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IMPACT OF E-COMMERCE ON SUSTAINABLE ENVIRONMENT- A SYSTEMATIC ANALYSIS

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ABSTRACT

In an effort to provide convenience, the paper discusses that there have arisen major environmental issues with the emergence of e-commerce, unrelated to the convenience, such as carbon emission, packaging, and logistics and data centre energy requirements. It thoroughly analyses these concerns, as well as determining the adverse effects (such as higher wastes and electric consumption) and the beneficial ones (such as a decrease in retailing area and effective control of stock). Besides, the study suggests remedies towards more sustainable e-commerce activities, such as sustainable packaging, green logistics, renewable energy, and measures to reduce the rate of returns. The paper wraps up by stating that collaborative efforts between companies, governments and consumers have to be made in order to ensure sustainable future of e-commerce.

KEYWORDS: e-commerce, the environment, sustainable packaging, last-mile delivery, carbon footprint, inventory management, packaging waste, green logistics, renewable energy, carbon offset, and efficient shipping

1. INTRODUCTION

Introduction

“Environmental Concerns Associated With E-Commerce”

“It is also evident that the issue of environmental concerns concerning e-commerce are gaining prominence due to the growing number of individuals that settle to do their shopping online. This study is therefore aimed at researching the impacts of e-commerce on the environment in terms of energy consumption, wastage, and carbon emission produced in the tourism sector.” As the task will involve examining the environmental implication that can be drawn as a result of using e-commerce in relation to various areas, recommendations will be given to be applied to minimize the undesirable elements related to the system. To facilitate them to make informed decisions on how to establish mechanisms that would see sustainability in the e-commerce system, policymakers need to know the environmental impact that e-commerce has.With e-commerce, consumer and manufacturer

interactions have reshaped into business activities of buying and selling goods and this has recorded significant shifts in customer buying habits and business trends. But as the more and more consumers are adopting e-commerce in an effort to enjoy the convenience and accessibility of e-commerce, "the question of the environmental impact of e-commerce is becoming a growing concern. This study aims to examine the environmental impact of the e-commerce business in general and more precisely the amount of energy it consumes, the wastes that it produces and the carbon it produces". It is by examining various facets of an e-commerce business, including its manufacturing to packaging and delivery that we hope to establish the impact of e-commerce to the environment and how we can ensure that e-commerce business practices are sustainable.

1.1 "Statement of the Problem"

"One of the largest environmental disadvantages of e-commerce is packaging and shipping. As more and more individuals make their purchases over the web, the market demand of associated packaging materials such as cardboard boxes, bubble wraps, and plastic envelopes has grown." The result of these is deforestation, supplementation of emission of greenhouse gasses produced in production and additional wastage. There is also the transportation means of the delivery of what is bought online to the CO2 footprint of e-commerce. The huge delivery trucks release all types of pollutants, causing air contamination and traffic congestion. On average, shopping online emits more carbon emissions when compared to purchasing in a brick-and-mortar store; in online shopping, the product is shipped one at a time and it takes many miles long before a consumer is reached. Given the projections of e-commerce expansion in the world, these factors of concern should require interventions. Moreover, the delivery systems of goods bought online also lead to emissions of carbon footprint due to e-commerce. The pollution of the air and traffic jam are caused by the emission of various pollutants by delivery trucks. The World Economic Forum argues that the carbon emission generated by online shop is usually higher than by the traditional brick-and-mortar retail since items are shipped individually. With the expected growth of e-commerce in the global world, these environmental problems should be sorted out to avoid more harm to the earth. Ecological impact of e-commerce will also require sustainable packaging, optimisation of the routes and greener delivery options. Alan McKinnon

1.2 Need of the study

The e-commerce has grown tremendously over the last twenty years and it has transformed consumer-driven purchasing methods. This expansion has however resulted in environmental challenges too. It is paramount to know the environmental impact of e-commerce to have a sustainable future. Its effects have been packaging waste, rising carbon levels through delivery, consumption of data centres with energy and high rate of returns, and use of resources. Research may assist in coming up with a new way of packaging, the optimal way to ship the package, the integration of electric or hybrid vehicles, and the promotion of environmentally-friendly shipping solutions. "Gathering knowledge of the

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lifecycle of any electronic product can contribute to more sustainable production process and recycling systems." Extensive studies of the environmental effects of e-commerce can create policies and regulators, shape corporate responsibility, enhance consumer behaviour and awareness, create sustainable technologies innovation, and achieve long-term environmental sustainability. We can solve these problems and come up with new packages to reduce packaging materials, limit carbon emission, shorten transportation lines, move towards green energy, cut high returns, and encourage environmentally friendly supply processes.

