



(REVIEW ARTICLE)



## An analysis of sustainable e-commerce logistics in supply chain management

Jubin Thomas <sup>1,\*</sup>, Kirti Vinod Vedi <sup>2</sup> and Sandeep Gupta <sup>3</sup>

<sup>1</sup> Media, Pennsylvania, USA.

<sup>2</sup> Highland Park, New Jersey, USA.

<sup>3</sup> SATI, Vidisha, M.P. India.

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### Abstract

The rise of new business models has stimulated e-commerce, which is expected to continue to grow over the next several decades. Logistics, which operates in the background, has been significantly affected by the enormous number of firms engaging in E-commerce. Examining the critical role of sustainable e-commerce logistics in SCM, this review article explores the importance of reducing the environmental implications of online shopping. It explores a spectrum of sustainable logistics facets, from green sourcing and efficient production to smart inventory management, sustainable warehousing, green transportation, eco-friendly packaging, and effective reverse logistics. By integrating these practices, businesses can optimise their supply chains, reducing environmental footprints while enhancing operational efficiency and brand reputation. The paper discusses key environmental challenges facing e-commerce supply chains, including carbon emissions, packaging waste, energy consumption, and resource depletion, proposing strategies such as green sourcing, efficient production, and eco-friendly packaging to address them. It also reviews existing literature, covering topics like intelligent logistics management analysis, sustainability in attended home delivery, semantic similarity for fashion recommendations, and sentiment analysis of public views on e-commerce. This comprehensive examination provides valuable insights for businesses and researchers aiming to bolster the sustainability of e-commerce supply chains.

**Keywords:** E-Commerce; Sustainability; Logistic Environment; Supply Chain Management (SCM)

### 1. Introduction

The so-called "last mile" to the consumer is a particularly difficult part of the supply chain for online retailers. One side of the coin is the capacity problem that has arisen in logistics networks as a result of the recent exponential growth rates. [1]. With a passage of decades, discussions on the concept of "supply chain (SC)" have been ubiquitous in numerous studies. Supply chain management's (SCM) primary goal before environmental issues became prominent was to evaluate the responsiveness and efficiency of a system that started with the acquisition of raw materials and continued through the delivery of finished goods to consumers.[2][3][3]. The term "e-commerce" describes the online purchasing and selling of goods and services. Online shopping has revolutionized business practices by bringing buyers and sellers together on an equal footing, made possible by the proliferation of computer networks and the Internet. The Philippines is one of the countries where online shopping is on the rise, providing exciting new opportunities for companies looking to expand their reach. When it comes to e-commerce, the Philippines is well-positioned to take advantage of a regulatory climate that encourages its development and acceptance. The global value chain and regional commerce can become more intertwined as a result.[4][5][6] [7]. Figure 1 shows the key factors in sustainable logistics.

\* Corresponding author: Jubin Thomas



**Figure 1** Key Factors in Sustainable Logistics

Depleting natural resources is counterproductive to sustainability, which is taking measures to keep the planet's ecology in a state of long-term balance. With the expectation of same-day delivery, the worldwide supply chain and industrial transportation networks have been disrupted by the meteoric rise of online shopping. E-commerce's objective is to mitigate the environmental consequences of delivering goods to consumers through the implementation of "green logistics." The phrase "sustainable transportation" refers to transportation options that are economical, use little energy, and produce little or no emissions [8] [9]. By implementing environmental controls into their everyday operations, businesses may cut their environmental impact by up to 80%. Green logistics encourages environmental research and assists industrial operations in avoiding the risks connected with non-green operations [10]. Reducing carbon emissions, enhancing waste reduction, and improving energy efficiency are all ways in which green logistics management strategies may help the environment. [11].

The expansion of online shopping must be coordinated with efforts to protect the environment, and sustainable e-commerce logistics are key to this goal. By adopting green transportation, eco-friendly packaging, energy-efficient warehousing, effective reverse logistics, and collaborative strategies, businesses can reduce their environmental impact while maintaining efficiency and customer satisfaction. As consumer awareness and regulatory pressures mount, sustainable logistics will become increasingly integral to successful supply chain management in the e-commerce sector. This paper aims to address the growing need for sustainable practices in e-commerce logistics within supply chain management. Given the escalating environmental impacts of online retail, integrating green sourcing, efficient production, and eco-friendly transportation is crucial. The significance lies in not only reducing carbon emissions and waste but also in enhancing operational efficiency and brand reputation. The scope of this paper encompasses an overview of sustainable e-commerce logistics, key aspects, technological developments, and strategies, along with a review of current literature and future research directions, contributing to an ongoing discourse on sustainable SCM in the evolving e-commerce landscape.

