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A study on the effects of Green Supply Chain Management on the performance of e-commerce companies, with a focus on Flipkart and Amazon

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ABSTRACT

This study aimed to evaluate the impact of green supply chain management (GSCM) on the organizational performance of two major e-commerce companies, Amazon and Flipkart. A mix of qualitative and quantitative secondary research was conducted to gather a cost-effective range of information. The analysis found that the most effective GSCM practices for e-commerce companies are using alternative modes of transport and fuels, incorporating Industry 4.0 technology in packaging and transport, and optimisation of resource usage in warehousing. These practices can be effectively implemented through the use of technologies such as blockchain, route optimization software, and intelligent manufacturing, as well as basic green practices such as using solar energy and energy-saving measures in warehouses and conducting energy audits to identify opportunities for improvement. A framework comprising three pillars sustainability, technology, and personnel was suggested as a reference point for companies seeking to make their supply chains greener while also achieving monetary and non-monetary benefits.

Keywords: Commerce, Supply Chain, Management, Sustainable, Amazon.

Subject: Supply Chain Management

INTRODUCTION

Background

In today's competitive business era, it is crucial for organizations to adopt sustainable practices in order to reduce operational costs and improve their public image. Green supply chain management (GSCM) involves developing environmentally-friendly product designs, material sourcing, and manufacturing processes. Supply chain activities, including transportation and warehousing, are major contributors to greenhouse gas emissions. As the e-commerce industry grows, it is important for these companies to consider decarbonizing their supply chain operations and adopting a triple-bottom-line focus on social, environmental, and financial outcomes.

Supply Chain to a Green Supply Chain

Activities including logistics and warehousing, are significant contributors to greenhouse gas emissions. Road freight transport, which accounts for approximately 60% of the carbon footprint of the logistics sector, is particularly problematic for e-commerce companies due to its reliance on last-mile delivery. Green supply chain management practices, including the use of alternative modes of transport and alternative fuels, can help reduce the environmental impact and cost of e-commerce operations. Alternative modes such as rail and inland waterways offer lower costs and emissions compared to road transport. Alternative fuels such as electrified vehicles, biofuels, natural gas, and hydrogen can also reduce emissions. Route optimization technologies and Industry 4.0 techniques, such as the use of smart packaging and transport, can also help e-commerce companies improve efficiency and reduce their carbon footprint. However, implementing these practices can be challenging, and further research is needed to understand the most effective strategies for decarbonizing the supply chain in the e-commerce industry.

Research Aims and Objectives

The aim of this research is to examine the impact of green supply chain management on the performance of e-commerce companies and determine the financial and non-financial benefits of implementing such practices.

Research Questions

1. What are the top techniques for green supply chain management that e-commerce companies can utilize?
2. How can e-commerce companies effectively put these practices into action?
3. How will the implementation of these practices affect the performance of e-commerce companies?

Research Objectives

1. Identifying the most effective green supply chain management practices for e-commerce companies.
2. Creating a framework for efficiently implementing these practices in e-commerce companies.
3. Evaluating the potential cost and benefit impact of the discussed practices.

LITERATURE REVIEW

Definitions

Before analyzing the research questions, it is important to define key terms relevant to the topic. Supply chain management is the process of producing and delivering a final product from the supplier's supplier to the customer's customer, according to Larson et al. (2015). Logistics, a critical component of the supply chain, involves planning, implementing, and controlling the flow of goods and services, as well as related information, between the points of origin and consumption to meet customer requirements, according to Rushton et al. (2022). Green supply chain management and sustainable supply chain management are both concerned with integrating economic, environmental, and social sustainability with supply chain management activities, but sustainable supply chain management may also include economic and social sustainability, while green supply chain management focuses solely on environmental sustainability, according to Ahi et al. (2013).

E-Commerce and Green Supply Chain Management

The integration of supply chain systems into e-commerce businesses has improved customer service and satisfaction but also contributes to global warming. The digitization of supply chain management has allowed companies, particularly e-commerce companies, to organize and analyze large amounts of data and interact directly with customers. Efficient supply chain strategies can increase competitiveness in the market and many companies use e-commerce to incorporate green strategies, optimizing resource allocation and increasing influence. However, building a sustainable supply chain can be difficult and requires restructuring existing systems to meet environmental regulations. Collaboration with vendors, sellers, and even competitors can help create a more sustainable environment. The Paris Agreement, signed in 2015 by over 195 countries, aims to reduce greenhouse gas emissions to prevent warming the planet by at least 2 degrees Celsius. Making supply chains more sustainable can also improve the health and well-being of workers, such as by reducing the use of fertilizers and pesticides in the agriculture industry.

The Covid-19 pandemic disrupted the functioning of economies worldwide. However, as people stayed home, they turned to online ordering more frequently. Figure 1 shows the increase in the share of e-commerce in global grocery retail during this period. Figure 2 shows the increase and forecast of global retail e-commerce sales from 2014 to 2026.

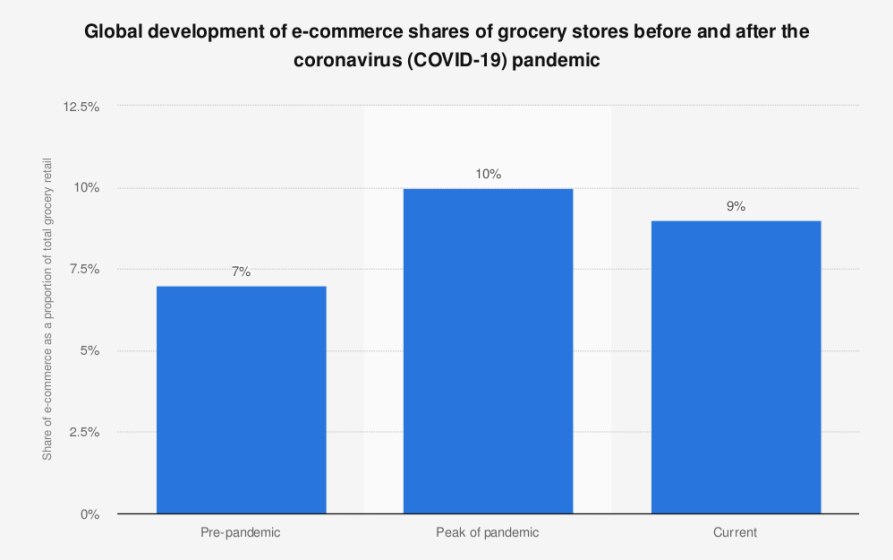

Figure 1: Change in e-commerce share of retail grocery
Source: Mastercard Economics Institute (2021)

