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A Sustainable Supply Chain Revolution to Improve Service and Cost Reduction: An Empirical Study using fsQCA

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Abstract

Background: The present-day corporate landscape is evolving toward sustainability, with firms adopting more ecologically and socially accountable procedures. The concept of a sustainable supply chain has emerged as a significant driver of competitive advantage and long-term performance in this setting. A supply chain which follows sustainability measures, incorporates environmentally sound and moral ideals into every step of the process, including sourcing, manufacturing, logistics, and distribution. Companies that employ such strategies may improve service levels while decreasing expenses, laying the way for a more stable and prosperous future. Existing research on sustainable supply chains highlights possible benefits such as reduced carbon footprints, improved brand reputation, and improved stakeholder relationships. Despite the theoretical characteristics, there is a paucity of empirical evidence to support these claims. To satisfy this need, this study will look at the influence of an environmentally friendly supply chain on service quality as well as cost reduction utilizing fuzzy set Qualitative Comparative Analysis (fsQCA). FsQCA is a novel methodological approach that enables academics to examine complicated causation completely and systematically. This study's empirical outcomes will be useful to practitioners in planning and executing successful sustainable supply chain techniques that benefit both businesses and the environment. Overall, this work fills an essential research gap by experimentally analyzing the relationships between sustainable supply chain strategies, service improvement, and cost reduction, contributing to the growing body of knowledge on sustainability-driven operations control.

Objective: The goal of the research is to look at the factors that direct a sustainable supply chain revolution in order to improve service and save costs.

Research Design: A standardized questionnaire is utilized to obtain information from 129 supply chain professionals. For data evaluation and model creation, the fuzzy-set qualitative comparative analysis (fsQCA) is used. The study constructs are then assessed for dependability and internal uniformity. A convenient sample selection strategy is employed for data collection.

Results: According to the findings of the fsQCA evaluation, four main characteristics drive enhanced service & cost reduction via the well-perceived significance of sustainable supply chain. Alternative pathways are selected depending on gender, importance on sustainability, and professional experience on supply chain. We also provide two perceived value topologies for cost reduction & improved service.

Originality: Because the data is primary, this is anecdotal observation acquired from supply chain professionals of various renowned companies who have good experience on this topic. The fsQCA method for assessing the role of sustainable supply chain to reduce cost, waste & improve service is studied for the first time.

Conclusions: The results provide several insights, including displaying diverse topologies of supply chain professionals and their opinion, contentment, and advice toward sustainability in supply chain, as well as revealing causative elements that impact the intention to ensure cost reduction. These insights can provide educators with valuable insights.

Keywords: Sustainable supply chain; fsQCA; improved service; cost reduction; sustainable sourcing, green logistics.

1. Introduction

The idea of a sustainable supply chain revolution has attracted substantial attention recently because of the rising awareness of old supply chain methods' environmental and social implications. As firms attempt to become more environmentally responsible and fulfill the needs of socially aware consumers, supply chain strategies that balance cost effectiveness, service quality, and sustainability are becoming increasingly important. The purpose of this study proposal is to delve into the topic of a sustainable supply chain revolution and its ability to improve service delivery while lowering costs. In traditional supply chains, cost reduction and operational efficiency are usually prioritized over environmental and ethical issues. This strategy has had various negative consequences, including excessive resource use, waste generation, greenhouse gas emissions, and worker exploitation (Ellram et al., 2006). Furthermore, supply chain delays caused by natural disasters, political instability, or civil unrest can have a significant impact on company continuity and consumer pleasure.

Modern business becomes more complex as sophisticated aspects influence our company decisions (Lisan, 2018). Both ethical and business factors drive the trend toward sustainable supply chains. Organizations are ethically obligated to reduce their ecological impact, improve social well-being, and maintain the planet's long-term survival. On the commercial front, sustainable supply chains have various benefits, including enhanced brand impression, higher customer reliability, better risk management, green logistics, and long-term cost savings (Lai et al., 2011). While sustainability has

typically been viewed as a trade-off with service quality and cost reduction, new research indicates that it can ensure a superior performance in these areas. (Holy et al., 2022a). Implementing sustainable actions like green procurement, energy-efficient transportation, waste reduction, and ethical labor practices can reduce costs by improving operational efficiency, eliminating waste, and making better use of resources. In addition, end-to-end tracking can be provided for logistical operations, as demonstrated in studies by (Hasan et al., 2022) (Haque et al., 2022). Customers are also increasingly interested to pay more for ecologically sound products and services integrating supply chain management and environmental initiatives. This makes sustainability a competitive advantage that can enhance service standard and customer contentment. (Handfield et al., 2005) (Klassen & McLaughlin, 1996)

Supply Chain Management is an approach for enhancing company processes to make them stronger, more agile, and hence more competitive. (Rahman, 2019a). Pursuing a sustainable supply chain transformation is essential in the current economic context. By addressing outdated supply chains' environmental and social challenges, organizations can ensure a more sustainable time ahead while improving service delivery and reducing costs. This research project focuses to offer valuable perceptions and ideas for firms embarking on a sustainable supply chain revolution, thereby expanding the current knowledge base.

One of the earliest strategies for investigating causal linkages was the fuzzy-set qualitative comparative analysis (fsQCA). It offers several explanations for the same result and demonstrating that the variables considered in this research define the value of sustainability in the supply chain (Rihoux & Ragin, 2009). FsQCA provides a more comprehensive data analysis and should be considered in addition to traditional variance-based approaches (Pappas et al., 2019a). The fsQCA results indicate varied, distinctive, and successful mixtures of actual supply chain knowledge, supporting variables, and information quality that accounts for supply chain management service improvement.

There are three possibilities for this work to be included in the body of literature. We started with a survey to get client input for the demographic study. Second, we look into different sustainable supply chain topologies. The overall effect on cost reductions and improved services is then assessed. Finally, we use fsQCA for the first time to analyze the causal link between a sustainable supply chain & service improvement. The following is the remainder of this research paper: section 2 covers a literature review, while Section 3 discusses the theoretical framework and hypothesis development, as well as the client experience, supporting conditions, information quality, and social interaction. Section 4 delves into the research methodology, fsQCA implementation, and how it operates. Section 5 summarizes the configurational & descriptive evaluation findings produced using fsQCA and the significant issues raised in the debate. Section 6 includes all of the main findings, feedback, and illustrations. Section 7 discusses the findings, implications, limits, and future study opportunities.

Questions

- What are the most important sustainable supply chain techniques that have the ability to improve service delivery while also lowering costs?
- What are the specific tactics and technology that firms have successfully used to accomplish a sustainable supply chain revolution?
- What are the motivators and success criteria for organizations aiming for a sustainable supply chain revolution?
- How do green logistics and transportation benefit from sustainable supply chain practices?
- What are the most important sustainable supply chain practices with the potential to increase sustainable sourcing, packaging, and delivery?

Objectives

This research project's key objective is to examine novel techniques and technologies that can change traditional supply chains into sustainable models capable of increasing service delivery while lowering costs. This study project seeks to fill that void by thoroughly analyzing the best practices, success factors, and problems related to executing sustainable supply chain activities. We hope to discover the major drivers and success elements that shape the sustainable supply chain revolution by reviewing real-world case studies and doing quantitative research.

2. Literature Review

In the contemporary business landscape, the pursuit of sustainability in supply chains has gained prominence due to environmental concerns and the recognition of its potential to enhance operational performance. This literature review aims to delve into the evolving paradigm of sustainable supply chain management, focusing on the integration of sustainability principles to achieve improved service quality and cost reduction. Through an empirical lens employing the fsQCA (fuzzy-set qualitative comparative analysis) method, this review aims to uncover key insights into the complex relationships between sustainability, service quality, and cost reduction.

Sustainable Supply Chain Practices: Various papers have mentioned the significance of maintaining sustainable supply chain practices to ensure environmental, socio-economic goals. Some key practices contributing to sustainability and improving operational efficiency while reducing costs are green sourcing, eco-design, energy-efficient transportation, reverse logistics, and waste reduction strategies (Lu & Chen, 2021) (Pagell & Shevchenko, 2014). These practices align with the circular economy principles, emphasizing resource conservation and closed-loop systems (*Global Logistics and Supply Chain Management | Request PDF*, n.d.). Sustainable supply chain management has also emerged as a strategic imperative for organizations aiming to align their operations with environmental and social responsibilities. Well-organized inventory management techniques are essential to achieve the aim (Das et al., 2022). Initiatives such as green sourcing, carbon footprint reduction, and ethical supplier selection have been explored as ways to drive sustainability across the supply chain (Holy et al., 2022b); (Tazneen et al., 2020). However, a comprehensive understanding of how sustainability impacts service quality and cost factors remains elusive.