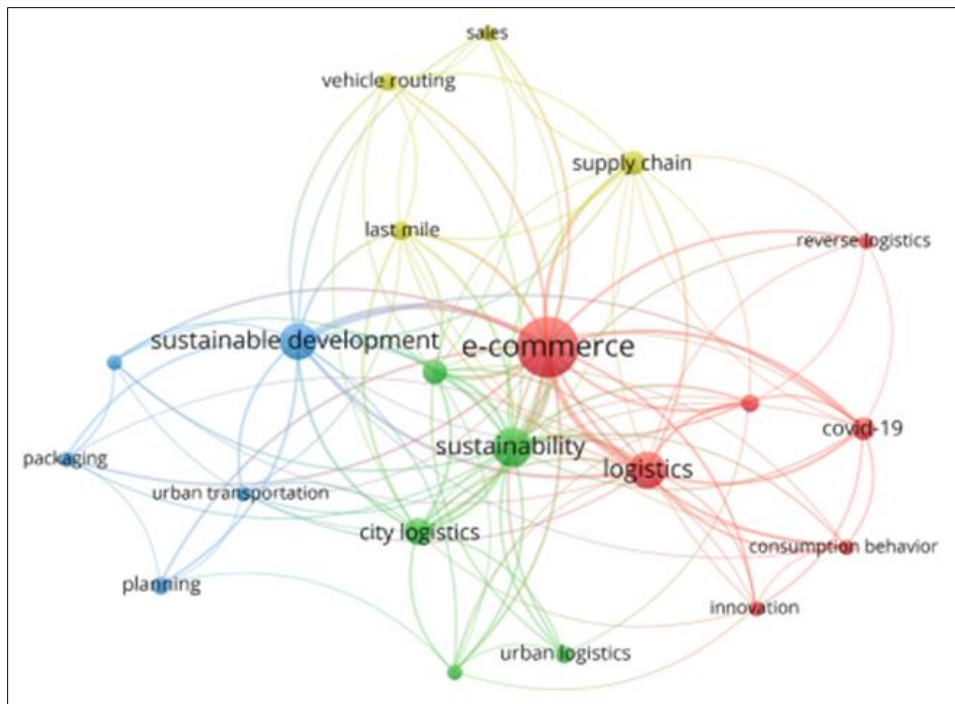
### 1.1. Organized of this paper

The rest of this paper follows as follows Sections I provide the overview of the sustainable e-commerce logistics environment and SCM; then II Section discusses some key aspects and approaches of sustainable e-commerce logistics discussed. After this, give overview of e-commerce in SCM in the III section. Section IV provides the sustainable e-commerce logistics in SCM. The last sections, V and VI, discuss the literature review on this topic and the conclusion of future work.

## 2. Sustainable E-Commerce Logistic

The phrase "e-commerce" describes the process of buying goods and services on the web or through mobile devices like computers, tablets, and smartphones. E-commerce encompasses more than only electronic money transfers (EFT) and electronic exchange communications (EEC); it also includes online shopping, e-commerce, online shops, e-tailers,

merchants, and online customers. Successful and long-term development in e-retail may be achieved via the use of sustainable practices in e-commerce. Figure 2 shows the interconnections between e-commerce and sustainable logistics [12].



**Figure 2** Interconnections in E-Commerce and Sustainable Logistics

Representing the current trend in development, "green logistics" is both an essential and forward-thinking component of contemporary logistics. By linking resources with goods and products with customers, green logistics serves as a bridge. Green logistics helps build a sustainable and circular economy by maximising logistical operations while highlighting environmental responsibility. To decrease a negative effect on an environment caused by logistics and delivery procedures, "green logistics" takes a methodical approach by using industry protocols. The objective is to use environmentally conscious tactics in order to decrease administrative expenses and carbon emissions. It entails using alternative fuel vehicles, streamlining transportation routes, and maximising the use of cutting-edge technology to boost productivity. It has several facets, including transportation, packing, material handling, and waste management. Environmental protection and lessening of the negative effects on the environment caused by the transportation of products is the main goal of green logistics. An eco-friendly and energy-efficient method of goods delivery may be achieved when businesses use sustainable practices in these areas. This concept was clarified by [13].

