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Last-Mile Carbon Emission under E-Commerce: Environmental Perspective

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Abstract

E-commerce is now a major, thriving industry that contributes significantly to global economic growth. The market is significantly impacted by the e-commerce sector's rapid expansion. The success is entirely attributable to consumer responses and buying habits. Given that it has more than 1.4 billion inhabitants and generates enormous earnings for e-commerce, India is seen as a prospective market. The recent growth of the e-commerce market and online shopping in India, there is a need for more environmentally sustainable and reliable last-mile logistics designs. Besides the success of e-commerce and its benefits for the environment, the study focuses on the status of e-commerce in India, carbon emissions, the impact of electric vehicles instead of fossil fuels and government decisions, and the use of technological advances, which are all subject to discussion. The international treaty on climate change was approved by 196 parties at the United Nations Climate Change Conference (COP21) in Paris, France on December 12, 2015, and became effective on November 4, 2016, and India is a party to the agreement. So, limiting carbon emissions, innovations in environmental e-commerce are important and the importance of last-mile delivery is changing the behaviour of e-commerce businesses. This study aims to the existing literature on environmental impact from the point of view carbon emission by e-commerce, and focus on how e-commerce in India is environmentally sustainable in relation to carbon emissions, technological advancements especially last-mile delivery and government initiatives.

Keywords

E-Commerce, Environment, Last-Mile Delivery, Carbon Emission, Electric Vehicles

1. Introduction

Internet assessments and technological development Global e-commerce is con-

tinuously growing (Oláh et al., 2018). It is a broad term that encompasses a variety of different types of transactions, and it is now a major part of the global economy. Customers who are technologically competent have benefited greatly from this type of online retail, which has increased accessibility to information and global connectivity. To be environmentally friendly, e-commerce business aims to have as little of an impact as possible on the environment. This can be achieved by adopting methods by the e-commerce business that emit less carbon like eco-friendly packaging, last-mile transport, customer awareness, minimize transportation route, and local e-retail delivery. But the most recent SDGs progress report for Asia and the Pacific countries demonstrates how ineffectively many countries are managing the problem of rising emissions. While the developed economies are making great strides toward a secure energy future and improving environmental quality, these countries are also seeing an increase in emissions and facing the problem of energy security. One of the main causes of these problems in these countries has been attributed to the predominance of fossil fuel-based economic growth patterns (Shahbaz et al., 2021). The use of digital nudges can aid in raising public awareness of environmental issues and encouraging the adoption of strategies to lower greenhouse gas emissions. The earth is under a lot of pressure from human consumption, yet these green digital nudges not only encourage individuals to make wiser choices, but also collectively force businesses to embrace sustainable practices (UN, 2022). However, as e-commerce and parcel delivery in cities continue to rise, more trucks, two wheelers, and cargo vehicles enter the cities, resulting in adverse environmental impacts such as an increase in traffic, greenhouse gases, and pollution (Arnold et al., 2018). Concerns about environmental sustainability are lessened using e-commerce and energy use, individual packaging waste, and pollution from transportation, all have an impact on the environment (Prasertwit & Kanchanasuntorn, 2021).

In 2022, the total size of the Indian e-commerce market was 71.5 (IMARC, 2023) billion USD and, India had over 865.90 million internet users, making it the second-largest online market worldwide (TRAI, 2022; Dewan, 2021; Minhas, 2023). By 2030, it was predicted that this amount will amount to 350 billion US dollars. How environmentally sustainable this huge market is, or how environmentally sustainable it has become, is a major concern, especially for last-mile delivery, as e-commerce businesses expand. With 508,368,361 people living in urban areas in 2022 roughly 35.87% of the country's total population and a GDP growth rate of 7% the same year (Macrotrends, n.d.), e-commerce has expanded even more. As more and more people continue to be shopping online, businesses fighting against persistent returns. In fiscal year 2022, the return of goods on total online sales was 9.8% whereas return from total cash-on-delivery was 19.3% (Makhija, 2023). As online sales increase, the percentage of returns will increase and thus traffic congestion will increase. That will increase the carbon footprint, and that's a big problem.