Service Quality and Cost Reduction in Supply Chains: Superior service quality and efficient cost management are fundamental objectives in supply chain operations. The literature has recognized the role of agile and lean practices in enhancing service quality (Holy et al., 2022b) and reducing costs (Lisan, 2019). However, there's a dearth of research that holistically examines how sustainability practices contribute to achieving these dual objectives.

Empirical Approaches (fsQCA Method): The fsQCA method offers a unique analytical framework to explore complex relationships within a limited sample size. This methodology enables researchers to identify causal configurations that lead to certain outcomes, offering insights into the intricate interplay of variables (Rahman, 2019b). By employing fsQCA, this study aims to uncover the nuanced linkages between sustainability practices, service quality enhancement, and cost reduction within supply chains.

Collaborative Supply Chain Model: Research has shown that implementing sustainable supply chain measures can positively influence the quality of service. Sustainable sourcing and collaborating with suppliers can improve product quality, shorter lead times, and higher customer satisfaction**.** (Klassen &

Vereecke, 2012) (C. Zhu et al., 2017). Sustainable practices like product traceability and transparency can also build trust and credibility with consumers (Pagell & Wu, 2009). We will use the cross-dock model to enhance supplier collaboration during deliveries.

Designing Sustainable Products and Packaging: Sustainable product development involves eco-design principles and the utilization of environmentally friendly products. Research by (Seuring & Müller, 2008) emphasized the necessity of integrating sustainability criteria into product outline to minimize environmental impact. The adoption of sustainable materials, such as bio-based or recyclable materials, can contribute to minimizing waste and resource consumption. Sustainable packaging practices, such as reducing packaging materials and using recyclable or biodegradable packaging, can help minimize the environmental footprint of products. Additionally, the implementation of Extended Producer Responsibility (EPR) programs holds producers liable for the whole lifecycle of the products, including packaging waste management. Research by (Blomsma & Brennan, 2017) highlighted the positive environmental outcomes of EPR programs and the importance of collaboration among stakeholders in sustainable packaging initiatives. For instance, research by (Vermeir & Verbeke, 2006) demonstrated that consumers' environmental attitudes positively influenced their purchase intentions of sustainable products.

Green Logistics & Transportation: The literature identifies several drivers and success factors for implementing green logistics. Research suggests that the utilization of eco-friendly transportation methods, like electric or hybrid vehicles, can significantly minimize carbon emissions and air pollution. For example, (Maya Jariego et al., 2023) found that the acquisition of electric vehicles in operational activities led to reduced greenhouse gas emissions and lower operational costs (Q. Zhu et al., 2008). By reducing empty miles and optimizing truck loading, organizations can improve fuel efficiency and reduce congestion. (Amon, 2019) demonstrated that route optimization and consolidation strategies resulted in reduced transportation costs and improved service levels. Green logistics also emphasizes the importance of reverse logistics, including the proper handling of returns, repairs, and reprocessing of products. This promotes the concept of a circular economy by minimizing waste and extending product life cycles. Research by (Govindan et al., 2015) highlighted the benefits of implementing reverse logistics processes, such as product take-back and remanufacturing, in terms of cost reduction and environmental sustainability.

Many examples of organizations have improved their supply chain sustainability while also saving costs and enhancing their brand reputation. Companies like Patagonia, Interface, and IKEA have implemented sustainable sourcing practices, improving product quality. (Carter & Rogers, 2008), (Hendricks et al., 2012) (Pagell & Shevchenko, 2014). These cases provide insights into the strategies, technologies, and challenges encountered during their sustainability journeys.

Research Gap

While existing literature recognizes the potential benefits of a sustainable supply chain revolution, further research is needed to pinpoint the particular strategies and technology that improve service delivery while cutting costs. More empirical research is needed to evaluate the efficacy, challenges, and trade-offs associated with various sustainable practices, as well as their implications on service quality and costs.

The literature review indicates the significance of a feasible supply chain revolution in enhancing service delivery and lowering costs. It emphasizes integrating sustainability with service quality and cost reduction, implementation motivations and success factors, and possible cost savings connected with sustainable practices. There is, however, a research deficit in understanding the precise methods and technologies that enable a sustainable supply chain revolution while improving service and

lowering costs. The proposed research project seeks to fill this void by performing a thorough examination and giving practical advice for firms looking to reform their supply chains sustainably.

3. Background and Hypotheses Development

A sustainable supply chain incorporates upstanding and environmentally responsible practices into a competitive and lucrative paradigm. Transparency throughout the supply chain is important; sustainability initiatives must include everything from raw material acquisition to last-mile transportation and even product replacing and recycling. Sustainability was almost solely associated with environmental friendliness twenty years ago. Nowadays, it is a much larger phrase. A modern sustainable supply chain incorporates networks that are green, transparent, and circular. Many elements influence how the supply chain may be operated sustainably. This section identifies four key factors: green logistics, sustainable products and packaging, sustainable sourcing, and supplier management. These factors will eventually influence cost reduction, waste reduction, and improved service to ensure a collaborative and sustainable supply chain.

Green logistics & transportation and overall cost + waste reduction: The environmental effect of the supply chain will be decreased by using eco-friendly transportation techniques and streamlining logistical procedures, resulting in less waste formation. This can be accomplished by measures such as efficient route planning, the utilization of fuel-effective vehicles, and the utilization of environmentally friendly packaging. Furthermore, eco-friendly practices usually result in increased resource utilization, streamlined procedures, and lower energy consumption, which may contribute to cost savings. According to the notion, sustainable logistics and transportation methods can assist decrease waste and save money in the supply chain.

H1. Green logistics & transportation approaches in a supply chain will reduce waste and lower overall costs.

Supplier management and overall cost + waste reduction: Companies can implement effective supplier management strategies to promote waste reduction in the supply chain, prioritizing suppliers committed to sustainability. By closely monitoring and collaborating with these suppliers, companies can encourage environmentally friendly production practices and efficient resource usage, which ultimately reduces waste throughout the supply chain. This approach benefits the environment and can lead to cost savings through increased resource efficiency, lower waste disposal charges, and reduced licensing costs. Improving supplier management is a practical way to create a more sustainable and financially effective supply chain.

H2. Efficient management of suppliers in a supply chain is associated with waste and cost savings.

Sustainable sourcing and waste reduction + improved service: Companies that practice sustainable sourcing are more likely to choose suppliers who value ecological responsibility and ethical manufacturing processes. Tracing raw materials, supporting renewable resources, and fostering waste reduction programs are all part of sustainable sourcing. Suppliers who adhere to these standards are more likely to use efficient methods and produce higher-quality products, resulting in less waste across the supply chain. Furthermore, sustainable sourcing promotes collaboration and transparency among stakeholders, which may result in greater service levels such as on-time distribution, higher goods quality, and higher customer happiness. As a result, the hypothesis suggests a favorable relationship between sustainable sourcing, less waste, and improved supply chain service.

H3. Sustainable sourcing techniques in a supply chain have been linked to lower waste generation and higher service levels.

Sustainable products packaging and packaging optimization + improved service: Companies that value sustainable product packaging and execute package optimization solutions can improve supply chain service levels. Sustainable product packaging entails utilizing environmentally friendly materials and minimizing extra packaging, which can result in less waste and a lower environmental effect. Packaging optimization seeks to improve productivity and reduce costs by streamlining packaging operations. Companies can use sustainable packaging and optimization to offer recyclable products, deliver items more efficiently, and meet client requests for eco-friendly solutions. This can result in higher levels of service, such as faster delivery, lower shipping costs, and more customer satisfaction, all of those bestow to a more profitable and sustainable supply chain.

H4. Improved service levels are connected to sustainable product packaging and package optimization in a supply chain.

Supply chain sustainability and enhanced service: Service levels increase when a supply chain combines sustainable practices like green logistics, sustainable procurement, waste minimization, and eco-friendly packaging. Sustainable supply chain techniques improve resource efficiency, decrease waste, and encourage environmentally responsible manufacturing and transportation methods. This can lead to faster and more consistent delivery, improved product quality, and enhanced customer service. Sustainable supply chains are frequently better suited to react to changing environmental requirements and consumer preferences, resulting in higher service quality and customer happiness. As a result, the hypothesis presumes that a sustainable supply chain improves service performance as well as customer experience.

