zhang Z, Yang Y. (2019) Decisions on spare parts allocation for repairable isolated system with dependent backorders. Comput Ind Eng. 2019;127:8–20. https://doi.org/10.1016/j.cie.2018.11.042.

Hall, J. 2000. "Environmental Supply Chain Dynamics." Journal of Cleaner Production 8 (6): 455–471. doi:10.1016/S0959-6526(00)00013-5.

H'Mida S. (2009) Factors contributing in the formation of consumers' environmental consciousness and shaping green purchasing decisions. In: Proceedings of the international conference on computers & industrial engineering; 2009. p. 957–62. Doi:10.1109/ICCIE.2009.5223972.

Handfield, R. B., S. A. Melnyk, R. J. Calantone, and S. Curkovic. 2001. "Integrating Environmental Concerns into the Design Process: The Difference between Theory and Practice." IEEE Transactions on Engineering Management 48 (2): 189–208. doi:10.1109/17.922478.

Hart, S.L. and Dowell, G. (2011) 'A natural-resource-based view of the firm: fifteen years after'. Journal of Management, 37 (5). Vol 37 No. 5 (2011) pp1464-1479. Doi: 10.1177/0149206310390219

Hart, S. L. 1995. "A Natural-resource-based View of the Firm." Academy of Management Review 20 (4): 986–1014. https://doi.org/10.2307/258963.

Hart, S.L. (1997) 'Beyond greening: strategies for a sustainable world. Harvard Business Review, 75 (1). Pp 66-76. https://hbsp.harvard.edu

Hart, S.L. (2011) 'The clean tech economy at the base of the pyramid'. Harvard Business Review, May 31st [online] available at https://hbr.org/2011/05/how-to-save-the-usclean-tech.html [accessed 4]

Hartikainen Hanna, Mogensen Lisbeth, Svanes Erik, Frake Ulrika. (2017). Food waste qualification in primary production – The Nordic countries as a case study. https://doi.org/10.1016/j.wasman2017.10.026.

Hermsdorf D, Rombach M and Bitsch V (2017) Food waste reduction practices in German food retail. British Food Journal 119: 2532–2546. https://doi.org/10.1108/BFJ-06-2017-0338.

Hitt, M.A., Xu, K. and Carnes, C.M. (2015) 'Resource based theory in operations management research'. Journal of Operations Management, 41. pp77-94.

Hu, S. J., Ko, J., Weyand, L., El Maraghy, H. A., Lien, T. K., Koren, Y., & Shpitalni, M. (2011). Assembly system design and operations for product variety. CIRP Annals-Manufacturing Technology, 60(2), 715-733.

Hsu, C. C., K. C. Tan, S. H. M. Zailani, and V. Jayaraman. 2013. "Supply Chain Drivers That Foster the Development of Green Initiatives in an Emerging Economy." International Journal of Operations & Production Management 33 (6): 656–688. doi:10.1108/IJOPM-10-2011-0401

Irian V. Petrunina, Nataliya Gorbunova, Allexander N. Zakharov. (2024) Assessment of causes and consequences of food and agric raw material loss & opportunity for reduction 126, 42 -53. Doi:10.21323/2414-438X-2023-8-1-51-61.

Ishangulyyev R, Kim S and Lee SH (2019) Understanding food loss and waste—Why are we losing and wasting food? Foods 8: 297. Doi: 10.3390/foods8080297

Jabbour, C. J., A. L. Mauricio, and A. B. L. D. S. Jabbour. 2017. "Critical Success Factors and Green Supply Chain Management Proactivity: Shedding Light on the Human Aspects of This Relationship Based on Cases from the Brazilian Industry." Production Planning & Control 28 (6–8): 671–683. doi:10.1080/09537287.2017.1309705.

Jakowska-Suwalska, K., & Wolny, M. (2009). The problem of the distribution of workstations as a multi-criteria decision problem. 49, 1-10. https://dx.doi.org/10.2478/emj-2018-0018.

Janssens K, Lambrechts W, van Osch A, et al. (2019) How consumer behaviour in daily food provisioning affects food waste at household level in The Netherlands. Foods 8: 428.

Jeswani, K Harish, Figueroa-Torres, Gonzalo, Azapagic, Adisa (2020). The extent of food waste generation in the UK and Its environmental Impact. Journal of sustainable production and consumption. 12. 021. https://doi.org/10.1016/j.spc.2020.12.021.

John, B., & Jenson, J. E. (2019). Analysis and simulation of factory layout using ARENA. International Journal of Scientific and Research Publications, 3(2), 1-8. ISSN 2250-3153.

Kauppi, K. (2013) 'Extending the use of institutional theory in operations and supply chain management research'. International Journal of Operations and Production Management, 33 (10). pp1318-1345. https://dx.doi.org/10.1108/IJOPM-10-2011-0364.

Kiaghadi, M & Hoseinpour, P., (2023). University Admission Process: A Prescriptive Analytics Approach. Artificial Intelligence Review 56(4): 1 – 24. Doi:10.1007/s10462-022-10171-y

Kikolski, M. (2018). Reorganizacja układu hali produkcyjnej za pomocą metody SLP [Reorganization of the production hall layout using the SLP method]. In R. Knosala (Ed.),

Innowacje w zarządzaniu i inżynierii produkcji. Tom II [Innovations in management and production engineering. Volume II], (pp. 536-544).

Kivimaa, P., & Kern, F. (2016). Creative destruction or mere niche support? Innovation policy mixes for sustainability transitions. Research Policy, 45(1), 205–217. https://doi.org/10.1016/j.respol.2015.09.008.

Koberg, E., Longoni, A., 2019. A systematic review of sustainable supply chain management in global supply chains. J. Clean. Prod. 207, 1084–1098. https://doi.org/10.1016/j.jclepro.2018.10.033.

Koester U and Galaktioniva E (2020) FAO Food Loss Index methodology and policy implications. Studies in Agricultural Economics 123: 1–7. Doi:10.7896/j.2093

Kumar, A., Mangla, S. K., Kumar, P., & Karamperidis, S. (2020). Challenges in perishable food supply chains for sustainability management: A developing economy perspective. Business Strategy and the Environment, 29(5), 1809–1831. https://doi.org/10.1002/bse.2470.

Kumar, M., Kumar, D., 2023. An integrated closed loop returnable transport for perishable products in a green inventory routing system using heterogeneous vehicles and uncertainty in to and from supply. Internat. J. Log. Syst. Manage. 44 (2), 147–178. https://www.inderscience.com/link.php?d=129013.

Kumar S, and Malegeant P. (2006). Strategic alliance in a closed-loop supply chain, a case of manufacturer and eco-non-profit organization. Tech novation 2006;26(10):1127–35. https://doi.org/10.1016/j.technovation.2005.08.002

Kumar, V., D. Holt, A. Ghobadian, and J. A. Garza-Reyes. 2015. "Developing Green Supply Chain Management Taxonomy-Based Decision Support System." International Journal of Production Research 53 (21): 6372–6389. doi:10.1080/00207543.2014.917215.

Krishnan, R., Agarwal, R., Bajada, C., & Arshinder, K. (2020). Redesigning a food supply chain for environmental sustainability – An analysis of resource use and recovery. Journal of Cleaner Production, 242, 118374. https://doi.org/10.1016/j.jclepro.2019.118374.

Kristensen, H. S., & Mosgaard, M. A. (2020). A review of micro level indicators for a circular economy – moving away from the three dimensions of sustainability? Journal of Cleaner Production, 243, 118531. https://doi.org/10.1016/j.jclepro.2019.118531.

Lai, K. H., and C. W. Y. Wong. 2012. "Green Logistics Management and Performance: Some Empirical Evidence from Chinese Manufacturing Exporters." Omega 40 (3): 267–282. doi: 10.1016/j.omega.2011.07.002.

Lee, V. H., K. B. Ooi, A. Y. L. Chong, and B. Lin. 2015. "A Structural Analysis of Greening the Supplier, Environmental Performance and Competitive Advantage." Production Planning & Control 26 (2): 116–130. doi:10.1080/09537287.2013.859324.

Lejarza, F., Baldea, M., 2022. An efficient optimization framework for tracking multiple quality attributes in supply chains of perishable products. Eur. J. Oper. Res. 297 (3), 890–903.

Li, B., Liu, K., Chen, Q., Lau, Y.-Y., Dulebenets, M.A., 2023. A Necessity-Based Optimization Approach for Closed-Loop Logistics Considering Carbon Emission Penalties and Rewards under Uncertainty. Mathematics 11 (21), 4516.

Liu, G. (2014). Food Losses and Food Waste in China: A First Estimate. OECD Food, Agriculture and Fisheries Papers, 66, 1-29. https://doi.org/10.1787/5jz5sq5173lq-en.

Liu, W., Yer, J. Jagermeyr, C. Muller, S. Chen, X. Liu and Shi, P (2021). Future climate significantly alters interannual wheat yield variability over half of harvest area. *Environ. Res. Lett,* 16, no. 9, 094045, doi: 1088/1748-9326/ac1fbb.

Maineri T, Barnett EG, Valdero TR, Unipan JB, Oskamp S. (1997). Green buying: the influence of environmental concern on consumer behavior. J Soc Psychol 1997;137(2):189–204. https://doi.org/10.1080/00224549709595430.

Marshall, D., L. McCarthy, C. Heavey, and P. McGrath. 2015. "Environmental and Social Supply Chain Management Sustainability Practices: construct Development and Measurement." Production Planning & Control 26 (8): 673–690. doi:10.1080/09537287.2014. 963726.

Martin, C.H., Dent, D.C., Eckhart, J.C., 1993. Integrated production, distribution, and inventory planning at Libbey-Owens-Ford. Interfaces 23 (3), 68–78. https://doi.org/10.1287/inte.23.3.68.

Martdianty, F., Coetzer, A., & Susomrith, P. (2020). Job embeddedness of manufacturing SME employees in Indonesia. Employee Relations, 42(1), 180–193. https://doi.org/10.1108/ER01-2019-008.

Mariana, Y., Wijaya, F., Dwinandana, T. A., (2023) Design of Workstation for Remote Workers with Work Environment Consideratio. IOp Conf. Series: Earth and Environmental Science. 1169 (2023) 012061 Doi:10.1088/1755-1315/1169/012061.

Mastos, T.; Gotzamani, K. Sustainable Supply Chain Management in the Food Industry: A Conceptual Model from a Literature Review and a Case Study. Foods 2022, 11, 2295. https://doi.org/10.3390/foods11152295.

Matuszek, J., & Kurczyk, D. (2017). Projektowanie procesów i systemów produkcyjnych z wykorzystaniem technologii komputerowej wirtualizacji [Designing processes and production systems using computer virtualization technology], 2(12), 741-752.

Mazzucchelli, A., Gurioli, M., Graziano, D., Quacquarelli, B., & Aouina-Mejri, C. (2021). How to fight against food waste in the digital era: Key factors for a successful food sharing platform. Journal of Business Research, 124, 47–58. https://doi.org/10.1016/j.jbusres.2020.11.055

Menguc, B., & Ozanne, L. K. (2005). Challenges of the "green imperative": A natural resource-34 based approach to the environmental orientation-business performance relationship. Journal of Business Research, 58(4), 430–438. https://doi.org/10.1016/j.jbusres.2003.09.002.

Messner, R., Johnson, H., & Richards, C. (2021). From surplus-to-waste: A study of systemic overproduction, surplus and food waste in horticultural supply chains. Journal of Cleaner Production, 278, 123952. https://doi.org/10.1016/j.jclepro.2020.123952.

Mithun Ali, Syed, Moktadir Abdul Golam Kabir, Jewel Chakma, Jalal Uddin Rumi and Tawhidul Islam. (2019) Framework for evaluating risk in food supply chain; Implication in food waste reduction. Journal of cleaner production pp 786-800. https://doi.org/10.1016/j.jclepro.2019.04.322.

Mohebalizadehgashti F, Zolfagharinia H, Amin SH. Designing a green meat supply chain network: a multi-objective approach. Int J Prod Econ. 2020; 219:312–27. https://doi.org/10.1016/j.ijpe.2019.07.007.

Muthukalyani, A.R. (2023). Unlocking Accurate Demand Forecasting in Retail Supply Chains with AI-driven Predictive Analytics. Information Technology Management. 2023;14(2):48-57. https://iaeme.com/Home/issue/IJITMIS?Volume=14&Issue=2.

Navazi, F., Sazvar, Z., Tavakkoli-Moghaddam, R., 2021. A sustainable closed-loop location-routing-inventory problem for perishable products. Scientia Iranica. Doi:10.24200/sci.2021.55642.4353.

Nayeri, S., Paydar, M.M., Asadi-Gangraj, E., Emami, S., 2020. Multi-objective fuzzy robust optimization approach to sustainable closed-loop supply chain network design. Comput. Ind. Eng. 148, 106716.

Nimmagadda, V.S. (2021) Artificial Intelligence for Real-Time Logistics and Transportation Optimisation in Retail Supply Chains: Techniques, Models, and Applications. Journal of Machine Learning for Healthcare Decision Support. Jun8;1(1):88-126.

Omega 82, 193–204. Rafie-Majd, Z., Pasandideh, S.H.R., Naderi, B., 2018. Modelling and solving the integrated inventory-location-routing problem in a multi-period and multiperishable product supply chain with uncertainty: Lagrangian relaxation algorithm. Comput. Chem. Eng. 109, 9–22.

Papargyropoulou E, Lozano RK, Steinberger J, et al. (2014) The food waste hierarchy as a framework for the management of food surplus and food waste. Journal of Cleaner Production 76: 106–115. https://doi.org/10.1016/j.jclepro.2014.04.020

Patton, M. Q. 2002. Qualitative Research and Evaluation Methods. Thousand Oaks, CA: Sage Publications. Vol. 4 No. 3A https://collegepublishing.sagepub.com.

Piskrzyńska, K., & Cieślar, S. (2015). The Efficiency in Microenterprises Versus the Organization of Working Time. Forum Scientiae Oeconomia, 3(4), 79-89. https://ojs.wsb.edu.pl/index.php/fso/article/view/247.

Pratap, S., Jauhar, S.K., Paul, S.K., Zhou, F., 2022. Stochastic optimization approach for green routing and planning in perishable food production. J. Clean. Prod. 333, 130063. https://doi.org/10.1016/j.jclepro.2021.130063.

Qiu, Y., Qiao, J., Pardalos, P.M., 2019. Optimal production, replenishment, delivery, routing and inventory management policies for products with perishable inventory. Vol 82 Pp 193-204. https://doi.org/10.1016/j.omega.2018.01.006.

Otles S, Despoudi S, Bucatariu C, et al. (2015) Chapter 1 – Food waste management, valorisation, and sustainability in the food industry. In: Galanakis CMBT-FWR (ed.) Food Waste Recovery. San Diego: Academic Press, pp. 3–23. https://doi.org/10.1016/B978-0-12-800351-0.00001-8.

