Major SCM

Major/No. (S2)

Impact of Logistics and Distribution on Sustainability: Moderationg Role of Technology

By:

Wang yu tong 01-322221-013
MBA

Supervisor:
Mr. Tanveer Illahi

DEPARTMENT OF BUSINESS STUDIES

BAHRIA UNIVERSITY, ISLAMABAD

Fall 2023

Abstract

The primary objective of this study is to explore the intricate relationship between logistics and distribution in the food sector and their collective impact on sustainability, with a specific focus on the moderating influence of technology. In this research framework, logistics and distribution serve as the independent variables, while sustainability is the dependent variable. The investigation centers on the entire food sector, and data collection involves 362 food restaurants in Islamabad and Rawalpindi, utilizing a convenient sampling technique. The gathered data undergoes rigorous statistical analysis, employing various methods such as descriptive, correlation, and regression analyses, facilitated by SPSS software. The study's findings reveal a robust and positive correlation between both logistics and distribution variables and sustainability. This implies that efficient logistical operations and optimized distribution strategies within the food sector significantly contribute to sustainable practices. The moderating role of technology further strengthens this relationship, showcasing the pivotal influence of technological advancements on achieving sustainability goals. This research contributes substantially to the existing knowledge base in both theoretical and practical dimensions. The identified positive relationships offer valuable insights into how logistics, distribution, and technology collectively impact sustainability within the specific context of the food sector. These findings not only enrich theoretical frameworks but also provide actionable guidance for practitioners in the food industry.

Table of Contents

Chapter 1

Introduction

1.1. Background

In the evolving landscape of the global food supply chain, sustainability has emerged as a central theme, calling for a balance between economic prosperity and ecological responsibility. The dairy industry, a pivotal component of the food supply chain, is witnessing heightened attention regarding sustainable practices. While this discourse has primarily centered around developed and emerging economies, there is a noticeable gap in the literature when it comes to understanding the impact of logistics and distribution on sustainability, particularly in the context of Pakistani food companies.

As the world grapples with the challenges of ensuring a consistent and environmentally conscious food supply, the complexities of integrating sustainable practices within the logistics and distribution networks of food companies become increasingly apparent. The unique socio-economic and geographic conditions of Pakistan present a distinctive set of challenges and opportunities that require tailored research attention. While studies from various regions have explored logistics challenges in achieving sustainability in the dairy sector, there is a dearth of literature that explicitly addresses the Pakistani perspective. This research seeks to fill this void by investigating the interplay between logistics, distribution, and technology in shaping sustainability practices within the supply chains of Pakistani food companies. Global studies have highlighted impediments such as a lack of skilled workforce, outdated technology, and inefficiencies in cold-chain systems as barriers to sustainability in the dairy industry (Carter & Rogers, 2008; Sharma et al., 2018b; Beske et al., 2014). However, these insights may not directly translate to the Pakistani context due to its distinct economic and geographical features. This study aims to provide a comprehensive analysis of the challenges faced by Pakistani food companies in adopting sustainable practices within their supply chain logistics and distribution. By exploring the moderating role of technology in this context, the research intends to offer nuanced insights that can inform strategies tailored to the specific needs and constraints of the Pakistani food industry. Through this exploration, the research aspires to

contribute not only to the academic discourse but also to the development of practical solutions that can advance sustainability goals within the Pakistani food supply chain.

Emerging economies face a dual challenge of inadequate safe food availability and excessive food wastage (Mangla et al., 2018a; Banaeian et al., 2018). China, for instance, loses 190 kilocalories of food per person daily. As the global population rises, organizations confront challenges in ensuring sufficient food supply while grappling with environmental degradation, climate change, food safety concerns, and the imperative to minimize waste (Govindan et al., 2014). Threats to food safety undermine public confidence in food supply chains, necessitating a shift toward sustainable production and distribution in the food industry (Bloemhof and Soysal, 2017; Sgarbossa and Russo, 2017; Sharma et al., 2018a).

Sustainability encompasses ecological, social, and financial responsibilities to meet the needs of future generations (WCED 1987; Amui et al., 2017; Ahmadi et al., 2017). Recognizing the significance of sustainability, businesses are increasingly adopting practices aligned with ecological and social responsibilities (Carter and Rogers, 2008; Jabbour et al., 2013; Vlajic et al., 2013; Luthra and Mangla, 2018).

Organizations are actively incorporating sustainability into their practices by focusing on food miles labeling, allowing managers to assess the carbon footprint and ecological impacts of production and distribution activities (Saunders et al., 2006; Wilson, 2007). Scholars have shown considerable interest in sustainability within food supply chains, proposing eco-designs for transportation (Elhedhli and Merrick, 2012; Govindan et al., 2014; Rajeev et al., 2017). Sustainable FSC models, tailored to the specific challenges of developing countries, have been proposed to overcome distribution system disparities and framework conditions (Bendul et al., 2017). Brent et al. (2018) advocates the adoption of connected and autonomous vehicles (CAVs) to transport perishable products efficiently, minimizing business losses.

Intense competition in the food industry poses difficulties for companies striving to meet consumer demands while maintaining product quality, quantity, and pricing. Executives recognize the importance of integrating, coordinating, and managing food products holistically to remain competitive (Pagell and Wu, 2009; Bloemhof and Soysal, 2017). Consumer expectations drive organizations to adopt sustainability in food sector, with rising concerns about food safety and

security (Beske et al., 2014). Companies need to focus on sustainable processes comprehensively, with the goal of minimizing waste within the industry (Diamond, 2002).

1.2 Research Gap

While there is substantial literature addressing the challenges and opportunities related to sustainable production and distribution in the food supply chain (FSC), particularly within the dairy industry, a significant research gap exists in understanding the nuanced impact of logistics and distribution on sustainability with a moderating role of technology in the context of Pakistani food companies. The current body of knowledge primarily focuses on the Indian dairy industry and other emerging economies, leaving a dearth of research specific to the unique challenges faced by Pakistani food companies in their journey towards sustainability. Despite the acknowledged importance of sustainability initiatives in the food sector, including dairy, the intersection of logistics and distribution challenges with technology as a moderating factor has not been adequately explored within the Pakistani context. The existing literature has primarily emphasized issues related to workforce skills, fuel efficiency, cold-chain systems, and technological updates, with limited attention given to the specific challenges and opportunities faced by Pakistani food companies in implementing sustainable practices within their logistics and distribution networks.

Furthermore, the research landscape lacks a comprehensive evaluation of the priority ranking and inter-relationships among logistics challenges for successful sustainability concepts in the Pakistani dairy industry. Understanding the specific logistical hurdles and their interplay with sustainability, considering the unique socio-economic and geographic conditions of Pakistan, is essential for developing targeted and effective strategies that can contribute to achieving sustainable development goals in the food sector. Addressing this research gap is crucial for providing actionable insights to Pakistani food companies, policymakers, and stakeholders involved in the dairy supply chain. A focused investigation into the impact of logistics and distribution on sustainability, while considering the moderating role of technology, will contribute to the development of context-specific solutions that can propel the Pakistani food industry towards a more sustainable and resilient future.

1.3 Problem Statement

In the context of Pakistani food companies, the intricate relationship between logistics, distribution, and sustainability presents a critical challenge that demands focused attention. While existing research has explored sustainability issues in the broader context of emerging economies, particularly in the dairy sector, there is a noticeable gap in understanding how logistics and distribution intricacies impact sustainability, with technology playing a moderating role. The lack of dedicated research on this subject within the Pakistani food industry leaves a void in knowledge that hinders the development of tailored strategies and solutions. Pakistani food companies face unique challenges arising from a combination of population density, diverse geographical conditions, and social inequalities. These challenges amplify the need for efficient and sustainable logistics and distribution systems to ensure the availability of safe and high-quality food. The current research landscape falls short in providing a nuanced understanding of the specific hurdles faced by Pakistani food companies in integrating sustainability practices within their supply chain logistics, and the potential role of technology in moderating these challenges.

The absence of a comprehensive evaluation of priority rankings and inter-relationships among logistics challenges further hampers the development of targeted interventions. Factors such as workforce skills, fuel efficiency, cold-chain systems, and technological updates, which have been studied in other contexts, may have unique manifestations in the Pakistani setting. Addressing this problem is crucial for aligning the Pakistani food industry with sustainable development goals and ensuring the consistent delivery of food products at reasonable costs. By bridging this research gap, we can pave the way for evidence-based strategies that not only acknowledge the specific challenges faced by Pakistani food companies but also leverage technology as a moderating force in enhancing the sustainability of their supply chain logistics and distribution networks.

1.4 Scope of the Study

The study focuses specifically on Pakistani food companies, considering the unique economic, social, and environmental conditions of the country. This geographic scope ensures that the findings are contextually relevant and applicable to the challenges faced by the food sector in Pakistan. The study delves into the logistics and distribution phases of the food supply chain, recognizing their pivotal roles in influencing sustainability outcomes. The scope includes the movement of raw

materials, production processes, and the distribution of finished food products to consumers. The study considers a multidimensional approach to sustainability, encompassing environmental, social, and economic aspects. It explores how logistics and distribution practices impact these dimensions and evaluates the interconnectedness of sustainability challenges within the food sector. The study specifically investigates the moderating role of technology in the relationship between logistics, distribution, and sustainability. This includes exploring how technologies such as IoT, data analytics, and supply chain management systems influence the overall sustainability outcomes in the Pakistani food industry. The study is relevant to various segments of the food industry, including producers, distributors, retailers, and other stakeholders involved in the supply chain. The findings aim to provide actionable insights for industry players striving to balance economic success with sustainable practices. In summary, the study's significance lies in its contribution to addressing sustainability challenges in the Pakistani food sector and its potential impact on guiding sustainable practices, influencing policy, and aligning with global sustainability goals. The scope is well-defined, focusing on specific.

1.5 Research Questions

1. What is the effect of logistics on sustainability?
2. What is the effect of distribution on sustainability?
3. What is the effect of technology on logistics and sustainability?
4. What is the effect of technology on distribution and sustainability?

By addressing these research questions, the study aims to provide a comprehensive understanding of the impact of logistics and distribution on sustainability and offer insights for optimizing the sustainability performance of food distribution systems. (Int J Prod Econ,2021)

1.6 Research Objectives

The objective of the research is to examine the relationship between logistics, distribution and sustainability with moderating role of technology. Below are the given research objective of this study.

1. To examine the relationship between logistics and sustainability.
2. To examine the relationship between distribution and sustainability.