1.3 Objectives

1. To "give an insight on the effects of e-commerce on environment."
2. To "determine the advantages and disadvantages of E-commerce on the sustainability of the environment."
3. To learn how and how the operations of e-commerce will protect the environment.

1.4 "Scope of the study"

An analysis of the environment impact of e-commerce operations should be clear enough in order to present practical details. Its goals involve measuring carbon release, energy use, as well as waste, comparing e-commerce to pure retail, critical areas that have been found to contribute to environmental degradation, and possible solutions that can be employed to curb these effects. The research will be based in the world, Asia-Pacific and developing countries. Areas of operation cover "supply chain and logistics, data centres, customer interactions and returns and Efficient Shipping."

1.5 "Methodology"

The research process employed to investigate the "environmental impact of e-commerce is a holistic research methodology that will involve both quantitative and qualitative research methodology". This is an integrated approach to assessment of various environmental factors such as carbon footprint, energy consumption, package wastes and use of resources. The following is the detailed description of the procedures that were used to conduct such a study.

1.6 Research Design The research design consists of a number of steps: "literature search, selection criteria, data extraction, and analysis. E-commerce has in the past years transformed the shopping experience and offers unmatched convenience and available of goods worldwide. Nevertheless, with the ongoing growth of the digital marketplace, one may want to raise some questions regarding its effect on the environment and what can be done to make e-commerce more sustainable. This paper explores the environmental effects of e-commerce and brings" out measures through which a green future can be developed.

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2. REVIEW OF LITERATURE

E-commerce has turned out to be an important aspect of the global economy that has changed the dynamics of the retail industry as well as Customer behaviour. However, its impact on the environment has attracted more focus amongst researchers, politicians and business stakeholders. This paper summarises the existing research on environmental implications of e-commerce with a particular focus on major findings and areas that should be further investigated.

"Sl No"	"Author(s)"	"Year"	"Key Variable(s)"	"Main Findings"	"Implications"
1	**Nguyen et al.**	**2020**	Consumer Behaviour	There is risi carbon emission d to rise in hon deliveries and onli shopping.	Warehouses th conduct e-commer require a lot energy, which related to size a operational needs.
2	Edwards et al.	2010	Packaging Waste	Plastic pollution a landfill wastes affe the world because e-commerce packaging.	Bio-related packaging method such as biodegra plastics and reusab systems can mitiga the environment impact but will be a disadvantage d to increased cost a scalability concern
3	Song et al.	2013	Warehousing Emissions	The size and t operation requirements of commerce warehouses u more energy.	e-commerce warehouses are a l more energ intensive in terms their size, as well operational need which means th they emit a lot carbon.
4	Verghese et al.	2015	Sustainable Packaging Solutio	The reduction environmental	It indicated that t wearing of the use

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"Sl No"	"Author(s)"	"Year"	"Key Variable(s)"	"Main Findings"	"Implications"
				impact wi biodegradable plastics and reusab systems may l achieved, yet the are several facto that should l considered such increasing the cos and scalin problems.	single-use plasti and cardboards in commerce has mar effects on th degradation of th environment.
5	Ellen MacArth Foundation	2016	Packaging Waste	The development e-commerce h prompted th increase in singl use packagin materials, pollutio in landfills and oth end of life materia on the planet.	It highlighted th role that commerce packaging plays the world pollutio of plastics and th wastes in landfills.
6	Jones	2018	Digital Infrastructure	It is estimated that 2 percent of the electricity used around the world is in data centres, which shows the growing consumption of electricity because of online shopping.	indicated the rising energy consumption with the advancement of online shopping.
7	Fichtinger et al	2015	Packaging Waste	Online shoppin enhances the use packaging materia	There should b sustainable polici and solutions

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"Sl No"	"Author(s)"	"Year"	"Key Variable(s)"	"Main Findings"	"Implications"
				that lead to landf wastes. Sustainab pack	waste manageme in the form sustainable packaging. .
8	Van Loon et al	2015	Carbon Emissio from Delivery	The process of t last-mile delivery especially carbo intensive, especial in the city areas.	The e-commer logistics cou reduce environmental impact considerab by the introducti of electric delive vehicles.
9	Jones	2018	Energy Consumption Data Centres	Centres of data a energy hungry and most cases they c be termed as usi non-renewable energy sources.	There is a need adopt renewab energy and ga energy-saving technologies in da centres to reduce t impact of da centres on t environment. .
10	Ramanathan	2011	High Return Rates	High return rat increase t transportation emission and waste	Better returns can predicted a managed with t use of artifici intelligence.
11	Golev and Corder	2016	Resource Utilizati	There are high cos associated wi production a disposal electronic devices.	The significance o circular econom approach is in t removal of t electronic waste.