India promised to attain net zero emissions by 2070 at the 2021 conference of

parties (CoP26), which was recently held in Glasgow. This is consistent with the regulations that Indian authorities have established in recent years, which show that India has taken serious steps toward decarbonization by encouraging and requiring market participants to adopt sustainable business practices (PIB, 2022) which is more carbon emission. However, it is true that integrating e-commerce in a country with a large population like India raises greater environmental sustainability concerns. Thus, studying the environmental impacts of e-commerce in the global context as well as studying e-commerce activities in the context of India is crucial. The article follows the current and future needs of e-commerce in India to reduce fossil fuel consumption and innovation of environmental last-mile delivery with a focus on electric vehicles, shorter delivery options and routes, and government policies and initiatives to promote environmentally sustainable e-commerce.

2. Research Methodology

Achieving Environmental sustainability is a lifelong journey, and to make e-commerce more sustainable over time, the secret is to develop and improve consistently to the use of technology and knowledge. The purpose of this paper is to explore the current scenario of e-commerce in India, find out the environmental influence from e-commerce activity in India with academic literature review intensively to acknowledge the basics of the environmental impact, and identifying and carefully examining the environmental impact of e-commerce in a global context with India. Studies are not homogeneous. In other words, there is no one right technique to do research (Mackey & Gass, 2015). Hence the research method is theoretically developed regardless of the subject, creating a study and linking it to existing knowledge, which is the basis of all academic research activities. To review the literature on various aspects of environmentally sustainable e-commerce last-mile delivery, while simultaneously reviewing strategic aspects and analysing theoretically how carbon emissions can be reduced.

The process of describing the problem, gathering data, analysing it and drawing conclusions that may take the form of recommendations for the situation at hand or broad generalizations (Kothari, 2004). Google Scholar and other website search engines are used to collect and analyse secondary data such as previous literature, articles, news, reports, etc., discuss measures, and find data. However, in an attempt to address the aims and objectives posed by this investigation in theoretical research:

1) Increasing consumption and consumption of fossil fuel in India and identifying fossil fuel carbon emissions in last mile delivery.

2) Examining future possibilities and strategies for reducing carbon footprint through e-commerce last mile delivery.

3) Analysing to use electric vehicles for last-mile delivery.

4) Focus on delivery routes for last-mile delivery, and

5) Analysing government initiatives and legislation to achieve low carbon

emissions.

The following paper elaborates on the use of literature review as a methodology and develops the theoretical potential by clarifying through a literature review.

3. Literature Review

Past few years, the e-commerce industry has revolutionized the way people buy goods and services. Global retail e-commerce sales, which were around 5.2 trillion dollars in 2021, and expected to increase 8.1 trillion dollars by 2026 (Chevalier, 2022). The impact of digitalized technologies on the digital economy is quickly advancing and is estimated to make up 5% of the global Growth Domestic Product (GDP) and 3% of global employment opportunities due to its extensive diffusion, integration of developing nations, and increasing dimension of implications (Williams, 2021). Also, consumer demand for quick product delivery has led to a substantial increase in single parcels and house deliveries, as well as increasing carbon emissions which is increasing environmental damage (Forbes, 2017). According to Mondal & Giri (2022) to maintain their comfort, people produce a lot of greenhouse gases (GHG), which is contributing to several social and natural disasters like earthquakes, torrential rain, floods, and desert storms, among others.

Now that they are aware that they must come up with a new solution in order to survive, they are more focused on using environmentally friendly items. And consumers are pressuring businesses to act responsibly in the face of global environmental and social issues. Companies must commit to sustainability if they want to maintain their relevance and competitiveness. Governments all over the world are utilizing green energy technologies (GETs) to mitigate the negative effects of climate change, as widespread reliance on conventional fossil fuels is the main contributor to environmental problems (Zeng et al., 2022). According to (Oláh et al., 2018), to preserve the environment and maintain economic viability, green marketing denotes an organization's attempts to summarize, push, evaluate, and communicate items that do not damage the environment (Sarkar, 2023). Companies should keep in mind that this is even more important now because of the widespread use of e-commerce businesses and that complete development in management is liable to find, forestall, and sustain the requirements of the consumers, businesses, and society, both commercially and environmentally. The overall emissions of internet shopping are significantly increased by returns of purchased goods. With free returns, businesses have encouraged larger and more frequent purchases. Depending on the type of transaction, the average return rate can range from 10% to 20%, potentially increasing overall emissions. Even yet, it's believed that 5% - 10% of deliveries never make it to their intended location. There are more emissions because of these problems (Katta & Lam, 2022). Environmental sustainability issues in e-commerce have also been the focus of many authors around the world, either global pack-