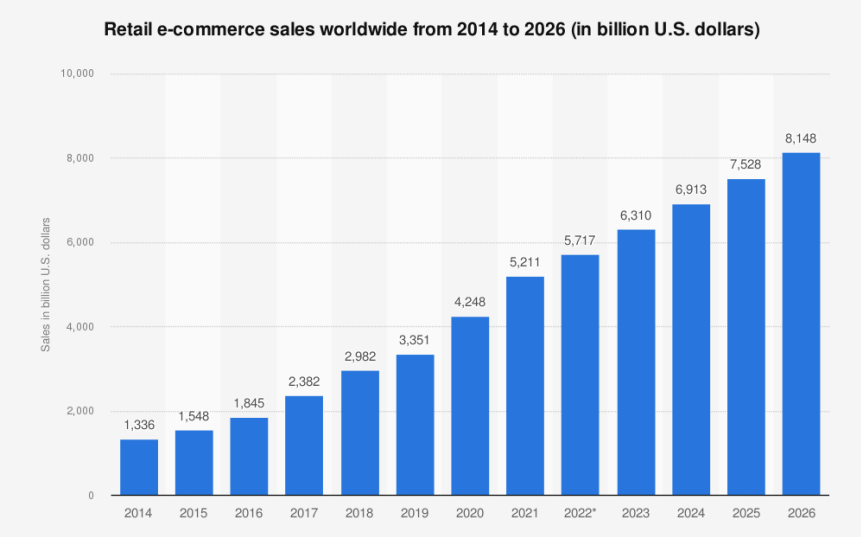

Figure 2: Retail e-commerce sales worldwide (2014-2026)
Source: Chevalier (2022)

The Covid-19 pandemic presented many challenges for businesses, particularly in regards to supply chain management systems. Companies struggled with rigid supply lines, centralized systems, and reliance on technology as the world entered lockdown. However, this also created opportunities for innovative thinking and technology to improve supply chain management processes.

Freight Transport Operations

The freight transportation sector is a challenging one to decarbonize due to its reliance on traditional fossil fuels like petrol and diesel. According to Meyer et al. (2020), by 2050, greenhouse gas emissions from freight transport are estimated to make up 16% of total emissions. As shown in Figure 3, medium and heavy trucks contribute 22% of the total CO2 emissions of 7.3 billion metric tons in the global transportation sector in 2020.

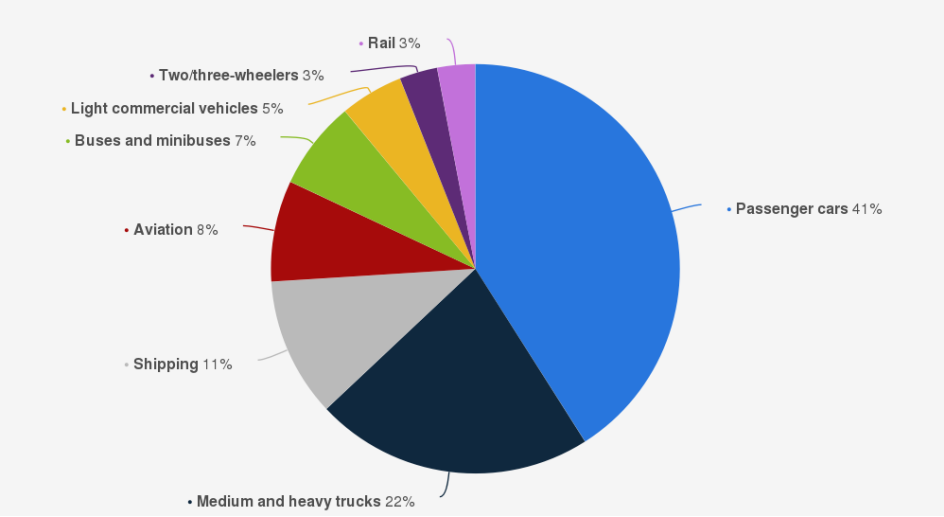

Figure 3: Distribution of CO_2 emissions produced by the global transportation sector in 2020
Source: IEA (2021)

The feasibility of using alternative modes of transportation in the e-commerce industry has been a topic of discussion for researchers. While modes such as sea and rail transport offer advantages such as low environmental costs and the ability to transport large volumes of goods at lower costs, they also have their drawbacks. Sea transport has a low operating speed, and both sea and rail transport require significant initial infrastructure investment and have limited network coverage. Road transport, on the other hand, is necessary for last-mile delivery in the e-commerce industry, but it can be made more environmentally friendly through the use of intelligent mobility options and alternative fuels. E-commerce companies must weigh the benefits and costs of each mode of transportation before deciding on how to optimize their supply chain.

E-commerce companies can adopt various strategies to make road freight transport more environmentally friendly. One such strategy is the use of intelligent mobility options such as route optimization technologies. These technologies can help improve the efficiency of transportation and reduce the environmental impact of operations. Additionally, e-commerce companies can consider using alternative fuels that produce fewer greenhouse gas emissions and are more fuel efficient. Examples of such fuels include hydrogen, electricity, biofuel, and natural gas. Biofuels, in particular, have the potential to significantly reduce greenhouse gas emissions from road freight transport. They can also lower noise pollution levels compared to conventional fuels. To effectively implement these strategies, e-commerce companies need to work closely with stakeholders such as governments, transportation providers, and consumers.

The use of biofuels is considered a promising technology for reducing greenhouse gas emissions from road freight transport. Kondili et al. (2007) consider liquid biofuels, produced from crops and other organic matter, as the best currently available technology on a mass scale to replace fossil fuels. Biofuels are expected to significantly reduce greenhouse gas emissions from road freight transport. Figure 4 projects the increase in biofuel consumption for different modes of transport between 2015 and 2030. Chiaramonte et al. (2021) estimate that biofuels will contribute 24.5 Mtoe in 2030 and 48.3 Mtoe in 2050, while advanced biofuels are projected to contribute an average of 8.7 Mtoe in 2030 and 36.5 Mtoe in 2050. The use of biofuels can reduce CO2 emissions by up to 60%, and vehicles running on biofuels have a much lower contribution to noise pollution levels compared to conventional fuels (McKinnon et al., 2015).

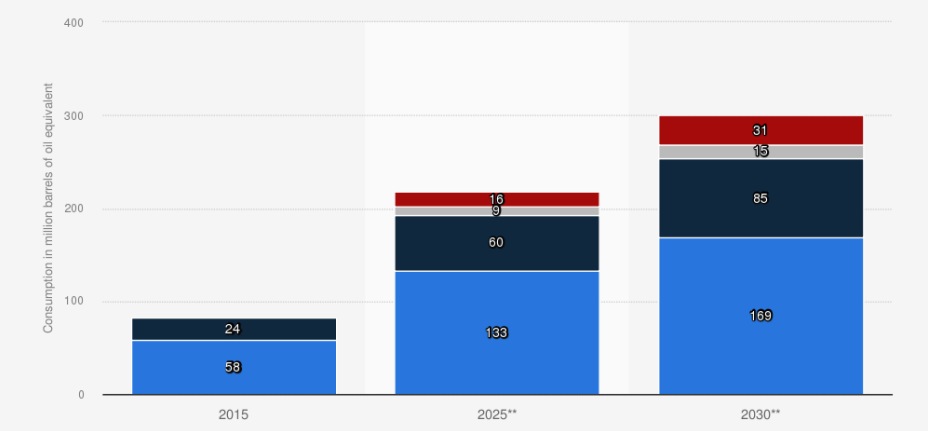

Figure 4: Change in Biofuel consumption for different modes of transport from 2015 to 2030 (in million barrels of oil equivalent)
Source: IEA (2020)

Electric vehicles can be a promising green supply chain management strategy for e-commerce companies, especially in regards to their truck and heavy goods vehicle fleet. Many experts have recognized the potential of electric vehicles and have released research and policy documents that support their adoption. The electrification of these vehicles can greatly reduce carbon emissions from petrol and diesel. However, it is important to consider the source of electric generation. While electric vehicles do reduce emissions at the source, the net effect can be zero or even negative if the electricity is produced from non-renewable sources such as coal, which releases harmful gases. Therefore, e-commerce companies need to consider the renewable energy mix in their country of operation before fully transitioning to electric vehicles. In a country with a higher proportion of renewable energy sources, such as solar, wind, and nuclear, the switch to electric vehicles can make the company's supply chain both green and sustainable.