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"Sl No"	"Author(s)"	"Year"	"Key Variable(s)"	"Main Findings"	"Implications"
12	**Dekker et al.**	2012	Comprehensive Environmental Impact	E-commerce ma close down th physical shops an save energ however, it als creates such issu as more was packaging an emissions durin transportation.	Environmental impacts of commerce are base on individu practices an policies. .
13	Chen & Dubinsky	2003	Future Direction and Gaps	Further research the long-ter environmental positives renewable power data centres.	Consumer behavio research and the ro of governme policies to influen sustainable commerce practices...

3.1. "Positive Environmental Impacts of E-commerce"

1. "Reduction in Physical Retail Footprints"

The physical space is one of the biggest benefits of e-commerce since it reduces the number of required retail areas. The traditional brick and mortar stores are very costly in terms of their construction, maintenance and also running them. In contrast, e-commerce will cut the requirement of such infrastructures, which may lessen the sprawl of urban areas and the environmental effects of constructing and operation of retail stores.

2. Efficient Inventory Management

High-tech algorithms and logistics systems are used to control inventory on e-commerce platforms. This optimisation ensures that there is cut down on overproduction, wastage that is in line with sustainable practices. The companies are likely to predict the demand more precisely and use their resources efficiently and reduce the impact of surplus inventory on the environment.

3. Consolidated Shipping

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E-commerce use could result in more efficient shipping operations as long as it is implemented properly. In the process of shipping consolidation and optimisation, e-commerce companies may make less delivery trips and consequently, carbon emission is reduced. The big players in e-commerce normally operate elaborate logistic networks to increase their delivery efficiency so that the impact of transportation on the environment can be minimised.

4. Dematerialisation of Goods

The adoption of digital products including e-books, music, and software, justifies the capability of e-commerce to minimize the production and distribution through physical means. These digital goods do not require physical materials and production and transportation of goods, thereby having a small environmental impact.

3.2. "Negative Environmental Impacts of E-commerce"

1. "Packaging Waste"

The growth in e-commerce has caused the growth of package waste. Most products that are ordered online have to go through several packaging to prevent damage during delivery, thus making them consume so much cardboard, plastic, and other types of materials. Regrettably, not everything among them is recyclable and results in a significant number of waste and pollution.

2. "Last-Mile Delivery Challenges"

They include "the last mile of delivery which ensures" the movement of good between a distribution centre and the final destination and is a significant environmental problem. As compared to bulk deliveries to retail outlets, the delivery of packages to home deliveries is less efficient resulting in increased vehicle emissions and traffic congestion. Part of the environmental advantage of consolidated shipping can be swallowed by this inefficiency.

3. High Return Rates

The e-commerce is defined as having higher rates of returns than the traditional retail. Such phenomenon leads to some extra transportation, treatment and possible waste when the returned goods cannot be resold. Processing costs, which result in environmental cost, can be significant "to the carbon footprint of e-commerce".

4. "Energy Consumption"

E-commerce applications require much energy in data centres. As some companies have made investments on renewable sources of energy, a number of companies also utilize non-renewable sources of energy as a way of reaching greenhouse emissions. Further, the energy used in maintaining and operating data centres only keeps on increasing with the increase in e-commerce.

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5. Resource Use

The costs on the environment are involved in the production and disposal of electronic devices that need to facilitate the e-commerce business like servers, computers and smartphones. These devices have a lifecycle that includes mining of raw materials, their manufacturing and disposal, which have a great impact on the environment.

3.3. "Strategies for a Sustainable E-commerce Future"

"Sustainable Packaging Solutions"

1. Sustainable packaging material can be used to address the problem of packaging wastage in e-commerce companies. Green packaging alternatives in the form of bio-degradable, recyclable and reusable can also play a big role in alleviating the environmental challenges. Such improvements include things as minimalist packaging design and eco-friendly materials.