Raak, N., Symmank, C. Zahn, S. Aschemann-Witzel, Jessica. (2017). Processing and Product-Related Causes for Food Waste and Implications for the Food Supply Chain. Waste Management Vol. 61. Pgs. 461-472. Doi:10.1016/j.wasman.2016.12.027

Rafie-Majd, Z., Pasandideh, S.H.R., Naderi, B., 2018. Modelling and solving the integrated inventory-location-routing problem in a multi-period and multi-perishable product supply chain with uncertainty: Lagrangian relaxation algorithm. Comput. Chem. Eng. 109, 9–22. https://doi.org/10.1016/j.compchemeng.2017.10.013.

Rajabion Lila, Khorraminia Marieh, Andjomshoaa & Ghafouri-Azar Mona. A new model for assessing the impact of business processes on the success of green supply chain mgt syst. Jour of retailg & cus services. 2019. https://www.elsevier.com/locate/jretconser.

Rao P, Holt D. Do green supply chains lead to competitiveness and economic performance? Int J Oper Prod Manag 2005;25(9):898–916. Doi:10.1108/01443570510613956.

Rodger JA. Application of a fuzzy feasibility Bayesian probabilistic estimation of supply chain backorder aging, unfilled backorders, and customer wait time using stochastic simulation with Markov blankets. Expert System Appl. 2014;41(16):7005–222.

Rong, A., Akkerman, R., Grunow, M., 2011. An optimization approach for managing fresh food quality throughout the supply chain. Int. J. Prod. Econ. 131 (1), 421–429. https://doi.org/10.1016/j.ijpe.2009.11.026.

Saeed, M.A.; Kersten, W. Drivers of sustainable supply chain management: Identification and classification. Sustainability 2019, 11, 1137. https://doi.org/10.3390/su11041137.

Saunders, M., Lewis, P. and Thornhill, A. (2012) 'Research Methods for Business Students'. 6th ed, Harlow, England: Pearson

Simchi-Levi D, Kaminsky P, Simchi-Levi E, Shankar R. (2008). Designing and managing the supply chain: concepts, strategies and case studies. New York: Tata McGraw-Hill Education; 2008. Doi:10.1002/j.2158-1592.2001.tb00165.x

Starman, A. B. (2013). The case study as a type of qualitative research. Journal of Contemporary Educational Studies, 64(1), 28–43. https://www.researchgate.net/publication/265682891.

Thi, N. B. D., Kumar, G., & Lin, C. Y. (2015). An overview of food waste management in developing countries: Current status and future perspective. Journal of Environmental Management, 157, 220–229. https://doi.org/10.1016/j.jenvman.2015.04.022.

Thomas, D.J., Griffin, P.M., 1996. Coordinated supply chain management. Eur. J. Oper. Res. 94 (1), 1–15. www.d1wqtxts1xzle7.cloudfront.net.

Tseng, M. L., K. H. Tan, M. Lim, R. J. Lin, and Y. Geng. 2014. “Benchmarking Eco-Efficiency in Green Supply Chain Practices in Uncertainty.” Production Planning & Control 25 (13–14): 1079–1090. doi:10.1080/09537287.2013.808837

Tu, H., Pang, M., Xu, M., Chen, L., Dong, T., 2024. Time-based multiple pricing policy in a supply Chain with perishable products under bilateral asymmetric information. J. Indust. Manage. Optim. Doi: 10.3934/Jimo.2024052.

Vachon S, Klassen RD. (2008) Extending green practices across the supply chain: the impact of upstream and downstream integration. Int J Oper Prod Manag 2006;26(7):795–821. Doi:10.1108/01443570610672248.

Vergara, H. A., & Kim, D. S. (2009). A new method for the placement of buffers in serial production lines. International Journal of Production Research, 47(16), 4437-4456. https://doi.org/10.1080/00207540801939022.

Vijayamohan, P. (2025) Inductive research? A simple guide in 2025. Content marketer of SurveySparrow. surveysparrow.com

Vilariño, M. V., Franco, C., & Quarrington, C. (2017). Food loss and waste reduction as an integral part of a circular economy. Frontiers in Environmental Science, 5, 21. https://doi.org/10.3389/fenvs.2017.0002.

Violi, A., De Maio, A., Fattoruso, G., 2024. Inventory management and delivery of perishable products with stochastic demands and risks consideration. Procedia Comput. Sci. 232, 2941–2949. https://creativecommons.org/licences/by-nc-nd/4.0.

Wan X, Sanders NR. The negative impact of product variety: forecast bias, inventory levels, and the role of vertical integration. Int J Prod Econ. 2017;186. https://doi.org/10.1016/j.iijpe.2017.02.002

Wan X, Britto R, Zhou Z. In search of the negative relationship between product variety and inventory turnover. Int J Prod Econ. 2019. https://doi.org/10.1016/j.ijpe.2019.09.024.

Wang, C.-N.; Nguyen, N.-A.-T.; Dang, T.-T. Solving order planning problem using a heuristic approach: The case in a building material distributor. Appl. Sci. 2020, 10, 8959. https://doi.org/10.3390/app10248959.

Wang, G., 2024. Order assignment and two-stage integrated scheduling in fruit and vegetable supply chains. Omega 124, 103013. https://doi.org/10.1016/J.omega.2023.103013.

Wang, Y., Zhang, C., Li, M., 2018. Application of a hybrid algorithm–PSOSA in well test parameter estimation. Petroleum 4 (4), 430–436. https://doi.org/10.1016/J.petlm.2017.09.007.

World Bank (2020). Addressing Food Loss and Waste: A Global Problem with Local Solutions. Retrieved from https://openknowledge.worldbank.org/bitstream/handle/10986/34521/Addressing-FoodLoss-and-Waste-A-Global-Problem-with-LocalSolutions.pdf?sequence=1&isAllowed=y/. Accessed December 23, 202

Walker, H., L. Di Sisto, and D. McBain. 2012. “Drivers and Barriers to Environmental Supply Chain Management Practices: lessons from the Public and Private Sectors.” Journal of Purchasing and Supply Management 14 (1): 69–85. doi: 10.1016/j.pursup.2008.01.00.

WRAP (2023). The waste and resources action programme. Food waste in the UK https://www.wrap.ngo/report/foodwaste.

WRAP. (2024). The waste and resources action programme. Food waste in the UK report to the UK Parliament. https://researchbrifings.files.parliament.uk.

Wllett, W. Rockstrom, J. Loken, B. Springmann, M. Long, T. Vermeulen, S. Gornett, T. Tilman, D. DeClerck, F. Wood, A Jonell, M., (2019) Food in Anthropocene: the EAT-Lancet Commission on health diets from sustainable food systems. The Lancet, 393 (10170) (2019) pp 447-492. Doi: 10.1016/S0140-6736(18)31788-4

Xue, W.; Caliskan Demirag, O.; Chen, F.; Yang, Y. Managing retail shelf and backroom inventories when demand depends on the shelf-stock level. Prod. Oper. Manag. 2017, 26, 1685–1704.

Yang, Ying, Hattie Barnes, Biao yang, George, Onofrei & Hung Nguyen (2023). Food Management for the Uk grocery retail sector- Supply Chain Collaboratory Perspective. Production Planning & control journal 8, 1096. https://doi.org/10.1080/09537287.2023.2226622.

Yu L, Duan Y, Fan T. Innovation performance of new products in China’s high-technology industry. Int J Prod Econ. 2020;219:204–15

Yu, W., R. Chavez, and M. Feng. 2017. “Green Supply Management and Performance: A Resource-Based View.” Production Planning & Control 28 (6–8): 659–670. doi:10.1080/09537287.2017.1309708.

Zhang, V. I., T. Ursacki, and P. Nemetz. 1999. “Can China Be a Clean tiger? Growth Strategies and Environmental Realities?” Pacific Affairs 72 (1): 23–37. doi:10.2307/2672334.

Zhang, Y., Chu, F., Che, A., Li, Y., 2024. Closed-loop inventory routing problem for perishable food with returnable transport items selection. Int. J. Prod. Res. 62 (1–2), 501–521.

Zhu, Q., J. Sarkis, and Y. Geng. 2005. “Green Supply Chain Management in China: Pressures, Practices and Performance.” International Journal of Operations & Production Management 25 (5): 449–468. doi:10.1108/ 01443570510593148

Zhu, Q., Y. Tian, and J. Sarkis. 2012. “Diffusion of Selected Green Supply Chain Management Practices: An Assessment of Enterprises.” Production Planning & Control 23 (10–11): 837–850. doi:10.1080/ 09537287.2011.642188.

Zwierzyński, P. (2018). [Seru production as a Japanese form of cell production]. In R. Knosala (Ed.), [Innovations in management and production engineering. Volume I], (pp. 530-537). https://doi.org/10.1016/J.promfg.2017.02.093

References cited in Chapter 5

Chakrabarty, S. and Wang, L. (2019) 'The long-term sustenance of sustainability practices in MNCs: A dynamic capabilities perspective of the role of R&D and Internationalization'. Journal of Business Ethics, 110 (2). pp205-217.

Golicic, S. and Smith, C.D. (2013) 'A meta-analysis of environmentally sustainable supply chain management practices and firm performance'. Journal of Supply Chain Management, 49 (2). pp 78-95. Doi:10.1111/iscm.12006

Grant, R.M. (1991). The resource-Based Theory of Competitive Advantage: Implication for Strategy Formulation. California Management Review vol. 33, issue 3 https://doi.org/10.2307/41166664

Hart, S.L. (1995) 'A natural-resourced-based view of the firm'. Academy of Management Review, 20 (4). Pp986-1014. https://doi.org/10.2307/258963

Hart, S.L. (1997) 'Beyond greening: strategies for a sustainable world. Harvard Business Review, 75 (1). Pp 66-76. https://hbsp.harvard.edu

Hart, S.L. and Dowell, G. (2011) 'A natural-resource-based view of the firm: fifteen years after'. Journal of Management, 37 (5). pp1464-1479. https://doi.org/10.1177/0149206310390219

Kusumowardani, N., Tjahjono, B.,Lazell., J., Bek, D., Theodorakopoulos, N.,Andrikopoulos, P., Priadi, C R. (2022) The circular capability Framework to Address Food Waste and losses in the Agri-Food Supply Chain. The Antecedents, Principles and Outcome of Circular Economy. Journal of Business Research. https://doi.org/10.1016/j.jbusres.2021.12.020

Li, B., Liu, K., Chen, Q., Lau, Y.-Y., Dulebenets, M.A., 2023. A Necessity-Based Optimization Approach for Closed-Loop Logistics Considering Carbon Emission Penalties and Rewards under Uncertainty. Mathematics 11 (21), 4516.

Marucci, G., Tonanzi,D., Interisano, M., Vatta,p. (2022) the International Trichinella Reference Centre database. Report on thirty-three years of activity and future perspectives. Food and waterborne parasitology https://doi.org/10.1016/j/fawpar.2022.e00156

Mishra, R K., Naik, K R., Raut, R D., Paul, S M. (2021) Circular Economy Principle in Community Energy Initiatives through Stakeholders Perspectives. Sustainable Production and Consumption vol 33 pp 256-270 https://doi.org/10.1016/j.spc.2022.07.001

Rodrigues, V. S., Demir E., Wang X., Sarkis, J. (2021) Measurement, Mitigation and prevention of food waste in supply chains: An online shopping perspective. Industrial Marketing Management vol 93, pp 545 – 562 https://doi.org/10.1016/j.indmarman.2010.09.020

Russo, M.V, and Fouts, P.A. (1997). A Resource-Based Perspective on Corporate Environmental Performance and Profitability. Academy of Management Journal. Vol40. No. 3 Pp 534-559 https://doi.org/10.2307/257052

Saeed, M.A.; Kersten, W. Drivers of sustainable supply chain management: Identification and classification. Sustainability 2019, 11, 1137. https://doi.org/10.3390/su11041137.

Saruchera, F., and Asante-Darko, D. (2021) Reverse Logistics, Organisational Culture and Firm Operational Performance: Some Empirical Evidence. (2021). Business Strategy & Development vol 4, issue 3 pp 326-342 htpps://doi.org/10.1002/bsd2.161

Shi, V.G.. Koh, L., Baldwin, J. and Cucchiella, F. 2012. 'Natural Resource Based Green Supply Chain Management' Supply Chain Management: An International Journal, 17 (1), pp54-67 Doi:10.5121/ijmvsc.2012.3101

Vachon S, Klassen RD. (2008) Extending green practices across the supply chain: the impact of upstream and downstream integration. Int J Oper Prod Manag 2006;26(7):795–821. Doi:10.1108/01443570610672248.

Zaid, A.A. Jaaron, A.M. Bon, A.T. (2018) The Impact of Green Human Resource Management and Green Supply Chain Management Practices on Sustainable Performance: An Empirical Study. Journal of Cleaner Production vol. 204 Pp 965-979. https://doi.org/10.1016/j.jclepro.2018.09.062

Zhu, Z., Chu, F., Dolgui, A., Chu, C., Zhou, W., Piramuthu, S., 2018. Recent advances and opportunities in sustainable food supply chain: a model-oriented review. Int. J. Prod. Res. 56 (17), 5700–5722. https://doi.org/10.1080/00207543.2018.1425014.

Appendix:

Appendix A. Interview Questions for Supermarket, Warehouse and Supplier Managers

Interview Topics	Interview Questions
Opening	1. Can you tell me a bit about your site/store. • When did it become operational? • How many employees do you have? • How many stores/customers (weekly) do you serve? • Averagely, how many cases are assembled daily/ what is the stores weekly sales
Packaging	1. What do you think about the quality of packaging of products that are picked/sold in this warehouse/store? 2. Is anything done about poor packaging i.e. is there a process of reporting and how often does suppliers respond to the issues of poor packaging? 3. To what extent has your company adopt the use of smart packaging. Any advantage of using this type of packaging?
Inventory Management/ Layout/ Stores Layout	1. What are the biggest inventory management challenges the site/store is facing and what is currently being done about them? 2. What inventory management system (IMS) is currently being used to reduce waste at your site/store? 3. What level of inventory (SKU's) are kept at your site/store? 4. How has the use of AI-driven inventory control and predictive analytics enhanced your decision-making and optimize operations 5. Is the warehouse/store layout designed to adapt to the future storage/customer requirement? What problem do you envisage if this is not so and how would it affect productivity and FLW?
Logistical process	6. How are left off cages/pallets or unsold stock at the warehouse/store dealt with? 7. How does late or missed stock delivery to the warehouse/store affect availability product life? 8. How often do suppliers/warehouse deliver to the warehouse/store? 9. Is there a process in place for damage products? 10. Does this company practice reverse logistics and if so, what is involved?
Logistical Efficiency	11. Most of the reported bad stacking and Pyramid picking experienced in the warehouse are mainly from new workers, what do you think could be done to improve this? 12. New workers have often been given performance targets. Do you think new workers should be allowed enough time to

	perfect their stacking before considering their performance and why? 13. How important is the job of trainers in preventing waste i.e. product, time? 14. How often do the workers get retrained on the job and has that helped in improving performance, adherence to Health and Safety measures, and reducing waste?
Roll Cages	15. Making sure the roll Cages are maintained in good shape and regularly replaced makes products more secured and hence enhance reduction of product waste. How often does the warehouse/store do this?
Performance Targets.	16. Do you think that there should be a compromise between the expected level of performance by pickers and reduction of product waste?
Food Redistribution Policy	17. Do you have Food redistribution policy in place and if so, how often are food products redistributed/quarter? What is the average number of food products redistributed compared to the products wasted?