### 2.1. The key aspects of environmentally friendly e-commerce are:

- The elimination of the need for distribution facilities to keep goods near retail outlets reduces energy consumption in warehouses.
- The promotion process has to be transparent and focused on the long term, with an emphasis on social acceptability and environmental sustainability.
- A fresh perspective on how the market, culture, environment, and economy are all interconnected and mutually reliant. Electronic vehicle effects on last-mile delivery are well-known for fleets with zero emissions.
- Promote recycling and paper packaging to promote environmental sustainability and foster a feeling of environmental consciousness.
- Raise customer knowledge about the importance of local e-commerce businesses' delivery services in reducing carbon emissions.

### 2.2. Main Approaches to Sustainable Logistics in E-Commerce:

- **Dimensions of Sustainability:** To ensure a long-term viability of a logistics network, Addressing the logistics of online shopping with a focus on long-term economic, social, and environmental viability is gaining prominence [14]. This includes striking a balance between the economic, social, and environmental advantages associated with energy, resources, and the environment.[15] . To further improve consumer welfare and stimulate economic growth, it can take into account a technical aspect pertaining to novel goods, services, and

procedures like autonomous vehicles, drones, and automated package lockers. [16], as well as collaborative innovation in delivery platforms[16].

- **Technological Developments:** One of the most important ways to assure sustainable urban mobility and lessen adverse environmental externalities is via technology. We anticipate that innovations in the future will bring about the most thorough integration of digital platforms, including tools for route planning, communication, and vehicle monitoring [17][18].
- **Operation Modes:** A viable alternative to unsuccessful home deliveries, collection and delivery centers allows for the concentration of goods in optimised trips, which in turn improves a sustainability of e-commerce logistics. Two components of this operating mode that affect the economy are the reduction of logistical flows to households and the growth of trips and vehicles used by logistics providers [16].
- **Government Policymaking:** To make e-commerce logistics more sustainable, governments must impose new rules and regulations, impose new restrictions on businesses, integrate their systems on a national and regional level, invest in infrastructure, and implement strategies that benefit all parties involved so that they can thrive in the long run without negatively impacting the environment, society, or the economy [19][17].

### 3. E-Commerce in Supply Chain Management

An efficient method for this is the electronic supply chain. To meet customer demands and provide each participant a leg up in the market, electronic supply chains may include both permanent and geographically connected participants that work together via the use of information technology. Efficient electronic supply chain development requires close collaboration, improved organisational alignment, and short-term coordination of communication networks. Company failures could escalate if management is ineffective in regulating and guiding collaboration among chain partners. Consequently, in order to deal with the actual nature of the supply chain, it is important to draft and implement appropriate collaboration plans.

Supply chain management and design have both recently undergone paradigm shifts towards operations. As means of electronic data transport, the internet, and the global network have advanced, the gravity of this problem has grown. Then, the impact on buyer-supplier interactions might become more complicated as a result of the system's efficacy. Supply chain management's complexity forces businesses to enhance their online communication platforms. Online interactions between businesses and customers, for example, have the potential to improve all relationships. Timer highlights the importance of the Internet in creating a strong supply chain from a business perspective to eliminate any obstacles associated with virtual institutions. Different approaches to restricting electronic data flow are planned by other researchers. For others, the moment has come to shift the supply chain's focus to online commercial societies. As an example, consider General Electric's Business Network, an e-commerce platform that processes more than one billion dollars in supplier transactions annually.