2. Green Logistics

Green logistics solutions are therefore important in order to minimize the environment footprints of e-commerce. It involves the use of electric delivery or hybrid delivery vehicles, of planning the delivery routes in a way that carries minimum emissions, and sustainable fuels. Additionally, it is possible to persuade customers to use slower and more environmentally friendly delivery methods to minimize the carbon footprint.

3. Reducing Return Rates

Return rates may be minimised through accurate product descriptions, descriptive sizing guides and customer reviews. The facilitation of customers accessing the appropriate products at the initial attempt guarantees the e-commerce companies minimize the environmental cost of the returns. In addition, adopting better returns process that operates in a manner that is more sustainable can address the ill effects.

4. Investing in Renewable Energy

E-commerce firms ought to keep on investing on renewable sources of energy to operate their data centres and warehouses. The renewable energy sources like solar, wind energy etc can contribute much to the reduction of the carbon footprint of these facilities. Such companies as Amazon and Google have already performed steps in this direction and leave an example to the industry.

4. Carbon Offsetting Initiatives

The e-commerce firms will be able to engage in carbon offset schemes in order to counter their effects on the environment. These programs recoup the emission through investments in projects, which connote less carbon dioxide emission in the form of reforestation and renewable energy projects. The

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firms can help in global sustainability by sponsoring such programs.

4. Data Analysis and Interpretation

4.1 "Market Size and Growth of E-commerce Worldwide"

Table:1

year	"Retail e-commere sales (in $ Trillion)"
"2019"	"3.361"
"2020"	"4.248"
"2021"	"4.938"
"2022"	"5.542"
"2023"	"6.151"
"2024"	"6.767"
"2025"	"7.391"

"Source: eMarketer (2022a)"

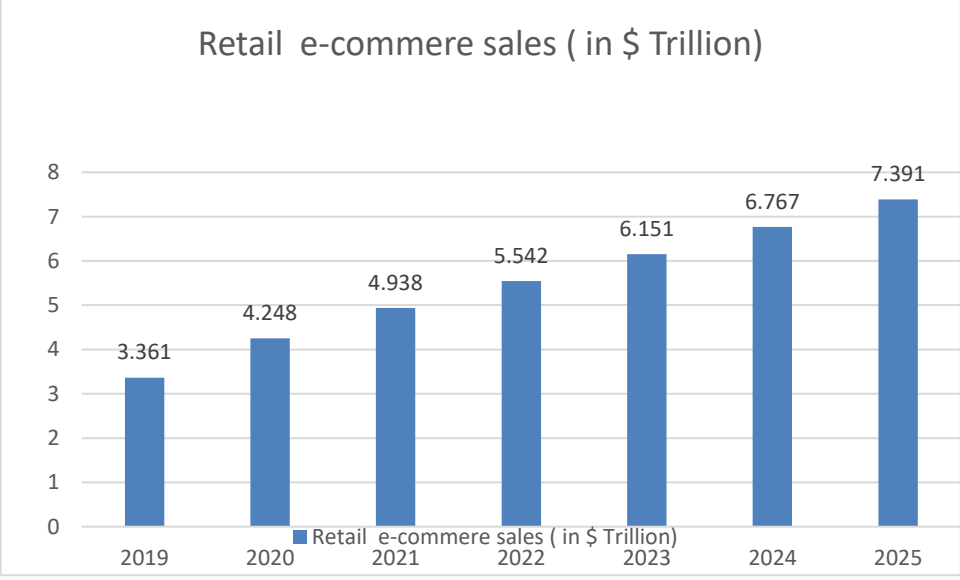

Figure:1 Market Size and Growth of E-commerce Worldwide

Interpretation: E-commerce retail sales are on the growing basis, with the growth being strong in 2020 of 14.1 percent to 17.9 percent. With unlocking of pandemic restrictions, the proportion is also likely to be rising steadily, with a report released by eMarketer (2022a) indicating a 23.6% growth by 2025.