H5a. Adopting sustainable supply chain methods is likely to culminate in higher service levels.

Sustainable supply chain & cost reduction: Sustainable supply chains, including green logistics, minimizing waste, energy conservation, and ethical sourcing, are more likely to save money. Sustainable techniques frequently result in better resource management, lower waste disposal costs, and lower energy use, resulting in lower total costs. Furthermore, ethical supply chains are better prepared to react to changing environmental rules, lowering compliance costs. As a result, the theory argues that sustainable supply chains are more likely to achieve cost-effective operations and financial rewards than non-sustainable equivalents.

H5b. The formation of a sustainable supply chain indicates efficient operations and financial gains.

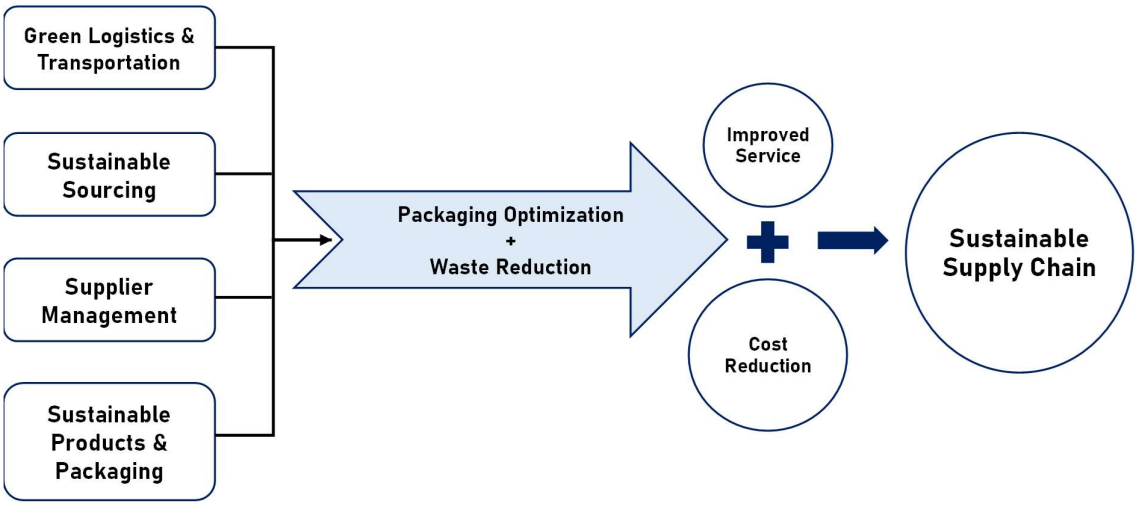

Figure 1: Research Model: Sustainable supply chain revolution to improve service & cost reduction

3.2 Strategies for Long-Term Supply Chain Management

A. Designing sustainable products and packaging

I. Sustainable product development practices

According to the ISO 2006 standard, Life Cycle Assessment (LCA) plays a critical role in sustainable product development by providing a scientific methodology to assessing a product's environmental impacts across its entire life cycle. This comprehensive evaluation enables companies to identify areas with high environmental impact, leading to informed decisions to minimize resource consumption, emissions, and waste generation. Design for the Environment (DfE) is another critical aspect of sustainable product development, first introduced by Mont in 2002 (Thompson, n.d.). It comprises incorporating environmental factors into the product design process in order to optimize the overall environmental performance of the product. This includes selecting environmentally friendly materials, minimizing energy and resource usage during producing, and enhancing end-of-life disposal alternatives.

The selection of materials significantly influences sustainable product development, as highlighted by Dangelico and Pujari 2010 (*Mainstreaming Green Product Innovation: Why and How Companies Integrate Environmental Sustainability | SpringerLink*, n.d.). Opting for environmentally friendly materials, such as those that are renewable, recyclable, or biodegradable, helps diminish the overall environmental footprint of products. Additionally, sourcing materials locally can reduce transportation emissions and support local economies, as emphasized by (Sarkis, 2003). Integrating energy efficiency considerations is imperative during the product development process, as stated by (Chang & Taylor, 2016). Developing products that consume less energy during their usage phase can substantially decrease their environmental impact. This may involve technological innovations to enhance energy efficiency, integrating energy-saving features, or designing products that require less energy to manufacture.

Incorporating circular economy principles is vital for sustainable product development, as advocated by (Geissdoerfer et al., 2017). Designing products for durability, reparability, and upgradability extends

their lifespan and reduces waste. Utilizing recycled or reused materials in new products helps diminish the demand for virgin resources. Implementing take-back events as well as partnering with recycling facilities also aid in the recovery and reuse of product components and materials, contributing to a more circular and sustainable approach.

Here are some big corporations that have made considerable commitments to sustainable development.:

- Unilever's emphasis on organic palm oil, as well as its overall waste and resource footprint,
- Nestlé in terms of product life cycle, climate, water efficiency, and waste management
- Pepsi and Coca-Cola have adopted ambitious objectives, such as increasing emphasis on water stewardship and setting replenishment targets.

Companies can still take action to promote sustainability. Even if the integrity of the biosphere cannot be maintained any longer and the harm caused by biochemical flows cannot be undone, there are still ways to have an impact on:

- **Consumption of water**: overused and contaminated
- **Fine particle emissions**: It is defined as airborne particles or droplets with a width of two and a half microns or less.
- **Carbon footprint**: The carbon footprint of an organization or product is the total amount of greenhouse gas (GHG) emissions, evaluated in carbon dioxide equivalent.

Developing sustainable product development and service approach for industrial lighting products, consider the following principles and strategies:

Energy Efficiency: Concentrate on creating lighting items that are as energy efficient as possible. Utilize sophisticated LED technology, which consumes less energy than traditional lighting sources such as incandescent or fluorescent bulbs. Utilize features such as motion sensors and daylight harvesting to reduce energy consumption.

Life Cycle Assessment (LCA): Conduct a comprehensive life cycle study of the product to identify its environmental effect from the procurement of raw materials through disposal. Identify opportunities for improvement and set targets to reduce the product's overall environmental effect.

Material Selection: Choose materials that are sustainable, recyclable, and have a low environmental impact. Prioritize materials with high durability, as they require fewer replacements and reduce waste generation. Consider using recycled or upcycled materials wherever possible.

End-of-Life Management: To ensure proper disposal and recycling of lighting goods at the end of their life, establish a take-back program or engage with recycling partners. Implement proper recycling techniques to recover valuable materials while minimizing environmental damage.

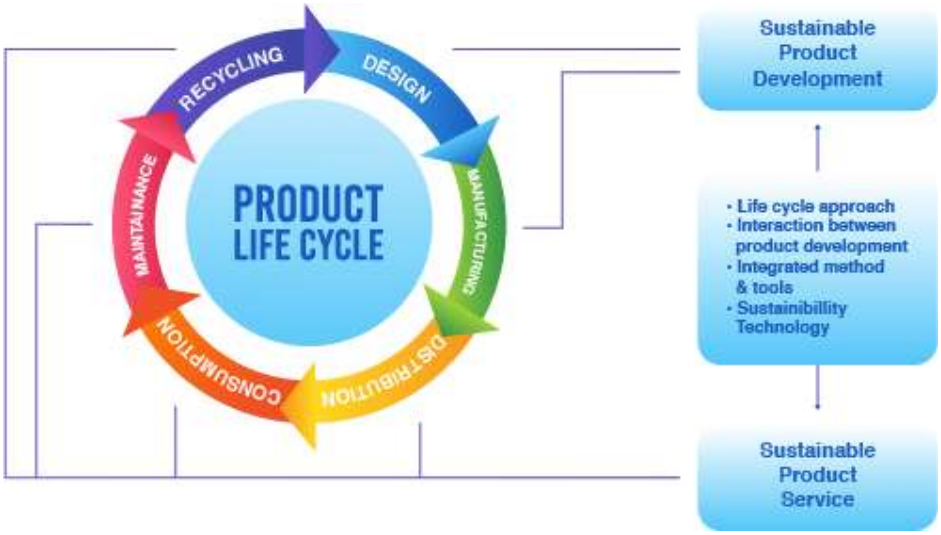

Figure 2: End of product life circle and management

II. **Packaging optimization and waste reduction**

Developing sustainable package development and service approach for industrial lighting products, consider the following principles and strategies:

Material Selection: Choose packaging materials that are sustainable, recyclable, and have a low environmental impact. opt for materials like recycled paper, cardboard, or biodegradable plastics. Avoid using excessive packaging or materials that are difficult to recycle.