E-commerce companies face the challenge of decarbonizing their supply chains, particularly in regard to freight transportation. Alternative modes of transport, such as rail and sea, have been analyzed for their potential as green supply chain management practices. However, road transport remains necessary for last-mile delivery and these alternative modes often require large initial infrastructural investments and have limited network coverage. To make road freight transport more environmentally friendly, e-commerce companies can adopt smart mobility solutions like route optimization technologies and use alternative fuels like hydrogen, electricity, biofuels, and natural gas. These alternatives can significantly reduce greenhouse gas emissions, improve fuel efficiency, and reduce noise pollution. However, the source of electricity for electric vehicles and the safety and reliance on natural gas must also be considered. Smart mobility solutions like route optimization technologies can also help e-commerce companies reduce costs and emissions through more efficient routing. Collaboration with suppliers and the use of environmentally friendly packaging are additional strategies that e-commerce companies can adopt to improve the sustainability of their supply chains.

Technologies for Green Supply Chain Management

The implementation of route optimization technology and the incorporation of Industry 4.0 technologies can help e-commerce companies make their reverse supply chain flows more efficient and sustainable. Route optimization software, which uses artificial intelligence to determine the most efficient path for a company's vehicles, can reduce costs and emissions simultaneously. Industry 4.0 technologies, such as interconnected computers and smart materials, can improve the flexibility, communication, and efficiency of supply chain operations, as well as reduce waste and pollution. As computer networks become more prevalent in modern logistics systems, artificial intelligence is becoming increasingly important in logistics and supply chain management.

Alternative modes of transport have mixed results, which necessitates e-commerce companies to find ways to make road freight transport more environmentally friendly. According to a literature review, there are two methods that can achieve this goal: increased focus on smart mobility management and the use of alternative fuels. The UNECE report "Recommendations for Green and Healthy Sustainable Transport - Building Forward Better" recommends these actions as part of its plan for sustainable transport. E-commerce companies can implement route optimization technologies, which use artificial intelligence to calculate the most efficient routes, to improve their performance and reduce their environmental impact. They can also use alternative fuels that produce lower GHG emissions, higher fuel efficiency, and less noise. The World Economic Forum and Accenture's 2009 report identified 13 strategies, including clean vehicle technologies, as effective for decarbonizing the supply chain in all sectors, including e-commerce. Of these, clean vehicle technologies, such as hydrogen, electricity, biofuel, and natural gas, are considered the most promising. However, their rapid implementation is necessary for a significant impact on greenhouse gas emissions. Biofuels, in particular, have the potential to significantly reduce GHG emissions from road freight transport. The use of biofuels can reduce CO2 emissions by up to 60%, and vehicles using biofuels produce little noise pollution compared to conventional fuels.

Warehousing

The importance of considering warehousing operations in green supply chain management for e-commerce companies cannot be underestimated. Warehousing, or distribution centres where products are stored before being delivered to consumers, consumes energy, land, and water, and can contribute significantly to a company's carbon footprint. In the UK, warehouses account for nearly 3% of emissions and 12% of total energy consumption in the service sector. Additionally, the concentration of warehouses in suburban areas around cities can have negative impacts on land usage and water consumption, as well as contribute to traffic congestion and potential health issues for local citizens. It is essential for e-commerce companies to consider the environmental impact of their warehousing operations as part of their green supply chain management strategies.

Packaging

Packaging is a critical aspect of the supply chain, and e-commerce companies should consider this when developing green supply chain management practices. Packaging materials contribute to energy consumption and waste generation, which can have negative impacts on the environment. Escursell et al. (2021) found that while packaging technologies have evolved rapidly in the past, they have stagnated in recent decades. Many e-commerce companies still use non-renewable materials for packaging, which can restrict growth and increase the negative environmental impact of their operations. However, new emerging technologies and techniques can help companies save costs and reduce the negative impact of their packaging operations. For example, using cellulose-based materials like carton boards, which are renewable and recyclable, instead of plastics can be more sustainable. Additionally, Industry 4.0 technologies like 3D printing and additive manufacturing can help optimize package volume and shape, leading to reduced CO2 emissions.

RESEARCH METHODOLOGY

Method of Research

This paper aimed to explore the use of green supply chain management practices in e-commerce companies, using a qualitative research approach based on secondary sources such as academic articles, company websites, and case studies. The research process involved conducting initial online searches using relevant keywords, screening the resulting articles for relevance, and using a branching process to find additional sources. Care was taken to ensure the credibility of the sources, only including articles from reputed journals in the review. The collected data was organized and analyzed according to themes to answer the research questions. The findings suggest that e-commerce companies can implement a range of green supply chain management practices, including alternative fuels, smart mobility solutions, and technologies like blockchains and smart contracts, but may face challenges such as a lack of infrastructure and high upfront costs in doing so.

Research Methodology - Justification

The secondary research method was chosen for this study as it allowed for a more efficient and cost-effective way to gather data on the topic. While primary research offers unfiltered data and the potential for new insights, it also requires more time and resources to collect. By using secondary sources such as academic journals and company websites, the

researchers were able to quickly access relevant information and filter out any data that was not directly related to the research questions. However, it should be noted that this approach does have limitations, such as the potential for bias in the collected data. Despite this, the research presented in this paper still provides valuable insights into the green supply chain management practices of e-commerce companies like Amazon and Flipkart, which can serve as a useful reference for other e-commerce companies looking to adopt similar sustainable initiatives in their own operations.

RESULTS

Case Study

The purpose of this section is to examine the green supply chain management practices of Amazon and Flipkart, two major e-commerce companies operating in different countries. Amazon, based in the United States, was one of the first e-commerce companies to gain widespread prominence, while Flipkart, based in India, was one of the first e-commerce companies to achieve a nationwide presence in that country. Flipkart is also backed by Walmart, Amazon's biggest competitor. By comparing the practices of these two companies, we can gain insight into how e-commerce companies in large countries (both in terms of geography and economy) manage their supply chains and identify similarities and differences in the operations of companies in both developed and developing countries.