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4.2. Emissions Embodied in Trade for Selected Countries

Table:2

Country	Exports %	Imports %
United States	8.3	15.6
Russian Federation	27.5	5.9
Japan	14.5	29.8
Germany	25.3	41
United Kingdom	21.3	37.9
Canada	31.7	28.8
France	22.7	38.8
Italy	26.5	41.8
Belarus/Ukraine	28.5	15.1
Australia	31.4	14.9
Poland	21.9	12.5
Spain	26.4	36.6
Netherlands	39.1	58.1
Belgium	45.5	89.4
Czech Republic	40.2	25.3
Greece	29.6	35.5
Finland	44.6	35.5
Denmark	34.1	47.8
Portugal	25.5	39.4
Sweden	34.1	73.7
Rest of Annex B	34	53.5
Annex B	18.9	24.5
China	24.4	6.6
Rest of Middle East	28.2	15.1
India	13.1	6.2
Korea	27.6	39.1
Mexico	19.4	23.9
Rest of Former Soviet	28.5	15.1
South Africa	44.6	6.4
Brazil	19.7	18.9
Indonesia	31.4	12.4

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Taiwan	40	36.9
Turkey	27.5	23.3
Thailand	41.8	28.1
Venezuela	29.3	8.9
Argentina	18.4	16.7
Malaysia	59.7	39.5

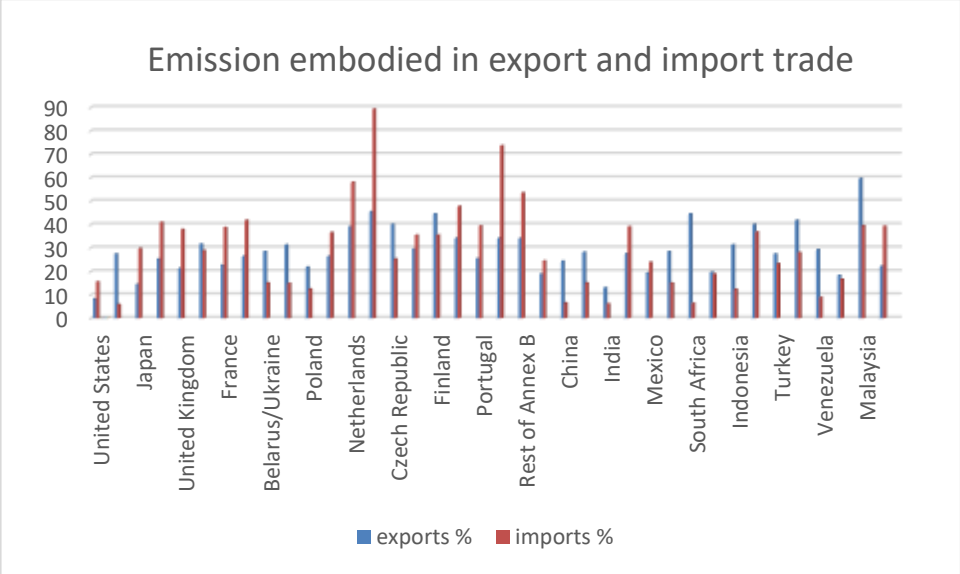

Figure: 2 Emissions Embodied in Trade for Selected Countries

4.3 "Firms Produced a Third of Global CO2 Emissions"

Table:3

Company	"Co2 Emission (billion Tons)"
"Saudi Aramco"	"59.26"
"Chevron"	"43.35"
"Gazprom"	"43.23"
"ExxonMobil"	"41.9"
"National Iranian Oil Co"	"35.66"
"BP"	"34.66"
"Royal Dutch Shell"	"31.95"
"Coal India"	"23.12"

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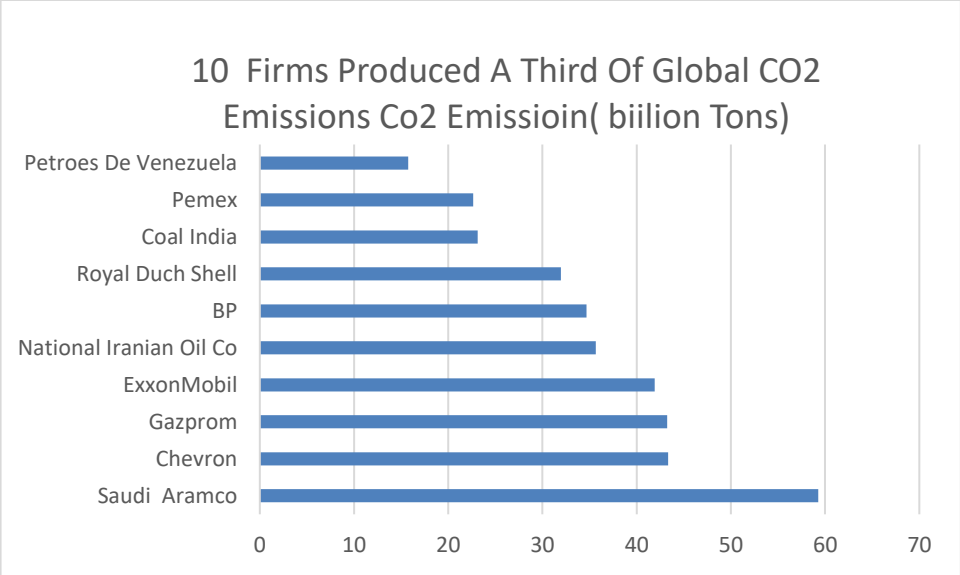
"Pemex"	"22.65"
"Petros De Venezuela"	"15.75"