ing waste greenhouse gas emission (Idrees et al., 2018; Kim et al., 2022; Pinos et al., 2022; Arora et al., 2023; Escursell et al., 2021), last-mile delivery emission (Comi & Savchenko, 2021; Caspersen & Navrud, 2021; Patella et al., 2021), cross-border e-commerce sustainability (Fan et al., 2022; Liu et al., 2022; Cheah & Huang, 2022), or three dimensions of sustainability (environmental, social, and economic aspects) (Ingaldi & Ulewicz, 2019; Oláh et al., 2018) in e-commerce.

There are now certain business concepts that get beyond the obstacles of e-commerce in developing nations. But surprisingly little attention has been paid to the developing world in e-commerce publications (Nir, 2007). The value and importance of e-commerce in modern India increasing day by day (Dutta et al., 2020) and protecting the organization's environment, maintaining environmental policies, presenting accurate results of environmental performance, reducing environmental costs and disclosing environmental information are covered by environmental considerations (Zhao et al., 2020; García-Sánchez et al., 2021). With approximately 932 million internet users, India, the world's most populous nation, is the second-largest online market globally. With rapidly growth of internet users, increasing numbers of deliveries across the country, and current state of infrastructures are challenges to facilitate efficient and eco-friendly delivery operations in India (Dasharath & Minal, 2023) means huge carbon emission, pollutions, and traffic. According to reports, last mile CO_2 emissions from e-commerce deliveries in India approximate half of the overall emissions and India's last mile emissions per delivery 285 gCO_2 are also much higher than the global weighted average 204 gCO_2 (Desk, 2022). According to the World Economic Forum, given present trends, the number of delivery vans in large cities might rise by 36% by 2030. The increasing volume of deliveries made by both petrol and diesel transport vehicles under the current situation, aggravating the problem of climate change (Deloison et al., 2020). In 2022, more than 400,000 fuel consumption two-wheelers have been used for country's last-mile delivery, according to industry estimates (Philip & Balakrishnan, 2022) which is quite worrying for the environment.

Primary objectives of the literature review are to improve the research question, spot any gaps in the previous studies, and choose an appropriate design and data gathering strategy for a future project. This study of the existing literature seeks to identify areas of ignorance that would require further research by carefully assessing and summarizing the present state of knowledge about the review. It is beneficial to professional development to do a literature review. It assists in defining the scope of the study and provides a theoretical foundation for it.

4. E-Commerce and Environmental Impact

E-commerce has made significant strides in the field of global trade. In 2023, it is anticipated that the worldwide e-commerce market would reach $6.3 trillion. It is estimated that this number will increase over the next years, demonstrating

how valuable borderless e-commerce is turning out to be for online merchants. Online sales will account for 21.2% of all retail sales by 2024 (Keenan, 2023). The global weighted average last-mile CO_2 emissions from e-commerce deliveries are 204 gCO_2.

Here, **Table 1** shows that global carbon emissions have greatly increased, causing massive damage to the environment. On the other hand, population expansion and remarkable technological advancements led to an increase in the number of digital consumers worldwide to 2.56 billion in 2022, the online e-commerce business is increasing its pace at an extraordinary rate. E-commerce business has got a new momentum since COVID-19. This speed, in particular, the on-road delivery goods or services are ultimately results in a huge carbon footprint of online sales. Every year with the increase in the production of fuel oil, its price is increasing at an abnormal rate. Fuel oil consumption was 97.31 thousand barrels/day in 2022, which is an increase of 3.16% from the previous year. But the price of fuel oil rose to 100.08 dollar/year in 2022, which is 43% higher than the previous year, and it is a financial loss as well as a huge pressor for developing countries. According to Alami et al. (2023), typical 1kg parcel within a country within 2 days or more to reach its destination by normal postal system produces an average of 1075 grams CO_2 of gas per unit.