Right-Sizing Packaging: Optimize the size and dimensions of packaging to minimize material usage and transportation space. Avoid oversized packaging that leads to wasted space and increases shipping costs and carbon emissions.

Eco-Friendly Printing and Labelling: Use environmentally friendly printing techniques such as water-based inks and vegetable-based dyes. Include clear and concise labelling on packaging to facilitate proper recycling or disposal instructions for customers.

Packaging Efficiency: Streamline packaging processes to reduce waste and increase efficiency. Implement automated packaging systems and optimize packaging designs to minimize labour and material requirements.

Figure 3: Efficient packaging system

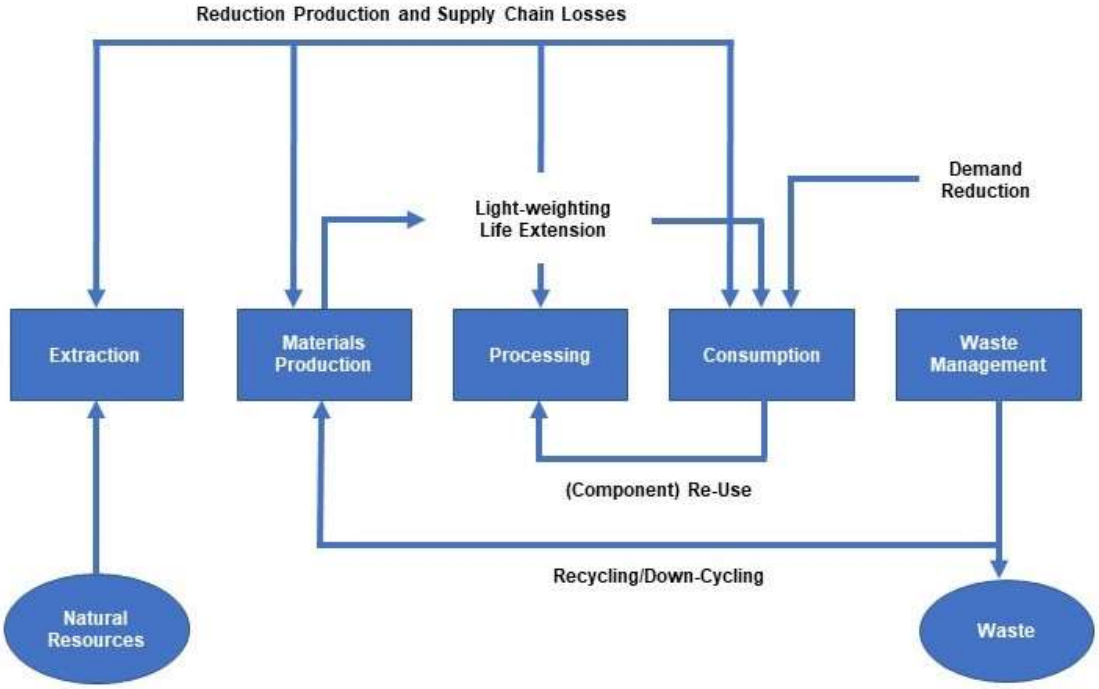

Figure 4: Efficient packaging process

B. Sustainable sourcing and supplier management

I. Ethical sourcing and responsible procurement practices

Ethical sourcing has numerous advantages for enterprises, society, and the environment. Here are some of the primary benefits of embracing ethical sourcing techniques.:

- **Improved Supply Chain Resilience:** Transparency and visibility are enhanced through ethical sourcing in every part of the supply chain. Companies can discover vulnerabilities and establish mitigation plans by analyzing their suppliers' activities and potential hazards. This improves supply chain adaptability by decreasing interruptions and assuring a more long-term and stable supply of products and services.
- **Compliance with Regulations:** Ethical sourcing helps companies meet legal and regulatory requirements related to labor, human rights, and environmental protection. By proactively implementing ethical practices, companies can avoid legal penalties, regulatory non-compliance issues, and reputational damage associated with violations.
- **Environmental Sustainability:** Ethical sourcing encourages environmentally responsible practices throughout the supply chain. This includes reducing carbon emissions, minimizing waste generation, conserving resources, and promoting sustainable sourcing of raw materials. Such practices contribute to environmental protection and help mitigate the impact of business operations on the planet.
- **Positive Social Impact:** Ethical sourcing supports the social and economic development of communities by promoting fair trade, local sourcing, and community engagement. It helps

create employment opportunities, fosters economic growth, and contributes to poverty reduction.

Ethical sourcing refers to the practice of ensuring that products or services are obtained from suppliers who meet certain social, environmental, and labor standards. The implementation of ethical sourcing involves several processes aimed at evaluating and monitoring suppliers' practices. Here are some common steps and processes involved in ethical sourcing:

- **Supplier Assessment:** Companies conduct assessments to evaluate potential suppliers' ethical practices. This involves gathering information about the supplier's policies, procedures, and past performance. Assessments may include questionnaires, on-site audits, interviews, or third-party certifications.
- **Supplier Selection:** Based on the assessment results, companies select suppliers that align with their ethical sourcing requirements. This includes considering suppliers' commitment to meeting social and environmental standards, their transparency, and their willingness to collaborate on improvement.
- **Supplier Collaboration:** Building strong ties with suppliers to promote continuing compliance and improvement is part of ethical sourcing. Companies engage closely with suppliers to ensure they understand and adhere to the code of conduct's ethical standards. Collaboration might take the form of training programs, capacity building, and the exchange of best practices.
- **Monitoring and Auditing:** Regular monitoring and auditing are essential to verify that suppliers maintain ethical practices over time. This can include scheduled or surprise audits conducted by internal or external auditors. The auditing process involves reviewing documentation, conducting interviews, and inspecting facilities to assess compliance.

II. Supplier selection and evaluation criteria

- Evaluation of suppliers' commitment to reducing environmental impact.
- Assessment of adherence to labor rights, human rights, and fair employment practices.
- Requirement for comprehensive supply chain information and transparency.
- Focus on optimizing energy, water, and material usage.
- Emphasis on developing environmentally friendly products.
- Willingness to collaborate and engage in sustainability initiatives.
- Requirement for suppliers to provide traceability of their supply chains to ensure responsible sourcing and prevent potential risks.
- Supplier actions to support circular economy principles, such as product recycling, reuse, or remanufacturing, are evaluated.

C. Green logistics and transportation

Taking action to reach zero waste

The message from the market is clear: green logistics techniques are becoming increasingly vital for enterprises. While not every company has fully adopted this strategy, those who prioritize environmental challenges in their supply chain will realize that being green is not only morally responsible but also financially lucrative. Companies must prioritize sustainability as they scale up their last-mile logistics to meet rising demand. Businesses must prioritize sustainability in their processes this year in order to achieve cost-effective and environmentally friendly logistics. To make a genuine difference, this requires harnessing technology and collaborating with green groups. Companies can successfully convey their commitment to sustainability to stakeholders by doing so. As green logistics grows more popular among all stakeholders involved in the logistics industry, implementing eco-friendly strategies becomes increasingly important. This not only pleases consumers, but also reduces

carbon emissions and fuel use, resulting in energy savings for businesses. Finally, these efforts help to make our globe a better place for generations to come.

I. **Efficient distribution and materials management**

The fewer miles your drivers drive, the less you contribute to releasing greenhouse gases. By designing more efficient routes, expenses are decreased by requiring fewer drivers for cars and trucks, and energy consumption is reduced. It's a fast victory for more environmentally friendly logistics. (*Logistic Activities and Their Green Dimensions | The Geography of Transport Systems*, 2017)

Table 1: Outcome & paradox of efficient distribution and materials management

	Outcome	Paradox
Costs	▪ Reduction through packaging optimization and waste minimization. ▪ The distributors reap the benefits.	Externalization of environmental expenses is common.
Time/Flexibility	▪ Supply chains that are fully integrated. ▪ Physical distribution systems using JIT and DTD.	Taking up more space, using more energy, and emitting more emissions.
Network	Increased system efficiency through network development (Hub-and-spoke structure).	▪ Environmental consequences around major hubs and along corridors. ▪ The impact on local communities.
Reliability	Freight and passenger distribution that is dependable and timely.	Trucking and air travel are the least environmentally friendly modes of transportation.
Warehousing	Lower warehousing costs per unit of freight. In transit inventory.	Some inventory was moved on the roads (or in containers), contributing to traffic congestion and space usage.
Information Technologies	Increased business prospects and supply chain diversification.	Physical distribution system changes that lead to greater levels of energy consumption

Material Management

- **Product design:** Consider the environmental impact and durability of the materials used.
- **Near sourcing**: Assess sourcing options based on logistics costs and energy/environmental constraints.
- **Sustainable sourcing:** Prioritize suppliers based on environmental standards and certifications.
- **Circular material use:** Emphasize reuse and recycling in manufacturing processes.