Company-in-Review: Amazon

Amazon is one of the fastest-growing companies that reached $100 billion in sales revenue in over two decades (LeBlanc, 2020). It has over 50% of third-party sellers leverage the platform that has sold over 3.4 billion products, according to Amazon's May 2020 Report (Conley, 2021). The supply chain management initiatives are known to be the most innovative in the world, with the constant adaptation of technology and extended capabilities to make the supply chain efficient (Banker & Cunnane, 2021). For instance, in 2021, Amazon looked at using long-range cargo planes to improve their shipment processes and delivery timings to bring about customer satisfaction, especially during the holiday season (Day &Johnsson, 2021). Now, a year later, Amazon has announced that drone deliveries, called Prime Air, will be launched by the end of this year, 2022, in collaboration with the Federal Aviation Administration, making California the first to get experience this (Reed, 2022). In today's time, Amazon has gone beyond the use of a supply chain traditionally to design and curate more global supply chain systems that are focused on indicators not only to be cost-effective but beyond it, as well (Billings & Ho, 2017). With more initiatives and motives towards building the company to become sustainable, Amazon ensures that it chooses its vendors, that fall well through its supply chain management, to be ones that would contribute to the cause (Ceil, 2018). Therefore, every vendor/seller goes through the Fulfilment by Amazon (FBA) services to ensure Amazon has more control over their shipment, packaging and delivery, which has also started including other e-commerce sites such as eBay and Walmart (Johnson, 2018; Schoolov, 2021).

To make the supply chain more efficient, and more specific to Amazon, the company reduced its dependency on other transportation companies as their vendors, given the shortages of transport vehicles, like trucks and cargo ships, that often make the shipping process easier and faster (CNBC, 2021). Reliance on external vendors for the transportation process, more specifically, means higher prices for the consumers to pay for the products as the vendors are also to be paid more. Therefore, Amazon spent approximately $61 billion on shipping in 2020, in comparison to 2019 where they spent $38 billion (CNBC, 2021). This is also because the shipment costs of one 40-foot box from China to the United States of America has increased massively ever since the pandemic: the cost pre-pandemic was $1,000 and; post-pandemic, it rose to $20,000 (Khasawneh& Xu, 2021). Figure 5 shows the drastic increase in container freight rate pre- and post-pandemic.

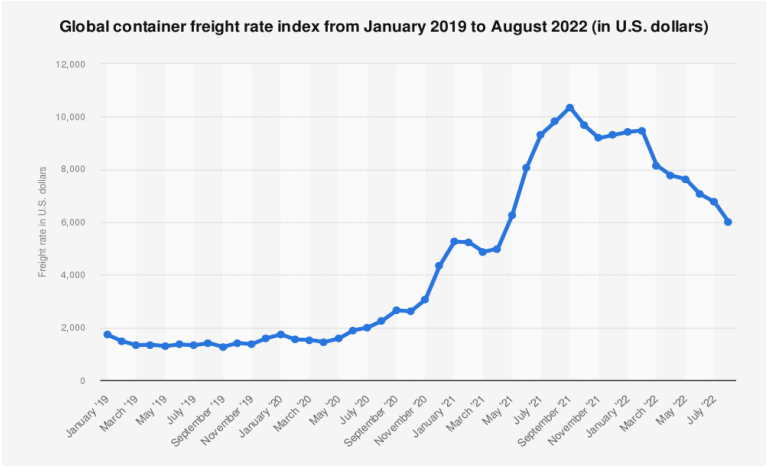

Figure 5: Global container freight rates 2019-2022
Source: Drewry (2022)

This, therefore, resulted in Amazon building its own modes of transportation for shipment purposes, which meant that the services were 100% available only for Amazon and its deliveries (Bensinger, 2016). It is now responsible for 72% of the shipping that it does by itself in 2020, as compared to 46.6% in 2019 (Schoolov, 2021). An insider strategy that best describes the decisions and implementation of strategies for Amazon is that they "always understood: they did not want to be the largest retailer, they wanted to be the largest logistics company" - building the largest global network of logistics (CNBC, 2021). This self-dependency has not only made Amazon more in control of its choices in collaborating with different vendors to go green but also created more job opportunities for people across the globe.

Amazon's goal and vision "is for our (their) products and services to be provided in a way that respects human rights and the environment" (Amazon, 2022). Amazon launched an extensive set of initiatives as its contribution to the environment globally. With its operations spread across various continents, the supply chain management of a large multinational such as this contributes a tremendous amount to the environment, without any particular schemes in place to safeguard the environment and human rights. Green initiatives for a more environment-friendly supply chain management focuses on the holistic wellbeing of its workers and the environment. To beat the other companies in terms of their supply chain, Amazon ensures fast delivery to its customers which makes it as reliable as it has been for over two decades now (LeBlanc, 2020). Shipment Zero is one of many initiatives that focus on the use of renewable energy across its shipment supply chain processes (Sturman, 2020). It reduced its reliance on big shipping companies like FedEx, USPS and UPS, to gain better control over the delivery experience to its customers (Banker & Cunnane, 2020). The Supplier Code of Conduct (2022) provides a list of things across different domains that the suppliers must prioritise and control as per the laws, promoting more green-friendly approaches to protect it. It has implemented some convenient, reliable and efficient supply chain management methods to utilise its base in many continents effortlessly. As LeBlanc (2020), in his article says, "The combination of sophisticated information technology, an extensive network of warehouses, multi-tier inventory management, and excellent transportation makes Amazon's supply chain the most efficient among all the major companies in the world."

Company-in-Review: Flipkart

Flipkart, headquartered in Bangalore, India - is an online retail store, 'revolutionising the way we all shop in India' (Flipkart, 2022). It initially sold books in 2007 but has now grown into one of the leading e-commerce stores, incorporating different marketing strategies for its brand presence, investing in high technology and providing more enticing offers to its consumers on the platform (Rajan, 2020). Flipkart struggled in its presence, during the first decade, which brought about investments of around Rs. 520-650 million from Tiger Global Management, a New-York based investment firm (Chanchani, 2010). Moreover, in 2018, Walmart, one of the leading competitors to Amazon, took a 77% controlling stake in Flipkart, making it the parent organisation of Flipkart (Ravikumar, 2020). Amazon and Walmart-acquired Flipkart are competing rivals looking at establishing themselves in the ever-growing demand of consumers in India. While Amazon is looking at expansion in India with 43 million cubic feet of storage spread across 15 different states and providing support to approximately 850,000 sellers in India, Flipkart had announced that it would strengthen its tech-dependent supply chain management network, based in Maharashtra, which would be a bigger opportunity to collaborate with more sellers locally and cater to the demand for e-commerce (Abrar, 2021).

Optimisation plays an important role in the efficiency of the processes. Flipkart has been growing in terms of its supply chain management, under the management of AmburIyyappa (Kam, Aggarwal &Madani, 2019). As a growing e-commerce in India, it has created more opportunities for employment whilst working with different Micro, Small and Medium Enterprises (MSMEs), sellers and farmers to cater to the growing demand of consumers (Abrar, 2021). Flipkart (2022) recently published its efforts to make more sustainable functions, in order to reduce the impact on the environment and build a more responsible supply chain. It is now focusing on ensuring there is an efficient use of resources by using more renewable energy and implementing initiatives to improve water management, water management, and the overall productivity of energy across the facilities (Flipkart, 2022). A WWF India report on Flipkart's sustainable packaging discusses one of the many initiatives implemented by the company, involving multiple stakeholders to corporate responsible actions towards environmental solutions (WWF India, 2022). The company has already shifted to more sustainable packaging that involves the 100% elimination of the use of plastic in the supply chain processes. Moreover, it is also one of the first companies that aim to 100% transition to the use of EV fleets by 2030 (D'Cunha, 2022). However, when questioned vendors, collaborating and working with Flipkart, of their experience in turning sustainable, they said, while packaging has turned easier and has been providing customer satisfaction, "lower costs will be a good factor as currently, the cost of green packaging is higher than plastic", indicative of the financing aspect to strengthened in order to go green (WWF India, 2022).