The rapid growth of e-commerce, with the rapid on-road delivery of goods to consumers by means of conventional vehicles increases the level of pollution. Due to increased fuel consumption, frequent stops (stop-and-go movements), and a higher percentage of idle times each journey, urban freight transportation produces more pollution per km travelled than long-distance transportation (Bandeira et al., 2018; Patella et al., 2021).

With a population of 1.4 billion people, India is now the world's most populous country and the second largest internet market, which did with over 62 billion financial transactions in 2022 through Unified Payments Interface (UPI) App (India Invest, n.d.). Not only that, but Indian government's also 100% Foreign Direct Investment (FDI) permits in B2B e-commerce, and the addition of 10 million new internet users every month, is expected to take India's e-commerce market to US$ 350 billion by 2030. But environmental sustainability is a big concern in India online retail market. According to the data of oil consumption in India in 2022, an average of 5185 barrels of oil was used per day, which is more

Table 1. Annual CO_2 emission, Consumption based (Ritchie, 2020).

Year	2015	2016	2017	2018	2019	2020
1. Consumption based CO_2 Emissions (India), billion ton	2.13	2.21	2.29	2.43	2.47	2.28
2. Consumption based CO_2 Emissions (World), billion ton	35.56	35.52	36.10	36.83	37.08	35.26
3. Consumption based CO_2 Emissions (Asia), billion ton	17.86	17.91	18.39	19.08	19.52	19.24

consumed then in 2021 an average of 4798 barrels per day (CEIC, n.d.). According to the 2020 report based on fossil fuel consumption, India carries for World's 6.47% of the total carbon emissions and Asia's 11.85% of total carbon emissions (Ritchie, 2020) and India's last-mile CO_2 emission per delivery (285 gCO_2) are much higher that the Global weighted average last-mile CO_2 (204 gCO_2) emission. The tremendous growth in e-commerce and the growth of home delivery has contributed tremendously to transportation, which is responsible for CO_2 emissions. In India, daily shipment of roughly 8 million logistics e-commerce will face various difficulties especially CO_2 emission for the country. Amazon shipped close to 3 million packages per day in 2020, with Flipkart and Myntra shipping about 2.5 million (GLG, 2021).

The ever-increasing supply and price of oil and the increased number of e-commerce to deliver the product to the end customer, is a big challenge for a developing country like India to be environmentally friendly. At **Table 2**, we can see that from 2016 to 2022 crude oil consumption in the world has increased by 3% and India rose by 14%, and the crude oil prices rose by 145% which is unusual. It is estimated that the e-commerce last mile comprises around 50% of delivery CO_2 emissions in India, and the last mile element of delivery logistics is similarly crucial from a financial viewpoint, as it represents 40% - 50% of delivery expenses (Katta & Lam, 2022) and road transportation accounted for over 70% of total freight transit in 2022 (Aayog, 2022) and an estimated 5,00,000 tCO_2 last-mile delivery emission and 2.6 billion of parcels delivered, which was 51% share of total delivery emissions strongly suggesting that last-mile delivery constitutes a significant share of delivery CO_2 emissions. In August 2022, India had 5.5 million two-wheelers and 8 million three-wheelers, most of which were propelled by combustion engines that produced a lot of pollution. In six major cities (Delhi, Mumbai, Pune, Bangalore, Chennai, and Kolkata), 78% of locals claim that last-mile delivery vehicles are a significant source of air pollution (Gokmen, 2023). As more and more people purchase online, businesses struggle with continuous returns, and in the fiscal year 2023 return orders made up 10.4% of all orders (Makhija, 2023).

Table 2. Crude oil consumption and price (CEIC, n.d.; Institute, 2023a, 2023b; en2x, 2023).