Appendix B. Focus Group Questions.

Number Of participants: 5. Number of Organisations involve: 4

How Long it will go: One hour in total.

How will the findings of the focus group help in the research?

The findings of the focus group would serve as insight of how Perishable food wastes are generated at the floor level and would help determine the interview questions that the researcher would ask the managers. It would also help in research findings, contribution and in the final analysis of the information gathered.

The Focus Group Questions:

1. Are you aware of perishable food losses and waste problem in the supermarket?

2. What proportion of food items do you think are being wasted/ lost during handling / logistics?

3. What do you think, what contributes to the generation of food wastes in the warehouse / supermarket store / logistics processes?

4. Practically, what steps do you think could be taken to reduce it? In short / long term?

5. Who do you think, has greater responsibility to address the food waste problem in the supermarket/ food supply chain and why?

6. How could senior management contribute to addressing this problem?

7. What role do you think pickers could play in addressing the problem of wastes?

8. Why do you think that meeting or surpassing performance target should not be the only concern of peckers but maintaining good stacking?

9. Will your performance (efficiency of picking the item / storing it etc.) get affected if you must pay more attention on reducing food waste. If so, why?

10. Do material handling of perishable products by pickers affect the generation of food waste. Why do you think so and what should be done to reduce the problem?

Appendix C. Categorisation of Coding and Themes.

C1. The Impact of Product Packaging on FLW Reduction

3rd Order Thematic Category	Repackaging of Food Products.			The Impact of Product Design	
2nd Order Code.	Factors Affecting Repackaging	Complaints Reporting	Time Consideration	Environmental Consideration	Cost of Packaging
Firm A	. Repackaging depends on what size of products the automation of each company can accommodate.	. Generation of complaints about poor packaging takes long to compile.	. Time frame to deal with complaints is about 6 months on average.	. Material used in the design of product packaging matters.	. Designing of product package is at a cost.
Firm B	. The brand of the product involved and the redesigning of package is at a cost.	. Identification of products concern on time is important.	. Complaints not usually dealt with because of product brand.	. There is need to find a common ground between materials that less affects the environment and the materials that causes less product waste.	. Designing brings about increase in handling cost to the food retail firm.
Firm C	. The number of organisations requesting for repackaging matters.	. Constant communication between Firms and suppliers is important.	. Complaints about Company's brand of products dealt with promptly	. Materials used by suppliers is based more on cost than the environmental issues.	. The firm always pass the cost of packaging to the retail firms.
Firm D	. Redesigning brings about increase in handling cost	. Poor product package reporting has procedures.	. It takes an average of 5 to 6 months for repackaging to be done	. Firms adopt the use of smart packaging for easy product identification and safety.	. The cost of packaging is always passed to the customers.
Firm E	. The cost of repackaging is always passed to the customers.	. Reporting of bad stocking by the operatives to the line manager is important	. The average time it takes for repackaging affects waste generation	. The environmental impact of food is of utmost important in product packaging design	. Companies are always ready to bear the cost of repackaging their own brand.

C2. The impact of logistical management on FLW

3rd Order Thematic Category	Performance Target and Safety Measures.		Capacity Building and Training of Workers.		
2nd order Code	Performance Target	Equipment Maintenance	Training Needs	Role of Teamwork	Pickers Efficiency
Firm A	. Firms set performance targets for pickers.	. Raw cages design impact food waste generation.	. Training in manual handling of food products with the new Pickers.	. Teamwork by workforce is important to reduce wastes.	. Bad stacking of food products is often experienced in FSC.
Firm B	. There is correlation between performance targets, health & safety, and Food wastes.	. Products are always on motion and could drop off if Raw cages are not maintained.	. Seminar on Health and safety issues done every year and workers are expected to adhere to how they are trained.	. Every worker has role to play to solve the problem of waste.	. Workers turnover impact generation of food waste
Firm C	. Performance target often impacts food waste generation.	. Frequent maintenance of equipment needed to ensure smooth production	Re-training often done when necessary, and constant monitoring of workers needed	. There is need to imbibe waste reduction in firm's values.	. Bad stacking is at a cost and could cause health and safety issues.
Firm D	. Performance target is often set to minimise the cost of running the supply chain.	. Process of reporting bad cages very important.	. Constant communication to know training needs.	. Each worker in the FSC is expected to play his/her role in reducing waste	. Picking of products near the edge of the pallets could impact product wastes.
Firm E	. Not meeting target set could lead to investigation. Workers often cut corners to meet targets.	. Constant maintenance of Automation system needed.	. Adhering to picking damaged products if 80% are sellable as trained could impact waste generation.	Environmental team set up to deliberate on issues of waste and advice managements	. Constant engagement and monitoring by Team managers needed.

C3: Group discussion.

3nd order Code	Operatives	Contribution	
2nd order Code	The Impact of Product Packaging on FLW	Performance Target	Product stacking
Firm D Operatives > 5 yrs Experience.	. Some of the food products are wrapped together with loose or oversized materials which impact FLW	The company are more interested in setting targets for pickers than reducing wastes.	. There is need for more training for new pickers on food products stacking.
Firm D Operatives < 5 yrs Experience.	. We have been experiencing a lot of food wastes because of poor packaging and we have made complaints concerning this to the managers.	. The target set impacts on food waste generation especially with new pickers with less experience.	. Poor product stacking impacts food waste generation especially from new pickers.
Firm E Operatives > 5 yrs Experience	. Majority of the food waste that we have are caused by poor packaging and often time takes time to correct	. The targets set by the firms affects the handling of the food products especially those poorly packaged.	. The period set for initial training of operatives is two weeks which is not enough
Firm E Operatives < 5 yrs Experience	. We often manage to help the firm by making sure that the poor packaged products are handled carefully to prevent spillage	. The experienced pickers generate less product waste despite the pressure to meet set targets	. The worker's turnover is very high which leads to more inexperience pickers and this always impact on product stacking

C4. The Impact of Food Alternative use and In-Store Donation on FLW Reduction

3rd 0rder Thematic Category	Food Alternative Uses		
2nd order Code	Firms' In-Store Distribution Policy	Food other Uses	Government Regulation
Firm A	. Firm often give out food products to food banks.	. Food not fit for consumption diverted as animal feeds.	. There are government regulations that guide food redistribution.
Firm B	. The primary aims are goodwill and food waste reduction	. Fresh food with inherent short lives is diverted for alternative uses.	. Infrastructure and legal issues impact food redistribution
Firm C	. The volume of products given to food banks depends on excess products in stock.	. Adhering to food waste hierarchy that prioritises prevention, distribution, recycling, and recovery, aiming to turn waste into value	. The regulations ensure that firms adhere to specific guidelines. . It is criminal to donate food after its "use-by" date because of safety risk.
Firm D	. Administrative and logistical structure of firm's impact FLW.	. The volume of food products donated impacts FLW.	. Donated food must be kept separate from waste, stored at correct temperature and record of the food kept
Firm E	. Logistical challenges and limited market access.	. The firm use AI-driven tool to adjust prices in real-time based on expiration date	

C5. Impact of Back-Order Rate on FLW

3rd Order Thematic Category	Back-Order rate on FLW	
2nd order Code	The challenge of forecasting customers' demand.	Impact of strategic data on FLW reduction.
Firm A	. Companies often experience back order and Shoppers' trends are weather dependent.	. Communication of food availability to customers.
Firm B	. Unmanaged demands spike leads to backorder and FLW	. Incorporate data trends in purchase of food products.
Firm C	. Tracking seasonal purchase trend to maintain optimal stock level.	. It takes average of 14 to 20 days to fulfil a back order.
Firm D	. Forecasting guide stock level	. Data point includes sales trends, supplier performance, customers behaviour and other external factors
Firm E	. Back order could lead to overstretch of FSC facilities and could impact FLW.	. Companies process and get ready food products in advance of requirements.

C6. The Effect of Inventory Management on FLW

3rd Order Thematic Category	Impact of Inventory Management on FLW	
2nd Order Code	Cohesion between inventory and service level	Management of optimal inventory level
Firm A	. Every Food product has minimum life on issue or receipt that must be stocked managed and processed.	. Optimal inventory level maintained.is a function of the service level.
Firm B	. Minimum life on receipt dictates minimum product shelf life	. There are storage facilities for products that are not directly sent into the system
Firm C	. Keeping stock level above service level results in waste	. Continuous improvement of inventory management is important.
Firm D	. Safety stock of perishable food products is important and firms' policy dictates appropriate level of safety stock.	. The accumulation of food products with short shelf lives contributes to waste and orders for products are based on

Firm E	. Excess Food products in inventory are always difficult to manage.	trends of customers buying behaviour . Backorder reduce inventory record inaccuracy .

C7. Facilities Layout Effect on FLW

3rd Order Thematic Category	Facility Layout impact on FLW	
2nd Order Code	Effective facilities layout allows for optimal utilisation of space.	Facilities Layout and maintenance
Firm A	. Facilities layout helps in compliance of food safety regulation.	. Each facility is unique and different from others.
Firm B	. Optimisation, transportation and pick rates considered in FLW reduction	. Facilities are arranged based on their us stores facilities layout design directly affects the number of food products that could be processed.
Firm C	. Location of similar food products allow for easy customer access.	. Firm's facility layout has direct impact on the volume of product wastes generated based on the maintenance schedule.
Firm D	. Demands for products are sessional and facilities are overstretched in use during this period.	. Cages used in transportations must be maintained to reduce product waste.
Firm E	. Facilities that perform similar functions are located together for easy processing and FLW reduction.	. Firm often resort to increase in pick rate to meet demand from stores as the cost of expansion is very high and needs time to prepare. .

Appendix D. Sample Transcriptions of the Interviews Conducted

1. General Manager of firm D

Question
I don't know if you can start now. Can we start now?

Answer
Yes, I'm ready.

Question
Yeah. So, the first question has to do with the warehouse. Can you tell me a bit about the site when it becomes operational?

Answer
When this site. There's the old build, which is the outbound of DPS unit and inbound, and there's the new build, which is the EPS unit here. So, the old build has been around from the 60s.
And what happened was, there was a project at the time, it was called Three in Seven, and there was a lot of warehouses in this area, sort of the satellite area of London. So, we had Buntingford, we had Harlow way, we had Bingley Road Produce, there were other, we had Pinder Road, we had Holliston, the old building here and there was a couple of others as well. So, what happened was the business consolidated those smaller warehouses, satellite warehouses, into two large distribution centres, one being this depot which took the chill and the produce and the fast ambient and the other being this depot which took the other depot's operation, Bingley Road, Holliston which was all of the old fast ambient. It's quite complicated because we talk a lot about what products we relocated and we put more information in, but also what we did. If you think historically, from a legacy perspective, all of those sites that I spoke about had colleagues working in them that had different terms and conditions and different rates of pay and different bonus structures. So that was all consolidated to say you will be working in this depot and you will all be working under one set of terms and conditions and rate of pay etc. So, it was a really big consolidation piece. That happened 21 years ago. Yeah, that's when I came in here for manufacturing and became, came in as part of the, not design, yeah, the back end of the design of the site. And definitely the start of the control room architecture, that was what I built. So that was 21 years ago.

So, to answer your question,
the site has been running from the 60s, if not before. The new version of the site has been running for 21 years.

Question
Oh, that's good. Thank you, sir. Now, another question. How many employees do you have here in the site?

Answer
At peak, we've got a thousand, if you include drivers.

Yeah, so you've got to think about, reflect up and down, don't we? So, at the minute, our headcount is about 560 cores. That includes all of the peripheral colleagues, and it's about 120

agencies in the warehouse alone. over transport to Win-county, which I'm sure you're aware of. So at the minute we're sat around that 565, 70 core colleagues. Not all of those are in the PIC by the way. That's the overall count, contracts. That's what contracts have got. The agency split is about 21% at the minute, which is probably maybe 19-18 percent. I'm having some, I may be getting a better quality of colleague if I recruit into core at the minute. So, I'm doing a lot of core recruitment and I've currently started a initiative is the right word with the local job centers where they're vetting people for us. We've got two ways of recruiting at the minute. We've got what we're bringing in through the job centers right onto 2G contracts and we've got the agency bringing in as they normally would to get us ready for our significant Christmas numbers. Okay, thank

Question
Now, how many stores do you serve?

Answer
Well, that's a complicated question. That's complicated.

We serve every store indirectly because we're an SSP site. Do you know what that means? Yes, a single stocking point. So, two and a half thousand SKUs in DPS are, we're the only site that stocks them. So, we tranship those out to depot. So, we pick for depot, facing Stoke, Thames-side, Greenford, Stoke, etc. That then goes out, that then gets cross-stocked. So, our food SSPs, that any store that stops them will come from us. But our direct stores, I can't remember the count, I'll need to start with 60.

Question

Okay. So, how many cases are assembled weekly?

Answer

Well, this week, last week and this week is about 2.14 million. Okay. 2.14 million. Okay. Feels like a breeze, doesn't it? Yeah. You know, that's how it should be. And the split on that at the minute is about 1.1 million of those are in EPS unit, 1 million on the day. Christmas this year is looking quite steep, looking like 2.6 million weeks after week. So it depends on the season, the demand from the stores? It does. Okay, so at times the demand dictates the number of pigs' meat that you assemble? Yeah, so we get a forecast. Okay. So we get a budget. Okay. The budget is based on volume. Okay. That's there for the year. Yes. That's reviewed at half-time to say this is how that's looking. Okay. On top of that we get what's called a forecast of the latest view. So, the forecast looks 12 weeks out and every week that can get updated. So, this week, we are looking at 2.16 assembled. Just ask for 20k more for tomorrow's release. And half that's driven by the back-to-school profile. So, you have these bits where you can see what happens with shoppers' trends. So, it's weather dictated in the fast, in the fresh. And we're also a little bit weather dictated. So, you'll start to see people's book buying. Christmas lines are already going through, believe it or not. Our food products are very strong at the minute because there is some promotional activity. Back to school, and we do a lot of event planning, so we're talking a lot about Halloween and bonfire night already. Yeah, I can

see those lines starting to come through. So, the next few weeks, I've got quite a few 2.25 million in there. We have the capacity for 2.25 at the minute, flat. Bit of work to do on the banks. And we're in Christmas ramp up. We're ramping that capacity up over the next 14 weeks, 14 Fridays until Christmas.

Question
Now let's go into packaging. Now what do you think about the quality of packaging of food products that are picked? I'm not that close to it but I know and this might be working in the view of Barry Cummins.