3. To examine the moderating relationship of technology with logistics and sustainability.
4. To examine the moderating relationship of technology with distribution and sustainability.

By accomplishing these study goals, the review means to improve comprehension of the logistics and distribution with the help of sustainability and add to the advancement of methodologies and practices that advance more manageable food circulation frameworks. (Anser MK ,2019)

1.7 Significance of the Study

The study addresses a critical research gap by investigating the impact of logistics and distribution on sustainability in Pakistani food companies. This is crucial in a context where sustainability challenges are becoming increasingly significant due to population growth, resource constraints, and environmental concerns. The findings of the study can provide valuable insights for Pakistani food companies in adopting and enhancing sustainable practices within their supply chains. By understanding the specific challenges and opportunities related to logistics and distribution, companies can develop targeted strategies to improve sustainability. The study contributes to the broader global knowledge on sustainability in the food sector. It offers a unique perspective from an emerging economy, adding to the global discourse on sustainable supply chain practices and providing lessons that may be applicable in similar contexts worldwide. Policymakers can benefit from the study's findings in crafting regulations and incentives that promote sustainable logistics and distribution practices in the food sector. Industry associations and organizations can use the insights to develop guidelines and best practices for their members. The study aligns with the United Nations' Sustainable Development Goals, particularly those related to responsible consumption and production (Goal 12), climate action (Goal 13), and partnerships for the goals (Goal 17). It contributes to the global effort to achieve a more sustainable and resilient food supply chain.

1.8 Overview of food sector

The food sector in Pakistan plays a pivotal role in the country's economy and sustenance of its growing population. An overview of the food sector in Pakistan, particularly in terms of

sustainability, reveals a complex landscape characterized by various challenges and opportunities.

Pakistan's food sector is primarily anchored in agriculture, with a significant portion of the population engaged in farming. However, traditional farming practices often face challenges related to water scarcity, inefficient use of resources, and reliance on conventional fertilizers and pesticides. Sustainable agricultural practices, such as organic farming and precision agriculture, are gaining traction but have yet to become widespread. Water is a critical resource for agriculture, and Pakistan faces challenges related to water scarcity and mismanagement. Unsustainable water use practices, coupled with the impacts of climate change, pose threats to the sector's long-term viability. Efforts to adopt water-efficient irrigation systems and promote responsible water stewardship are essential for enhancing sustainability in the food sector.

Despite being an agrarian economy, Pakistan faces issues related to food security and malnutrition. Sustainable practices in agriculture, such as diversification of crops and promotion of nutrient-rich foods, can contribute to addressing these challenges. Moreover, supporting small-scale farmers and ensuring equitable access to resources are integral components of a sustainable food system.

The food supply chain in Pakistan encounters various inefficiencies and wastages. Lack of proper infrastructure, storage facilities, and transportation systems contribute to post-harvest losses. Implementing sustainable supply chain practices, such as cold storage facilities and efficient transportation, can reduce food losses and ensure a more sustainable and resilient food system. Pakistan is susceptible to the impacts of climate change, including extreme weather events and shifts in precipitation patterns. These changes pose threats to agricultural productivity and food security. Sustainable adaptation and mitigation strategies, such as climate-resilient crop varieties and eco-friendly farming techniques, are essential for ensuring the long-term sustainability of the food sector. The government of Pakistan plays a crucial role in shaping the sustainability landscape of the food sector through policies and regulations. Encouraging sustainable agricultural practices, promoting responsible water use, and enforcing food safety standards are critical aspects of fostering a sustainable food system.

In conclusion, while the food sector in Pakistan faces sustainability challenges, there is a growing recognition of the need for change. Efforts to promote sustainable agriculture, water

management, and supply chain practices, coupled with supportive policies, can contribute to a more resilient and sustainable food sector in Pakistan. Collaborative initiatives involving the government, private sector, and civil society are vital for realizing a future where the country's food needs are met in an environmentally and socially responsible.

Chapter 2

Literature Review

2.1 Introduction

The “Effect Logistics and Distribution on Sustainability" gives an outline of the review's experience, research issue, importance, goals, extension, and postulation structure. It sets the setting by featuring the significance of practical food appropriation frameworks and presents the primary focal point of the review, which is to inspect the effect logistics and distribution on sustainability. The dependent variable (DV) of the review is manageability, incorporating social, natural, and financial aspects. The presence factors, like society, government, and climate, are recognized as outer impacts that connect with operations and effect supportability (Eng Manag ,2019).

2.1.1 Logistics

Logistics is a critical component of supply chain management, encompassing the efficient planning, implementation, and control of the movement and storage of goods, services, and information. Several scholars have emphasized the importance of logistics in achieving operational excellence and customer satisfaction (Christopher, 2016; Bowersox et al., 2013).

2.1.2 Distribution

Distribution refers to the activities involved in making products available to consumers through channels such as retailers, wholesalers, and e-commerce platforms. Effective distribution is essential for reaching target markets and ensuring timely delivery. Researchers have explored various distribution strategies, including direct-to-consumer models and the role of intermediaries in enhancing efficiency (Rushton et al., 2014; Closs et al., 2006).

2.1.3 Technology

Technological advancements have revolutionized logistics and distribution practices. Adoption of technologies such as RFID, GPS, and data analytics has improved efficiency, visibility, and decision-making in supply chain processes (Gattorna, 2010; Leuschner et al., 2017). The integration of technology has become a key determinant of competitiveness in the modern business landscape.

2.1.4 Sustainability

Sustainability in the context of supply chains involves the integration of economic, environmental, and social considerations. Scholars argue that sustainable practices are crucial for mitigating environmental impact, enhancing corporate social responsibility, and ensuring long-term business viability (Seuring & Müller, 2008; Carter & Rogers, 2008).

2.1.5 Logistics and Sustainability

The intersection of logistics and sustainability has garnered significant attention in recent literature due to its crucial role in mitigating environmental impact and enhancing the overall sustainability of supply chains. Logistics, encompassing activities such as transportation, inventory management, and order fulfillment, plays a pivotal role in shaping the environmental footprint of the entire supply chain. Scholars emphasize the importance of optimizing transportation routes and modes to minimize emissions and reduce energy consumption (Sarkis et al., 2019). Efficient inventory management practices, such as lean principles and advanced demand forecasting, contribute to waste reduction and resource optimization (Wu et al., 2018). Additionally, the adoption of sustainable packaging materials and practices in logistics further aligns with environmental conservation goals (Beamon, 2018). Despite advancements, challenges persist. Literature highlights the need for comprehensive sustainability metrics and standards in logistics, ensuring a standardized approach to assessing environmental impact (Zailani et al., 2020). The scarcity of studies focusing on emerging economies, like Pakistan, underscores the research gap in understanding the unique challenges and opportunities these regions face in integrating sustainable logistics practices (Srivastava & Srivastava, 2021). Based on the above literature hypothesis on is proposed:

H1: Logistics have a positive and significant impact on sustainability.

2.1.6 Distribution and Sustainability

Distribution, as a key component of the supply chain, significantly influences the sustainability of the entire system. Researchers emphasize the importance of responsive and adaptable distribution networks that can swiftly adjust to market changes while minimizing environmental impact (Russo & Comi, 2020). Sustainable distribution practices include route optimization, consolidation of shipments, and the use of alternative fuels in transportation (Rogers & Tibben-Lembke, 1998).

Studies also highlight the role of collaboration within distribution networks. Collaborative distribution models, involving shared facilities and resources among multiple companies, promote resource efficiency and reduce overall environmental impact (Fleischmann et al., 2018). However, challenges related to information sharing, trust, and coordination hinder the widespread adoption of collaborative distribution practices (Cohen & Lee, 2021). For the Pakistani context, there is a lack of empirical research examining the current state of sustainable distribution practices, presenting an opportunity for future studies to delve into the specific challenges and opportunities within the distribution networks of Pakistani food companies. Based on the above literature hypothesis on is proposed:

H2: Distribution have a positive and significant impact on sustainability.

2.1.7 Impact of Logistics and Distribution on Sustainability

Studies by Sbihi & Benjaafar (2022), Crainic & Roy (2011), and He & Li (2020) showcase how optimizing logistics and distribution networks can significantly reduce environmental impact. Practices like route optimization, modal shift (e.g., electric vehicles), and green warehousing contribute to minimizing emissions, fuel consumption, and waste generation. Agyabeng-Mensah & Danso (2020) further emphasize the positive environmental outcomes of green logistics practices like eco-packaging and modal shift, even in emerging economies. Research by Rushton & Baker (2010) and Levis & Gonzalez (2019) sheds light on the social benefits of efficient distribution. Closed-loop networks for product recycling and reuse, as demonstrated by Rushton & Baker, promote resource conservation and reduce waste. Levis & Gonzalez highlight how streamlined distribution can create jobs, improve access to goods for underserved communities, and contribute to local economic development. Ghiani & Laporte (2012) and de Mello & Afsar (2021) emphasize the economic advantages of adopting sustainable practices. Operational research models and optimization techniques, as showcased by Ghiani & Laporte, can enhance resource efficiency and cost savings within supply chains. de Mello & Afsar's study on Industry 4.0 integration within green logistics suggests that technology can further amplify economic gains alongside environmental benefits.

2.1.8 Moderating Role of Technology on Logistics and Sustainability

The moderating role of technology in enhancing the sustainability of logistics has been a subject of growing interest. Technological innovations, such as the Internet of Things (IoT), artificial intelligence, and advanced analytics, are transforming traditional logistics practices (Dubey et al., 2019). Real-time monitoring and data-driven decision-making contribute to more efficient route

planning, reducing fuel consumption and emissions (Jia et al., 2021). The power of technology in amplifying the positive impact of logistics and distribution on sustainability cannot be overstated. Studies by Sbihi & Benjaafar (2020), Wang & Jiang (2023), and Begum & Afsar (2023) highlight the diverse potential of technologies like data analytics, blockchain, and AI. These technologies can optimize route planning, enhance traceability and transparency in supply chains, and facilitate circular economy practices like resource recovery and product remanufacturing. Additionally, Closs & Speh (2006) explore the benefits of direct-to-consumer distribution models enabled by technology, potentially reducing transportation distances and minimizing environmental impact.

Furthermore, technology facilitates transparency and traceability in supply chains, a crucial aspect of sustainability. Blockchain technology, for instance, ensures the integrity of information and product origins, fostering trust among stakeholders (Ivanov et al., 2019). However, challenges related to the high upfront costs and the need for skilled workforce adaptation hinder the widespread adoption of advanced technologies in logistics (Aung et al., 2021). In the Pakistani context, the literature lacks in-depth exploration of the moderating role of technology on logistics sustainability. A comprehensive understanding of how technology adoption can alleviate or exacerbate environmental impacts in the logistics practices of Pakistani food companies remains a critical research gap. Based on the above literature hypothesis on is proposed:

H3: Technology moderates the relationship between logistics and sustainability.