Physical Distribution

- **Demand-responsive systems:** Integrate supply chains to align with expressed demand and reduce returns.
- **Load consolidation**: Optimize transportation by consolidating loads and pooling LTL cargo.
- **Alternative modes and fuels:** Utilize energy and environmentally efficient transportation modes and fuels.
- **Shipping scheduling and routing:** Optimize scheduling and routes to maximize asset utilization and avoid congestion.

Reverse Distribution

Activities and motions involving the return of used items and rubbish for recycling or disposal have created new market opportunities, particularly in materials management and physical distribution, such as collection channels. These opportunities are driven by the environmental benefits derived from recycling and waste management rather than direct financial gains. However, the transportation sector may not display a greener face because of the increased traffic load and infrastructure required to conduct reverse logistics. *Logistic Activities and Their Green Dimensions | The Geography of Transport Systems*, 2017)

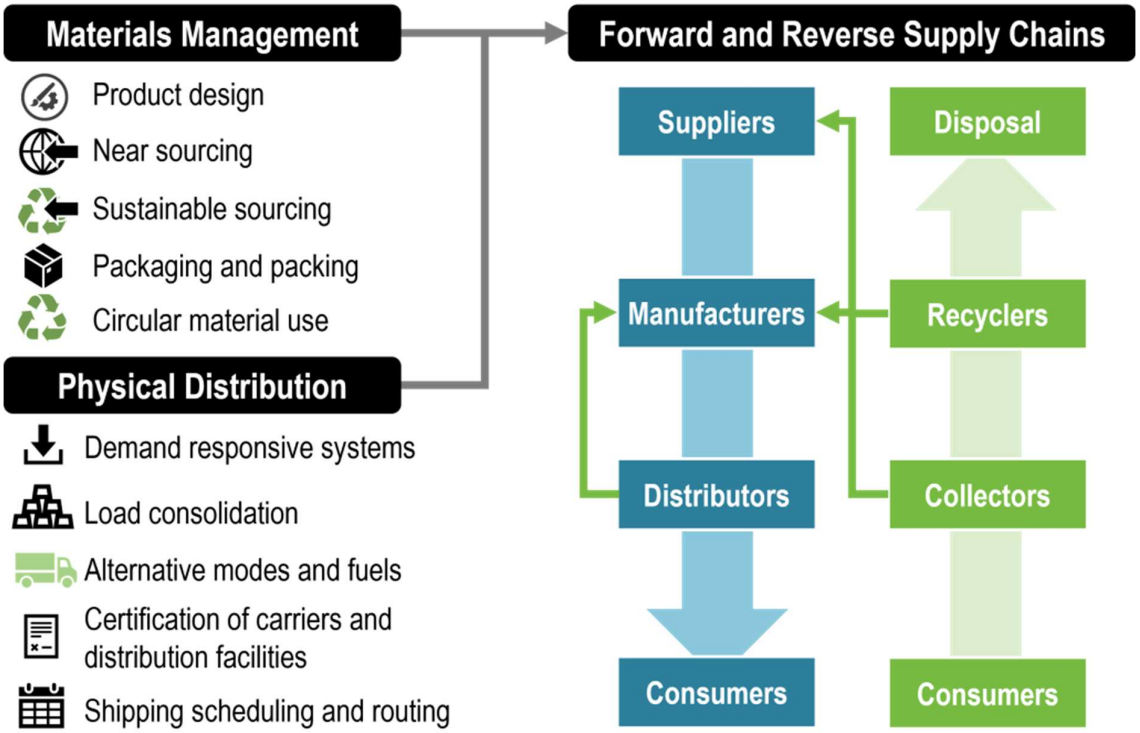

Figure 5: Reverse distribution system in sustainable supply chain model

II. **Alternative fuels and low-emission vehicles**

Alternative fuels and low-emission cars play critical roles in promoting sustainability and reducing greenhouse gas emissions in the transportation industry. Cleaner energy sources are utilized by choosing alternatives to conventional fossil fuels such as biodiesel, ethanol, hydrogen, and natural gas. These fuels can be used to power a variety of vehicles, such as cars, trucks, and buses, resulting in significant reductions in carbon dioxide emissions and air pollutants. Furthermore, low-emission vehicles, particularly electric vehicles (EVs) and hybrids, provide greener alternatives by utilizing electric power or a combination of electric and internal combustion engines. EVs have no tailpipe emissions, but hybrid vehicles use a combination of an internal combustion engine and an electric motor to lower both fuel consumption and pollution. The International Energy Agency emphasizes the critical role of adopting alternative fuels and low-emission vehicles in achieving sustainable transportation and combating climate change. By embracing these technologies, the transportation sector contributes to reducing air pollution, enhancing air quality, and mitigating the overall environmental impact. These advancements mark significant progress toward creating a cleaner and more sustainable future. (*Global EV Outlook 2020 – Analysis*, n.d.) (*World Energy Outlook 2020 – Analysis*, n.d.)

III. **Efficient vehicle management**

Solar panels can be integrated into vehicles to harness solar energy and provide auxiliary power. They can be used to charge the vehicle's battery or power-specific components such as ventilation systems, lighting, or entertainment devices. Solar panels on vehicles contribute to reducing reliance on conventional energy sources and can help extend the driving range of electric vehicles (EVs) by supplementing their battery charging. By using harvested energy from the sun, our Vision Techniques solar panels are used to power all your vehicle's onboard ancillary equipment, reducing the strain on your vehicle's alternator. This can save you a lot of money on maintenance costs, as your alternator is far less likely to need replacing due to the reduced pressure being put on it.

Benefits of Solar Vehicles:

- **Zero Emissions:** Solar vehicles emit no tailpipe emissions, helping to reduce greenhouse gas emissions and contribute to cleaner air and a healthier environment.
- **Renewable Energy Source:** Solar energy is a renewable resource that is abundant and available indefinitely, in contrast to fossil fuels, which are finite and contribute to environmental destruction.
- **Reduced Operating Costs:** By relying on solar energy, vehicle owners can reduce their reliance on conventional electricity and fuel, leading to potential cost savings in the long run.

Solar vehicles present a compelling solution to the environmental challenges posed by traditional fossil fuel-powered vehicles. With advances in PV technology, solar vehicles have become more efficient and practical for everyday use. The benefits of zero emissions, reliance on renewable energy, reduced operating costs, energy independence, and long-term environmental impact make solar vehicles an essential part of the sustainable transportation landscape. As technology continues to evolve and supply chains become more efficient, the future of solar vehicles looks even brighter, offering a cleaner, greener, and more sustainable mode of transportation for the world.

3.3 Equation

A regression equation is needed to identify the link between service quality & cost reduction:

Cost Reduction = $\alpha + \beta 1 * \text{Service Quality} + \varepsilon$

Where:

- Cost Reduction represents the extent of cost reduction achieved within the supply chain.
- The level of service quality offered by the supply chain is represented by Service Quality.
- α represents the intercept, indicating the baseline level of cost reduction when service quality is zero
- The regression coefficient $\beta 1$ shows the change in cost reduction associated with a one-unit change in service quality.
- ε reflects the error term, which accounts for unexplained variance in cost reduction.

3.4 Parameters

In the given equation: Cost Reduction = $\alpha + \beta 1 * \text{Service Quality} + \varepsilon$

The dependent variable is "Cost Reduction," as it is the outcome or variable that the equation predicts or explains.

The independent variable is "Service Quality," as it is thought to have an effect on the dependent variable. We are investigating how changes in service quality (independent variable) affect the level of cost reduction (dependent variable) within the supply chain in this equation.

It is worth noting that the equation may contain extra independent variables represented by additional coefficients. These variables would reflect other elements that could influence the level of cost reduction; however, the presented equation concentrates on the relationship between cost reduction and service quality for simplicity.