Figure 6 provides an interpretation of the strategy that has been incorporated by Flipkart through its developments and growth since 2007 (Kam, Aggarwal &Madani, 2019).

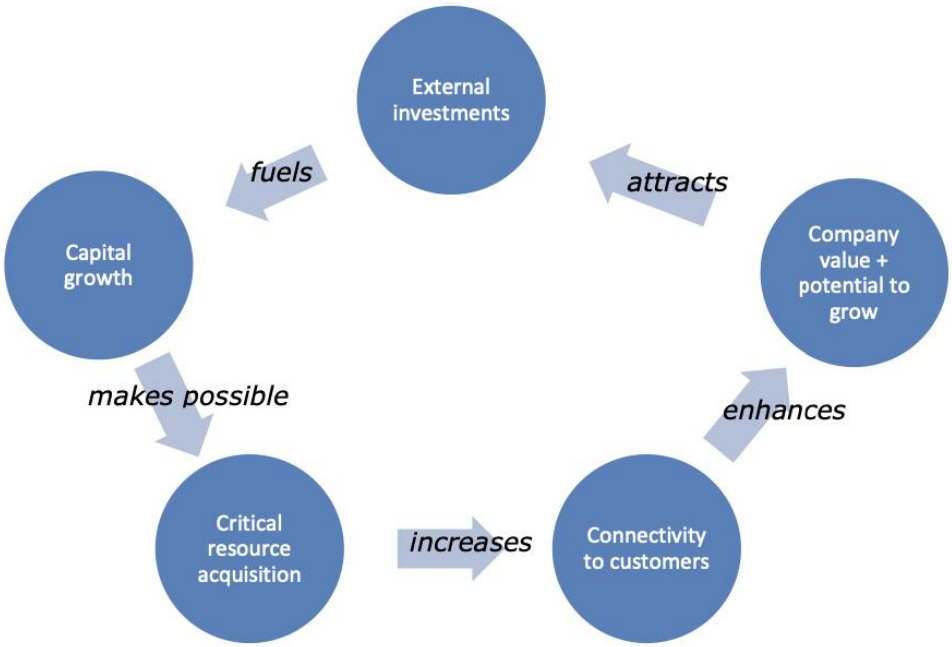

Figure 6: Flipkart's strategy cycle for building resources and generating capitalSource: Kam, Aggarwal &Madani (2019)

Moreover, Flipkart is collaborating with pioneers in sustainability and green technology, to ensure that its partners hold Flipkart responsible for its positive contribution to the environment. These stakeholders, such as World-Wide Fund for Nature (WWF), Canopy and World Business Council for Sustainable Development (WBCSD), also release reports on growing advancements that occur through the company for its consumers and other researchers to be aware of the steps that have been taken (Flipkart, 2022). The company has also aligned itself to the Government of India's 'Net Zero by 2070', wherein by 2040 it will reduce its carbon emissions to zero, making it one of many Indian companies that committed to this initiative so far (D'Cunha, 2022). As Dhanashree Panda, the Director of Sustainability at Flipkart has said, "The platform has delved deep into the nuances of packaging material design to reduce the dependence on the evolution of the packaging materials or supplier ecosystem" (D'Cunha, 2022).

Contribution of Different E-commerce Activities to Greenhouse Gas Emissions

It has been found that various e-commerce activities contribute to global greenhouse gas emissions massively. The graph below breaks down the contribution of different e-commerce activities to global greenhouse gas emissions.

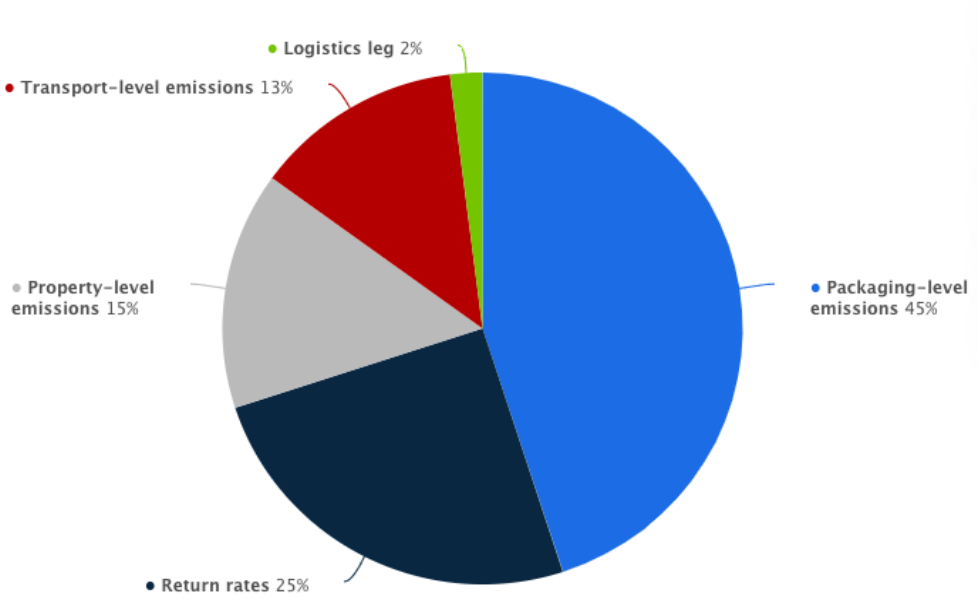

Figure 7: Share of e-commerce greenhouse gas (GHG) emissions worldwide as of 2020
Source: MIT Real Estate Innovation Lab (2021)

In conclusion, both Amazon and Flipkart have made significant efforts to make their supply chains more sustainable. Amazon has focused on building its own transportation network and implementing initiatives such as Shipment Zero to reduce its carbon footprint. Flipkart, on the other hand, has collaborated with organizations such as WWF and Canopy to promote sustainability in its supply chain. Both companies have also made commitments to reduce their carbon emissions, with Amazon targeting net-zero emissions by 2040 and Flipkart aiming for 100% electric vehicle use in its fleet by 2030. However, it is clear that there is still room for improvement, particularly in the area of packaging, which accounts for a significant portion of greenhouse gas emissions in the e-commerce industry. To fully realize their sustainability goals, it will be important for these companies to continue to innovate and invest in new technologies and practices that can help reduce their environmental impact.

Answering the Research Questions

Based on the results of the case study as well as the literature review, the paper will now progress towards answering the three research questions it had started out to answer.

RQ 1: What are the top techniques for green supply chain management that e-commerce companies can utilize?

Green supply chain management practices can be broadly classified into three categories: alternative modes of transport and alternative fuels, use of industry 4.0 technology for packaging and transport, and resource efficiency in warehousing activities. These practices aim to reduce the environmental impact of e-commerce companies and make their supply chains more sustainable. Some examples include the use of electric vehicles or drones for delivery, more environmentally friendly packaging materials and methods, and optimizing resource use in warehouses. By addressing these key areas, e-commerce companies can work towards reducing their carbon emissions and contributing to a more sustainable future.