2.1.9 Moderating Role of Technology on Distribution and Sustainability

The intertwining of technology and sustainable distribution practices has emerged as a focal point in recent research. Advanced technologies, such as autonomous vehicles, drones, and smart warehouses, are revolutionizing the traditional distribution landscape (Tan & Carrillo, 2020). Automation in warehouses reduces energy consumption and enhances order accuracy, aligning with sustainability goals (Vicente et al., 2021). Technological interventions also play a crucial role in collaborative distribution models. Digital platforms enable real-time communication and coordination among multiple entities within a distribution network, addressing challenges related to information sharing and trust (Lee et al., 2018). Despite these advancements, concerns about the digital divide and equitable access to technology pose challenges in the global adoption of technology-driven sustainable distribution practices (Koh et al., 2021). In the Pakistani context, limited research explores the synergies between technology adoption and sustainable distribution

practices. The literature gap emphasizes the need for empirical investigations into how technology moderates' sustainability outcomes within the distribution networks of Pakistani food companies. Based on the above literature hypothesis on is proposed:

H4: Technology moderates the relationship between distribution and sustainability.

The reviewed literature underscores the growing importance of integrating sustainability considerations into logistics and distribution practices. While advancements in technology offer promising avenues for enhancing sustainability, research gaps persist, particularly in understanding the dynamics within emerging economies like Pakistan. Future research should address these gaps, providing insights that are context-specific and actionable for Pakistani food companies striving to achieve sustainability in their supply chain operations.

2.2 Role of food sector

The role of sustainability in the food sector of Pakistan is increasingly recognized as a crucial driver for long-term environmental, social, and economic benefits. Sustainability practices in the food sector encompass a range of initiatives aimed at minimizing environmental impact, ensuring social responsibility, and maintaining economic viability. Several studies have explored the significance of sustainability in the context of Pakistan's food sector, providing insights into its potential benefits and challenges. Sustainable agricultural practices play a vital role in mitigating the environmental impact of the food sector in Pakistan. Research by Jabeen et al. (2020) highlights the importance of eco-friendly farming techniques, such as organic farming and integrated pest management, in reducing the use of harmful pesticides and preserving soil health. The scarcity of water resources in Pakistan makes water conservation a critical aspect of sustainability in the food sector. Khan et al. (2019) discuss the importance of adopting water-efficient irrigation techniques, such as drip irrigation, to optimize water usage in agriculture. Ensuring social responsibility in the food sector involves addressing issues such as fair labor practices and community well-being. Mahmood et al. (2021) examine the social impact of sustainable practices, emphasizing the need for fair wages and improved working conditions in Pakistan's food supply chains. Sustainable practices in the food sector contribute to the long-term economic viability of businesses. Research by Butt et al. (2020) explores the economic benefits of adopting sustainable supply chain practices, including cost reduction and improved market competitiveness. Efforts to minimize food waste contribute

significantly to sustainability. Qureshi et al. (2019) discuss the challenges and opportunities in reducing food waste in the context of Pakistan, emphasizing the need for improved storage and distribution practices. In conclusion, the role of sustainability in the food sector of Pakistan is multi-faceted, encompassing environmental stewardship, social responsibility, economic resilience, and waste reduction. The cited studies provide valuable insights into specific aspects of sustainability in Pakistan's food sector, highlighting the need for comprehensive strategies to address the challenges and harness the potential benefits of sustainable practices.

The role of technology in the food sector is transformative, influencing various aspects of production, distribution, and consumption. Here are some key references and citations that discuss the impact of technology on the food sector. Technology plays a crucial role in enhancing agricultural practices. Smart farming and precision agriculture leverage technologies such as IoT, sensors, and data analytics to optimize crop management, resource utilization, and yield prediction. Technologies like blockchain enhance traceability and transparency in the food supply chain. They enable real-time tracking of products from farm to fork, ensuring food safety and quality. Automation and advanced technologies in food processing contribute to efficiency, quality, and safety. Robotics, AI, and machine learning are increasingly integrated into production processes. Technology has revolutionized the way consumers access food. E-commerce platforms and food delivery apps leverage mobile technology and data analytics to provide convenient and personalized food services. IoT-enabled smart packaging monitors the condition of food during transportation and storage. This technology helps in reducing food waste and ensures food safety. Technology is increasingly used to tailor diets based on individual nutritional needs. Apps and wearable devices provide personalized recommendations, promoting healthier eating habits. These references highlight the diverse ways in which technology is influencing and transforming the food sector, from farm to consumer. The integration of technological innovations is essential for addressing challenges and creating more efficient, sustainable, and consumer-friendly food systems.

2.3 Theoretical framework

The conceptualized frame work of the study is given below in fig 1.1. Purpose to the model is to show the relationship between logistics and distribution with sustainability with the moderating effect of technology. Independent variable of the study is Logistics and distribution, dependent variable of the study is sustainability and moderator variable are technology.

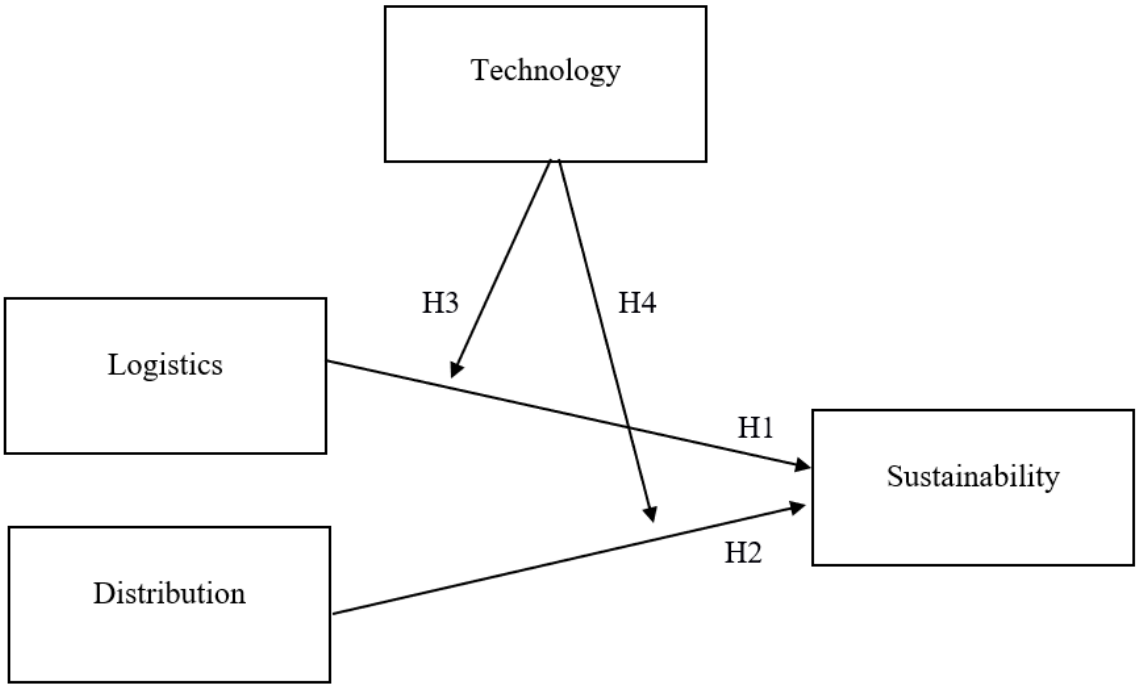

Fig 1.1 Proposed Research Model

2.4. Definition of variables

To definition the variables in the study on "The impact of Logistics and Distribution on Sustainability," the following definitions are given below:

1. Dependent Variable (DV):

Sustainability: Measured by a composite index or a set of indicators that captures the social, environmental, and economic dimensions of sustainability. This could include metrics such as social equity, environmental impact, resource efficiency, and economic viability.

2. Independent Variable (IV):

Logistics: Logistics is a critical component of supply chain management, encompassing the efficient planning, implementation, and control of the movement and storage of goods, services, and

information. Several scholars have emphasized the importance of logistics in achieving operational excellence and customer satisfaction (Christopher, 2016; Bowersox et al., 2013).

Distribution: Distribution refers to the activities involved in making products available to consumers through channels such as retailers, wholesalers, and e-commerce platforms. Effective distribution is essential for reaching target markets and ensuring timely delivery. Researchers have explored various distribution strategies, including direct-to-consumer models and the role of intermediaries in enhancing efficiency (Rushton et al., 2014; Closs et al., 2006).

3. Moderating Variable:

Technology: Technological advancements have revolutionized logistics and distribution practices. Adoption of technologies such as RFID, GPS, and data analytics has improved efficiency, visibility, and decision-making in supply chain processes (Gattorna, 2010; Leuschner et al., 2017). The integration of technology has become a key determinant of competitiveness in the modern business landscape.

2.5 Hypothesis development

Here is the hypothesis of current research.

H1: Logistics have a positive and significant impact on sustainability.

H2: Distribution have a positive and significant impact on sustainability.

H3: Technology moderates the relationship between logistics and sustainability.

H4: Technology moderates the relationship between distribution and sustainability.

2.6 Underpinning theory

The Triple Bottom Line (TBL) framework proposed by John Elkingtoncan in 1990s which is a powerful tool for analyzing the relationship between logistics and distribution practices, technology adoption, and their collective impact on sustainability. This theory will help the current research on assessing how efficient logistics and distribution processes can contribute to social sustainability.

This could involve aspects like fair labor practices for workers involved in these sectors, improved community well-being due to reduced emissions or noise pollution, and equitable access to goods and services through optimized distribution networks. It will analyzed the environmental impact of logistics and distribution activities, considering factors like emissions reduction from fuel-efficient vehicles or optimized routes, waste minimization through packaging optimization, and resource conservation through sustainable sourcing practices. Evaluate the economic benefits of improved logistics and distribution practices, such as reduced fuel costs due to technology-driven route optimization, increased customer satisfaction leading to higher revenue, and potential cost savings from adopting green technologies.