Year	Oil consumption barrel/day (India)	Oil consumption million barrel/day (World)	Crude oil price (in US dollars per barrel)	Global oil production (Production in million barrels per day)
2016	4544	94.52	40.76	92.012
2017	4724	96.48	52.51	92.519
2018	4974	97.71	69.78	94.914
2019	5150	97.96	64.04	94.972
2020	4700	89.14	41.47	88.630
2021	4798	94.37	69.89	90.076
2022	5185	97.31	100.08	93.848

5. Strategies to Reduce Carbon Footprint

With a large population and the world's second largest internet market, India's technological advances and making e-commerce technologically eco-friendly is a huge challenge. Transportation is an important part of this consideration due to the relevance of oil demand and direct emissions to e-commerce business, as well as its role as a major enabler for economic development. Global output, freight, and traffic have increased significantly as e-commerce continues to grow in India, e-commerce companies should be more aware of the need to reduce their carbon footprint.

5.1. Reduce Return or Delivery Fail

The overall emissions of internet shopping are significantly increased by returns of purchased goods. With free returns, businesses have encouraged larger and more frequent purchases. Depending on the type of transaction, the average return rate can range from 10% to 20%, potentially increasing overall emissions. Even yet, it's believed that 5% - 10% of deliveries never make it to their intended location. There are more emissions because of these problems (Katta & Lam, 2022). The description of the goods should be presented online in a more accurate and advanced manner and more advanced technology should be used and the product description should be detailed enough so that the customer gets the right item.

5.2. Electronic Vehicle (EVs) for Last-Mile Delivery

According to the data of 2021, the total pollution of two wheels in India was 38.2 gCO_2/km which is 5.72% less than the previous year but is a matter of concern for the e-commerce business (Anup, 2021). Because the e-commerce business growing rapidly. So, EVs is the ultimate options to replace the oil two wheelers for reduce carbon emission.

5.3. Optimize Delivery Route

To find the way to reach the end customer very quickly, at the right time, and in less time and for that advanced technology, navigation system (internet), Artificial Intelligence (AI) should be used so that CO_2 emissions are the least. To better create last-mile delivery solutions with sellers, package carriers are boosting their investments in urban and automated distribution hubs. Since the automobile transportation challenge is a significant difficulty in the logistics distribution system, it has long been a focus of research (Liu, 2020).

5.4. Encourage Customer to Choose Sustainable Delivery

E-commerce businesses can also persuade clients to select environmentally friendly delivery methods, such delivery by bicycle, public transportation, collection points, or pick up points. Companies can lessen their carbon footprint and support a more environmentally friendly manner of conducting business by

providing incentives for sustainable solutions.

5.5. Innovations in Renewable Energy in E-Commerce

To lower carbon footprint, more environmentally responsible, and long-term energy cost reduction for e-commerce businesses, renewable energy systems can result in significant energy savings. The carbon footprint of the e-commerce sector will expect to significantly decline if more e-commerce businesses adopt these cutting-edge solutions.

5.6. Governmental Initiatives Promoting Environmental Sustainability under E-Commerce

Due to the revolutionary growth of e-commerce and increasing developments regarding consumers' environmental consciousness, government should take necessary actions like Emission Reduction Fund, Renewable Energy Target Scheme, Carbon Credit, Carbon Audit, etc. The road system is the only way for goods and services to reach consumers by e-commerce, so the need for electric vehicles and charging points which will encourage more to make the environment sustainable and the target of "net zero" emissions is met within time.

If we try to understand through Figure 1, we will see that as soon as the customer orders online, all the information will reach the warehouse and manufacturing or production department. The warehouse and the manufacturing department communicate with each other to decide where the parcel will be delivered. If the distance of the customer from the production department is less, then the customer can be delivered from there, or the product can reach the customer through the warehouse. And all this depends on strategic last-mile delivery that will help reduce carbon emissions. In addition, external factors such as high-speed Internet, modern technology, renewable resources, abundant charging stations, customer awareness for sustainable delivery, and governmental initiatives will take green last-mile delivery to another level, good for environment.