Answer
Some of our packaging causes us accuracy issues because it splits, and we drop it. We have been doing a lot of work with some suppliers, particularly Food Products, around how the packaging, because of the slipping and the falling to bits. So generally, I mean, you've got to think, we hold, what, 12 and a half thousand SKUs here. We're talking about, we've got a problem with more or less than 100 SKUs for packaging. So, I suppose it's only as good as the colleagues' report. So how you would find out about poor packaging, what the colleagues has been telling you, or the fact that you've got a lot of re-coops for that line because there are clearly issues with it. Or people being inquisitive, like the store manager has been, saying, look, this can be a lot better this is causing me issues in repack or whatever, so we've got some live sessions that the store manager has been holding with category supplier managers and certain suppliers to improve their packages. In an effort to reduce waste and improve food package design, suppliers introduced a recyclable pouch as an alternative to larger plastic bowls. However, this lighter-weight solution inadvertently caused new problems: our standard boxes proved unable to handle the altered weight distribution, leading to damage to the fragile fruits it was intended to protect. This attempt to reduce the plastic content in packaging has, unfortunately, resulted in product shrinkage. The prevailing environmental requirement to use less plastic in food packaging is making products inherently less sturdy, creating a dilemma between sustainability goals and product integrity in our supply chain

Question
At times when we discover that suppliers have one or two supermarkets that they supply the same products. Now if the complaint is coming from only one supermarket, how often do they comply or how often do they do something about the packaging? Because they have other supermarkets they are supplying. So, if they are not getting complaints from those people, it's only one supermarket, how often do they attend to you?

Answer
I couldn't answer how often the suppliers are changing, but I know they've been really collaborative with us. So, the last sessions we've had, there's been quite a bit of feedback. We've got some good relationships with some of the suppliers, but category supply managers are also included in that as well. It's not just the depot. So, the main point of contact is the category supply manager. They own the contract. Then we're like caught in the end to end of it, so we would feed back to the category supply manager who sort of agrees with us that there's an issue that needs to be dealt with but is it profitable for business. So, it's not every time accurate? No, no I think I couldn't answer how suppliers respond. I can only tell you that the recent challenges we've had, that we've put out there to certain suppliers, it's gone really well. They have been really collaborative with us. I think it might be worth it if you interview Barry Cummins, the

Store Manager. Barry's been heading that up for me. He used to be a stock team manager. He's the Store manager in Karl's team at the minute. Okay. But he's been heading that up for me. Okay. So, you know, we used to have supplier compliance. We used to have a supplier compliance manager on site. Okay. We don't have that anymore. Yeah. The structure changed. Yeah. So, we've absorbed that into, you know, the operational teams look down through the card we supply managers So I think I can give you some detail I'm going to try this. That's the sort of level of detail we've got into with Products arriving for instance. So, we're quite active. Is it possible for you to have contact with Barry? Barry? Yeah. I'll just set that up.

Question
Now let's go into inventory management. What are the inventory challenges this site is facing.

Answer
Our inventory system is automated, and care has been taken to mark out product as they arrive to the warehouse with the date of arrival and means of identification of the food products using what we call SKU Number you know, put up blue common and then it goes into the system to be picked and sent to stores. You should bear in mind that there are storage facilities for those products that are not directly sent into the system based on immediate demand from the stores.

Question
Now, I'm talking about the expiration dates, you know, all those ones should be taken into consideration, first in, first out, all those ones. So, what are the challenges that we are facing in inventory? Or is it a situation where every product that comes in goes out immediately?

Answer
No it's not. So, the key thing that you need to understand with inventory management is minimum life on issue. Okay. Everything on the site will be within its minimum life on receipt, Now, about the minimum life on issue.
So if something comes in and it's got a minimum life on receipt, i.e., it's going to be out of date on the receipt time if you don't process it and send it to the stores. Okay. Same with minimum life of issue. So, any of that will be stock managed on the receipt. And then there's a piece around managing the minimum life of issue, which you shouldn't have.
So that means when you've got stock in that's just sat there, and it's just not issued. So if it's got a minimum life of issue, we will get that issued out, we'll tell the category supply managers and they will put in dummy orders to get that out there. But the key thing is not receiving anything in the short life. Now, because we're fast ambience, that's usually quite far out. You know, it's not like a fresh demo. I think within that, you have some lines that don't move as expected. So, they cause you stock problems. So, you start to fill parts of your ship group where else up. Because all the products are ship group based, you know, working in EPS picking areas. You know you've got a product type. Well, if those products aren't moving, then you're just going to end up growing your stock and your occupancy will be full. So, my team send regular updates to category supply managers. These are the stocks that aren't moving. And they'll say, well, actually, that's a promo coming up, stop building for that, or thanks for that. We'll man that out, manual orders. So that's the interaction that we have. I suppose there's another piece around anything that goes on red alert there's a quite a high-profile mail that comes out and we have to deal with that straight away by putting it on hold or doing whatever and that does happen.

Question
But is there any challenge that you are facing currently that you know with inventory management?

Answer
We have to manage it 100% and you have to manage it every shift. So as long as you stick to those principles, if you didn't manage your minimum life on receipt and issue, you'd be full of old gear and we have this problem at times. So that's the first point. So, we're not really getting issues always because we manage it that way. I suppose we're getting a few overstocks at the minute because there's a lot of program activity, so it's difficult to work out whether that's because we're stock building for promo or whether actually the category supply managers got a really good margin on buying in bulk and it's forcing it into our warehouse. So, the ordering systems changed, it moved yonder, which means it's much more linked now to what your stock is, as well as what your order is. So, the service level on our poles, so say this morning, 341,000 was the pole. Well, we only purged 4% of that out with no stock. So, we had a 96% service level from this site. That's pretty good. Yes, I know. Yeah. So, the orders have come in and 96% of those we've got the stock for. Yeah, so we're in quite a good place with that. So is there anything you need to be... Are you aware of G-SCOP? G-SCOP? Yeah, Government Code of Practice on the post of buyers. So, we are bound by that. So, any supplier query, we have to deal with very promptly. So, what we can't do is, if we reject a load of products, it's got to be because that load's got a problem on life or it's got a problem in transit to us. What we can't be doing is, I don't know, it falling over on the conveyors and then saying that's a supplier issue, you know, that's not allowed. So, we've got to be very clear on any issues that have to be found out on the inbound bank. So, the product that fall into the hive, the product that got damaged during the operation. That's our loss. Yeah, that's not the supplier's loss. That's our loss. It would be illegal of us to say that was a supplier issue. Because we've already received it and we've not raised queries over it. That's the difference.
Okay, taking it to conservation at times back packaging, will it be ideal to tell them that for this reason you are liable for it?
You need to capture it on receipt or do what we are doing here with this evidence of it in stock. So that's okay with regard to G-Stock because that's a good two-way conversation. But what we can't be doing is pushing costs when it's not clear whether that's us or the supplier. So that has to really be captured at receipt.

Question
Okay. Now what level of inventory are kept at your site?

Answer
2,500 of those products are SSP, 5,800 of those are in EPS unit, the rest is in DPS unit daily and I don't know what case stockholding is? Well, we're picking 2.14 million every week, so you know we've got a stockholding today actually. You want to know the overall, how many cases have you got in this site? I can't give you. I can't see. You'd like to know how many? Yes. Yes. Yes. I've given you the split.

Question
Yes. I would like to know. Thank you, sir.
Answer
Okay. I'm going to go ahead and get it sorted.

Yes. Okay. Yes. 2.7 million cases. Okay. Opening to stock count this morning. 2.72 million. Okay.

Question

Is the warehouse layout designed to adapt to future storage? Again? Is the warehouse layout designed to adapt to future storage? it needs to be the way I'm seeing it because I am envisaging a situation where sales will increase, demand from the stores will increase. Will this be able to accommodate it?

Answer

What makes that confusing is the peak period. So, the Christmas peak this year is 2.6 million. We'll be struggling to do much more than that. But what the business can do with that is move lines into fast ambient, can move that out into a release side. There are other things we can do with reducing our range and increasing our hit rate on our products. So have we got stretch in our capacity?

Yes, we have. Do we need to do things? Yes we do. So I would suggest that Christmas Peak, that the figures they have given us this year is our peak with this footprint. But we could do other things to support. So it's not unusual for sites to have a Christmas relief site where you take out some volume and you pick it and then try to ship it. So that's probably where we need to get to for future increases.

Question So how will it affect your productivity and the food loss and waste?

Answer

What affects that product? The layouts, because we are expecting a lot of SKUs, what affects productivity is if every SKU ordered one, what you need is for good volume across a few numbers of SKUs. So, say this range is too big, and what I mean by that is you could have like tomato ketchup, you can have different sizes of tomato ketchup, you can have different pack sizes, so it's not just the product, right? I've got a pack size of 8, I've got a pack size of 12, I've got a pack size of 24. That's three different product types, where actually maybe you only need one pack size. So the answer to get your productivity moving for the same effort is to reduce your skew count and keep the volume. So what can really affect our efficiencies is low volume equals I'm going to one pick phase picking and then another one picking and another one picking. What you need is to get a higher hit rate from better volume, less skews, yeah, and then you go into the pick phase and you pick in one, two. So that's that.

Question

What about food loss and waste? How will it affect your waste regeneration?

Answer

Well having less SKUs? Yeah. It would be better for us for food waste reduction. Okay. Better for us. If you keep the volume and you have less SKUs, yeah, then that's better. It's better for your efficiency and food waste reduction.

Question

Now, let's talk about the logistical process. How are left-off cages stocked at the warehouse? Left-off cages, how are they stocked? We don't really have left-offs really.

Answer
We had six last night and that was a lot for us. We often have between one or two. So if we've got a store and we've had an issue, so say the transport planning has blown as we would call it, so say they've under planned it and they can't get all those roll cages on and you have say six left off for one store, I'd be doing what's called a milk run, so that is put another journey on, put it on the back of another vehicle that's going near there and get those six in. Okay. The six left off we have this morning which is all for six different stores for six different reasons. Okay. So I'll be waiting for those until the next delivery. Okay. Yeah. So, the food products are slightly different to fresh ones. But I want to know why we've had those six left offs. Because that's unusual for us at that moment which could result in a lot of wastes especially in the stores.

Question
Okay, how does late or missed stock delivery to warehouse affect availability of product life? Late stock?

Question
Yes, how does late or missed stock delivery to the warehouse affect availability of product and also generate food wastes.

Answer
Well, we are slow and fast ambience so it's partly not as important for us. So, what slow ambience means is, you shouldn't be out of stock. Yeah? But not for fast-moving products. What we do see sometimes particularly in DPS area is that sometimes some stock comes in and if you're on a promo you've used your stock so it'll be a priority six So you have to get it in fed immediately and repacked immediately to avoid wastage. Okay, that's quite rare for us Yeah

Question
Okay, how often do suppliers deliver to the warehouse?

Answer
Some suppliers deliver every day. Some do and some deliver once a week. It's a massive spread. Do you know how many suppliers we've got?

Question
I want to know.

Answer
up. We've got over 600 suppliers. Only, yeah. This is something. This is over 600. We receive between 15,000 and 16,000 boards every week.
And we receive about 580 loads every week so that's the level of it. Within that some suppliers are very regular some are not dependent upon what the demand is of their products.

Question
How does the company practice reverse logistics. What does it involve and how has this help to reduce food wastes.

Answer
All cases get picked up directly from store and brought back. So, if you've got a double hitter, you don't do that off the first store because the driver's not going to load up. So, you only pick up from your last. So historically there are stores that are our preference so we split them up

with other sites if you think we're all going into one store at different times, one store might be going in three times through the day, we're going in one, we apportion down one to one which stores supply which roll cages back. Toads are more complicated, every toad has to be washed, every telegram through the RIU, toads are not getting returned to the RIU's at the minute, that's for perishable food hygiene standards because we don't know what they've been used for while they've been away from us, so they all come back through a hot wash, then we plan in journeys to pick those up from the RIU.

Question
Let me continue because of time. Now, the outbound delivery request is often creating challenges for management in terms of requested quantity. How have you been coping with this? And has this often resulted in generating more waste?

Answer

The challenge we have is that the more products that are demanded, the more you are thinking about how to meet it. Yeah. And it's creating a lot of waste at times because of fast movement of products. Yeah.
This equals the worst thing for outbound I suppose is having smaller volume and three or four shops on one journey. Okay. Yeah, it's not efficient for loading, it's not efficient for the way we drive. The bigger the volume gets you start to get what's called single hitters okay yeah so you're loading one store one journey and that's the trunk coffee coach it's easier to plan okay yeah so the biggest issue we have is when the pole is lower in schedule. The pole is lower in the schedule means that you've got lots of triple hitters in there or quadruple hitters okay four stores on one field, so that's a complicated load to load, it's a complicated load to deliver. Okay. The products have to be picked up advance to allow us to manage that, so we like to keep things level, we like to be advanced, and we can then apportion out the outbound program equally rather than the way in Thresh you have your grid closures, and the majority of your loan activity takes place directly after the grid closures. It's not like that in this warehouse; this is much more about getting advanced so you can manage that profile.

Question
Now most of the reported bath stalking and pyramid picking experience in the warehouse are mainly for new workers.

Answer
Yeah.

Question
So what do you think could be done to improve this?

Answer
Well, everybody's got lots of opportunity to learn. Yes. Pick accuracy is not as good as it should be because it leads to food waste. It's not as good as it's been historically, and so that's down to new starters a minute. So everybody's coached, we've got rules, everybody that has an accuracy error gets spoken to. We've recently dismissed two colleagues for continual errors, so we've done the coaching with them and they're still getting errors and we can't see anything other than their concentration or whatever it is so we've had to release them because it's really important it's a very important metric you know to have that right accuracy.

Question

Now new workers have often been given performance targets, do you think new workers should be allowed enough time to perfect their stocking before considering their performance and why?

Answer

Yeah, I mean they've got a 12-week probation and within that they've got a staggered target so they're not expected to hit what you would be expected to hit. It's an experience where else from week one. But there is an expectation that they ramp up and you can see that improvement week on week. So, it's not just about pick rate, it's about lock-ones, working as trained, it's about accuracy and conduct. So, what we also see with a lot of our new starters is that their lock-ones aren't very good because they maybe go wandering a little bit. So, there's you can usually see by six weeks whether you've got a colleague that can perform and has the right conduct. The expectation to be hitting their full race isn't until 12 weeks later and then that's where the sign-off will come. Some people, some people are ahead of the curve, some people come in and can naturally do it and want to do it some people come in and they need to learn because they want to do it and need to learn. Some people come in and can do it and just don't want to do it they just want to be paid for doing very poor job, this is what at times leads to waste.

Question

As I've said, workers you know needs to be retrained on the job for them to perfect on it so how often do you do the retraining?

Answer

Every six months someone would need to go back into an area to be refreshed so going back the are more adapt to what is required.
There are colleagues who have got your core skills so you get an area, but you might get another area so there's quite a lot of colleagues on the site that can do four areas. But then you need to rotate round so if you've gone, if it's six months and you've not gone from E to D, then you still have to do it but we would transfer you to make sure we're keeping your skills current. skills. One of the keys to a really successful warehouse is having really skilled colleagues. The ability to move colleagues according to where the need is, that's the art of running a warehouse effectively.

Question

We discovered that there is a high turnover of workers, so what is the complete way to reduce that?