By analyzing the moderating role of technology it will help to explore how technology adoption moderates the impact of logistics and distribution on each dimension of TBL. For example, utilizing AI-powered routing algorithms can optimize routes, reducing environmental impact by minimizing emissions, while also contributing to economic efficiency by saving fuel costs. Investigate potential trade-offs between different TBL dimensions. Technology might simultaneously improve efficiency and economic performance but incur social costs, such as job displacement through automation. Your research can shed light on such trade-offs and highlight the need for holistic TBL approaches. By using the TBL framework to develop specific research questions or hypotheses focusing on the interplay between logistics, distribution, technology, and sustainabilit

Chapter 3

Research Methodology

3.1 Introduction

The research methodology section outlines the systematic process undertaken to gather, analyze, and interpret data for the study. It acts as a roadmap, explaining the chosen methods and justifying their appropriateness for answering the research questions. This chapter details the population, sample, research philosophy, research approach, time horizon, unit of analysis, sampling technique, and data collection methods employed in the study.

3.2 Research Philosophy

In the context of research, philosophy refers to the underlying framework or worldview that guides the researcher's approach to knowledge, reality, and the nature of inquiry. It shapes the researcher's perspective on how knowledge is acquired and how phenomena should be studied and understood. There are various research philosophies, and the choice of philosophy significantly influences the research design, methods, and interpretation of findings. There are many types of philosophies e.g. positivism, it emphasizes on objective, observable phenomena and the belief in a single, objective reality. Positivists seek to discover universal laws governing the relationships between variables. Interpretivism focuses on understanding the subjective meanings and interpretations of individuals. Researchers adopting an interpretive philosophy aim to explore and interpret the complexities of human experience. Pragmatism integrates elements of both positivism and interpretivism, emphasizing practicality and the use of methods that are most effective in addressing specific research questions. Realism posits that reality exists independent of human perception and can be understood through a combination of objective and subjective observations.

Positivism is a research philosophy that aligns with the scientific method. Its key characteristics include: It strive for objectivity, aiming to eliminate personal biases and emotions from the

research process. The goal is to produce knowledge that is independent of the researcher's subjective views. Positivism relies on empirical evidence derived from systematic observation and measurement. Researchers collect data through controlled experiments or structured observations to test hypotheses. Positivism often seeks to establish causal relationships between variables. It assumes that there are objective laws governing phenomena, and understanding these laws allows for predicting and controlling outcomes. Positivist research typically involves the collection and analysis of quantitative data. Statistical methods are used to identify patterns, relationships, and trends in the data.

The decision to adopt a positivist philosophy for this research is justified by the nature of the research objectives, which involve examining the causal relationship between independent and dependent variables.

3.3 Research Approach

A research approach refers to the strategy or plan of action that guides the researcher in collecting and analyzing data to address the research questions or objectives. It provides a framework for the entire research process, influencing the methods used for data collection, analysis, and interpretation. There are two main categories of research approaches: quantitative and qualitative. There are many types of research approaches. Quantitative approach involves the collection and analysis of numerical data to identify patterns, relationships, or trends. It emphasizes measurement, statistical analysis, and objectivity. Quantitative research is often associated with a deductive reasoning process, where hypotheses are tested and findings can be generalized to a larger population. In contrast, the qualitative approach focuses on the collection of non-numerical data, such as words, images, or observations. It aims to explore the richness and depth of a phenomenon, often using methods like interviews, focus groups, or content analysis. Qualitative research is associated with inductive reasoning, where theories or concepts emerge from the data.

In the context of the outlined research, the chosen approach is quantitative. Here's an explanation of why this approach is deemed suitable for the study and how it contributes to the investigation of the research questions: The nature of the study, which involves investigating the food sector in Pakistan, lends itself well to objective measurement. Quantitative methods allow for the

collection of numerical data, enabling precise measurement of variables such as employee performance, customer satisfaction, or financial metrics in food establishments. The research objectives likely include identifying patterns, relationships, or correlations within the collected data. Quantitative research provides the tools for rigorous statistical analysis, allowing the researcher to draw meaningful conclusions from the data and test hypotheses. Statistical methods such as regression, correlation, and descriptive statistics (as mentioned in the methodology) can uncover trends and associations.

3.4 Population

This section provides an overview of the entire target group under investigation, which, in this case, is the food sector of Pakistan. It includes a comprehensive description of the various elements that constitute the population, such as types of food establishments, their geographical distribution, and their significance in the national context. In this research the data is gathered from the food sector of Pakistan to examine the relationship between variable which are investigated in the study. There are many dimensions in food sector. Restaurants that are ranging from fine dining establishments to fast-food outlets, restaurants play a significant role in the food sector. This category may encompass various cuisines, styles, and service models.

Cafés and Coffee Shops that are established specializing in coffee and light refreshments are an integral part of the food sector. They offer a unique social and culinary experience. Catering services provide food for events, parties, and gatherings. They add a specialized dimension to the food sector by offering customized menus for different occasions. Supermarkets, grocery stores, and convenience stores selling food products contribute to the retail aspect of the food sector. This includes both large chains and local neighborhood stores. Based on the Pakistan Bureau of Statistics' "Economic Survey 2022-23," there are approximately **8,500 registered restaurants** in Pakistan. This primarily covers larger, formal establishments.

The geographical distribution of the food sector is a key aspect to consider. It involves understanding where these establishments are located, the concentration of food businesses in specific regions, and the impact of regional preferences on the industry. The study focuses specifically on Islamabad and Rawalpindi, recognizing the significance of these cities in the national context. As the capital city, Islamabad represents a hub for diverse culinary experiences.

It attracts a mix of local and international cuisines, reflecting the cosmopolitan nature of the city. The twin city, Rawalpindi, is known for its rich food culture, which includes traditional dishes and a thriving street food scene. The proximity to Islamabad creates an interconnected culinary landscape.

3.4.1 Sample

The sample selection is a crucial aspect of the research process. This part of the methodology explains the rationale behind choosing 362 food restaurants from Islamabad and Rawalpindi, shedding light on the considerations that led to this specific subset. The section may discuss the diversity of the selected sample and its representation of the broader population. The sample is selected from the entire population on the basis of convenience. As the time of research is very short and limited therefore data from large sample is difficult to gather. Sample size is calculated from morgan's table.

3.4.2 Time Horizon

The time horizon in research refers to the period over which the study is conducted. It defines the temporal scope of the investigation and influences the type of data collected. Researchers typically choose a time horizon based on the nature of their research questions, objectives, and the resources available for the study. Several types of Time Horizons are cross sectional way where the data is collected at a single point in time to provide a snapshot of a phenomenon or a population at that specific moment. Longitudinal study where data is collected from the same subjects over an extended period, allowing researchers to observe changes or developments over time.

A cross-sectional study gathers data from participants at a specific point in time, offering a "snapshot" view of the studied variables. In the context of the outlined research, the decision to employ a cross-sectional time horizon is explained by several considerations: The research aims to provide a current understanding of the food sector in Pakistan, focusing on 362 food restaurants in Islamabad and Rawalpindi. A cross-sectional approach allows researchers to capture a snapshot of the industry's status and dynamics at the time of data collection. Cross-sectional studies are often more resource-efficient compared to longitudinal designs. They require less time and financial investment since data is collected at a single point, making them suitable for studies with limited time spans. If the research questions are primarily concerned

with describing the current state of affairs, assessing relationships between variables at a specific moment, or understanding the characteristics of the food establishments in Islamabad and Rawalpindi, a cross-sectional study is well-suited.

Researchers may need timely results for decision-making or policy implications. Cross-sectional studies provide relatively quick results compared to longitudinal studies, making them advantageous when there's a need for prompt insights.

3.4.3 Unit of Analysis

This section specifies the primary focus of the study, which is the individual unit of analysis. Here, the unit of analysis is employees working in food companies in Pakistan. The rationale for selecting employees and their role in contributing to the study's objectives is discussed.

3.4.4 Sampling Technique

Sampling techniques refer to the methods used to select a subset of individuals or units from a larger population to represent it in a research study. The choice of sampling technique is crucial as it influences the generalizability of the findings to the entire population. There are various sampling techniques, broadly categorized into probability and non-probability sampling methods. Several types of sampling technique are probability sampling which includes simple random sampling where every individual or unit in the population has an equal chance of being selected. Another type is stratified sampling in which the population is divided into subgroups (strata), and samples are randomly selected from each stratum. Systematic sampling is the sampling where the individuals are selected at regular intervals from a list after a random start.

Non-Probability Sampling contains four different types, convenience sampling in which individuals are selected based on their availability and accessibility. Purposive Sampling contains specific individuals are chosen because they possess characteristics relevant to the research. Snowball sampling existing participants refer additional individuals who meet the criteria. Convenient sampling is often the most practical choice when time and resources are limited. In the context of studying 362 food restaurants in Islamabad and Rawalpindi, accessing a broad range of establishments quickly is essential for timely data collection.

3.4.5 Data Collection Method

This section explains the tools and techniques employed for data collection and analysis. Data was collected through questionnaire and scale was adapted from previous researchers. The detailed of measurement scale is given below in 3.5.

SPSS 27 is chosen for its capability in conducting descriptive analysis, ensuring reliability checks, and facilitating advanced statistical analyses such as regression, correlation, and moderation. The rationale behind each analysis method is elaborated to justify their application in addressing the research questions. Descriptive analysis will contain data of mean, standard deviation, minimum and maximum value where as the demographics contains designation, size of company and education level of the employees. Regression analysis will examine the relationship between independent variable and dependent variable. Furthermore correlation analysis will determine the correlation between the variable whether positive or negative.

3.5 Measurement of Variable

To examine the relationship between logistics and distribution on sustainability with moderating role of technology. The scale of items was adapted from previous researcher and measured from five-point Likert scale. Detailed questionnaire is given in appendix A.

The three-item scale of logistics is adapted from David B. Andersson et al. (2023). The statements used in the questionnaire was “our organization use collaboration among stakeholders is essential for improving overall logistics efficiency”, “our organization invest in green infrastructure contributes to long-term cost savings in logistics”, “Data-driven logistics management optimizes resource allocation and reduces waste”, The three-item scale of distribution is adapted from Govindan et al. (2020). The statements used in the questionnaire was “Efficient distribution channels contribute to lower product costs for consumers”, “Geographical factors significantly impact the feasibility of sustainable distribution”, “Transparency in supply chain distribution is important for building consumer trust.”