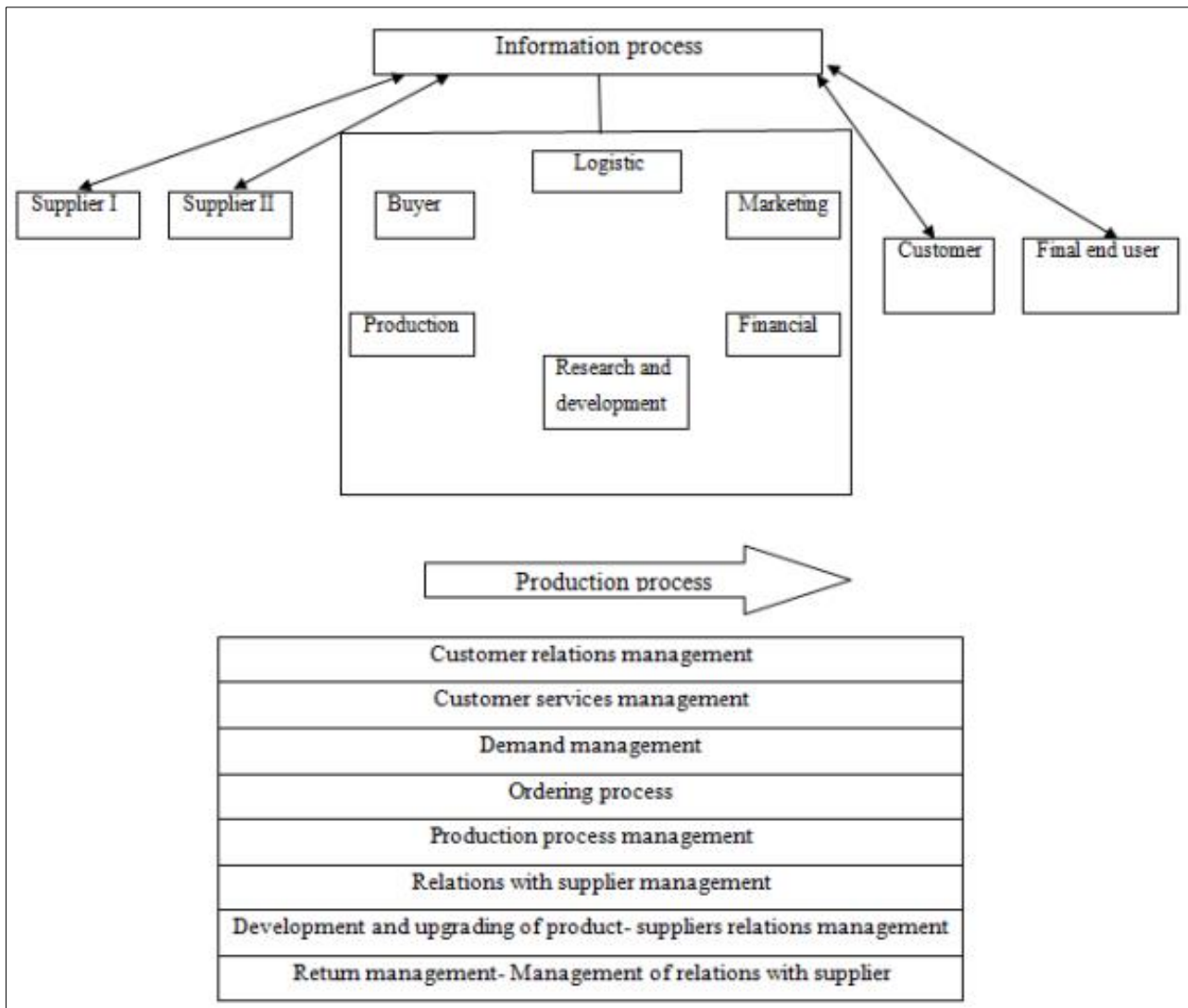
#### 3.1. Effect of e-commerce on supply chain management

There has been a notable impact of e-commerce on SCM, and it has the potential to streamline interactions between different organisations and cut down on delays caused by increased collaboration. The opportunity presented by e-commerce is for a business looking to expand globally. A rise in demand may be anticipated when a business describes its goods and services. The SCM system has an obligation of providing an efficient response to all growing needs. Additionally, SCM has to be sufficiently online to respond to any unique client needs. Systems programming and/or virtual agency make this feasible. E-commerce will increase networking and communication possibilities.

The full integration of business partners is supported via online shopping. Costs may rise with this kind of enterprise. In order to create new goods and better understand client input, e-commerce also fosters new relationships and group projects between management and customers. As a result, effective responses to the shifting markets are achievable. In relation to the contemporary e-commerce procedure, a considerable number of businesses want to sell their goods and services online.

The benefits of online shopping for SCM in general are as follows:

- Replying to the orders
- Electronic payments.
- Receipt of orders through web.
- Reduction of stock level.



**Figure 3** Integration form of SCM and relevant processes in chain

A link among supply chain activities and the members' output structures is shown in Figure 3. The supply chain's current operating fields are as follows:

- Marketing and financial sale
- Research and development
- Purchase and logistic
- Business processes

Following are the five ways that e-commerce and the Internet affect supply chain economic efficiency:

- Limiting the expenses associated with transactions and distribution.
- The creation of new products is happening more quickly.
- Giving vendors and purchasers more information.
- Expanding the customer's alternatives and their supplier network.
- Reducing the time intervals.