4. Methodology

4.1. The QCA and fsQCA

The qualitative comparative analysis (QCA) research method is well-established for testing theoretical hypotheses and gaining theoretical insights. QCA reasoning is based on set-theoretic Boolean logic. It follows the case comparison concepts that are commonly used in qualitative research. (Ragin, 2014). A researcher can flip between information, evaluation, and theory while using this methodological style to explain factually observed phenomena (Sukhov et al., 2020) (Furnari et al., 2021). The QCA logic assists in grasping a particular conclusion in its actual environment (Ragin, 2014) (Sihvonen & Pajunen, 2019) (Furnari et al., 2021).

QCA is frequently performed in one of the following methods. The crisp set qualitative comparative analysis (csQCA) or the fuzzy set qualitative comparative analysis (fsQCA) can be used by researchers. CsQCA combines quantitative and qualitative methods, while fsQCA can handle ongoing data and fragmented identities within a set (Mumu et al., 2022) (Chowdhury et al., 2022). However, while employing fsQCA, the researcher must describe its components and procedures as theoretical concepts and identify set identities using qualitative labeling and logical criteria rather than depending exclusively on responses. FsQCA is a case-adjusted approach and is not necessarily intended for generalization (Ragin, 2014).

The study's findings were analyzed using the fsQCA technique, which has the advantage of utilizing both quantitative and qualitative assessments to determine how much a case matches a set (Rihoux & Ragin, 2009). Unlike conventional statistical methods that focus on the overall impact of independent factors on dependent variables, the fsQCA method identified various combinations of causal elements that could produce similar outcomes. This approach revealed that different causal connections could lead to the same results. Additionally, the fsQCA approach identified the conditions necessary for an inevitable conclusion. It is important to note that the presence or absence of the outcome could be allotted to multiple factors.

The researcher must fully comprehend the theoretical structure, context, and variables under investigation (conditions and findings). This understanding is applied during the study, incorporating (1) data calibration (converting variables into fuzzy sets), (2) simplification of the numerous approaches, and (3) result interpretation. Researchers should make decisions based on the data available at each level, as is standard in qualitative analysis. It is important to note that the fsQCA function has both advantages and constraints. One advantage is its versatility in handling data, making it useful for experimental and confirmatory purposes. However, researchers should avoid using it mechanically and

instead follow recognized rules and best practices. Purposeful decisions should be made throughout the analysis and presentation to ensure the study's validity and promote replication.

4.2. Research Design

For this research method, a survey is conducted to gather information from a particular group and investigate the connections between significant elements of the study. The intended audience of the survey comprises supply chain analysts, teachers, entrepreneurs, employees, and others. They were asked to complete a questionnaire about improving services, reducing waste, and cutting costs in sustainable supply chain management.

4.3. Data collection and survey instrument

To analyze the paper, we used both **qualitative & quantitative** method. That indicates we used basically the mixed method to analyze. This research project incorporates secondary as well as primary information.

Primary Data - A Google form of Questionnaire
The forms were distributed to industrial employees. And the mode was online. The analysis of the responses is done through fsQCA software.

Secondary Data – Appropriate publications, research projects, online articles
Because the field is new, secondary data for the literature review portion is gathered. This study project's variables and constructs were identified from the literature.

A 29-item questionnaire is developed to assess the impact of a sustainable supply chain. In addition, three new survey questions were included to evaluate the success and prospects of the sustainable supply chain. A panel of supply chain specialists with at least one and a half years of professional supply chain competence examines the preliminary scale's questions qualitatively. As a result of the comments and reviews, two items have been removed. For completeness and correctness, the entries below have been morphologically changed. The re-calibrated assessment is then returned to the group for review to see whether the new preliminary scale has content validity. The final questionnaire contained 27 questions, five of which assessed sustainable supply chain management. Likewise, five questions the questionnaire used a five-point Likert scale, with 1 indicating "strongly disagree" and 5 indicating "strongly agree." Respondents are encouraged to choose a scale based on their understanding and awareness of each questionnaire item.

4.4. Sample and Data analysis

We gathered information through our own analysis and sample collecting. Convenience sampling was used to gather the samples. It is a non-probability sampling strategy in which components are chosen for inclusion in the pattern because they are the easiest to obtain for the researcher [e.g.,(Jiang et al., 2000); (Kettinger et al., 1997); (Kang et al., 2002)]. This could be due to location, availability at a given time, or agreement to participate in the research. We requested that the responders fill out the questionnaire through email. Out of 134 responses received, 129 were chosen for final analysis as 5 were found to have invalid information or were incomplete. To validate the hypotheses and conclude the study findings, statistical approaches such as descriptive statistics, reliability assessment, factor evaluation, and regression were applied. The factors were filtered through a reliability test and factor analysis.

5. Analysis

Demographic analysis:

Respondents were asked about their age, gender, educational level, work, professional experience in supply chain management, and the importance of sustainability in the context of supply chain. The most of individuals polled are between the ages of 21 and 40. It is worth noting that the majority of professional responders are under the age of 30. The breakdown of respondents is seen in Table 1.

Table-2: Demographic breakdown

Respondents	Frequency	%
Gender		
Male	77	59.68
Female	52	40.32
Age		
16-20	4	3.1
21-30	58	44.96
31-40	39	30.23
41-50	22	17.05
51-60	6	4.65
Education level		
Junior High School	6	4.08
Senior High School	14	9.52
Under Graduate Program	51	34.69
Graduate Program	41	27.89
PhD program	18	12.24
Others	17	11.56
Occupation		
Student	20	15.5
Teacher (Lecturer/ Professor)	12	9.30
Supply Chain Analyst	26	20.15
Entrepreneur	18	13.95
Employee	29	22.48
BCS Cadre	4	3.10
Civil Servant	9	6.97
Others	11	8.52
Professional Experience in Supply Chain Management		
Less than 1 year	17	13.17
1-3 years	61	47.28
4-6 years	38	29.45
7-10 years	11	8.52
More	2	1.5
Importance of Sustainability in SCM		
Not important	2	1.5
Somewhat important	21	16.27
Important	32	24.8
Very important	74	57.36

Use of FsQCA:

An assessment of the necessity for the factor's presence and absence is done to determine whether any causal aspects are necessary for its accessibility of objective toward cost reduction and enhanced service (Table 2). (Ragin, 2006) claims that a prerequisite is a "superset of the outcome" if necessary, suggesting that the membership functions value of the output is smaller than the fuzzification value of the causative conditions for each appearance in the supplied information (Pappas et al., 2019b). Similarly, (Schneider & Wagemann, 2010) said that the integrity of a situation needs to be greater than 0.9 always to qualify for it to be essential.

It Ragin in 2006, who defines consistency as the percentage of appearances in an analysis that are part of a causal pattern that results in the intended outcome. To explore the effects of importance, the updated function in fsQCA application 3.0 generates coherence and coverage findings for each causal event and its negated values. We can proceed with our data calibration review because all characteristics have values between 0.2 and 0. 9. The following is an evaluation of the prerequisites:

Table 3: The study variables' necessity breakdown (Outcome factor: SSC)

Constructs	Consistency	Coverage
GLT	0.798942	0.859349
~GLT	0.306122	0.900000
SS	0.852608	0.888189
~SS	0.267574	0.863415
SPP	0.876795	0.880121
~SPP	0.232048	0.848066
SM	0.586546	0.822905
~SM	0.501134	0.899593

Data Calibration

Calibration of data is an essential stage in fsQCA. Almost every statistic (e.g., survey responses, clickstreams, user engagement data, and physiological data) can be used. When analyzing a variable or constructing a structure with multiple components, we must calculate a single estimate per component to utilize as input in fsQCA. On the other hand, we require one answer for each construct in the dataset (column) for each event (row). The simplest way is to determine the components' mean to produce a single value for each case (for example, for assessing correlations). The fsQCA technique necessitates calibration of all precondition and result variables. The calibration employs theoretical and practical knowledge to deliver a fuzzy-set value matching a set's membership degree.