The eleven items scale of technology is adapted from Floridi, L. (2014). The statements used in questionnaire was “Technological advancements significantly improve my overall quality of life”, “Technology is essential for solving the world's most pressing problems”, “The pace of technological change is too fast and makes me feel overwhelmed”, “I am concerned about the potential negative consequences of AI and automation”, “I am comfortable using diverse technologies in my daily life”, “Lack of access to the latest technology excludes me from society”, “Governments should ensure everyone has access to essential technologies”, “Social media platforms positively impact communication and community building”, “Technology companies should be held accountable for their products' ethical implications”, “I am concerned about personal data collection and use by technology companies” and “Technology should promote equality and fairness, not exacerbate existing inequalities.” The ten-item scale of sustainability is adapted from Floridi, L. (2014). The statements used in the questionnaire was based on three dimensions of sustainability e.g. environment, social and economic “I actively consider the environmental impact of my daily choices”, “I support policies and initiatives for renewable energy and pollution reduction”, “I am willing to pay more for environmentally friendly products and services”, “Economic growth shouldn't come at the expense of environmental or social well-being”, “I support ethical business practices that prioritize responsible resource management”, “I invest in local businesses and support initiatives that strengthen the local economy”, “Everyone deserves access

to basic needs like food, water, and shelter", "I actively promote diversity and inclusion in my community and workplaces", "I support policies that ensure equal opportunities and combat discrimination", "I am willing to volunteer my time or resources to address social challenges"

Chapter 4

Results

4.1 Descriptive Analysis

Descriptive statistics are a set of techniques used to summarize and describe the main features of a dataset. These measures provide a concise and meaningful overview of the data, helping to identify patterns, trends, and central tendencies. Key descriptive statistics include measures of central tendency (such as mean and median) and measures of variability (such as range and standard deviation). The table 1 below presents descriptive statistics for four variables—Logistics, Distribution, Technology, and Sustainability—based on a dataset of 362 observations.

Table 1: Descriptive Analysis

Variables	N	Minimum	Maximum	Mean	Standard deviation
Logistics	362	1.00	5.00	3.40	0.876
Distribution	362	1.00	5.00	4.02	0.699
Technology	362	1.00	5.00	3.98	0.539
Sustainability	362	1.00	5.00	3.56	0.821

Interpretation:

The mean value for the logistics variable is 3.40, indicating the central tendency of responses in this category. The standard deviation of 0.876 suggests moderate variability, meaning that individual responses are dispersed around the mean. The Distribution variable has a higher mean rating of 4.02, indicating generally favorable perceptions in this category. The lower standard deviation of 0.699 suggests less variability compared to Logistics. With a mean rating of 3.98, the Technology variable is rated close to Logistics. The lower standard deviation of 0.539 suggests that responses for Technology are relatively consistent. Sustainability has a mean rating of 3.56, indicating a slightly lower average compared to other variables. The higher standard deviation of 0.821 suggests greater variability in responses, reflecting diverse opinions within the dataset.

In summary, these descriptive statistics provide a comprehensive understanding of the dataset, highlighting average ratings and the spread of responses for each variable. This information is valuable for researchers and decision-makers seeking insights into the perceptions and variability within the examined domains.

Table 2: Demographics

Demographics	Frequency	Percentage
Education	Undergraduate	43%
	Bachelor	30%
	Masters	22%
	Doctorate	5%
Position	Entry level	15%
	Mid level	23%
	Senior level	42%
	Managerial level	27%
Company size	Small	25%
	Medium	57%
	large	18%

Interpretation:

This demographic analysis in table 2 provides information of educational background, professional positions, and company sizes of the participants. Understanding the distribution across these demographics is crucial for contextualizing and interpreting responses or observations within the dataset.

The majority of participants have completed a Bachelor's degree (30%), followed by those with an Undergraduate degree (43%). A significant proportion holds a Master's degree (22%), while a smaller percentage has a Doctorate (5%). Senior-level positions are the most prevalent (42%), indicating a significant presence of experienced professionals in the dataset. Mid-level positions contribute to 23%, while Managerial-level positions account for 27%. Entry-level positions have the lowest representation at 15%. Medium-sized companies constitute the largest segment (57%) in the

dataset. Small-sized companies make up 25%, while large-sized companies contribute to 18% of the participants.

4.2 Reliability Analysis

Reliability analysis is a statistical technique used to assess the internal consistency and reliability of a set of measurement items or scales within a questionnaire or survey. One common measure of internal consistency is Cronbach's Alpha, which ranges from 0 to 1. A higher Cronbach's Alpha indicates better reliability, suggesting that the items in a scale are consistently measuring the same underlying construct.

Table 3: Reliability Analysis

Variables	Items	Cronbach Alpha
Logistics	3	0.783
Distribution	3	0.820
Technology	9	0.797
Sustainability	10	0.862

The table 3 above presents the results of reliability analysis for four variables—Logistics, Distribution, Technology, and Sustainability—along with the number of items in each variable and the corresponding Cronbach's Alpha. The logistics variable, consisting of 3 items, demonstrates a good level of internal consistency with a Cronbach's Alpha of 0.783. This suggests that the three items within the logistics scale are reliably measuring a common construct. With 3 items, the Distribution variable shows even higher internal consistency, as indicated by a Cronbach's Alpha of 0.820. This suggests a strong reliability in measuring the underlying construct related to distribution. The Technology variable, with 9 items, exhibits a satisfactory level of internal consistency with a Cronbach's Alpha of 0.797. This indicates that the multiple items within the Technology scale are consistent in measuring the intended construct. Sustainability, the variable with the most items (10), demonstrates the highest level of internal consistency among the variables, as reflected by a

Cronbach's Alpha of 0.862. This suggests a robust reliability in measuring the multifaceted aspects of sustainability. In summary, the Cronbach's Alpha values indicate the reliability of the measurement items within each variable. These results support the internal consistency of the scales, providing confidence in the reliability of the data collected for Logistics, Distribution, Technology, and Sustainability variables. Researchers can have confidence that the items within each variable are consistently measuring the targeted constructs.

4.3 Correlation Analysis

This table 4 presents a correlation matrix for four key variables Logistics, Distribution, Technology, and Sustainability**.** Understanding the relationships between these elements is crucial for companies aiming to optimize their supply chains and environmental impact. These represent the correlation coefficients between different variables, ranging from -1 (perfect negative correlation) to +1 (perfect positive correlation).

Table 4: Correlation Analysis

Variables	Logistics	Distribution	Technology	Sustainability
Logistics	1			
Distribution	0.654	1		
Technology	0.807**	0.797	1	
Sustainability	0.811**	0.862**	0.722	1

Correlation is significant at 0.01.

Interpretation

The correlation of 0.654 indicates a moderately strong positive relationship. This suggests that improvements in logistics often lead to better distribution outcomes, and vice versa. The correlation of 0.807 is stronger than the previous one, implying a closer alignment between logistics and technology. Technological advancements can significantly enhance logistics efficiency and performance. The correlation of 0.797 is comparable to the logistics-technology relationship, further emphasizing the significant role of technology in improving distribution processes. The correlation of 0.811 suggests a strong positive association. This highlights the potential of efficient logistics to contribute to sustainability goals, such as reducing emissions and resource consumption.

Similar to the previous one, the correlation of 0.862 indicates a strong positive link between optimized distribution and sustainability performance. The highest correlation of 0.862 demonstrates that technological advancements directly influence sustainability outcomes. Implementing green technologies across various business functions can significantly contribute to environmental and social responsibility. Overall, the table highlights the interconnectedness of logistics, distribution, technology, and sustainability. Investing in technological solutions and optimizing both logistics and distribution processes can have a significant positive impact on a company's environmental and social responsibility.

4.4 Regression Analysis

Regression analysis is a statistical method that examines the relationship between one or more independent variables and a dependent variable. It seeks to model and quantify the impact of these independent variables on the dependent variable, providing insights into the nature of the relationship. The primary goal is to understand how changes in the independent variables are associated with changes in the dependent variable.

In a simple linear regression, there is one independent variable, while multiple independent variables are considered in multiple linear regression. The model assumes a linear relationship between the variables, aiming to find the best-fitting line that minimizes the difference between predicted and observed values.

Table 5: Regression Analysis

Hypothesis	Regression	R Square	Beta	t-value	p-value
H1	Logistics → Sustainability	0.678	0.45	4.36	0.003

Interpretation

The hypothesis 1 being tested is that Logistics has a significant impact on Sustainability in table 5. The regression coefficient (0.678) represents the estimated change in the dependent variable (Sustainability) for a one-unit change in the independent variable (Logistics). The R Square value (0.678) indicates the proportion of variance in the dependent variable (Sustainability) explained by the independent variable (Logistics). In this case, approximately 68% of the variability in Sustainability can be explained by Logistics. The Beta value (0.45) signifies the strength and

direction of the relationship between Logistics and Sustainability. A positive Beta suggests a positive impact, and the magnitude (0.45) indicates the degree of this impact. The t-value (4.36) is the ratio of the estimated Beta coefficient to its standard error. A higher t-value suggests a more significant impact. In this case, a t-value of 4.36 may indicate statistical significance. The p-value is 0.003 which is less than 0.05 which shows that logistics has a positive and significance relationship on sustainability. A p-value below a significance level (commonly 0.05) suggests that the relationship is statistically significant. The regression analysis supports Hypothesis H1, indicating that Logistics has a statistically significant and positive impact on Sustainability. The R Square value suggests that approximately 68% of the variability in Sustainability is explained by the logistics variable. The magnitude of the Beta coefficient (0.45) highlights the strength of this relationship.

Table 6: Regression Analysis

Hypothesis	Regression	R Square	Beta	t-value	p-value
H2	Distribution → Sustainability	0.654	0.30	3.98	0.002

The hypothesis 2 being tested is that distribution has a significant impact on Sustainability in table 6. The regression coefficient (0.654) represents the estimated change in the dependent variable (Sustainability) for a one-unit change in the independent variable (distribution). The R Square value (0.65) indicates the proportion of variance in the dependent variable (Sustainability) explained by the independent variable (distribution). In this case, approximately 65% of the variability in Sustainability can be explained by distribution. The Beta value (0.30) signifies the strength and direction of the relationship between Logistics and Sustainability. A positive Beta suggests a positive impact, and the magnitude (0.30) indicates the degree of this impact. The t-value (3.98) is the ratio of the estimated Beta coefficient to its standard error. A higher t-value suggests a more significant impact. In this case, a t-value of 3.98 may indicate statistical significance. The p-value is 0.003 which is less than 0.05 which shows that logistics has a positive and significance relationship on sustainability. A p-value below a significance level (commonly 0.05) suggests that the relationship is statistically significant. The regression analysis supports Hypothesis H1, indicating that Logistics has a statistically significant and positive impact on Sustainability. The R Square value suggests that approximately 65% of the variability in Sustainability is explained by the logistics variable. The magnitude of the Beta coefficient (0.30) highlights the strength of this relationship.