**Table 1** E-commerce in different fields of supply chain management

Applicable fields of the organisation	Effects of e-commerce
Marketing	The procedure includes producing and distributing products, using a direct economy, improving customer service, reducing order flow times, increasing online sales, discovering new markets, and obtaining replacement parts.
Research and development	Product planning, QFD, data research, time engineering, enhancing the precision of new product planning, decreasing the amount of time spent on planning, managing customer interactions, and receiving feedback from consumers are all part of this process.
Purchase/supplies	Transferring authority from seller to buyer, shortening order flow, improving inter-organizational procedures, minimising bureaucracy, designating suppliers, receiving advisors based on purchases, and transferring funds are all part of the purchasing process.
Stock management	Accessibility, prompt information transmission, inventory reduction, reduced pricing and updating expenses, timely delivery, decreased warehousing expenses, ordering, bookkeeping, and customer support.
Transportation	Transportation management, activity assignment, reviewing raw material orders, decreasing loading and unloading timings,
Customer Servicing	broad information for customers, client order browsing, and prompt customer service when answering inquiries.
Relations among suppliers	The improvement of the ordering flow, the completion process, and the delivery of products; the decrease of ordering expenses and the receipt of bills; and the increase of collaborative and coordinating business.
Production	This is also seen in other contexts, such as when building and producing things electronically, assigning sales, and engaging in pure production (via things like online cooperative production programming, bulk ordering, and the rapid transfer of qualitative issues through the development of standard chains and qualitative explanations for knowledge management chains).

Table 1 shows that all of the aforementioned things are a compilation of various supply chain operations that provide value for consumers.[20].

#### 4. Sustainable E-Commerce Logistics in Supply Chain Management

A proliferation of e-commerce has fundamentally altered global supply chains, presenting unique opportunities and challenges. As the demand for online shopping continues to escalate, a need for sustainable logistics practices within SCM becomes more critical. Sustainable e-commerce logistics aims to optimise an entire supply chain process, by procurement to delivery, in a manner that minimises environmental impact while maximising efficiency and customer satisfaction.

##### 4.1. The Role of SCM in E-commerce

Coordination and optimisation of the movement of products, data, and resources from suppliers to final consumers are key components of SCM in e-commerce. Key components include:

- Sourcing and Procurement: Selecting suppliers and acquiring raw materials or products.
- Production and Manufacturing: Transforming raw materials into finished goods.
- Inventory Management: Managing stock levels to meet demand without overstocking.
- Warehousing and Distribution: Storing and moving goods to various locations.
- Transportation and Logistics: Delivering products to customers, including the last-mile delivery.
- Returns and Reverse Logistics: Handling product returns and recycling processes.

## 4.2. Environmental Challenges in E-commerce Supply Chains

The growth of e-commerce has intensified several environmental challenges:

- Carbon Emissions: Increased transportation activities, especially last-mile deliveries, contribute significantly to greenhouse gas emissions.
- Packaging Waste: The necessity of protecting products during shipping leads to excessive use of packaging materials, much of which is non-recyclable.
- Energy Consumption: Large quantities of energy, sometimes from non-renewable sources, are used by warehouses and distribution centres.
- Resource Depletion: The high demand for products accelerates resource extraction and production, impacting natural ecosystems.

## 4.3. Strategies for Sustainable E-commerce Logistics in SCM

To address these environmental challenges, several sustainable practices can be integrated into supply chain management:

### 4.3.1. Green Sourcing and Procurement

- Partnering with suppliers who adhere to sustainable practices.
- Sourcing raw materials that are renewable or have lower environmental impacts.

### 4.3.2. Efficient Production and Manufacturing:

- Implementing energy-efficient manufacturing processes.
- Reducing waste by optimising production techniques.

### 4.3.3. Smart Inventory Management:

- Using predictive analytics to balance supply and demand, reducing excess inventory.
- Implementing just-in-time inventory systems to minimise storage needs and waste.

### 4.3.4. Sustainable Warehousing and Distribution

- The warehouses' use of renewable energy sources for heating, lighting, and cooling.
- There are solutions, which include the use of renewable energy like use of solar panels.
- Maximizing uses of space in the warehouses for efficiency and minimising energy usage.