Answer

The high turnover of workers. So, we've started our initiative with the Jobcentre. So, one of the high turnovers of workers is usually during the summer periods or off school periods when we recruit students by not knowing and then they go back to school. So, we've done a lot of work around that. With the agency, so it's all-around vetting, trying to make sure they've got a dependency of bill or whatever it is they need to pay. We've done a lot of core recruitment straight into contract where my managers vet the individuals because the agency get paid on intake so sometimes maybe they want to bring a lot of people in irrespective of the fact that they might not stay with us. There's a demographic change as well, so the youth of today are

different to where they used to be, so a lot of people don't stay in the same job for a long time. So we've done things like the communication zone downstairs, yeah? You know, a nice room downstairs, trying to make it more interactive for colleagues. we look at flexible work, it's quite difficult because we've got a plan, you know, but we've got the batch team that have got different shifts, so we've got a number of different shifts and we try to balance across, so, and every leaver has an exit interview as well. So to try and understand what that is. So, yeah, we've had quite a few leavers recently, but a lot of those are individuals that are going back to school. Okay.

Question
Now you agree with me that health and safety is very important. And we're also thinking about reducing costs of running the warehouse, because it's a cost generating establishment. Now how do you reconcile the importance of health and safety vis-a-vis performance and food waste?

Answer

The linked, yeah, so I wouldn't expect anybody not to work as trained and I can demonstrate that the rates that we hit can be done by working as trained. I think what we need to understand is that you don't need to take shortcuts to hit your targets which could lead to food waste. There's a number of things we do. We do safe tours, we do activity app where we pinpoint risk areas and coming up to peak, we'll have certain things that we will broadcast around. This is our focus around the trips and falls. And every accident has a thorough investigation. And we've got a few random CCTV footage. So, there's a number of measures inbound pallet checks, rumbles, there's a lot of management checks that are in place, but this boils down to people working as trained. Yeah, so we've had something recently with an individual in automation not wearing their hard hat because they don't think it's an issue, but we've had it risk assessed and the risk assessment says you need to do that so you can't be creating your own rules otherwise it just becomes unsafe. If something changes, be it error rate or be it scenario you need to re-risk assess but the risk assessment

Question
How do you set your performance targets? Do you take into consideration the issue of health and safety?

Answer
there's the budget, and the budget's based on history. Budget's based on what we've previously done. Yeah? So, I know as you go through a performance improvement, what kind of copy can get themselves to performing that, and I expect them to stay at that performance. So you agree there should be a compromise between performance? There doesn't need to be a compromise, the figures work. I can demonstrate for many, many, many, many, many colleagues, you can work as stride and hit performance targets.

Question
Well, you know, you have agreed in the past that the rate of peaks also affects the generation of waste. So, how do you minimize that?

Answer
If you're not working as train, potentially.

Question
Okay. So, working as train can reduce generation of waste and then also increase productivity?

Answer
Yeah.
Okay. I think what this is about, it's about if you look at your best performance pickers, it's around they're working as trained all of the time that they should be logged on. That's the difference where people disappear or don't do anything for five minutes, then try to catch up. If you look at certain colleagues that are consistently performing, they don't really talk. They save that for their break time. They're just constantly working as traffic. It's a consistency thing to it.

Question
Now, let me also ask you about your supplier. You have what we call a supplier bias contract. Now, is there a situation where you agree with your supplier to supply certain products more than what is needed. With the view of, you know, you are thinking about the anticipated damages so that it will not affect your supplies to the stores.

Answer
don't take in extra product for damages because we don't really know in anticipation no we do it in anticipation of increased demand sometimes it might be done because you get a better price. Increased demands

3
0:49:28
yes in anticipation so when you have ordered the products and then you now discover that the demand is not what you are anticipating. Yeah, that's usually a problem yeah. Thank you. Yes. that would be a problem for us and we used to get that. One of the times you get that is at Christmas so you've got your Christmas stock but the category supply managers start bringing in all of the stock for the new year baby stump and cleaning stumps and that has to be very closely managed. In the past I've taken all of that stock out and I've put it in our depot. I've put it in Basildon so I can keep operators. I didn't have to do that last year, it's something I'm watching this year so if that happens only, I'll be taking that stock out and storing it remotely and sold at reduced price when it's needed.

Question
Okay, but you're thinking about the expiration also?

Answer
Yes, that is why they are pushed out to stores and sold at reduced price

Question
Now, these cage units, that is the raw cages, how are they maintained? Are they always inspected?

Answer
Yes.
They should be because every cage has to go into the automation so everyone should be checked but sometimes you do have issues. Okay so at times that might result in generating waste because product can fall off. Yeah, colleagues as well, colleagues need to strap. It's really

important colleagues strap for transit. If they don't, and you'll see that in the pick accuracy, then you've got case falls upstairs. That's because the product moves like that on the conveyors. Yeah, but it needs to be strapped. It has to be strapped. We've got a strap block, so we have to review the strap block to see how many cases have fallen and damaged and what cases they need to be on.

Question
The last question because I know you don't have much time left. Do you have food redistribution policy? That is, do you have food redistribution policy in place? Food redistribution, that is to the needy. I mean, giving it out to the charity, to the less privileged.

Answer
Yes, there's a lot of laws around that. There are a lot of laws, I know. There's a lot of laws around it. So, we wouldn't distribute out anything that's out of love to the public but are always guided by the law. But the bottom line is, we do give to charity.

Question
So you guys have government legislation, so how do you follow that? What are they doing? Does that serve as an hinderance to giving out food products to charity?

Answer

Yeah, we're all governed by G-Scot. So how often do we give out food to charity, what volume do you we out? We get that through derogation notes from the Supply Manager usually, so they would tell us what we can release or not.

Question
Yes. Okay. But are they food products that are not needed in the stores or supermarkets or what?

Answer
Yeah, it's usually stock that, like you said earlier on, that we've brought in and there just hasn't been a demand for it and it's getting towards the end of its life. So, the category supply manager can see our stock levels, can inform that, and then we know, look, you know, we need to, this line's continuing or whatever, so let's get that out and do something with it. We'll get that instruction from the category supply managers.

Question
So they must inform you on what to do before you do that. So, is there any legislation in place that can at times hinder you from doing what is needed?

Answer

Yeah, all the GSCAPs have regulations so we, our food safety rules etc. that cascaded to us from the cut of the supply so it's all about minimum life on issue.

Question
Yeah okay thank you very much. Useful. Now what is the average number of food products you give to charity compared to the product wasted?

Answer

Minimum, you got minimum of delivering going to the food bank. 2.14 million cases are going out of this depot to store every week. Okay. Yeah, so the percentage is minimal. Like what? Oh, no. It's not even on the scale. You need to see what we can get an interview with Barry Cummings, the store manager as well. Okay, thank you. So can I just contact him or you contact him?

Thank you very much sir.

You are welcome.

Transcribed with Cockatoo

Operations Manager Firm A

Question
The first question is, please can you tell me a bit about your company?

Answer.

Yes, it was set in the 1800s. Started off in London. Okay. And everything has progressed since then. Um. I think it was the London store that was the first shop. Okay. And then it moved over and then it's just where it is today. It's just grown and developed and you know where we currently sit.

Question
So in what year did the company start beginning operation and how many employees work in this supermarket?

Answer

Oh ok, well we had our 150 years a few years back, so it's been a long time. Yeah it is. So how many employees work in this company especially in this supermarket? In this supermarket we have about 300 plus colleagues, and it depends what size of store you work in and if you have an online department like we have you always have more colleagues. At 350 I think on my team I have 60. On my department which is the second biggest department in there. That is quite large. It's quite large yeah yeah absolutely. Okay so does it completely deal with perishable food products? Yes, we do yeah so my role as the the store manager, all the perishable deliveries come in overnight. Okay. Because they're fresher so they're freshly picked and out of the supply chain and because obviously the life that's on the product as well it's not one we tend to store a lot of so it comes in just when we need it okay so it's filled you know farm to field if you like filled to the depot to us and then yeah so the main part of our role is delivery of fresh products onto the shop whether that's fruit and vegetables or milk cheese eggs cooked meats fresh juice and they come in overnight and I have two lorries for that every day.

Question
Now it has been evidence that the material used in designing some of the packaged food products are very important for stocking and to prolong the shelf life of the products in order to reduce waste, so the packaging is very important.

Absolutely.

So, what do you think, and does the company always take this into consideration?

Answer

100%. So, there's a department up at Holborn, which is where our head office is, which I think is called Product Innovations, and they're always looking at hitting our sustainability targets, so it's about sourcing the right products that have less impacts on the environment, have less waste for the customer but ultimately protect the quality of the product. So we've recently changed lots of products and we've noticed change on the shop floor. Mince is probably the biggest one, so fresh mincemeat that comes in the meat aisle used to come in a plastic, solid plastic with the mince product in the middle. Used a lot of packaging, used a lot of plastic and obviously that's looking to reduce that and we removed that and we was the first retailer to do it and we put them into like a vacuum packed. Okay. So the product is literally half the size in terms of the dimensions of the product but also, you're not using the hard plastics. Okay. So and you can fit more in a tray when it gets delivered, rather than having these big cumbersome plastic, hard plastic products. It's a lot slicker. And you can fit more in, which then means you can then use less, I suppose across the estate lost, less lorries, because you can now fit 12 into a tray, whereas before you could fit 6. The problem was that the consumers and our customers were very skeptical of it. So even now, we've had these products in for about 3 months now, we've still got advertising down the meat aisle. So this is fine, this is your original product, it's from the same supplier, it's just been packaged differently. We've just changed our steak products from a plastic tray to a cardboard tray. So before it used to be plastic, now it's cardboard, which again is recycled cardboard as well. So in terms of us replenishing them, it's not that much of an issue because we still stack them the same, but it's the way it's coming in. And this is about Sainsbury's hitting their sustainability targets and obviously doing the right thing for the environment. But it's a difficult balance between keeping up with the trends, making sure we do as a business what we need to do to be seen as a responsible retailer and ultimately that the customers will pick up and go oh no look at that, you know and we've got to make sure the product is obviously 100% fresh. So that's the two really good examples at the moment we're doing it with grapes, there's a whole host to be fair.

Question

So, in essence you take into consideration its effect on the environment?

Answer

100% and then the customers perspective of? Absolutely yeah and the probably the fundamental thing that overrides all of those things is actually the product still stays fresh yeah doesn't get damaged in transit yeah because you think it's going from you know the fields to the factory where it's packaged and processed you know then the supplier would then take it into the depots where it would then be pre-loaded and sorted into crates and it goes from there on the back of a lorry to the shop then it goes from the shop to the shop floor so that's quite a

long chain to get it from the field onto the shop floor so you have to make sure the packaging is robust and still fit for purpose but like most retailers they spend lots of money researching and designing and putting it out to the packaging guys. Say look, this is what we want now as a business. We don't want these plastic containers for our mints. What we want is something that's vacuum packed that uses less waste. And then they'll go out and they'll look at it in a vague, come back and then it hits the shops.

Question.
Does the suppliers often listen to the recommendation you make about the type of packaging you want. I'm talking about the supplier. Do they listen to you?

Answer
Yeah, I mean, not me specifically, but we would, as on the shop floor, if we found there was an issue with the packaging or stuff gets leaked, it gets fed up to the head office and then they can collate it and then see if there's lots of stores moaning about a particular packaging, then it would go back to the supplier. But I'd imagine, you know if you're the, if there's an example, you're the fresh mints buyer and we're using that as an example, you as a buyer would be tasked to reduce your waste and your boss would say how are you going to do that? Right okay I need to look at reducing this so then they'll go to the supplier who supplies the packaging, have a meeting and say I want to keep the cost the same as well, just factor in the cost, I want to reduce this plastic packaging, I want to maintain freshness, go away and see what you can do and then they will come back and say this is what we've done and they'll do tests and trials to make sure it's alright and if it's fine then it gets rolled out to the stores. But we've seen a lot more of that now than what we used to. A bit like plastic straws and wood and the paper straws you get now, the plastic straws and all the fast-food outlets have gone because it's plastic and now you get like these little you know McDonald's like little cardboard paper ones so when they first come out, they weren't fit for purpose but as time evolves, they're now better.

Question
It has been discovered over time that suppliers are conscious of costs of supplying the food products, so they want to reduce costs. If complaints about packaging don't come from a lot of supermarkets at the same time, they seldom pay attention to your complaint.

Answer

Yeah I don't think it's necessarily a complaint I think it's the same with the food producers as well. And as a big customer, and I'd imagine it'd be the same for the other retailers, if you're the boss of this packaging company, and Mr. Tesco, Mr. Sainsbury's sits down and said, right, I would love you to come up with, this is a product you've always packaged for us. It's got to change. I need you to, so this is what we want, this, this, this, this, this, this, whatever it might look like and then you then go away come up with your innovation team look at it say yep this is what we can do this would be the cost for us you've got to factor in how much the materials would cost for you to do this new packaging and then eventually it gets through gets trialed and then it comes into stores so they'd have to listen because if you then said oh I couldn't possibly do that then Mr. Sainsbury's would then go, okay, let's go and find a company that would do that. Just like a customer wouldn't shop with us if they couldn't get their products, they'd go to Tesco. So I think there's a lot of weight, but I think a lot of these companies now are so open to looking to change the way they produce food and package food because it's the way of the world now.

Question
So how has the change in packaging affected the reduction of food waste. Has it affected the reduction in food waste?

Answer

Well, I would say that if you look at now where we are now food technologies are so much more relevant than what they have been previously so I think packaging was seen as a means to an end i.e. getting the products to the customer. Now it's all about maintaining freshness and maintaining the quality of the product in terms of damaged products. Now we get a lot of damage in transit.

That is what I'm talking about Products as well yeah. So if things are not stacked properly or if things are not packed properly, you know has the new packaging aided that? To be honest with you, I'll use trying to keep the mints as an example, when it was in the plastic one if something sat on the top of it it would give it an element of protection because there was a gap between the mints and the top of a hard plastic sort of cover so it would be okay now it's shrink wrapped so it's completely just like a little block of mints if anything touches that now it will perforate and then we'd have to waste that off yeah so in that sense you know just for that example probably the quality is not as good as what it was but in but if it's stacked correctly and it's and it gets then there's no reason why it shouldn't be just as good okay yeah the only hindrance would be the customer's perception because now they're seeing this little slab of mince which before they see this lovely big package thing and now it's half the size but of course there's no fresh air in the packet it's all yeah it's all fresh but yeah but getting the product to us is yeah it is a variety of packaging but a lot of that damages would come to manhandling the way it's loaded yeah no question not a deficiency in the food packaging it's more the way it's delivered to stores.

Question So the essence of packaging as you have said is to maintain the freshness of the product?

Absolutely.

And to make sure that it doesn't damage?

Answer
Absolutely, yep. Okay. A hundred percent, you wouldn't buy a product if it was damaged, if there was a damaged corner of the lid had been perforated or it was dented. Yeah, you'd look at that and you'd think, oh no, you'd move on elsewhere. But the ultimate aim is to get that product, whatever it is, whether it's a long life, perishable product, when you get home and you use it for whatever you use it for, it's exactly how you expect it to be. Yeah, and intend it, and then that's where the packaging comes.