We must assess the parameters' 0-1 values in order to turn them to fuzzy sets. A value of 0 denotes non-membership, while a value of 1 indicates full set membership. The dataset file should be in comma-separated values (.csv) format to be compatible with fsQCA. Calibration is performed using the software's calibration tool, which requires as input the factor to be validated and the three directions (highest to lowest values). In QCA, researchers employ two strategies for data calibration. At first, the direct approach includes creating three criteria to determine when a case is regarded a member of a set: total membership, full non-membership, or crossover point. The indirect strategy, the second option, entails rescaling judgments based on how well a researcher understands the instances. Although this study might use either methodology based on the research hypotheses and case framework, we chose the direct method. The three requirements were developed using the five-point Likert scale from the study questionnaire (Rihoux & Ragin, 2009). The calibration approach was used, with 0 indicating entire non-membership and, 1 indicating full membership, 0.50 indicating the crossover point. Finally, the data was calibrated employing a linear framework to check that it met the three requirements (Pappas et al., 2019b).

The scale was transformed into persistent fuzzy sets (direct approach) in this experiment employing the calibration method described below in the fsQCA application:
Calibrate (x, n1, n2, n3), in which x is the recognized research concept, n1 is the full membership range with a value of 4, n2 is the crossover point with a value of 3, while n3 is the complete non-membership range with a rate of 2.

The structures' mathematical model is as follows:
Evaluate: SSC = calibrate (Sustainable Supply Chain, 5, 4, 3)
Evaluate: GLT = calibrate (Green Logistics & Transportation, 5, 4, 3)
Evaluate: SS = calibrate (Sustainable Sourcing, 5, 4, 3)
Evaluate: SPP = calibrate (Sustainable Product & Packaging, 5, 4, 3)
Evaluate: SM = calibrate (Supplier Management, 5, 4, 3)

Representing the truth chart
Based on the recently calibrated data, the fsQCA application 3.0 develops a truth chart. The truth chart creates 2n rows, at which n is the total number of conditions, and each row represents one viable combination for the specified criteria. The chart presents the sixteen viable options. Following the creation of the truth chart, it needs to be sorted by adjusting the frequency & consistency cut-off settings. (Rihoux & Ragin, 2009). Table 3 depicts the truth chart.

Table 4: Truth Chart

GLT	SS	SPP	SM	Number	Raw Consist.	PRI Consist.	SYM Consist
1	1	1	1	15	0.901869	0.86334	0.917051
1	1	1	0	11	0.965909	0.95443	0.95443
0	1	1	1	3	0.907217	0.80292	0.859375
0	1	0	0	1	0.933333	0.847457	0.847457
1	0	1	0	1	0.913876	0.775	0.873239
0	0	1	1	1	0.960699	0.907216	0.907217
0	0	0	0	0			
1	0	0	0	0			
1	1	0	0	0			
0	0	1	0	0			
0	1	1	0	0			
0	0	0	1	0			
1	0	0	1	0			
0	1	0	1	0			
1	1	0	1	0			
1	0	1	1	0			

A frequency cut-off value is required for an appropriate amount of controlled observation. The cut-off number for tiny to medium-scale systems with fewer than 150 instances is 1. However, as mentioned by (Rihoux & Ragin, 2009), for more significant simulations with more than 150 instances, the cut-off rate should be adjusted to >1. Because there are 129 occurrences, the cut-off frequency ratio is indicated as "1". (Dul, 2016), addressed the likelihood of mistakes and false-positive circumstances induced by poor consistency criteria in his study. An accepted standard for fuzzy-set assessment with a significant

consistency threshold of >.80 has been devised to deal with this. Table 4 shows the consistent results for each combination, including the overall outcome of more than 0.8 (Pappas et al., 2019b). In contrast to coverage, which evaluates the statistical use of a trustworthy subset, the reliability of an individual link is assessed. (Rihoux & Ragin, 2009).

Table 5: Truth chart after logical elimination

GLT	SS	SPP	SM	Number	SSC	Raw Consist.	Cases	PRI Consist.	SYM Consist.
1	1	1	0	11	1	0.965909	11,13,16, 27, 33,42,52,56,62, 68,72	0.95443	0.95443
0	0	1	1	1	1	0.960699	22	0.907216	0.907217
0	1	0	0	1	1	0.933333	3	0.847457	0.847457
1	0	1	0	1	1	0.913876	29	0.775	0.873239
0	1	1	1	3	1	0.907217	9	0.80292	0.859375
1	1	1	1	15	1	0.901869	1,2,7,24,31,44,45, 49,51,78,86,89,96 ,98,102	0.86334	0.917051

Table 6 displays the descriptive statistical analysis, including the mean value & standard deviation. It also implies no missing information when we identified the result using fsQCA 3.0.

Table 6: Descriptive Statistics Analysis

Variables	Mean	Standard Dev.	Maximum	Minimum	No. of Cases	Missing
SSC	0.7875	0.3004832	1	0	129	0
GLT	0.7321429	0.3354672	1	0	129	0
SS	0.7559524	0.3051546	1	0	129	0
SPP	0.7845238	0.2725515	1	0	129	0
SM	0.5613095	0.3884762	1	0	129	0

6. Findings and Discussion

FsQCA Analysis:

The fsQCA study identifies five measures to ensure supply chain sustainability through improved service and cost savings. The void spots mean a "ignore" situation, where the crosses (X) indicate a low existence, and the black rings (●) represent the existence of a situation.

Table 7: Configurations leading to sustainable supply chain

PATHS	GLT	SS	SPP	SM	Raw Coverage	Raw Consistency	Solution coverage	Solution consistency
GLT*SPP*~SM	●		●	X	0.41421	0.938356		
~GLT*SPP*SM	X		●	●	0.254724	0.925824		

~GLT*SS*~SPP*~SM	X	●	X	X	0.0952381	0.933333	0.860166	0.906773
GLT*SS*SPP	●	●	●		0.680272	0.917431		
SS*SPP*SM		●	●	●	0.505669	0.902834		

Five causal schemes are empirically significant, according to Table 6, with an overall assessment of (consistency = 0.906773) & (coverage = 0.860166). It is essential to remember that long-term supply chain management sustainability cannot be accomplished by focusing just on one criterion. As (Ragin, 2009) suggests, coverage scores help determine the practical significance of causative factors. The empirical relevance of a causal situation is how effectively it can explain an observed outcome.

Outcome 1 This conveys a unique group of supply chain experts and entrepreneurs from well-known companies in the country. According to the findings, modest supplier management, green logistics, planned transportation, sustainable packaging, and the absence of a sourcing element are sufficient for creating a sustainable supply chain (consistency = 0.938356) and (coverage = 0.41421). Businesses may enhance their environmental stewardship, lower their carbon footprint, and build a resilient supply chain that meets the demands of socially and environmentally concerned consumers, all while contributing to a more environmentally friendly and profitable future.

Outcome 2 This depicts a sample subset, including employees, teachers, and others. This pathway demonstrates that suitable transportation, environmentally friendly packaging, competent supplier management, and the absence of a sourcing component are sufficient for producing a sustainable supply chain (consistency = 0.925824) and (coverage = 0.254724). It appears that some individuals do not consider sustainable sourcing to be a significant issue in the supply chain. Nevertheless, eco-friendly transportation methods can help reduce emissions and minimize the environmental impact of product transportation. Sustainable product design and packaging, which employ renewable materials and reduce waste, promote responsible usage and disposal. Additionally, appropriate supplier management ensures that partners meet sustainability standards, promoting ethical practices throughout the supply chain.

Outcome 3 This shows a tiny proportion of the responders are teachers, BCS cadres, or civilians with supply chain knowledge. This pathway demonstrates that moderate supplier management, green logistics, sustainable packaging, and improved sourcing are required to produce a sustainable supply chain (consistency = 0.933333) and (coverage = 0.0952381). This result reveals that ethical sourcing is critical for superior supply chain management, with logistics, transportation, and packaging playing minor roles. According to these respondents, embracing sustainable procurement improves overall supply chain adaptability, minimizes environmental footprints, and builds a favorable reputation.

Outcome 4 This constitutes a significant sample component, including supply chain analysts, academics, and employees with at least five years of supply chain expertise. The findings indicate that assuring green logistics, improving transportation facilities, sourcing and packaging sustainable products, and avoiding supplier management is adequate for attaining the ideal supply chain management (consistency = 0.917431) and (coverage = 0.680272). This can be understood as a holistic approach to sustainability in sourcing, goods, packaging, and green logistics, fostering transparency, resilience, and beneficial environmental and social benefits.

Outcome 5 This is a portion of the sample, which includes students, professors, employees, and others. The responses demonstrate that eco-friendly sourcing, products, and packaging, in addition to guaranteeing efficient supplier relationships and the lack of green logistics, can be adequate configurations for attaining a sustainable supply chain (consistency = 0.902834) and (coverage = 0.505669). It might indicate that by incorporating these principles, businesses can create an agile and secure supply chain that helps the earth, society, and their longevity.