### 4.3.5. Green Transportation and Logistics

- Promoting the use of electricity and hybrids in car production for greater circulation.
- Applying computational technology to improve the usage of fuel and cut down the amount of released emissions.
- Promoting bicycle or pedestrian delivery personnel in the business areas for the last meters delivery.

### 4.3.6. Eco-friendly Packaging

- Using reusable, biodegradable, and recyclable packaging materials.
- Creating a favourable packaging design that will use fewer materials as it covers the product.

### 4.3.7. Reverse Logistics and Recycling

- Development of an effective strategy on returns and disposition of products.
- Promotion of reuse and recycling of packages by customers.

### 4.3.8. Collaborative Logistics

- Sourcing from other companies so that the transport and/or storage facilities can be shared.
- Increasing the readiness at improving joint distribution networks to increase effectiveness and decrease emissions.
- Benefits of environmentally friendly e-commerce logistics for SCM

#### 4.4. Adopting sustainable logistics practices within supply chain management offers multiple benefits

- **Environmental Conservation:** The use of resources such as carbon, waste as well as energy minimisation is vital in environmental conservation and the fight against Climate change.
- **Cost Efficiency:** Efficient management of energy use and efficient supply chain management can sometimes mean the difference between profits and losses.
- **Improved Brand Image:** Sustainability strategies are the best for the companies since it attracts the right customers, and at the same time, the corporate image is well enhanced.
- **Regulatory Compliance:** Compliance with the environmental standard promotes efficient operations and prevents fines from being issued.
- **Risk Mitigation:** Reducing vulnerability to resource shortages and regulatory changes is one goal of sustainable practices.

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## 5. Literature Work

To anticipate agricultural yields, previous research has used statistical approaches and simplistic ML models.

In this paper, Wang, (2021) carries out a perceptive examination of the information flow in business logistics management, and the AI algorithm's output is 6.3% more efficient. This includes addressing issues like managers' lack of management awareness, low informationization, and irregular business processes. Furthermore, based on agile SCM, the algorithm recommends actions for corporate logistics management informatisation, which enhances dispersed node analysis of logistics data by 7% [21].

This paper, Yuan, Li and Ji, (2021) Focus on the proposed solution to the sustainability issues with Attended Home Delivery, which proposes a new way to achieve greener deliveries by utilizing ML predictions based on real-time data, different dynamic route planning algorithms, logistical event monitoring, fleet capacity, and other relevant data. A preplanning method involves selecting more sustainable routes based on anticipated traffic or other factors. Assuming that just 20% of customers approve of longer slots, they may increase travel distance by around 5.5% and reduce costs by roughly 11% by extending time slots from two to four hours [22].

In the study, Yethindra and Deepak, (2021) user's click and search history is transformed into query terms by the proposed method. Classification employing logistic regression is done on the given dataset, with semantic similarity calculation applied to the top 50% of findings. In order to ensure that the findings are relevant, semantic similarity calculation is performed using measures such as Normalised Google Distance and Semanto Sim. From the findings obtained via semantic similarity, the user is presented with suggestions of fashion goods and fashion companies. An average precision of 96.31% and an accuracy of 97.14% are achieved by the onto-infused recommendation method[23].

In this study, Hossain, Sharif and Moshui Hoque (2021) They have compiled a database of public comments about products and services provided by different e-commerce organisations in Bangladesh in Bengali so that the task may be finished. On top of that, they have used six distinct ML algorithms—MNB, LR, SVM, DT, RF, and SGD—to forecast and examine the direction of mass opinion. The TF-IDF method, which makes use of Trigram characteristics, has been implemented. At last, a SVM classifier showed a best accuracy90.68% for forecasting public attitudes after optimising the hyperparameters utilising the Randomized-Search CV method[24].

This paper Oršič, Jereb and Obrecht,(2022) is focused on the sustainability opportunity solution for attended home delivery, which uses a unique method to achieve more ecologically friendly deliveries by using ML predictions based on real-time data, different dynamic route planning algorithms, logistical event monitoring, fleet capacity, and other relevant data. As a result of anticipated traffic or other factors, more environmentally friendly routes are chosen during the preplanning phase. Assuming just 20% of consumers are on board with longer time slots, expanding them from 2 to 4 hours may enhance travel distance by around 5.5% and reduce cost by 11%[25].