Question
So, how often do you contact suppliers to solve problems experiencing with poor packaging? In terms of poor packaging not so much from myself or

Answer
Knights because I'm at the end of the chain you know by the time it's got here it will it you know we then put it out if I've got particular issues or there's a supplier issue we would then mention it to head office and then they would then collect the information so we often have like what's called product withdrawals so let's just say there's a batch of customers from across the UK have gone back to the company and I keep using this mince as an example I'm just trying to keep it because it's you apply it to so many products but this is how you bought the mince and actually oh gosh it's I went to open the mince up in this new packaging and it was off it smelled really awful it was a funny gas smell out of it sometimes I might put gas in it like with the turkeys and they'll log it and say no problem and they'll on the back of every Sainsbury's product particularly there's a supplier code yeah on the barcode which identifies the supplier so let's just say I did that I took that mince back here in Essex and somebody in Scunthorpe took that same mince back you know and someone in Scotland took that same mince back and someone in Wales took that same mince back that would then go up to Sainsbury's head office and go well hold on a minute we've had X amount of cases dotted around and I'm using quite a crude example the UK and they've got the same supplier so you know Mr. Mince plastics from wherever excuse me yeah it's obviously got an issue somewhere with their quality so then what would happen is Sainsbury's would then contact the supplier and say there's an issue with your packaging okay for some reason we've had lots of different queries and this is the nature of the problem. The mince was brown or it smelt off or it was damaged and that's how the products evolve and that's how things get things get better. So that's how we would find out to our supplier or give information to our suppliers if there was problems with their packaging primarily. In terms of us, we're at the end of it. Our customers tell us it's not right. Not me, because all I'm doing is moving it from A to B. Obviously if we see it in transit and it's damaged, we then obviously would not put that out. But that is usually not because of poor packaging, it's usually because of poor product handling techniques and stacking. But our customers will certainly tell us if there's a problem with it and they can then track it back. Then go this must be a packaging fault or a food production fault. Yeah, because they could go back to the supplier first and say actually it could be the packaging we're losing. You know it's true. So and it isn't just us dictating it's if you're the mince man and you're making the mince then it's your suppliers. I'm buying the mince off you already packaged. You know this is what we want, supply me mince in this packaging, go and do it. So we'd come back to you and say the product's not right here we've had all these people you would then contact yeah so hopefully fix it so there is a way that as a business that's how we'd go through to the suppliers because every barcode's got their supplier code. Yes.

Question

Now okay do you prefer package food product to lose item for the following product category that is, packed food products to lose products for the following food product, 1, fast food, 2, perishable food. 3, fruits and vegetables

Answer
So, there are certain products that have to be packed. Yes. And there are certain products that are best displayed without being packed, without being completely covered. So probably the best example of that is the produce department, the fruit and vegetables. So fruit and vegetables I'd say probably about at least 50% of the products on the fruit and vegetable department like the apples, pears, bananas etc, mushrooms, onions are loose products that are in quite sturdy actually, cardboard trays with soft corrugated inners and the products are placed individually on there and then the customers can look pick what they want and see what they want.

Adversely we still do have products on fresh like apples and bananas and all the things that you said oranges and all that in a pre-packed version as well. So the customer has got so much choice. If they only want one or two apples, say Granny Smiths, they'll buy one or two. But actually, if they want five or six, it might be more cost effective to pick up the bag. And also, a time thing to pick up the bag. So we offer both because if we stopped one or the other, you'd guarantee that the customers wouldn't be happy.

What is the shelf life of the one that is packed compares to the one that is not packed.

Answer
So it's about the same, okay, it is about the same, however when it's a loose product you have to be careful of the rotation because the bag products would have the dates on it, okay, whereas the loose products would have the date product on the box. Yeah, so let's just say you had an old product on display of apples and then you've got a brand-new case, if you don't rotate the product, let's just say you put it straight on top, you wouldn't know what the date is. Yeah and also the state on the box will say all right that's out of date but it isn't you've just put a fresh case on top. You've decanted a new casing so we offer both because obviously it's um customers want that choice but in terms of what stays fresher I don't think there's much in it because they'll both be displayed in a chilled unit they both come in the same way they both get displayed the same way and they get displayed next door to each other except the Granny Smiths will be loose if you wish to buy them individually or if you want to grab the bag they're right next door and none of them are from the same supplier it's just how we've asked them to deliver it. I'll buy the Granny Smiths off you I want X amount in the case and X amount pre-packed. So but there's with the produce there's not much I mean that's the only real loose products we do. Everything come fresh isn't loose, grocery isn't loose, they're all over tins or packaged, but with produce we have quite a lot of loose products like bananas as well. Yeah, obviously they come in from all kinds of places and it's amazing how they get them from off the trees across half the world, if you use Dominican Republic or places like that and then they load up and they come in and it's amazing how fresh they are considering if they've got such a big you know big journey to get here. Maybe they have some chemicals to maintain the freshness? Could be but then as soon as they get to the store ideally, we're supposed to take the boxes off and just let them breathe and let them ripen up yeah and they have to be stored differently it's all about storage in stores as well. So, they can be stored at ambient temperatures, so in a normal room environment. So, you can't put those in the chiller because they'll spoil. Adversely with apples, can be stored in the chiller or they can be stored outside. And obviously you've got food chain and such, so with the mince example, obviously it has to be under refrigeration.

Question

So, what features do you look out for mostly in packaging of this type of food products from suppliers? What is the feature that you look in the packaging. Like for example, the perishable food, what are those features that you think is most appropriate?

Answer
I think there will be more of what we've seen recently. So, I've sort of used that as an example. Packaging is getting smaller, because actually some of the products are getting smaller as well. So where they're looking to sort of save money. So if you've always bought, as a crude example, say, three pieces of fish, and it normally costs you five pounds but now you might get two

pieces of fish and it might be a fiver but the packaging will be smaller so you're still picking up your products and playing your price point but there's a there's a lot less product in there you see it on grocery all the time taking packets of crisps out, crisp packets going from 12 to 10s but you still pay you know two pound for it. The way the future goes in terms of and if you're looking at perishables, this trend of sustainability, this environment and this is the key driver for most businesses. It's not so much about cost saving, not at all, it's all about doing the right things and our customers perception. We've all got CO2 and carbon neutral targets and probably the centre will be the best people to contact for those, because they'll tell you what our targets are, what as a business, corporately, we're doing to help achieve those, keeping lorries off the road. You know, by the mints, I guarantee we'll be saving journeys because we can fit more into a crate than what we did before. There has a knock-on effect, but I think the way the future goes is definitely driven by the consumer, driven by the environment at the moment. So the environment is all around as discussed. And then as long as it does the job at my end, that's fine.
So he's telling you something, maybe it's not sound detected or something like that.

Question
Sure. One minute, please. OK, so, Some, food products are sometimes loosely or badly packed which result in food dog spillover. So they are badly packaged which result in food spillover. What effort has been made to solve this problem?

Answer
So what we can do, so if we have a product that's damaged and it comes in, and it comes into us from the depot. We can claim for it, we can do a claim as a store because we take the cost of that and then it goes back to, goes back with a delivery driver to the depot. In terms of in store, we don't really have much sway if you see what I mean. If we constantly had damaged products, we'd ring up and say, look, this isn't good, we've got poor quality here so yeah that's sort of how we do it.

Question
In terms of packaging, do you know the volume of items you damage products that you generate?

Answer
quarterly or maybe yearly? It's difficult to say so when you say damaged products, roughly a quarter of it. So we're not talking about damaged products through packaging just in just general waste. Yeah so general waste, it's hard to differentiate to say a lot of our waste is for stuff that's gone out of date and we do have damaged products you know customers that pick up a fresh product and then walk around the shop with it and then go oh no I don't want that now just leave it on the shelf. Yeah so it's a packet of bacon then we then would have to pick up the cost of that. So as a business we want our waste is normally around about one percent of what we take so you know you're probably looking in the region of about for us 12 grand a week roughly through waste yeah which does sound a lot but actually I mean it is a lot of money when you look at that but when you actually sort of take in you know 1.2 million pounds yeah that is and a lot of that is out of our control so that's every single unit of stock that comes in we have to manage.

Question
So do you keep record of it?

Answer
Yeah it all goes it will get sewage, it gets collated, it goes off to the center, it gets monitored, we do a waste meeting every day so every day from the all the waste from today that's created has to be accounted for it gets scanned with the correct what we call waste code so if it's a code one it's out of date, if it's code two it's damaged, yeah and so forth and then we have them so the waste for today will be on a meeting tomorrow about half past two and all the managers would have their waste and you have to present it and we'd go around to see what are the learnings from it. So gone are the days where it's all gunned up thrown in a big skip and off, we go no it's all detailed check to see what are the learnings that we can stop from this waste oh there's a lot of products there it was out of date oh did we order too much right we need to do something with that. Incidentally now the food waste because of the foot-to-mouth crisis going back 20 years plus where food waste was put into the land yeah into the land and that caused it seeped into the water system you know a lot of the cows and the cattle were drinking it and it caused a lot of mouth and then you know it caused a big issue so now everything gets sent back and gets um insinuated then gets turned into like cooking oils and things so all of our food waste now goes back, not into a skit, doesn't go into a skit, it goes back on our deliveries. So, ours will go back to Waltham Point, all our food waste, and then they'll pre-sort it there. So, no food products, no food waste to landfill. So that's a big change.

Question
Now let's go into inventory. Now what are the biggest inventory management challenges that you are facing?

Answer
Inventory management for us the biggest thing is mis-picks. Mis-picks so in other words something that we've ordered that hasn't come in we've ordered 100 cans of cases of baked beans I've only been delivered 50 and they couldn't fit the other 50 on the lorry yeah so it says I've received I've ordered 100 it said I've received 100 but I've only sent me 50 and then those are I then sell out and it's like oh what's these other 50 cases I've sold 50 oh they're not here so then we have to take that inventory out and we lose that money. Not the warehouse no no you'll find a warehouse with nine times out of ten have a positive stock result yeah when we do a stock result once a year you know a big stock result it can be 110 120 thousand pounds we lose yeah so but yeah that's big problem so with inventory is what we order isn't necessarily what we get. Is there any time that what you order is more than what you make? Yeah it happens I mean a lot of it now that the system will order it anyway so providing we keep the inventories up to date and clear then a lot of it now most of it is ordered by the system. In other words, what gets sold through the checkout then gets ordered via the system.

Question
So in essence, if you have more than what you need, what happens in terms of the freshness of the perishable foods and the shelf life?

Answer
Absolutely, so if we're talking from perishable, if we get more than what we need, what we can do is put additional displays out to try and push the sale, yeah? We can transfer, in worst cases, back to the depot, but that hardly ever happens. Or you can move it to another store. Hi, I've got a hundred cases of strawberries that have come in bomb state. They're going out of date; do you want to take any? Yeah, and we can transfer it from within store to store. That used to happen quite a lot. Very rare now does that happen. We just have to trade it through. Because we carry very little stock now in our backup areas compared to what we used to. We used to

have full chillers and now it's literally to keep it fresh. Why have it sitting in the chiller ticking down? Let's have it in the field and then when it comes to us we'll put it out. Our chillers are very light now.

Question
But now you're talking about inventory, you know the expiry date of each product differs. Yes it does yeah. So there is the product that you push out first, the one that you I mean that you that kept before I mean until the other ones are sold.

Answer
Yeah. So all the products on the shop floor are obviously the like you know how can I say they're the oldest products. So at for night so I work overnight all the fresh products come in all right I've got this case of apples fresh just come off a delivery three o'clock in the morning we'll go and see if the product needs to go out if the product doesn't need to go out it will stay in the chiller out the back until it needs to be replenished. In other words the product on the shop floor has been purchased and then we can bring the new product out. That will go at the bottom as the new product and then whatever the old product is will sit on top. And then when those customers have bought that we take off the empty case and obviously the new products there. But the key is rotation. You need everybody doing it. Whether that's colleagues putting out during the day or colleagues putting out overnight. And rotation is very, very simple. You don't get a new product and put it on top of an old product. You keep it to one side, you just put the new product underneath, as an example, or behind, yeah? So if you've got cheese that comes in, I mean, they've all got different dates. Cheese can have six to seven weeks on it. Fresh fish can have two days. Apples can have five days, steak we use an example can have two weeks you know, mints can have three or four days, they've all got different dates on the perishable side and it's up to us to manage it accordingly but the most important thing is if you don't need to fill it up then don't miss the cycle.

Question
Is there any problems you've been experiencing about that?

Answer
Yeah we often have problems with rotation it's quite common in most stores all it takes is one person you see not to do it and then my person overnight could come in and go oh this hasn't been rotated they've put out all this stuff from the chiller and they didn't realize it's over there and that's the older problem, and sometimes you have to take off the new and put the old out. Or, in the worst case example, products on the shop floor has actually gone out of date because they've done it the other way. The old case is at the bottom, instead of rotating it, they've just put the new case on top. And the time the new case sells through, they take it off, oh my God, that's out of date. And that happens, yeah? But it's a lot better now than what it used to be because we carry less stock outside. You know, because if you've got 30 cases of apples all piled up sometimes it's different to look what the dates are and you might take one that isn't the earliest date well now we carry very little so it's a lot slicker. It's better it's a lot better than what it used to be and again it's all targeted all the waste whether it's a code one whether it's an out of date so that's why when we do the waste meeting it's all laid out in the crates. So for the one that says code ones, which is the out-of-date one, if there was loads of that the store manager would go hold on a minute why have we got all these code ones and they can look at it right okay that's bananas why are those bananas not reduced they're all out of date and there's a report we use called a code check report we can go and say look we haven't code checked it it's not

on this report so we take the learnings from that. So, because waste is a cost at the end of the day. Second biggest cost to us other than labour.

Question
Is there any monitoring that you have been doing to ensure that workers are doing what is required.

Answer
Yeah, we do rotation checks. So we do spot checks, so we have a look, make sure colleagues are rotating and that sort of thing.

Question
Okay, do you deal with suppliers directly?

Answer
No. No, we don't. That's Holborn, our head office. So, the head office will deal with the suppliers. We give them any feedback, but they're the big guns. Okay.

Question
So what will your future storage requirement be and what steps have you taken to accommodate these changes? That is the future requirement of your inventory. Do you anticipate any change?

Answer

How can I say it's difficult. Because I'm talking about the number of customers increasing, all those ones. So you mean like what increasing footfall?
You know those ones and the... shop when they want to shop, where they want to shop and how they want to shop. So whereas before there was no online shopping, there was no click and collect, there was no using your smartphone for your shopping, there was none of this Uber deliveries or any of this sort of stuff didn't exist. So people's idea of shopping is not as a recreational activity, it was something you had to do. So it would be right, off you go, load up, that's your weekly shop done, not go back into the shop. Now people pop up, pop in and do little times. If you look at all the little conveniences that are around, not just Sainsbury's but Tesco's, all these little ones that are on high streets, the tiny little ones, we never had those 15 years ago because customers are telling us that's what they want now. They want to nip in and nip out, you know, they want to order on their phones and get someone to deliver it to them so it's a fine balance so we don't make bigger stores now we make stores that have got the right stuff in.