R1.1 - Use of alternative modes of transport and alternative fuels for transport

Additionally, the use of alternative fuels for transport can also contribute to a more sustainable supply chain. For example, companies can consider using electric vehicles or biofuels as alternatives to traditional fossil fuels. These alternative fuels can help reduce greenhouse gas emissions and improve the environmental performance of the transport sector.

The use of technology can also help improve the sustainability of the supply chain. For example, companies can use advanced packaging materials that are lightweight, reusable, and recyclable, which can help reduce the environmental impact of packaging. Additionally, the use of technology like artificial intelligence and the Internet of Things can help optimize the transportation of goods, reducing the distance travelled and the associated emissions.

Finally, companies can focus on more efficient usage of resources through their warehousing activities. For example, they can implement measures like energy-efficient lighting, insulation, and heating/cooling systems in their warehouses, which can help reduce energy consumption and greenhouse gas emissions. They can also consider using renewable energy sources like solar or wind power to power their warehouses. By adopting these practices, e-commerce companies can improve the sustainability of their supply chain and reduce their environmental impact.

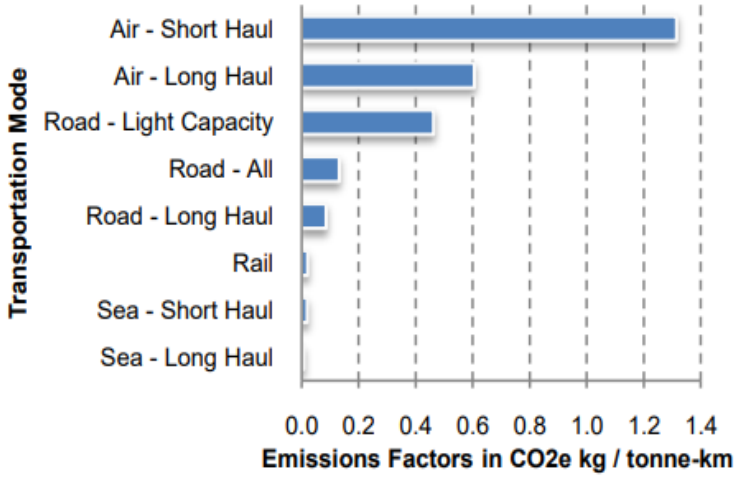

Figure 8: Emission Efficiency per Transport Mode
Source: World Economic Forum (2009)

In addition to alternative modes of transport and alternative fuels, the use of technology and more efficient resource usage can also play a role in making the supply chain of e-commerce companies more sustainable. The use of Industry 4.0 technologies such as artificial intelligence, the Internet of Things, and robotics can help to improve the efficiency and sustainability of the supply chain by streamlining processes, reducing waste, and increasing the use of renewable energy. For example, the use of robots in warehousing can help to reduce the need for manual labour, leading to fewer emissions and more efficient resource usage. In addition, the use of data analytics can help companies to optimize their routes and reduce unnecessary transportation, further reducing emissions. Overall, e-commerce companies need to consider a variety of strategies to make their supply chains more sustainable, including the use of alternative modes of transport, alternative fuels, and technology to improve efficiency and reduce waste.

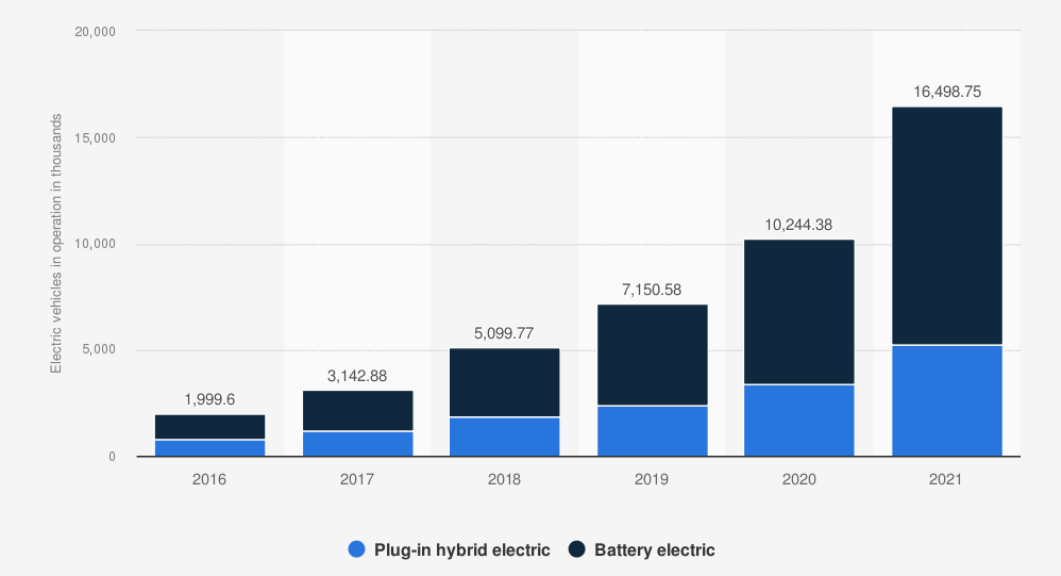

Figure 9: Number of electric vehicles in use worldwide between 2016 and 2021
Source: IEA (2022)

E-commerce companies have several options for making their supply chains more sustainable, including using alternative modes of transport such as rail and waterways, alternative fuels like hydrogen and electricity, and biofuels like biodiesel and bioethanol. Each of these options has its benefits and challenges, and companies must consider which one is the best fit for their operations. For example, hydrogen fuel cells and electrolysers have become more affordable in recent years, but electric vehicle users have reported shortages of key ingredients like lithium, nickel, and cobalt. Biofuels, on the other hand, are both sustainable and have the added benefit of waste treatment, but can be expensive when used exclusively. E-commerce companies should consider these options and their specific needs when deciding how to make their supply chains more sustainable.

R1.2- Use of better technology brought by industry 4.0 for packaging and transport

In summary, there are several ways that e-commerce companies can make their supply chains more sustainable. These include using alternative modes of transport and alternative fuels, such as rail, water, hydrogen, electricity, and biofuels, adopting technology from industry 4.0, including additive manufacturing, 3D printing, and blockchain, and using software to optimize routes and reduce fuel waste. These practices can help e-commerce companies reduce their greenhouse gas emissions and contribute to a more sustainable future.

R1.3 - Focus on more efficient usage of resources by warehousing activities

Furthermore, e-commerce companies can also consider using warehouse automation to increase efficiency and reduce energy consumption. Automated storage and retrieval systems (ASRS) can help e-commerce companies to store and retrieve products more efficiently, reducing the need for energy-intensive processes such as forklifts and conveyor belts. Warehousing automation can also help to reduce the physical space required for storage, leading to further resource and energy savings. Additionally, implementing a real-time inventory management system can help e-commerce companies to reduce the need for unnecessary transportation, further reducing energy consumption and emissions. Overall, there are many ways in which e-commerce companies can make their warehousing operations more sustainable, including the use of renewable energy, energy-efficient appliances, and automation.