In this study Zulfiker et al., (2022), they have collected public comments regarding the products and services given by various e-commerce institutions in Bangladesh into a Bengali corpus in order to reach this purpose. In addition, they have used six distinct ML algorithms—MNB, LR, SVM, DT, RF, and SGD—to forecast and examine the direction of public opinion. Using Trigram characteristics, the TF-IDF approach has been implemented. With the hyperparameters optimised using the Randomized-Search CV method, a SVM classifier finally achieved a best accuracy90.68% in predicting public sentiment[26].



In this study, Akter, Begum and Mustafa, (2021) sentiment analysis allows for the extraction of the true sentiment from a review text. Our dataset employs five ML methods; it was compiled by hand from data collected on the "Daraz" e-commerce site in Bangladesh. They have taken use of our dataset to test out several methods, including XGBoost, LR, SVM, and RFC. Regardless of the performance measure we used— f1-score, recall, accuracy, and precision—KNN consistently beats the other four algorithms. The recall, f1-score, and accuracy of KNN are all 0.96, and the overall accuracy is 96.25 percent[27].

**Table 2** Comparative analysis on Sustainable E-commerce Logistics environment in supply chain management using various machine learning techniques

Ref	Methodology	Dataset	Performance	Limitations & future work
[21]	Intelligent analysis of information flow in logistics using AI algorithms for agile supply chain management	Data from enterprise logistics management systems	AI algorithm improved efficiency by 6.3%; improved distributed node analysis by 7%	Insufficient management awareness; low degree of informatisation; irregular business processes; propose informatisation measures based on agile SCM
[22]	Machine learning forecasts for sustainable Attended Home Delivery, dynamic route planning, real-time data tracking	Real-time data on logistics events, fleet capacities	Travel distance improved by 5.5%; costs decreased by 11%	Assumes only 20% of customers agree to larger time slots; future work could focus on increasing customer agreement and further optimisation of delivery windows
[23]	Ontology-based feature extraction from fashion-related external sources, logistic regression for classification, semantic similarity computation	Historical click data and searches, external fashion sources	Recommendation system accuracy of 97.14%, average precision of 96.31%	Highly domain-specific ontology; future work may explore expanding the ontology and incorporating more diverse data sources
[24]	Sentiment analysis using six machine learning algorithms, TF-IDF technique with Trigram features	Consumer feedback on various Bangladeshi e-commerce sites' goods and services	SVM classifier achieved highest accuracy of 90.68%	May benefit from larger, more diverse datasets and real-time sentiment analysis
[27]	Sentiment analysis of Bangla text reviews using five machine learning algorithms.	Reviews from Bangladeshi e-commerce site "Daraz"	KNN achieved highest accuracy of 96.25%, precision, recall, and f1-score of 0.96	Dataset manually gathered; future work could focus on automating data collection and exploring additional machine learning algorithms.

### 5.1. Research gaps

Despite the valuable insights provided by existing studies on logistics management, sustainability in delivery systems, fashion recommendation systems, and sentiment analysis in Bangladeshi e-commerce, notable research gaps persist. These include limited analysis on the scalability and generalizability of machine learning models across diverse contexts, insufficient exploration of emerging technologies like blockchain and IoT in logistics optimisation, and a lack of consideration for broader organisational and socio-economic implications. Future research should aim to address these gaps through interdisciplinary studies, longitudinal assessments, and a focus on real-world applicability and sustainability.

## 6. Conclusion and Future Work

In conclusion, this paper underscores a critical importance of integrating sustainable practices into e-commerce logistics within supply chain management. Green sourcing, efficient production, sustainable warehousing, green transportation, eco-friendly packaging, and effective reverse logistics are way to go for businesses looking to reduce

their environmental footprint while simultaneously boosting operational efficiency and improving their brand image. A review of existing literature highlights various approaches and technologies being explored to address sustainability challenges in e-commerce logistics, ranging from intelligent logistics management analysis to sentiment analysis of public views on e-commerce. Future work in this area should focus on further exploring and implementing advanced technologies like AI, ML, and data analytics to optimise supply chain processes and enhance sustainability. Additionally, there is a need for more research on the development and adoption of innovative solutions for sustainable packaging, last-mile delivery optimisation, and circular economy practices within e-commerce logistics. Furthermore, collaborative efforts between businesses, governments, and academia are essential to drive policy changes, investments in infrastructure, and the development of industry standards for sustainable e-commerce logistics. We can establish the foundation for a more effective and sustainable e-commerce environment by persevering in our innovation and cooperation.

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## Compliance with ethical standards

### *Disclosure of conflict of interest*

No conflict of interest to be disclosed.

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