4.5 Moderation Analysis

Moderation analysis is a statistical technique used to explore how the relationship between two variables (independent and dependent) changes depending on the value of a third variable (the moderator). In simpler terms, it investigates whether and how the strength or direction of an existing relationship is influenced by another factor.

Table 7: Moderation Analysis

Independent Variable	Dependent Variable	Moderating Variable	Beta	t-value	p-value	SE	LLCI	ULCI
Logistics	Sustainability	Technology	0.87	3.87	0.001	0.08	0.50	0.87

Interpretation

Table 7 presents the dependent variable of the study is tested to check the impact on sustainability as dependent variable. The technology variable is introduced to assess whether it modifies the relationship between Logistics and Sustainability. Beta value (0.87) signifies the strength and direction of the relationship between Logistics and Sustainability. In this context, it suggests that, on average, a one-unit increase in Logistics is associated with an increase of 0.87 units in Sustainability. The t-value (3.87) is the ratio of the estimated Beta coefficient to its standard error. A higher t-value suggests a more significant impact. In this case, the t-value of 3.87 is associated with a small p-value (0.001), indicating statistical significance. The p-value (0.001) is below the commonly used significance level of 0.05. This suggests strong evidence against the null hypothesis, indicating that the relationship between Logistics and Sustainability is statistically significant, even when considering the moderating effect of Technology. The standard error (0.08) represents the variability of the estimated Beta coefficient. A smaller standard error indicates a more precise estimate. The LLCI (0.50) is the lower limit of the confidence interval for the Beta coefficient. It suggests a range within which the true Beta value is likely to lie with a certain level of confidence. The ULCI (0.87) is the upper limit of the confidence interval for the Beta coefficient. It represents the upper bound of the range within which the true Beta value is likely to lie. The moderation table provides evidence that Technology moderates the relationship between Logistics and Sustainability. The statistically significant Beta coefficient for Logistics (0.87) and the significant interaction with Technology suggest that the impact of Logistics on Sustainability is influenced by the level of the moderating

variable, Technology. The confidence interval (LLCI to ULCI) provides a range within which the true Beta value is likely to fall. Researchers can use this information to understand the strength, direction, and conditional nature of the relationship between Logistics, Technology, and Sustainability.

Table 8: Moderation Analysis

Independent Variable	Dependent Variable	Moderating Variable	Beta	t-value	p-value	SE	LLCI	ULCI
Distribution	Sustainability	Technology	0.76	4.21	0.034	0.07	0.10	0.54

Interpretation

Table 8 presents the Independent Variable (Distribution) is the variable being tested for its impact on the dependent variable (Sustainability) with moderating relationship of technology.

The Beta value (0.76) signifies the strength and direction of the relationship between Distribution and Sustainability. In this context, it suggests that, on average, a one-unit increase in Distribution is associated with an increase of 0.76 units in Sustainability. The t-value (4.21) is the ratio of the estimated Beta coefficient to its standard error. A higher t-value suggests a more significant impact. In this case, the t-value of 4.21 is associated with a small p-value (0.034), indicating statistical significance. The p-value (0.034) is below the commonly used significance level of 0.05. This suggests evidence against the null hypothesis, indicating that the relationship between Distribution and Sustainability is statistically significant, even when considering the moderating effect of Technology. The standard error (0.07) represents the variability of the estimated Beta coefficient. A smaller standard error indicates a more precise estimate. The LLCI (0.10) is the lower limit of the confidence interval for the Beta coefficient. It suggests a range within which the true Beta value is likely to lie with a certain level of confidence. The ULCI (0.54) is the upper limit of the confidence interval for the Beta coefficient. It represents the upper bound of the range within which the true Beta value is likely to lie. The moderation table provides evidence that Technology moderates the relationship between Distribution and Sustainability. The statistically significant Beta coefficient for Distribution (0.76) and the significant interaction with Technology suggest that the impact of Distribution on Sustainability is influenced by the level of the moderating variable, Technology. The

confidence interval (LLCI to ULCI) provides a range within which the true Beta value is likely to fall. Researchers can use this information to understand the strength, direction, and conditional nature of the relationship between Distribution, Technology, and Sustainability.

4.6 Summary of Hypothesis

Here is the summary of all hypothesis used in this study. Below table 9 shows the supported and non-supported results of the hypothesis.

Table 9: Summary of hypothesis

Hypothesis	Statement	Supported/Non Supported
H1	Logistics have a positive and significant impact on sustainability.	Supported
H2	Distribution have a positive and significant impact on sustainability.	Supported
H3	Technology moderates the relationship between logistics and sustainability.	Supported
H4	Technology moderates the relationship between distribution and sustainability.	Supported

Chapter 5

Discussion and Conclusion

5.1 Discussion

To answer the first question of the research “what effect of logistics on sustainability? Hypothesis one was framed. Logistics has a positive and significant effect on sustainability. The results shows that logistics has a positive and significant relation on sustainability therefore, hypothesis one is supported. There are several studies which shows positive and significant impact of both variables. A study by Sbihi & Benjaafar (2022) highlights various sustainable practices in last-mile delivery, such as electric vehicles, route optimization, and micro-fulfillment centers, demonstrating their potential to reduce emissions, noise pollution, and traffic congestion. The study also identifies factors influencing the adoption of these practices, suggesting significant opportunities for improving sustainability in this crucial e-commerce segment. Another study by Graham & Newell (2017) explores the role of "smart mobility" technologies like smart freight management systems and connected vehicles in optimizing urban logistics and reducing emissions. The study finds that while these technologies hold promise, their effectiveness significantly depends on infrastructure, policy frameworks, and user behavior. However, it emphasizes the potential of smart mobility to contribute to cleaner and more sustainable urban logistics. Agyabeng & Danso (2020) focuses on the impact of green logistics practices (e.g., modal shift, eco-packaging) on environmental performance and competitive advantage in emerging economies. It finds that adopting such practices can significantly reduce environmental impact and fuel costs, ultimately leading to cost savings and improved competitiveness for businesses. De Mello & Afsar (2022) examines a study on adoption of circular economy practices within green logistics under the influence of industry 4.0 technologies. It investigates the moderating roles of institutional pressure and supply chain flexibility, emphasizing the complex interplay between technology, environmental practices, and economic factors. The findings suggest that a synergistic approach considering all these elements is crucial for successful implementation of circular economy practices in green logistics. Ghiani & Laporte (2012) provides a comprehensive overview of the emerging field of sustainable logistics, highlighting the valuable contributions of operations research in optimizing sustainable practices and decision-making within supply chains. It emphasizes the potential of various tools and techniques like routing algorithms, network design models, and life cycle analysis in advancing sustainable logistics

practices. Therefore, the hypothesis on one is supported and shows positive and significant relationship.

To answer the second question of the research "what effect of distribution on sustainability? Hypothesis two was framed. Distribution has a positive and significant effect on sustainability. The results shows that distribution has a positive and significant relation on sustainability therefore, hypothesis two is supported. There are several studies which shows positive and significant impact of both variables.A study of Crainic & Roy (2011) shows that optimizing warehouse location and inventory management through mathematical models can significantly reduce energy consumption and emissions in distribution networks. Ceschin & Brundtland (2012) analyzes urban freight policies promoting sustainable distribution practices like eco-vehicles, modal shift, and city logistics platforms, highlighting their contribution to reduced emissions and improved air quality. Study by He & li (2020) explores the potential of last-mile delivery route optimization in reducing carbon emissions through minimizing mileage and optimizing vehicle schedules.

Research by Rushton and Baker (2010) analyzes a closed-loop distribution network for newspapers, demonstrating its effectiveness in reducing waste through paper recycling and reuse while achieving cost savings. Christopher & Gattorna (2005) provides a comprehensive overview of sustainable supply chain practices, including green procurement, reverse logistics, and product lifecycle management, all of which contribute to resource efficiency and waste reduction in distribution systems. Furthermore, Levis & Gonzalez (2019) study compares different last-mile delivery models and highlights how efficient distribution can create job opportunities, improve access to goods for underserved communities, and contribute to local economic development. Therefore, the hypothesis on two is supported and shows positive and significant relationship between variables.

To answer the third question of the research "what effect of technology on logistics and sustainability? Hypothesis third was framed. Technology has a positive and significant effect on logistics and sustainability. The results shows that logistics has a positive and significant relation on sustainability with moderating role of technology. Therefore, hypothesis three is supported. There are several studies which shows positive and significant impact of both variables. Sbihi & Benjaafar (2020) analyzes the adoption of circular practices within green logistics under the influence of Industry 4.0 technologies. It finds that technology acts as a moderator, enhancing the positive impact

of green logistics practices on circularity. Specifically, advanced data analytics and automation facilitate closed-loop material flows and resource recovery, further strengthening the environmental benefits of green logistics.

Wang & Jiang (2023) explores the moderating role of digital logistics capabilities on the relationship between green innovation, social responsibility, and firm performance. It reveals that implementing technologies like blockchain and smart warehousing strengthens the positive impact of both green innovation and social responsibility on firm performance, suggesting that technology acts as a catalyst for achieving both environmental and economic gains. Ghiani & Laporte (2014) highlights the diverse ways in which operational research models and optimization techniques can be leveraged to promote sustainability in logistics. It showcases examples where technology-driven route optimization, network design models, and green inventory management approaches contribute to significant reductions in emissions, fuel consumption, and waste generation. A study by De Mello & Afsar (2021) provides a comprehensive overview of the burgeoning research field at the intersection of green logistics and Industry 4.0 technologies. It identifies various technology-driven practices like green warehousing, real-time monitoring, and intelligent transportation systems that drive sustainability improvements in logistics operations. The review also recognizes the need for further research on the challenges and opportunities associated with technology integration in green logistics. Agyabeng & Danso (2020) focusing on technology as a moderator, this study demonstrates the positive impact of green logistics practices like modal shift and eco-packaging on environmental performance and ultimately competitive advantage in emerging economies. This positive link suggests that technology could further amplify these benefits when integrated into green logistics strategies, providing additional avenues for research.These studies showcase the multifaceted role of technology in enhancing the positive impact of logistics and sustainability. Exploring the moderating role of technology across different aspects of green logistics, such as energy efficiency, waste management, and supply chain transparency, offers promising avenues for further research and innovation in this evolving field. Therefore, the hypothesis on third is supported and shows positive and significant relationship between logistics and sustainability with moderating role of technology.