RQ 2: How can e-commerce companies effectively put these practices into action?

Green supply chain management practices are meant to make the operations of e-commerce companies more sustainable. However, sustainability should also provide benefits not just to society but also to the company implementing them (Narayana et al., 2014). Therefore, it is important for companies to be able to understand the

different aspects of green supply chain activities and implement them efficiently. The literature review and the case studies have presented some distinct solutions that can be implemented efficiently by e-commerce companies.

One of the most important interventions presented in the paper is technological intervention. It was observed that technological interventions like blockchains, route optimization software, and smart manufacturing can solve nearly 70% of the emission-related problems in the e-commerce industry due to packaging and reverse flow of goods (Boçek et al., 2007; Dhanalakshmi et al., 2018). E-commerce companies should focus on the use of existing and upcoming technologies in the supply chain process. Moreover, the use of other modern technologies like alternative fuels was found to be a strong response to the problem of emissions from transport-related activities (McKinnon et al., 2015). Alternative fuels and investing in these technologies can help in reducing another 13% of the total emissions from e-commerce companies' activities (Statista, 2022; Bader et al., 2010). Therefore, companies can implement green supply chain practices efficiently only when they invest and adopt the technologies that are being created to help them reduce emissions.

Sustainability can also be achieved with very basic interventions as well. E-commerce companies can make the important components of the supply chain more environmentally friendly. Warehousing, in particular, can become more sustainable if proper sustainable practices are implemented by the organisations. The use of solar energy, as displayed by Amazon, can help companies reduce their carbon emissions from warehousing activities that account for 15% of the overall emissions. Simple efficiency can also be achieved through basic initiatives to not waste electricity in warehouses (McKinnon et al., 2015).

Moreover, energy audits can help e-commerce companies understand how to efficiently implement these green supply chain management activities. Energy audits, usually conducted by third-party experts, help a company understand the energy efficiency and the carbon sink created by the warehouse. Energy audits can help identify waste of energy, and scope for improvement for the warehouses. The design of warehouses can also have built-in sustainability. Design methods like BREEAM (Building Research Establishment Environmental Assessment Method), LEED (Leadership in Energy and Environment Design), CASBEE (Comprehensive Assessment System for Building Environmental Efficiency), GREENSTAR, and DGNB (German Sustainable Building Council) can serve as useful standards for e-commerce companies to implement while building warehouses and balance sustainability with profitability through efficient implementation (McKinnon et al., 2015).

It is worth noting that apart from technological intervention and sustainable management practices, the role played by the staff of e-commerce will be integral in efficiently implementing these green supply chain management practices. Pandey et al. (2012) have mentioned that good HR (human resource) practices like information sharing and well-skilled staff have a significantly positive effect on supply chain integration and performance. This will be a crucial factor in determining how successfully e-commerce companies can implement technologies introduced by industry 4.0. Proper training and skilling of the staff responsible for the implementation of the technological and sustainability initiatives will determine if the e-commerce company can implement them efficiently.

RQ 3: How will the implementation of these practices affect the performance of e-commerce companies?
Despite the potential benefits of using alternative fuels such as electricity and hydrogen, Jones et al. (2020) have found that diesel vehicles remain the most cost-effective option for commercial use. Similarly, 3D printing and additive manufacturing techniques are still relatively expensive for e-commerce companies to adopt on a large scale (Escursell et al., 2021). Similarly, blockchains may not be affordable for smaller players in the e-commerce industry (Dhanalakshmi et al., 2018). Therefore, while these practices can increase efficiency and reduce waste, they may not be practical for companies to implement in the short term due to the high upfront costs. In the short term, companies may consider using cheaper methods of green supply chain management such as natural gas or biofuels for road transport (McKinnon et al., 2015) and cellulose-based manufacturing for packaging (Escursell et al., 2021). Additionally, route optimization software, which can help with the reverse flow of goods, is currently more affordable for companies to adopt. While all of these innovations can improve efficiency and reduce fuel usage, they must also be considered in the context of cost and profitability. Without considering these factors, it may be difficult to persuade companies to invest in more sustainable supply chain practices (Narayana et al., 2014). However, it is important to note that industry 4.0 technologies will likely be crucial for designing and planning sustainable supply chains in the long term.

DISCUSSION

Discussion Introduction

There are several ways that e-commerce companies can implement green supply chain management practices in order to improve their performance and increase efficiency. However, some of these practices may be expensive to adopt, particularly for smaller companies. Therefore, it is recommended that these practices be implemented gradually, starting with the less expensive options in the short term and gradually transitioning to more expensive but more efficient practices in the long term as the technology becomes more affordable and ready for mass adoption. Different activities within e-commerce companies may require different types of green supply chain management innovations. This discussion provides suggestions for how e-commerce companies with limited spending ability but a desire to

implement green supply chain management practices can approach these activities in both the short term and the long term.

Activity	Short-term intervention	Long-term intervention
Packaging	Use of cellulose-based manufacturing	Adoption of 3D printing and additive manufacturing
Transport	Use of biofuels or natural gas	Adoption of electric or hydrogen fuel vehicles
Warehousing	Implement simple energy saving measures and use of solar energy	Use of renewable energy sources and implementation of energy audits
Reverse flow of goods	Use of route optimization software	Implementation of blockchains for real-time data sharing and traceability

Table 1: Activity-related emissions and short- & long-term interventions

Activity	Contribution to Emissions	Short-Term Intervention	Long-Term Intervention
Packaging	45%	Cellulose based manufacturing as well as the use of those products that are renewable in the packaging process to reduce the importance of plastics	3D printing and additive manufacturing techniques that can create the packaged products with less waste and reduced carbon emissions at a lower cost in a quicker period of time
Return Rates	25%	Route optimization software that can help companies identify the best route to facilitate the reverse flow of goods and reduce fuel wastage and carbon emissions	Use of blockchains and smart contracts that can trace the location of the products and ensure a speedy reverse flow of goods
Property-level emissions	15%	Simple housekeeping measures to reduce energy and water wastage as well as the use of energy audits to understand the places where the e-commerce company can become more efficient in its utilisation of energy and water at its warehouses	The use of solar or other sources of renewable energy to reduce the carbon emissions due to energy usage at the warehouses as well as using design methods like BREEAM (Building Research Establishment Environmental Assessment Method), LEED (Leadership in Energy and Environment Design), CASBEE (Comprehensive Assessment System for Building Environmental Efficiency), GREENSTAR, and DGNB (German Sustainable Building

			Council) for building warehouses in the future
Transportation and Logistics	15%	Use of relatively available fuels like natural gas and biofuel that can cut down emissions by up to 60% and already have existing infrastructure to support their mobility	Use of extremely efficient fuels like hydrogen and renewable energy produced electricity that has almost no combustion emissions and can reduce the emissions from e-commerce companies transport and logistics drastically

Developing a broad framework

Adopting green supply chain management practices can bring both monetary and non-monetary benefits to e-commerce companies. These benefits can be achieved by saving on fuel, transportation and energy costs, as well as improving the health of customers, reducing the impact of global warming, and improving the skills of company personnel. The three pillars of technology, personnel, and sustainability can be used as a framework to guide e-commerce companies in implementing green supply chain management practices, as demonstrated in the literature review and case study examples of Amazon and Flipkart. The three pillars can be summarised in:

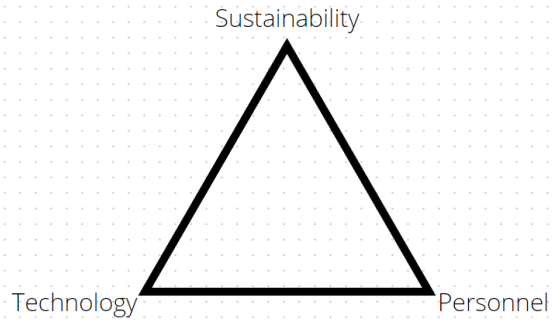

Figure 10: The 3 Pillars of a Green Supply Chain for E-commerce Companies.