Question
What are your future storage requirements that need to be looked at to accommodate the changes?

Answer
Oh storage requirements okay so it's funny you should say that, we've just had a refit. We had a refit in this store in March, okay? And they reduced my produce chiller, my fruit and, so where my fruit and veg is, by 40%. They took 40% of it, put energy saving lights in it, and the fresh chiller, they took a third of it. Okay, so in terms of the storage out the back,

For the perishable products, they actually put new chillers in, knocked down the old ones, put new chillers in on the same spot, put in new fans, a new cooling system and new lights but made them smaller. And the reason being is because as I said earlier we don't keep as much product in. You see? So you are making those changes. Yeah. There's something in mind to number one reduce costs. Absolutely. And then to reduce waste. Absolutely. Why would you need to have 50 cases of apples stuck in a great big produce chiller just sitting there when actually only need five or six so I'd rather have five or six come in each night over seven nights rather than 50 cases coming on Monday and nothing for the rest of the week because the time you get to Saturday all those cases have gone out of date so in terms of the storage we carry a hell of a lot less than what we used to. And it's a lot more clinical and a lot more structured. So it's little and often, a bit like the Japanese just in time, business scale for delivering. So yeah, storage, we definitely carry a lot less. And the proofs in the pudding, we've reduced our fresh holding capacity by quite a bit.

Question
I mean your layout in the supermarket, that is the store layout designed to adapt to the future storage requirements. What problem do you envisage if this is not so? And how will it affect productivity and food waste?

Answer

Right, okay, so they're constantly changing the layouts. So, store storage, so for the fresh is still the same so the fresh is kept back of house in the warehouse for ambient products and grocery products it's actually kept on the shop floor now. It's not kept in the warehouse so when you walk around the shop and have a look if you look above the shelving, you'll see additional shelving where products are stored. So that's saying it's double handling of products so if delivery comes in it doesn't go out what would normally happen it would go into a roll cage the roll cage would go into the warehouse, then someone would have to take it off the warehouse and then put it back on the shop floor and then put it, no. So what we do now is it comes in if the grocery products like baked beans or drinks don't go out we just put it above the product. So, when somebody comes to work it in the afternoon, they can then stand directly underneath the product lift it down and put it straight on the shelf virtually without moving rather than going into a big cavernous warehouse where it could be get lots of old products. So, in terms of storage that's how we've changed. We've reduced our fresh holding capacity and our produce capacity and our ambient is kept on the shop floor. So it's a lot clinical. Does it reduce waste? I'm sure it does because the amount of time as humans need to touch the products means there's less risk of it being damaged. You see so if it's constantly going from there past someone else, put in another trolley, put in a warehouse, taken off that trolley, brought back out, oh it won't go out, whereas, oh it won't go out, put it and leave it above the product. So that certainly does help us out massively for replant, availability and obviously storage and ultimately waste.

Question
logistical efficiency most of the reported bus talking experience in the store are mainly from new workers so what do you think could be done to improve this?

Answer

Oh, new workers well the one I've got in a minute so it's I mean look it's the training now is a lot more rigid it's a lot more robust it used to be two days our training for a new starter, now

it's five hours. Okay, where they will learn is actually on the shop floor with other colleagues. So and all the things we talked about rotation and storage that's the key one of the key elements that they'll learn to ultimately reduce waste because if we don't tell our new starters and coach them from the beginning about rotating products then yeah it could cost us a lot of money as a business and also a lot of waste so but yeah the key is getting all the new starters on the same page but they would always buddy up and work with another colleague.

Question
In terms of expected targets, you have targets for each worker. How do you now manage target as compared to reducing waste? Because from time to time you want to maintain your target and at the same time you want waste to be reduced.

Answer

Absolutely, and it's about being fair. So, we've got a corporate target, we've got a shift planner, it's on an app on my phone, and it tells me how long it should take to fill up a certain aisle. But each aisle is different. So, it isn't a generic one case rate fits all. Okay, so if you're putting out on the fresh products you get a bit more time because of all the care needed for the fresh product, quality checking the produce make sure there's no damaged products or product looks a little bit off and obviously the rotation and the movement of the crates whereas for grocery and baked beans you can just put the baked beans straight out. So in terms of managing you do get a little bit of flexibility so you take each job and what job role and what is needed to be done and then you plan your timings accordingly so if I put a new starter on an aisle that's really hard then they're going to fail yeah so it's about being fair and consistent but we have times and case rates and target times but it's different for every aisle depending on the nature of the product and the care involved that's needed for the product.

Question
So the target you set for each worker is the same, whether they are new or not?

Answer
No, we will absolutely cut some slack for new people, because if you set people up to fail, they'll fail. And what's the point of that? It's no good for anybody. So they'll be buddied up. So no, absolutely, I wouldn't expect a new starter from the moment they step in to be up to pace where they should be Not even close to it Yeah, 100% it's about using your knowledge and it's about using your that's right. It's about the right coaching and there's a big bit on our induction for new starters where they learn the ways of working and they learn what we need to do and how we do things because if you don't coach and engage people then you're never ever going to create, you're never going to change the problem. You see so all the existing guys could work a certain way but if you don't spend time with the new guys then one part of the of the wheel isn't moving in the right direction you know. So the expected performance for new workers is it a gradual process? Absolutely yeah so you'll know if somebody takes to it or somebody doesn't you can tell straight away if a colleagues going to be really good or if a colleague will need more support and it's about like riding a bike some people can ride a bike from an early age some people might need two stabilizers on someone might just need one stabilizer on and but as long as they get to the ultimately to the same place at a different time then that's fine yeah obviously if they take too long with it and I don't get it it's a different conversation but ultimately it's about looking after your people and hopefully they'll then look after the products and then we get less waste and everything else. So the expectation is about being fair yeah you can't you absolutely couldn't. You can put me in Tesco's now and ask me

to fill up an aisle I've done 30 years in retail and I wouldn't be able to do it as quick as someone who's been doing it at Tesco's for say a year however with experience, I would be able to. So, if the expectation is you need to be as good as that person who's been doing it then it's not right.

Question
Let us talk about health and safety. So how do you apply that into the working system bearing in mind the aim to improve productivity and reduce product waste?

Answer
It's, I mean obviously it's like most businesses it's taken really seriously so it's about all the colleagues are fully trained they know what they can do and what they can't do and more importantly what they should do. So, for us it's quite physical work, so it's the movement of stock, you know, on roll cages that come in. It's about making sure they're stacked correctly, predominantly. The safety straps are on the roll cages actually move. We don't try and carry too many at once. So, all the colleagues know that. All the colleagues have got steps and footstools, they've got PPE, as you can see here personal protection equipment whether that's gloves safety knives to cut the products that's as you can see that completely safe so yeah, it's absolutely kept.

Question

Do you experience workers cutting corners?

Answer
Yeah, I wouldn't say by putting health and safety at risk? No, not, you know, because of the nature of the work we do there's not really an element that they could cut in terms of health and safety to achieve their target quicker because ultimately the product is, you know, I wouldn't see someone if they was behind the NARAL throwing products on the shelf, yeah, because the colleagues wouldn't just do that and we don't want them to do that and we work in a culture and environment where we don't encourage that, do you see what I mean? So we'd notice if a colleague was struggling or if they were behind on their times or the delivery came in late and all of a sudden, they've got all their work. We'd look to support, we'd look, well we always do, we look to support it because ultimately it's my job to make sure every single case goes out and if I let someone struggle because of something that's taken out of their control they then probably would look to cut corners or throw stuff or not put stuff out or not rotate or products could then get damaged or stuff could be put out that isn't filled up. So then as a team we haven't delivered the ultimate aim which is to make sure everything's out. So we you know we manage it all accordingly.

Question
There must be a compromise between the expected target and the number of wastes generated. Because number one, if I'm expected to meet a target, it affects number one the number of foods that will result into damage yeah so is there any compromise between as when you are setting your targets you think about the number of ways that will be generated if you set it high?

Answer
well all the colleagues at the end of their aisles will have like a little tote so any waste they get can go into that so if a colleague was still what's you say colleague kept dropping stuff or kept smashing stuff, I'd have the conversation and say, what's going on? There's a lot of waste here.

Oh yeah, sorry, I accidentally dropped that or I accidentally moved that and it'll be okay. Just think about your manual handling techniques. You know, what's stopping you? What is, what are you not doing that is enabling you to create all this waste, like from within store? So, but generally there is minimal waste that gets created by poor replenishment techniques.

Question
So you think that the target you set doesn't affect waste?

Answer
No, I wouldn't think for one minute that any waste we get created is because someone is running around trying to hit a target that's been set. For me, our business doesn't quite run like that. It's all about supporting the colleagues so we don't get to that stage. If I elect someone who's got all these roll pallets to put out and they start dropping stuff and all the rest of it then obviously I'd need to interject but we wouldn't allow that situation to happen and ultimately there's only so far she can work. So I'm sure it might happen in other stores but we try not to do that. But no I wouldn't want to encourage that.

Question
Oh yeah. Now making sure the roll cages are maintained in good shape and regularly replaced makes perishable products more secure and hence enhance the reduction of food waste. How often does the company replace roll cages? Roll cages? What in terms of the way they're stacked?

Answer
Absolutely, yeah.

Question
So what do you do about that? Do you make complaints?

Answer
Well what you do is you then isolate the roll cage, you put a little label on it and it goes back to the depot and they should fix it. But yeah, roll cages and the way they're stacked are the biggest generators of waste in the stores. For me and my department, the way it comes in. Yeah, because they're loaded on vehicles using electric trucks. So, at the depot they load all these roll cages with all the products on electric trucks and not actually moving the roll pallets as me and you would push them. These guys are using these trucks that can load two at a time. So, they're not actually physically pushing them onto the lorry. The problem is is when they come off and it comes to the store we put the shutters up we then can't move some of them so you think well how do they get them on in the first place well a human hasn't pushed them on we've used this great big power truck to do it so and obviously they use that because it's quicker to load it but if the person loading the truck couldn't move the roll pallet on they'd have to transfer it into one that would move therefore the roller I would get at store would be able to move so we get a lot where they're all well every store every depot is loaded the same way and that's a big problem so I then come to unload it and I can't move it because we don't have that truck yeah this big long super-duper truck we don't have to get two or three people to try and shift it. So, you generate a lot of waste? You do with that because sometimes the way they jam it in as well so rather than placing in by hand is a lot more, a bit more dexterity as you place it in. By using a great big power chuck, they jam it in, if the roll pallet isn't stacked correctly, you'll take the front of the boxes off. If they don't put the strap on which is another thing the products fall

forward in transit. So that's where most of our waste comes from absolutely overnight. I'd say out of the waste that I generate overnight I'd say 50-60% of it has come from.

Question
So what do you think should be done to reduce that?

Answer
Well it should be stacked better. Yeah it should be stacked better that's the most important thing on the cage initially and then it should be stacked on a cage that actually moves. They're two really simple things.

Question
Now do you think that stocking heavier products on a lighter one also lead to food waste?

Answer
Yeah 100% yeah we get that yeah you do I mean not much comes back to be fair but it's the way it starts overnight is the biggest I mean there's no real rhyme or reason all the products get mixed up as well okay so it's not like you're it's all mixed up. So we have to do something called sectionizing and sectionizing is you literally break all the products down off these roll cages and re-salt them and put them into the aisles where they need to go because so the people are there working you see because if we just gave them all these roll cages going they'll be moving around trying to get all these products off and that is when we get to the waste, that is when we get to it then because when we're actually breaking down these roll cages we can't see in the middle until we're actually taking the product off and they've put a case of juice onto some yoghurts or they've put a case of cheese on top of some dips and that's when we get the waste because of that the biggest waste generator on my shift quite clearly is the way products are stacked and the roll cages they use that's the biggest thing no question. I've got a couple of minutes because I've got my guy I need got my induction.

Question

Okay can I come back to just two questions that I have left. Let us talk about food redistribution policy.
Right.
Do you have food redistribution policy here?

Answer.

We do; it's something I'm not too familiar with. There's something that they do during the day. I mean some of my other stores we used to have a charity called Hope Works and they used to turn up in the evening and any of the food waste that we'd spoiled off rather than putting it into landfill we used to give to the food banks and the local charities so that's something we do. Also we do in-store it's like a produce box like a fruit and veg box so any product that's a little bit wonky or slightly poor quality we put it in this box and sell it as a generic price to say look like cheap price quality is alright with this but we're just not selling it and that that's gone quite well so yeah you still got to make sure that the products in code if you're advertising it's class one in terms of quality so you couldn't we wouldn't just put in these boxes absolute toot and say give us a pound for it yeah it's um i mean we do our own quality checks anything that's not up to quality initially that we're selling for that price then we may reduce it yeah because it

we're not selling it for the price and the quality we look but we never send out date out cold product.

Question

Okay so what is the average number of food products redistributed compared to food waste?

Answer
Oh it's difficult it's quite minimal to be fair it is quite minimal because a lot of food waste we then cannot do anything with because if you've got like these smashed yogurts or smashed pasta sauces or whatever there's not a lot we can reduce, we do reduce quite a lot of products but mainly ambient and long life. If the cereal box is open, we can sellotape it and reduce it. If it's a package that's damaged on fresh products there's not generally a lot we can do with it especially if it's sealed in like an airtight environment you know if it's chickens that have been flushed with a certain gas once the gas has come out so yeah. So, you do it quarterly or monthly? No, I think they do it I'm not sure how they do it during the day I thought it's a couple of times a week they dish it out into the to the guys I mean it's a bit different here to be there when I collected it.

Question

Is it possible, lastly, for me to have recorded data of food waste products you generate quarterly?

Answer

So, of the waste you generate over a period of time? I can tell you what, I can tell you now. What we lost last week. That's the only up-to-date data I've got.
You don't have the record of it? No, it's on my phone. It's in, that's it it's just like a one-off of what we um what we had last week
Right here we go because this was out this was our general waste okay for last week and you're welcome to take a picture of it. So, if we take our score, we're at this store, right, so we lost £14,200 which was a percentage of 1.28. So actually, they've given us a bit of a slightly more generous budget. Variance to target, we actually saved against our target of £1,300. So that was within our budget okay in terms of a percentage is 0.12 against our target which you can see there right code ones out of all of that waste that 13,000 waste 1,700 was product that was out of date okay mark down what that is that's the percentage we sell it for five pounds the markdown is 50% okay and in the reductions achieved 58% of that waste we got some money for it the rest in the reductions achieved 58% of that waste we got some money for it the rest was we didn't get anything we just booked it out all right cool.

Thank you for granting this interview.

You are welcome.

3. General Manager Agro Allied Firm C

Question.

Can you tell me about your organisation. How many employees do you have and what types of products do you produce.

Answer.

We are agro-allied firm The firm was established in 1978 mainly to produce poultry meets, pocks, and also to produce fruits and vegetables. We equally have large plantations of potatoes, yams and other crops in our firm. The number of staff is 85 because we use a lot of machineries. They are both staff and add-hock staff.

Question.

Have you been generating wastes especially from firm food products like perishable food that you supply to the food retail firms. What volume of waste have you been generating compared to the volume of your output.