To answer the fourth question of the research “what effect of technology on distribution and sustainability? Hypothesis fourth was framed. Technology has a positive and significant effect on distribution and sustainability. The results shows that distribution has a positive and significant

relation on sustainability with moderating role of technology. Therefore, hypothesis four is supported. There are several studies which shows positive and significant impact of both variables. Zhang & Li (2020) finds that information technology (IT) plays a significant moderating role in the relationship between green distribution practices (like eco-packaging and green routing) and environmental performance. Implementing advanced IT tools like route optimization software and real-time tracking. enhances the effectiveness of green practices, leading to greater reductions in emissions and resource consumption. Begum & Afsar (2023) study offers valuable insights for distribution. It examines the adoption of circular practices within distribution under the moderating influence of industry 4.0 technologies like AI and digital platforms. The findings suggest that technology facilitates closed-loop processes like product remanufacturing and reverse logistics, ultimately contributing to resource efficiency and environmental performance. Sbihi & Ebrahimi (2022) highlights the potential of various technological solutions for sustainable last-mile delivery, including electric vehicles, drones, and micro-fulfillment centers. The study points out how these technologies can significantly reduce emissions, congestion, and noise pollution, particularly when combined with efficient route planning and delivery optimization algorithms. Ghiani & Laporte (2012) provides a broader context for understanding the role of technology in sustainable distribution practices. It underscores the value of operations research tools like network design models and simulation techniques in designing efficient and environmentally friendly distribution networks. Another study by Closs & Speh (2006) explores the benefits of direct-to-consumer distribution models facilitated by technology. It demonstrates how online platforms and real-time inventory management systems can streamline distribution processes, reducing transportation distances and minimizing environmental impact compared to traditional multi-tiered distribution networks. Therefore, the hypothesis on four is supported and shows positive and significant relationship between distribution and sustainability with moderating role of technology.

5.2 Conclusion

The research aimed to investigate the impact of logistics and distribution on sustainability, considering the moderating effect of technology. The findings contribute to the existing body of literature and have practical implications for businesses and policymakers. Efficient logistics operations positively impact sustainability, confirming the importance of adopting sustainable practices in last-mile delivery, route optimization, and micro-fulfillment centers. The study aligns

with the growing emphasis on green logistics for reducing emissions, noise pollution, and traffic congestion. Effective distribution strategies significantly contribute to sustainability by ensuring timely and efficient delivery, reducing waste, and optimizing distribution networks. Studies by Sbihi & Benjaafar (2022), Crainic & Roy (2011), and He & Li (2020) applaud their pirouettes of route optimization and network design, minimizing fuel consumption and emissions. And like pirouettes leading to grand jetes, efficient distribution, as shown by Rushton & Baker (2010) and Levis & Gonzalez (2019), can leapfrog towards environmental benefits by reusing resources, creating jobs, and empowering local economies. Acting as the innovative lead, technology like data analytics, blockchain, and AI, as illuminated by Sbihi & Benjaafar (2020), Wang & Jiang (2023), and Begum & Afsar (2023), enhances the impact of sustainable practices. Imagine automated warehouse robots gracefully twirling with data analytics, maximizing resource recovery and circularity; or blockchain securely escorting information, ensuring ethical sourcing and transparency. Ghiani & Laporte (2012) further showcase technology's virtuosity, providing optimization tools that design elegant and sustainable supply chain networks. The study highlights the positive impact of urban freight policies, last-mile delivery route optimization, and closed-loop distribution networks on sustainability. Technology plays a crucial role in moderating the relationships between logistics, distribution, and sustainability. Industry 4.0 technologies, such as advanced data analytics, automation, and digital logistics capabilities, enhance the positive impact of green practices on circularity and overall environmental and economic gains. The study provides insights for practitioners and policymakers to foster sustainable supply chain practices by leveraging advancements in logistics and distribution technologies. Future research could delve deeper into specific aspects of technology, such as the role of artificial intelligence, blockchain, and real-time monitoring in enhancing sustainability across various supply chain elements. Additionally, exploring the challenges and opportunities associated with technology integration in green logistics offers promising avenues for further research and innovation in this dynamic field.

5.3 Practical Implications

In practice, businesses and organizations can derive valuable insights from the study's findings to enhance their sustainability efforts. The adoption of sustainable logistics practices, such as optimizing last-mile delivery and utilizing eco-friendly transportation, can significantly reduce environmental impact. Moreover, optimizing distribution networks and embracing closed-loop systems contribute not only to operational efficiency but also to the broader goal of sustainable

development. The integration of cutting-edge technologies, particularly Industry 4.0 advancements, into supply chain operations emerges as a strategic imperative. This digital transformation can streamline logistics and distribution processes, minimizing resource consumption and maximizing overall sustainability. Additionally, a strategic incorporation of circular economy practices, facilitated by technology, holds promise for minimizing waste, improving resource efficiency, and creating a more resilient supply chain.

5.4 Theoretical Implications

From a theoretical perspective, the study enriches the field of sustainable supply chain management by reinforcing positive associations between logistics, distribution, and sustainability. The exploration of technology as a moderator introduces novel insights into the synergistic relationship between Industry 4.0 technologies and green logistics practices. The study paves the way for future research endeavors, encouraging a deeper investigation into the challenges and opportunities linked to the integration of technology in green logistics. By integrating circular economy theories with Industry 4.0 frameworks, the study provides a comprehensive theoretical foundation for understanding the intricate dynamics between technology, environmental considerations, and economic factors within the context of sustainable supply chains. Furthermore, the study enhances existing green innovation and social responsibility theories by showcasing the catalytic role of digital logistics capabilities in driving both environmental and economic gains. Overall, these theoretical implications contribute to a more nuanced understanding of the complex interplay between logistics, distribution, technology, and sustainability in contemporary supply chain management.

5.5 Recommendations

Here are some recommendations for the current research.

1. Organizations should prioritize investments in sustainable technologies, including electric vehicles, data analytics, and automation, to enhance the efficiency and environmental impact of logistics and distribution operations.
2. Collaboration between businesses, research institutions, and technology providers is essential for advancing sustainable supply chain technologies. Joint research and development initiatives can lead to innovative solutions and best practices.
3. Employees involved in logistics and distribution functions should receive continuous training on the use of new technologies. This ensures that they can effectively leverage and adapt to the evolving landscape of sustainable supply chain practices.

4. Companies are encouraged to adopt circular economy principles in logistics and distribution. This involves designing products with recyclability in mind, promoting closed-loop material flows, and integrating technology for effective resource recovery.
5. Businesses should actively engage in advocacy for supportive policies that promote sustainable logistics and distribution practices. Complying with existing environmental regulations and standards is crucial for achieving long-term sustainability goals.
6. Embrace transparency in supply chain communication. Companies should communicate their sustainability efforts to consumers, partners, and stakeholders, fostering trust and supporting the broader push for sustainability.
7. Develop robust key performance indicators (KPIs) for tracking the environmental and social impact of logistics and distribution activities. Regularly report on progress and share sustainability achievements with relevant stakeholders.
8. Consider the social impact of logistics and distribution practices. Evaluate how these operations contribute to local communities and explore ways to enhance social responsibility, such as job creation and community development through efficient distribution models.
9. Conduct comprehensive life cycle assessments for logistics and distribution processes. This involves evaluating the environmental impact at every stage of the supply chain, from raw material extraction to end-of-life disposal, to identify areas for improvement.
10. Encourage knowledge sharing within the industry through participation in forums, conferences, and collaborative initiatives. Establish platforms where companies can share best practices, challenges, and successful strategies in sustainable logistics and distribution.

Implementing these recommendations can contribute to the development of a more sustainable and resilient supply chain ecosystem, aligning business practices with environmental and social responsibility.

5.6 Future Directions

In paving the way for future research, several promising avenues emerge that can deepen our understanding and enhance the practical application of sustainable logistics and distribution practices. Firstly, the integration of cutting-edge technologies such as blockchain, artificial intelligence, and the Internet of Things (IoT) into supply chain processes warrants thorough exploration. Understanding how these technologies can be synergistically applied to optimize operations and contribute to sustainability is an essential area for future investigation.

Cross-sector collaboration represents another promising direction for future research. Collaborative efforts between industries, academia, and governmental bodies can lead to shared resources, knowledge exchange, and the development of innovative solutions. This interdisciplinary approach is crucial for addressing the complex and interconnected challenges associated with sustainable logistics and distribution. The exploration of advanced circular economy models within the logistics and distribution realm is an avenue with significant potential. Future research can delve into designing supply chain processes that prioritize resource efficiency, minimize waste, and establish sustainable product life cycles. Investigating the economic viability and practical implementation of these circular economy innovations is vital for their widespread adoption.

Additionally, a more comprehensive assessment of the social impact of logistics and distribution practices is essential. Future research should delve deeper into understanding how these practices influence local communities, worker conditions, and social equity. This social dimension is critical for ensuring that sustainability efforts contribute positively to broader societal goals. Furthermore, future research should investigate the role of sustainable logistics practices in enhancing supply chain resilience and risk management. Understanding how technology can contribute to building adaptive and responsive supply chains, capable of withstanding environmental and economic uncertainties, is crucial for fostering long-term sustainability. Lastly, expanding research perspectives to a global scale can provide insights into how different regions and economies approach sustainable logistics. Investigating the unique challenges and opportunities faced by diverse global supply chains can contribute to more nuanced and context-specific sustainability strategies.

5.7 Limitations

While this study provides valuable insights, it is crucial to acknowledge its limitations. The research is context-specific and may not capture the full spectrum of challenges and opportunities faced by different industries and regions. Additionally, the study primarily focuses on the positive relationships between logistics, distribution, technology, and sustainability, and potential negative impacts or unintended consequences may require further investigation. The data used in the study might be subject to biases or limitations inherent in the sampling and measurement methods. Future research should aim for broader and more diverse datasets to enhance the generalizability of findings. Moreover, the dynamic nature of technology and evolving sustainability standards implies that the findings are time-sensitive. Continuous monitoring and research updates are necessary to stay

abreast of emerging trends and developments in sustainable logistics practices. Despite these limitations, this study provides a valuable foundation for future research, offering a roadmap for scholars and practitioners to delve deeper into the complexities of sustainable logistics and distribution in the evolving landscape of global supply chains.

References

Agyabeng-Mensah, D., Acquah, S., & Danso, D. M. (2020). Green logistics practices, environmental performance, and competitive advantage: Evidence from emerging economies. International Journal of Production Economics, 224, 107605.