Technology

The adoption of technology is crucial for e-commerce companies to implement green supply chain management practices effectively. This includes investing in vehicles that can run on alternative fuels such as hydrogen and electricity, as well as utilizing blockchain and smart contracts and route optimization software. For example, Flipkart's goal to become net zero by 2040 relies on the successful implementation of these technologies. While some technologies may require an initial investment, they can ultimately lead to cost savings and reduced emissions for the company. E-commerce firms should consider these expenditures as long-term investments rather than simply viewing them as costs.

Sustainability

The adoption of green supply chain management practices can bring a range of benefits for e-commerce companies, both monetary and non-monetary. Monetary benefits can come in the form of cost savings, such as reduced fuel and energy expenses, while non-monetary benefits can include improved health for customers and a positive impact on the environment. To make their supply chain more sustainable, e-commerce companies should focus on three pillars: technology, personnel, and sustainability. In terms of technology, companies can invest in vehicles that use alternative fuels like hydrogen or electricity, and adopt blockchain and route optimization software to reduce costs and emissions. Sustainability can be improved through the creation of self-sufficient warehouses that generate their own solar power, as well as through energy audits and grading systems that encourage the implementation of eco-friendly practices. Adopting these measures can also lead to increased investment from those who prioritize environmental, social, and governance (ESG) goals, as well as contribute to the United Nations' Sustainable Development Goals.

Personnel

The personnel, or staff, who will manage the green supply chain practices for e-commerce companies are the final component of the framework. These employees will need to be trained and skilled in new technologies, such as blockchains and smart contracts, that are being implemented as part of the green supply chain. E-commerce companies can utilize various methods of teaching, such as lectures, case studies, simulations, and group projects, to ensure that their staff is prepared to handle the evolving technological needs of the supply chain industry. Additionally, the creation of warehouse management systems for sustainable practices in warehousing will require technically skilled staff to run and manage them. This training and skill development for employees will require a significant initial investment for e-commerce companies, but it is expected to generate a higher return on investment and create a

workforce that is capable of handling the changes brought about by Industry 4.0 technologies. Investing in the upskilling of employees may also increase their loyalty to the organization.

It is important to note that the three pillars of this framework, which cover all activities in e-commerce that contribute to carbon and greenhouse gas emissions, are interconnected and rely on each other. For example, the sustainability pillars will be strengthened by the implementation of technological interventions such as vehicle route optimization, while the investment in technology will be strengthened by investing in personnel training to enable staff to handle these technological changes. The insights provided by technology, such as route optimization software, must be analyzed by humans who must make decisions based on this analysis, so the personnel responsible for this software in the supply chain must be proficient in understanding and interpreting data.

This paper presents a three-pillared framework and short and long-term intervention model for e-commerce companies to follow based on their available resources. One way that e-commerce companies can make their supply chains more sustainable is by collaborating with other companies to share resources, such as creating a shared alternative fuel infrastructure or carpooling. However, the recommendations and discussion in this paper are limited to the perspective of a single company, and a more detailed analysis of resource sharing is beyond the scope of the paper to maintain simplicity and reduce the number of assumptions made, such as the willingness of e-commerce companies to collaborate despite competing in the same industry.

CONCLUSION

The purpose of this paper was to identify the best green supply chain management practices for e-commerce companies and to develop a framework for their effective use. Through a literature review and case studies of Amazon and Flipkart, alternative modes of transport and fuels have been found to reduce transport-related emissions. However, these options require significant infrastructure investment and have limited network coverage. Technologies such as route optimization software and blockchains can help companies better manage the reverse flow of goods. Warehouses can become more energy efficient through the use of renewable energy sources, energy and water conservation audits and assessments, and smart design methods. Packaging can be made more environmentally friendly through the use of renewable materials and modern techniques such as additive manufacturing and 3D printing.

To help e-commerce companies implement these practices efficiently while considering costs, it was suggested that they be divided into short- and long-term interventions, with short-term interventions being less expensive and less complex, while long-term interventions are more expensive and more complex. A framework with three pillars - technology, sustainability, and personnel - was provided to help companies in a holistic manner implement green supply chain management. In addition to the recommendations of this paper, e-commerce companies may also consider sharing resources and creating a common infrastructure with other companies in their supply chain to facilitate the adoption of these technologies.

Limitations

One limitation of this research is the use of only secondary data, which may not be entirely reliable. Additionally, the scope of the research is limited to the work of established researchers, whose biases or perspectives may influence the results. By relying solely on secondary data, this research does not have the benefits of primary data, such as control over the data collection process, which could lead to more precise conclusions.

Scope for Further Research

There is always the potential for further research in any study, as it is impossible to fully examine all aspects of the subject. Additionally, new areas of investigation may emerge during the research process. This research primarily focused on the e-commerce companies' supply chains but did not look at how these companies could share resources to make their supply chains more sustainable. Future research could explore this possibility and consider how willing e-commerce companies would be to work with their competitors while keeping personal profit and society in mind.

Additionally, future research could examine the integration of endpoints in the supply chain - manufacturers and consumers - with the adoption of Industry 4.0 technologies. Manufacturers often prioritize revenue over sustainability, but technologies like blockchains can be used to inform consumers about production processes and trace the origin of raw materials. This connects the manufacturer and consumer, the two endpoints of the supply chain. Future work could explore how such initiatives can be implemented to involve manufacturers in the green supply chain and other ways to integrate these endpoints.

Research Contribution

This paper offers potential solutions for e-commerce companies seeking to make their supply chains more sustainable, based on technology, the human element, and sustainability. Companies can review the results and discussion in the paper to identify solutions that will reduce costs and increase sustainability. With the increasing focus on logistical social responsibility, industry players will likely be held accountable for the environmental impact of their actions. The

solutions have been divided into short and long-term options to allow companies time to transition to more expensive and sophisticated technological interventions. The paper assumes that companies will want to implement green supply chain practices that offer both cost and emission-reduction benefits. The three-pillar framework provided in the paper can serve as a broad guide for e-commerce companies looking to implement the suggested practices. The human element of the framework ensures that companies can make this shift efficiently and also create a workforce prepared for the changes in the supply chain, including the fourth industrial revolution and new technologies. The recommendations provided in the paper, including the use of blockchain and renewable fuels such as electricity and hydrogen fuel cells, contribute to the growing field of implementing these technologies in the supply chain.

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