According to the outcomes presented above, it can be inferred that the findings of this fsQCA study support hypothesis 1, 3, and 4 since green logistics, sustainable sourcing, products, and packaging are critical parts of supply chain management for lowering costs and improving service. Similarly, hypothesis 2 is rejected since the moderate supplier is relevant for most solutions. Figure 2 depicts a visual presentation.

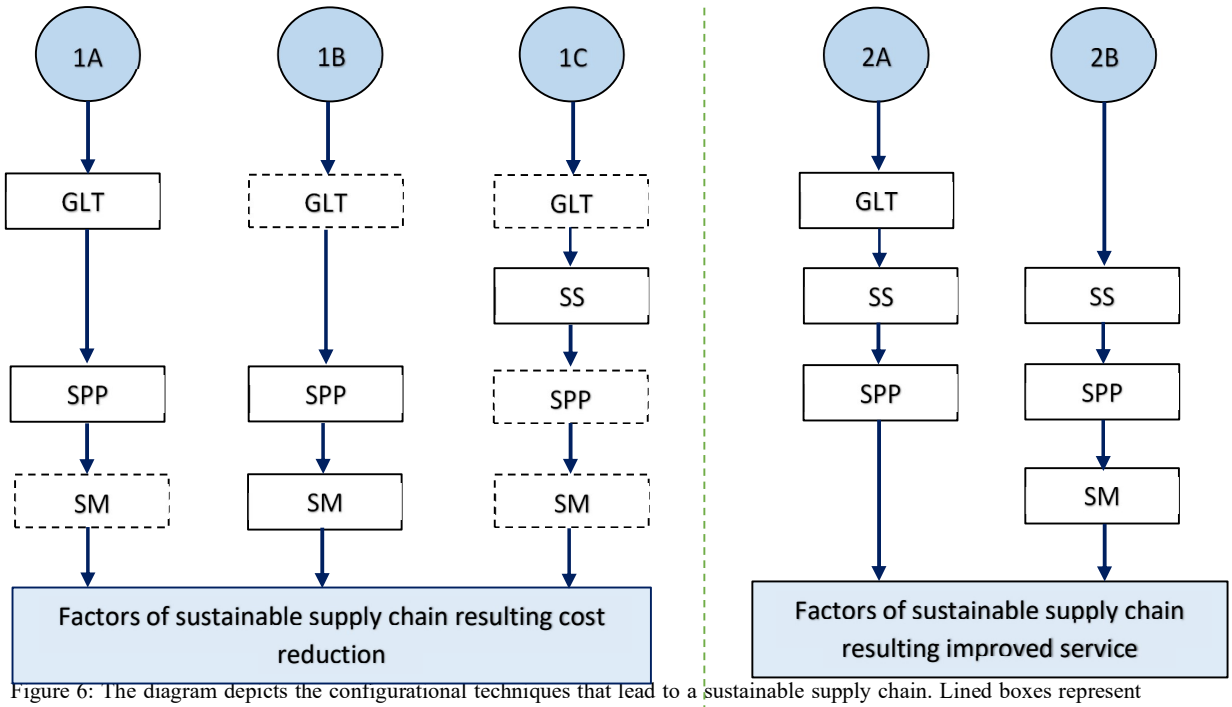

Figure 6: The diagram depicts the configurational techniques that lead to a sustainable supply chain. Lined boxes represent complete membership; dotted boxes represent the presence and non-existence of the factors; no boxes represent total non-membership.

We identify two supply chain topologies and their different approaches to sustainable management based on the prior arguments and real options, as illustrated in Table 7. These topologies are intended to save costs and enhance service

Table 8: Topologies of sustainable supply chain to ensure improved service & cost reduction

Label	Definition	Key insights
Cost Reduction (S1, S2 and S3)	Green logistics & transportation, sustainable packaging with moderate supplier identification.	The environmental effect of moving products can be reduced by adding green logistics, like employing fuel-efficient trucks, optimizing routes to decrease emissions, and utilizing renewable energy sources. Implementing effective packaging & supplier management minimizes waste even more.

	Ensuring best suppliers & sustainable products along with better transportation.	Developing products with little environmental effect, using renewable resources, and adopting eco-friendly production practices contribute to a lower total carbon footprint. Working directly with suppliers supports the use of environmentally friendly techniques as well.
	Best possible sourcing besides ensuring green logistics, sustainable packaging & effective supplier management.	Ethical sourcing strategies strengthen local people while minimizing negative societal consequences. Businesses can boost sustainability by emphasizing green logistics, employing efficient packaging, and managing suppliers.
Improved Service (S4 and S5)	Sustainability in sourcing, products, packaging besides maintaining green logistics.	Companies can lessen their environmental effect from sourcing to delivery by carefully choosing suppliers with responsible and eco-friendly practices, employing renewable materials, and implementing sustainable packaging solutions. Green logistics reduce emissions as well as waste during transit even more.
	Sustainability in sourcing, products, packaging along with efficient supplier management.	Businesses can keep ethical standards throughout the supply chain by carefully picking eco-conscious suppliers and encouraging responsible practices. Environmental effect is further reduced by emphasizing sustainable goods and packaging, employing renewable resources, and eliminating trash. Clear communication and regular supplier reviews ensure compliance and stimulate continual progress.

6. Conclusions and Implications

The purpose of this study is to gain a better knowledge of the elements that influence service improvement in the supply chain context. The empirical study shed light on the complex interactions between green logistics, sustainable sourcing, sustainable packaging, and supplier management in terms of increasing service and cutting costs. Through thorough data analysis and methodical investigation, we identified crucial insights emphasizing the relevance of sustainable procedures in changing supply chains into sustainable and competitive systems. Our findings unequivocally show that introducing sustainable principles into the supply chain increases both service standards and efficiency. Green logistics was found as an important factor with a significant and direct impact on service quality growth. At the same time, environmentally friendly procurement and supplier management were critical in meeting cost-cutting targets. Using environmentally friendly packaging.

In addition, the study discovers that incorporating green logistics, sustainable sourcing, sustainable packaging, and efficient supplier management has a synergistic effect, driving the most significant gains in both service and cost dimensions. This comprehensive approach highlights the interconnectedness and mutual amplification of sustainable practices throughout the supply chain, emphasizing the importance of a collaborative approach rather than individual efforts. Our research contributes to current research on sustainable supply chains by providing empirical facts to support theoretical claims. These findings have practical implications for businesses looking to initiate a sustainable supply chain revolution. As long as sustainability is a consideration in the global business environment,

implementing a sustainable supply chain strategy becomes both a strategic choice and a moral obligation. We hope that our study inspires additional investigation.

Implications

Analyzing how a sustainable supply chain can revolutionize service and reduce costs has produced several noteworthy implications for businesses and researchers. Sustainable supply chain techniques, such as green procurement, waste reduction, sustainable packaging, sourcing, delivering, and energy-efficient transportation, can enhance service delivery and operational efficiencies while saving costs. Additionally, companies prioritizing sustainability in their supply chain operations can improve their brand reputation, increase customer loyalty, and minimize the risks associated with supply chain interruptions and regulatory noncompliance. Lastly, incorporating sustainability indicators in performance assessment systems enables firms to evaluate their sustainability efforts' effectiveness and make future improvements.

Limitations & Suggestions for Further Studies

It is critical to recognize some limits in the data analysis. To begin, the analysis relied primarily on existing literature, case studies, and corporate reports, which may only reflect a subset of experiences and practices from various industries and geographies. Second, changes in the availability and quality of information on sustainable supply chain strategies, service quality, and cost reduction may have an impact on the findings' generalizability. Third, the study could have taken into account specific organizational circumstances such as size, industry, and geographical location, as these characteristics can influence the success and acceptance of sustainable supply chain strategies.

Future research might be offered to increase knowledge on a sustainable supply chain shift to improve service and reduce costs. For example, empirical research encompassing a larger range of sectors and organizational situations would improve the findings' generalizability. Second, longitudinal studies that follow the adoption of sustainable supply chain strategies through time shed light on the long-term implications on service quality and cost reduction. Third, comparative research examining the variations and similarities in sustainable supply chain practices throughout different locations and cultures would help us better understand contextual aspects. Furthermore, research focused on the obstacles and constraints that firms experience while implementing sustainable supply chain practices, and ways to overcome them would be beneficial.

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