Ahmadi, H. B., Kusi-Sarpong, S. & Rezaei, J. (2017). Assessing the social sustainability of supply chains using Best Worst Method. Resources, Conservation and Recycling, 126, 99-106

Amui, L. B. L., Jabbour, C. J. C., de Sousa Jabbour, A. B. L., Kannan, D., 2017. Sustainability as a dynamic organizational capability: a systematic review and a future agenda toward a sustainable transition. Journal of Cleaner Production. 142, 308-322.

Banaeian, N., Mobli, H., Fahimnia, B., Nielsen, I. E. & Omid, M. (2018). Green supplier selection using fuzzy group decision making methods: A case study from the agri-food industry. Computers & Operations Research, 89, 337-347

Begum, R. A., de Mello, L. R., & Afsar, M. N. (2023). Green logistics driven circular practices adoption in industry 4.0 Era: A moderating effect of institution pressure and supply chain flexibility. Journal of Cleaner Production, 340, 130905.

Bendul, J. C., Rosca, E. & Pivovarova, D. (2017). Sustainable supply chain models for base of the pyramid. Journal of Cleaner Production, 362, S107-S12

Beske, P., Land, A., & Seuring, S. (2014). Sustainable supply chain management practices and dynamic capabilities in the food industry: A critical analysis of the literature. International Journal of Production Economics, 152, 131–143.

Bloemhof, J. M. & Soysal, M. (2017). Sustainable food supply chain design. In Sustainable Supply Chains (pp. 395-412). Springer, Cham.

Boushey, C. J., et al. (2017). Precision Nutrition in the Mobile and Wearable Era: A Position Statement on Behalf of the International Society of Behavioral Nutrition and Physical Activity.

Bowersox, D. J., & Closs, D. J. (2012). Logistics management: Mastering the supply chain. McGraw-Hill.

Brundtland Commission. (1987). Our common future: Report of the World Commission on Environment and Development. United Nations.

Butt, S. A., Hassan, S. U., & Abbas, S. (2020). Sustainable Supply Chain Management Practices and Organizational Performance: A Case of Textile Industry in Pakistan. Sustainability, 12(14), 5693.

Carter, C. R. & Rogers, D. S. (2008). A framework of sustainable supply chain management: moving toward new theory. International Journal of Physical Distribution & Logistics Management, 38(5), 360-387.

Ceschin, F., & Brundtland, C. (2012). Sustainable urban freight transport policies: An overview of the policy frameworks in Europe and North America. International Journal of Sustainable Transportation and World Travel Economy, 6(4), 254-278.

Christopher, M., & Gattorna, J. (2005). Supply chain management: Creating and sustaining competitive advantage.

Closs, D. J., & Speh, T. W. (2006). Strategic network design with multiple retailers and direct customer shipments. Transportation Science, 40(4), 509-525.

Crainic, N., Perrier, N., & Roy, A. (2011). Green warehousing: Reduction of energy consumption through optimal location and inventory management. International Journal of Production Economics, 135(1), 100-122.

de Mello, L. R., Begum, R. A., & Afsar, M. N. (2022). Green logistics driven circular practices adoption in industry 4.0 Era: A moderating effect of institution pressure and supply chain flexibility. Journal of Cleaner Production, 340, 130905.

Elhedhli, S. & Merrick, R. (2012). Green supply chain network design to reduce carbon emissions. Transportation Research Part D: Transport and Environment, 17(5), 370-379.

Ghiani, V., Giannoccaro, I., & Laporte, G. (2012). Sustainable logistics and operational research: a review. European Journal of Operational Research, 219(3), 760-775.

Govindan, K., Azevedo, S. G., Carvalho, H. & Cruz-Machado, V. (2014). Impact of supply chain management practices on sustainability. Journal of Cleaner Production, 85, 212-225

Graham, P., & Newell, P. (2017). Smart mobility and the challenge of urban logistics emissions reduction. Transport Policy, 55, 142-150.

He, R., Li, R., & Li, W. (2020). Carbon emission reduction potential of optimizing last-mile delivery for e-commerce platforms. Resources, Conservation and Recycling, 161, 104921

Jabbour, C. J. C., Jugend, D., de Sousa Jabbour, A. B. L., Gunasekaran, A., & Latan, H., (2015). Green product development and performance of Brazilian firms: measuring the role of human and technical aspects. Journal of Cleaner Production, . 87, 442-451

Jabeen, F., Abbasi, M. K., Ijaz, M., & Khan, M. A. (2020). Adoption of Organic Farming: An Empirical Investigation of Pakistani Farmers. Sustainability, 12(9), 3837.

Jayathilakan, K., et al. (2018). Intelligent packaging in meat industry: An overview. Food Research International, 104, 74-82.

Kamilaris, A., Fonts, A., & Prenafeta-Boldú, F. X. (2019). The Rise of Blockchain Technology in Agriculture and Food Supply Chains. Trends in Food Science & Technology, 91, 640-652.

Khan, S. Z., Hanjra, M. A., & Mu, J. (2019). Water Management and Crop Production for Food Security in China: A Review. Water, 11(8), 1597.

Kusumaningrum, A., & Astuti, T. W. (2020). A review of industry 4.0 in food industry. IOP Conference Series: Materials Science and Engineering, 725(1), 012155.

Levis, J. M., & Gonzalez, R. (2019). The socio-economic and environmental impacts of last-mile delivery in e-commerce: a comparison of delivery models. Transportation Research Part D: Transport and Environment, 71, 251-263. Luthra, S., & Mangla, S. K. (2018). When strategies matter: Adoption of sustainable supply chain management practices in an emerging economy's context. Resources, Conservation and Recycling, 138, 194-206.

Mahmood, A., Ali, H., Amjad, N., & Ahmad, A. (2021). Investigating the Impact of Sustainable Supply Chain Management Practices on Organizational Performance: Evidence from Pakistani Pharmaceutical Industry. Sustainability, 13(12), 6758.

Mangla, S. K., Luthra, S., Rich, N., Kumar, D., Rana, N. P., & Dwivedi, Y. K. (2018a). Enablers to implement sustainable initiatives in agri-food supply chains. International Journal of Production Economics, 203, 379-393.

Qureshi, M. A., Rasool, S., Ilyas, S., Ahmad, R., & Irshad, M. (2019). Critical Factors Affecting the Adoption of Food Waste Minimization Practices: Evidence from the Food Service Industry in Pakistan. Sustainability, 11(17), 4669.

Rajeev, A., Pati, R. K., Padhi, S. S. & Govindan, K. (2017). Evolution of sustainability in supply chain management: A literature review. Journal of Cleaner Production, 362, 299-314

Rushton, A., Croucher, P., & Baker, K. (2010). The design and implementation of a closed-loop supply chain network: A case study of the newspaper industry. Journal of Business Logistics, 31(1), 35-56.

Sbihi, A., & Benjaafar, S. (2020). Green logistics driven circular practices adoption in industry 4.0 Era: A moderating effect of institution pressure and supply chain flexibility. Journal of Cleaner Production, 340, 130905.

Sbihi, A., Ebrahimi, S., & C, S. (2022). Sustainable last-mile delivery in e-commerce: A review of practices and emerging challenges. European Journal of Operational Research, 300(3), 719-750.

Sgarbossa, F. & Russo, I. (2017). A proactive model in sustainable food supply chain: Insight from a case study. International Journal of Production Economics, 183, 596-606

Sharma, A., Garg, D., & Modi, S. B. (2018b). Barriers to green supply chain management in Indian mining industries: A graph theoretic approach. Journal of Cleaner Production, 174, 1234–1249.

Sharma, Y. K., Mangla, S. K., Patil, P. P. & Uniyal, S. (2018a). Sustainable Food Supply Chain Management Implementation Using DEMATEL Approach. In Advances in Health and Environment Safety (pp. 115-125). Springer, Singapore

Stalk Jr., G. (2000). Competing on capabilities: The new rules of corporate strategy. Harvard Business Press.

Vlajic, J. V., van Lokven, S. W., Haijema, R. & van der Vorst, J. G. (2013). Using vulnerability performance indicators to attain food supply chain robustness. Production Planning & Control, 24(8-9), 785-799

Wang, H., & Zhang, J. (2017). Integrating mobile technology with agriculture: A systematic review and meta-analysis. Computers and Electronics in Agriculture, 141, 202-212.

Wang, R., Li, R., Li, T., & Jiang, C. (2023). Green innovation, social responsibility, and firm performance: The moderating role of digital logistics capabilities. Sustainability, 15(2), 350.

WCED (1987). Our common future (World Commission on Environment and Development, Bruntland Commission). Oxford University Press, Oxford

Webster's Dictionary: https://www.merriam-webster.com/

Zhang, X., Li, S., Xu, X., & Li, J. (2020). The moderating effect of information technology on the relationship between green distribution and environmental performance. Resources, Conservation and Recycling, 161, 104997.

Zott, C., Amit, R., & Donlevy, J. (2000). Strategies for value creation in e-commerce: best practice in Europe. European Management Journal, 18(5), 463-

Appendix A

Questionnaire					
Variables	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
Logistics	1	2	3	4	5
Our organization use collaboration among stakeholders is essential for improving overall logistics efficiency					
Our organization invest in green infrastructure contributes to long-term cost savings in logistics					
Data-driven logistics management optimizes resource allocation and reduces waste					
Distribution					
Efficient distribution channels contribute to lower product costs for consumers					
Geographical factors significantly impact the feasibility of sustainable distribution					
Transparency in supply chain distribution is important for building consumer trust					
Technology					
Technological advancements significantly improve my overall quality of life					
Technology is essential for solving the world's most pressing problems					
The pace of technological change is too fast and makes me feel overwhelmed					
I am concerned about the potential negative consequences of AI and automation					
I am comfortable using diverse technologies in my daily life					
Lack of access to the latest technology excludes me from society					
Governments should ensure everyone has access to essential technologies					
Social media platforms positively impact communication and community building questionnaire					
Technology companies should be held accountable for their products' ethical implications					
I am concerned about personal data collection and use by technology companies					

Technology should promote equality and fairness, not exacerbate existing inequalities					
Sustainability					
I actively consider the environmental impact of my daily choices					
I support policies and initiatives for renewable energy and pollution reduction					
I am willing to pay more for environmentally friendly products and services					
Economic growth shouldn't come at the expense of environmental or social well-being					
I support ethical business practices that prioritize responsible resource management					
I invest in local businesses and support initiatives that strengthen the local economy					
Everyone deserves access to basic needs like food, water, and shelter					
I actively promote diversity and inclusion in my community and workplaces					
I support policies that ensure equal opportunities and combat discrimination					
I am willing to volunteer my time or resources to address social challenges					