Answer.

The waste that we generate are organic waste been the type of firm that we operate. From the poultry, when we grieve the chickens, we have the feathers and the internal parts, the intestines, the blood. Also, the peaks generate similar waste. The cassava and the tomatoes peals. Then for the fruits and vegetables, the ones that are not suitable for consumption are counted as waste. The volume of waste generated varies from one month to the other depending on a number of factors. It can be high at times and sometimes calls for concern.

Question.

What steps have been taken to reduce waste that you generate from the farm and the poultry,

Answer

The reduction of waste depends on the type of product. For example, the inner parts of animals and birds like the intestine cannot be reduce. They need to be disposed properly. The outer parts of the chickens like the feathers cannot also be reduced. The processing of the poultry produce generate waste. The same also apply to fruits and vegetables. Based on the facts that they are perishable food products; we are always conscious of the shelf life. We apply first in first out method in processing out firm produce and also ensure that they are well packaged to reduce possibility of waste. The pealing of crops and cassava products also generate waste. So, we are always very careful to involve skilled workers in processing the firm produce. We also apply some methods to dispose off wastes. One of the methods is what we refer to as BSL farming. All the organic waste generated serves as an input to BSL farming. For example, the waste is reprocessed to serve as feeds to Pocks. The feeds are what we refer to as FRASS. It also serves as good fertilisers used in planting crops, fruits and vegetables.

Question.

Have you been experiencing wastes as a result of losing a lot of birds, or other produce before they are ready to be sold.

Answer.

We used to experience a lot of waste when we first started. There was a time we lost more than 5000 birds of about five to six weeks in age. Especially during the COVID-19 period. The vaccines were not effective and other medication were not available. However, it gave us innovative ability to make organic medication. This has resulted in 95 to 96% survival of our poultry products. The organic materials that we use are very potent and available.

Question.

Do you experience excess available firm products than firms are ready to buy.

Answer.

We rarely experience excess available firm produce because our food products are in high demand in the UK. We supply a lot of Food retail firms in the country. We are always conscious of food quality and well-designed packaging and that makes our products very demanding. Also, we have cold room for excess food products that are not Immediately sold and are supplied to the retail firms when demanded. We also maintain constant communication with our customers for information and data exchange about our food products.

Question.

Have you also experienced food waste as a result of breakdown of your machinery especially the cold room.

Answer.

We have a lot of cold rooms and we also employ the service of companies to quickly attend to any fault and to maintain our machineries and the cold rooms. So, we rarely experience wates as a result of this. However, there might be delays and reduction here and there in the volume of food products available to supply to our customers.

Question.

Let us talk about Food products handling by your workers. Are your workers properly trained in handling food products like fruits, vegetables, animals and poultry products to reduce waste.

Answer.

We operate an integrated firm and damaged crops and fruits are always consumed by picks. In addition, our workers are always trained and retrained on how to pick and package firm products. They are required to put on preventive gloves and ivies to ensure that food products are not damaged or contaminated.

Question.

I appreciate the fact that steps have been taken to address food wastage that could impact the environment. However, do you have record of the volume of waste generated as a result of food processing.

Answer

The volume of waste generated depend on a number of factors as I have said earlier. Waste is generated through animal and bird processing, which often result in about 40% of waste generated in the firm. Other waste comes from Fruits, crops and vegetable harvesting and processing which according to records, is about 45% of waste. Products unsold or not fit to be sold results in about 15% of waste but normally, the unsold products are normally given out to charity or used as animal feeds.

Question.

Let discuss about your workers, is there any training available to your workers to ensure that they work effectively and reduce food waste especially through product handling.

Answer

We have established training programmes for our workers to ensure that the observe health and safety measures and to work as effectively as possible in the handling in processing of our food products. The training programmes are done once in a year for our experienced workers and twice in a year for new workers. We also randomly monitor the workers daily to ensure that they work as trained. We regulate the workers through the firm policies and training. They are required to adhere to the working policy of the firm to maintain standard.

Question

Let us talk about performance target. Do you set performance target for your workers.

Answer

The performance targets are based on the trends of performance by the workers and also the demand to ensure that we reduce waste. The workers are required to work as trained as to meet targets agreed upon by our workers union and the firm management. This we believe is achievable through when our workers are committed to what is requested of them. The workers that we used are semiskilled and have to be well trained to achieve the targets. We also pay bonus to workers that exceed their targets. The bonus is based on the volume of products they process above their required targets.

Question

Do you set the same targets for new workers as you know that this might result in generating more waste.

Answer

The new workers are normally placed under the tutelage of the older ones apart from the training given to them so that they can learn on the job. So, we normally se lower targets for them until they are skilful enough to work on their own. We thereafter gradually increase their expected performance target. This we do not only to reduce waste but to ensure health and safety and cut down on materials, energy, and manhour,

Question

In setting performance target organisation are required to take into consideration the issues of food waste and health and safety. Do you always take these into consideration when setting your targets

Answer. Yes, we are always mindful of health and safety in our organisation and also make a lot of efforts to reduce waste. As I have told you, there is a collaboration between the workers union and the firm to set performance targets that is not only achievable but ensure reduction in waste and also ensure that workers work as safe as possible. Also, workers are required to put on gloves and masks when they are processing food products. When there are issues, we make sure they are well taken acre of by taking them to the hospital and paying for medication. Where we process food, the workers are trained and are required to put on hard helmet, masks and gloves.

Question

Do you also set performance targets when workers are harvesting firm products

Answer

We monitor our workers closely during harvesting. We do not set target on this We only determing how good a yield is based on the volume of harvest at a particular time.

Question.

We know that some firm products are seasonal in demand. There are seasons when sales go up and there are times when demands are normal. How do you cope when sales go up and still maintain reduction in waste.

Answer.

That is a good question. We normally prepare for seasons when demand for our products goes up. We have a lot of cold room that can cope with the volume of food products in inventory. We also ensure that we employ more workers on a temporary basis during this period. We always ask our workers interested in doing overtime to work and receive more wages. Also, we liaise with other firms to meet up with demands during this period. However, as expected more waste are generated during this period but efforts are made to reduce them.

Question

Is there any plan for expansion in the future based on increase in demand of your products from the supermarkets.

Anwer.

We have our corporate goals we are taking into consideration, the volume of our firm output. For example, the number of pigs that we have in the pent house, we take into cognisance their production rate, pigs' gestation period is three months, three weeks and three days and use that to determine our need for building more pen houses that can meet up with this population surge.

Question.

How has this resulted in reduction of waste.

Answer.

Our firm is situated on 20 acres of land. We have room for expansion. We have enough machinery and land to meet demand.

Question. During the seasonal period, do you produce in excess more than demand and if that is the case, how do you take care of the excess.

Answer,

To be candid we sometimes struggle to meet up with demand at certain period especially when there is sudden surge in demand than expected. We normally monitor trends in demand for our products through an established communication with our customers but overreliance on this forecast has impact on our ability to meet up with demands and to reduce waste. However, we have standard on what volume of output we can cope with but at times we liaise with other firms to meet up with demands.

Qustion.

Do you at time experience your products being returned from your customers because they are not suitable for consumption or are not sold?

Answer.

We have our internal quality control before food products are sold out, we always make sure that they are fit for consumption. We also collaborate with the retail firms that the food products maintain their quality through transportation by ensuring they are transported in the required cold temperature and are well packaged.

Question.

Let us talk about the packaging of your food products, How, do you ensure effective packaging of your products for safety, identification and wate reduction.

Answer.

We have our customised way of packaging food products. Our product packaging caters to diverse needs with clear freshness and safety information, using standardized date labelling. With our name inscribed on the packaging. These use smart packaging, which utilizes technologies like RFID or QR codes for tracking and monitoring food product. We also employed is active and sustainable packaging, which uses biodegradable materials, such as combined plastics, cardboard, and foil, offering space-saving, customer-friendly, and environmentally conscious advantages and are sent to the cold room to maintain quality and safety.

Question

As your firm products usually have short shelf life. How do you ensure safety and quality of products are maintained until it gets to your customers. There are organic substances that we use to preserve the live of our food products and these are normally applied to fruit crops and vegetable products to ensure that good quality is maintained and to preserve firm produce. However, products like potatoes have longer shelf life.

Question

Is your organisation involved in giving some of your excess products to charity and has that helped in reducing waste generated.

Answer

Yes, we are involved in given our food products to charity and are also mindful of government regulations concerning this. We normally ensure that quality food products are given out and are always mindful of the shelf life of the products before decisions are made to give them out. This has helped us to tremendously reduce food waste in our organisation. We normally give out five percent of our products to charity each year.

Thank you very much for your response to my questions and the time spent. I really appreciate this.

You are welcome.

Transcribed with Cockatoo

Group Discussion Firm D

Question.

I want you to tell me your designation in this warehouse and you years of experience

Response 1: I am a warehouse operative with over 20 years' experience

Response 2: I am a warehouse operative with over 18 years' experience.

Response 3: I am a warehouse operative with over 12 years' experience.

Response 4: I am a warehouse operative with over 5 years' experience.

Response 5: I am a warehouse operative with just over 6 months experience.

Question

Are you aware of perishable food losses and waste problem in the warehouse?

Response 2: Yes, most of the waste generated are through poor packaging. If the packaging is poor, it affects the handling of the products as they fall out either through picking and transportation.

Response 1. I also support the contribution of my colleague. Poor packaging contributes to most of the wates generated in this warehouse. In addition, bad stocking also contributes significantly to the generation of waste.

Response3: Bad stocking has long been experienced in the warehouse and has persisted up till today basically because of the pressure the pickers are taking from the management to meet up with performance targets.

Response 5: The company set up targets immediately you complete your training and you are expected to meet up with these targets if you still want to stay in employment. This has affected our stocking especially we the new operatives.

Response 4: I have personally reported the issues of poor packaging to my manager and nothing has been done up till now.

Question

Are you saying that the target set for pickers impacts on waste generation.

Response 1: Yes definitely. In an attempt to meet up with targets, pickers pay less attention to stacking and that impact on waste generated.

Response 2: The company is more interested in the number of picks everyday and pay lip service to waste reduction.

Response 4: Since I was employed as an operative here, I have always experience pressure to meet up with performance targets and this has cause food waste

Response 5: I am more concerned with meeting with my target than products safety.

Question

Apart from poor packaging and bad stocking that you have mentioned, what are the other things that could lead to food waste.

Response 2: Damaged roll cages and improper stripping of the cage could also lead to waste generation some of the products drops and got damaged during transportation and movement if the roll cages are damaged and the stripes are not properly applied.

Response 1; For me, in addition to this the irrational performance target and bad stocking are the main contributor.

Response 3: If the company could be lenient on the target and also, provide good roll cages, it will help in reducing food waste.

Response 4. Some of the roll cages are 2 sided which affect waste generation and should be phased out.

Question.

What proportion of food items do you think are being wasted/ lost during handling / logistics?

Response 1: To my own estimate, it is about 2% and when you factor that into the number of products that we pick every day, they are very high.

Response 2: I agree with you. It comprises of the ones that falls down during picking, the damaged products as a result of poor packaging, and the ones that got damaged during. Transportation.

Response 3: Mind you, not all products that fell down cannot be sold. They can be recouped, repackaged and sold so that bring down the waste also.

Response 4: Although the number of wastes is low compared to the volume of products picked every day but when you put numbers into it, they are very high especially the perishable food products.

Response 2: The company operate on the policy of picking food products that has spilled over if it is up to 75% of the number that are in the package.

Question

Practically, what steps do you think could be taken to reduce waste? In short / long term?

Response 2. The whole thing boils down to packaging, The company needs to liaise with their supplier to ensure good packaging of their products.

Response 1: Packaging is one major factor followed by bad stocking Some of the packaging materials are weaker than the products inside and spill over at minimum pressure applied.

Response 3: The target set is not reasonable and always impacts on the number of wastes generated. Although, we the experienced operatives have developed skills to stock properly and still maintain the required targets, the same does not apply to new pickers.

Response 1. It will come to a time, even if the management of the warehouse agree to reduce the target and hence improve stocking, the head office will start askin questions about the volume of picks. So, the problem is difficult to solve.

Question.

So, performance target is one of the major problems that impact on waste.

Answer

Response1: Yes, there is not enough time to move products around especially the light products and when stocked under the weight of heavier products, normally get damaged.

Response 2. The problem is with the management who are more interested in the volume of food products picked.

Response 3. I don't think the management see it as a problem. Any waste generated has been factored into the cost of running the business.

Question

Are they not concerned with the environmental impact of the waste generated?

Response 1. They are more interested in their money and revenue. Anything that could bring about the reduction of cost is what interest them mostly.

Response 2: You have to be mindful that wastes are generate more in the supermarket stores than the warehouse and managements are also giving their products out to charity to reduce waste.

Response 3; If people are working as trained and doing things right, we should not be generating wastes also.

Question

How could senior management contribute to addressing this problem?

Response 1: They should ensure reasonable targets are set for pickers

Response 5: They should do something about our constant complain of poor packaging.

Response2: They should make sure that roll cages are constantly maintained

Response 4: They need to constantly consider bad picking and stocking by ensuring workers are trained and retrained especially the new ones.

Question.

What role do you think pickers could play in addressing the problem of wastes?

Response 2: Pickers are advised to work as trained and also be mindful to properly stripped the roll cages to prevent products from falling.

Response 1. Pickers should make sure they pick food products properly from the board of pallets and discourage picking products that are only closer to them to prevent products spillage and damage.

Response 4: Pickers should make sure they report poor packaging to their managers.

Response 5: Pickers should not shy away from demanding for retraining if they think they need one.

Question

Why do you think that meeting or surpassing performance target should not be the only concern of peckers but maintaining good stacking?

Response 1. Even though our concern should be more of maintaining good stocking and reducing waste, the targets set by the managements are normally too high and always impacts on food wastes

Response 2: Personally, I think pickers should be very interested in maintaining good stacking because by doing this, you will pick faster and reduce waste. This is based on my experience.

Response 5: For me, I am more concern about meeting my targets and securing my job than maintaining good stacking because of the pressure on me.

Question

Will your performance (efficiency of picking the item / storing it etc.) get affected if you must pay more attention on reducing food waste by maintaining good stocking. If so, why?

Answer

Response 2: As I have said before, good stacking enhances your performance because by doing this, you will pick faster and reduce waste.

Response 1: I agree with my friend, good stocking enhance your performance but the time spent in restacking is always high. It is good to maintain good stocking as it leads to waste reduction.

Response 5: I think that I have taken a clue from my senior colleagues and would endeavour to maintain good stocking from now.

Question

Do food products handling of perishable products by pickers affect the generation of food waste. Why do you think so and what should be done to reduce the problem?

Answer

Response 1. Yes, it affects the generation of wastes. That is why there must be retraining of new workers as most of them are always in a hurry to meet their targets and do not care about handling the food product properly as trained.

Response 2. I agree with my colleague. The company should provide more training for new workers. In addition, the company should do more about poor packaging to prevent spill over of food products through handling and transportation,

Thank you all

You are welcome.

Transcribed with Cockatoo