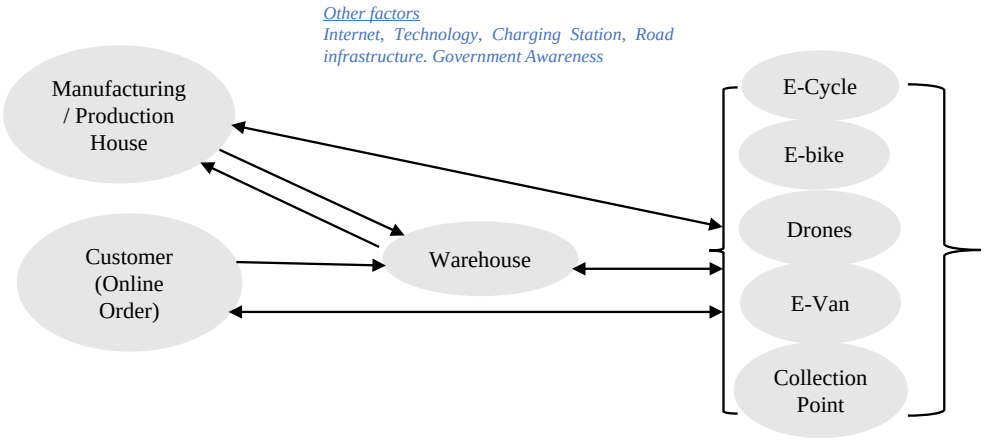

Figure 1. Conceptual last-mile delivery.

6. Discussion and Future Direction

Since the COVID-19 outbreak, parcel deliveries under e-commerce which is the largest source of CO_2 emissions have increased significantly. This increase in parcel delivery has led to an increase in local pollutants, more automobiles, and a warning for the environment. Concerning Indian environmental policies for the e-commerce sectors, these sectors are hugely dependent on fossil fuel-based energy for last-mile delivery. The government should improve environmentally friendly, long-term policy frameworks for e-commerce industrial sectors to instigate policies in related sectors. These measures and policy structures may also help improve management capability, foster public awareness of energy efficiency, and support green technology in the e-commerce sector for green delivery. It is also noticeable that worldwide CO_2 emissions per-capita in 2021 was 4.7 tons, India's per-capita CO_2 emissions was only 1.9 tons (Ritchie et al., 2020). In 2022, industry estimates state that the nation's fleet of last-mile two-wheeler delivery vehicles now includes at least 80,000 electric two-wheelers (Philip & Balakrishnan, 2022).

E-commerce businesses in India like Amazon India supports goal of achieving net-zero carbon emission by 2040 and is making progress toward a brighter, more sustainable future by effectively incorporating electric cars into its delivery fleet across more than 400+ Indian towns (Amazon, 2023). Whereas Flipkart to deploy 25,000 electric vehicles across the nation by 2030 has partnered with initiatives including the Climate Group's EV100 campaign (Flipkart, 2022). Most e-commerce home delivery in India is through two wheelers out of which the share of India's EVs market is only 2.4% in 2022 report, which is very low (Standard, 2023).

E-commerce that is environmentally friendly aims to have as little of an impact as possible on the environment and the use of electric vehicle delivery by electric vehicles in cities, delivery at night, before or after working hours, weekend days delivery, and value brand parcel lockers could reduce CO_2 emission. **Figure 2** shows that between 2016 and 2022, the use of electric vehicles took a huge peak and according to the Indian government think tank Niti Aayog, by 2030, there may be over 50 million electric vehicles on Indian roads. If all e-commerce deliveries were made using EVs, 44% of the emissions from conventional vehicles would be avoided, which would result in a 30 billion liter decrease in fossil fuel usage (Gokmen, 2023). Reduced air pollution is one of the main advantages of using electric cars. These vehicles also assist vendors solve the issue of pollution and the usage of non-renewable resources by reducing their negative environmental effects. India signed the COP26 declaration on the transition to 100% zero-emission automobiles and vans by 2040, with plans to mandate that all two-wheelers be electric by 2026 (Riehle et al., 2023).

As for global volatility, the fossil fuel market is volatile and harmful to the environment. If we look at **Figure 3**, the lithium battery production price is gradually decreasing, while the production price was $324/kWh in 2016 to $151/kWh

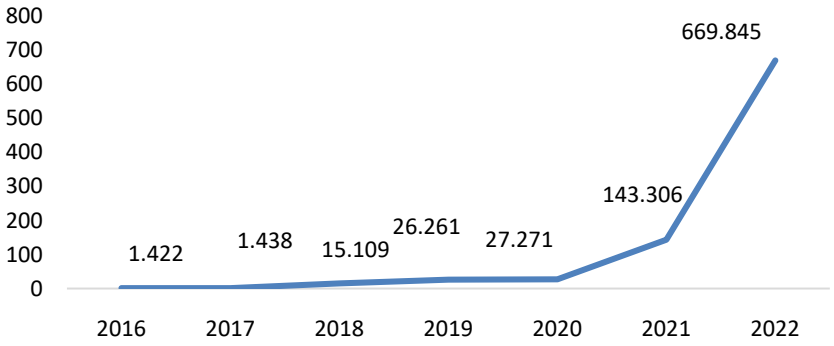

Figure 2. Two-wheeler Electric vehicles sold in India (Tandon, 2022; Yilmaz, 2023).

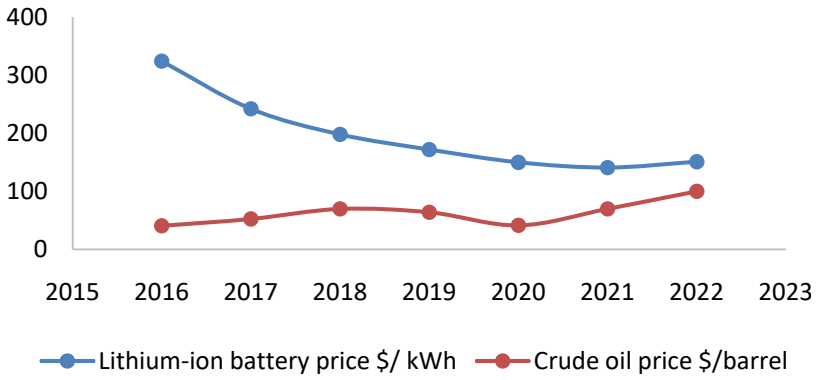

Figure 3. Lithium-ion battery pack price and Crude oil price (Henze, 2022; en2x, 2023).

in 2022, which is about 53% price reduction. As the use of electric vehicles increases, production will increase, and production costs will decrease, which is not only financially profitable but also more sustainable in terms of environment. In a populous and developing country like India, online business is experiencing phenomenal growth. At the same time, the use of 2-wheeler and 3-wheeler fossil fuel vehicles are used for last-mile delivery of goods, which is a major barrier to environmental sustainability.

7. Conclusion

The goal of this research is to examine prior research on the environmental sustainability of e-commerce, the development of environmentally conscious e-commerce businesses in India, the use of electric vehicles and infrastructure, last-mile delivery vehicles that run on fossil fuels, the average cost of fossil fuel consumption, global last-mile carbon emissions, and last-mile delivery studies to talk about India's position's sustainability in the future. The economic development of any country is very much dependent on the country's business and trade, and e-commerce business in India and foreign investment are very much dependent on the economic development of the country. E-commerce business in India is growing rapidly, and last-mile delivery is the most important part of e-commerce business. So, this literary study is about how much last-mile delivery can be made more environmentally friendly. In the literature, global fossil

fuel production and its use and price growth, increase in fossil fuel consumption in India, year-on-year increase in carbon emissions from fossil fuels, last mile delivery e-commerce business CO_2 emissions globally and in India, and strategies that make e-commerce business in India more environmentally friendly.

A content analysis of the growth of e-commerce for the environment sustainability in India has been created under the direction of ground theory and through the analysis and synthesis of the secondary data that has been acquired. Because e-commerce is still in its development stages and because of their prospective environmental activities, demands, and concerns, the market stakeholders may benefit from the study's findings. As primary data is not here, more research is needed, and it will be seen in future.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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