(Source: www.statista.com)

Figure: 3 Firms Produced a Third of Global CO2 Emissions

4.4 "Greenhouse gas emission by mode of transport."

"Packaging causes CO2 emissions, pollution, and landfill waste. In 2020, the courier in China processed 83 billion express packages", and the volume of plastic and paper-based waste was 1.8 million tonnes. The amount of packaging waste that was generated in Hong Kong was 780 million. "Agreements such as Alibaba are also coming up with sustainable packaging to overturn the trend and the Chinese government is governing packaging."

Table: 4

Type of Vehicle	Co2 Equivalent per passenger
Cruise Ship	250
Short -haul flight	246
Diesel Car	171
Petrol Car	170
Medium-haul flight	151

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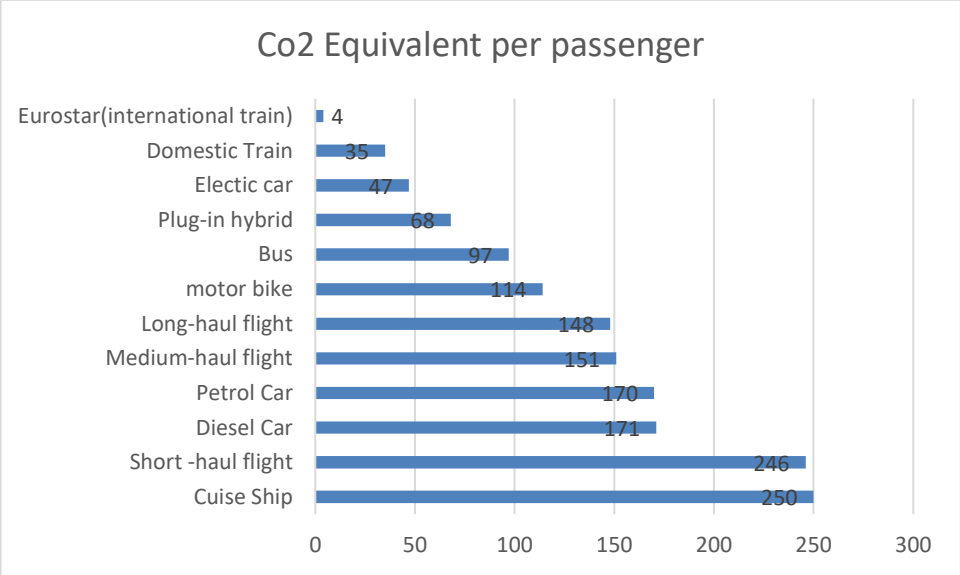
Long-haul flight	148
motor bike	114
Bus	97
Plug-in hybrid	68
Electric car	47
Domestic Train	35
Eurostar (international train)	4



(Source: www.statista.com).

Figure 4 Greenhouse gas emission by mode of transport.

Transport is a significant contributor to almost a quarter of the world carbon dioxide emissions with the most carbon intensive modes of transport "being cruise ship travel, domestic flights and journeys by cars powered by combustion engines. The minimal per capita and distance travelled emissions are those of the trains. Each country has different data with electric cars having a smaller carbon footprint throughout their lifetime, although their emissions are affected by the production of electricity within a country."

5. FINDINGS

• In 2022, the US produced the largest transportation emissions in the world of 1.72 billion GtCO2, followed by China; however, with an average carbon footprint of 0.62 metric tons, China remains among the largest emitters on this basis.

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Transportation Emissions: Gains through more deliveries of goods to the home and shopping online lead to an increase in carbon emissions. A significant contributor of these emissions comes in the aspect of last-mile delivery.

• Warehousing Emissions: Most e-commerce warehouses require more energy because they are bigger in size and their operations.

• Packaging Waste: The revolution in e-commerce has contributed to the escalation in one-use packaging materials" posing challenges to plastic pollution in the globe and landfills.

• Sustainable Packaging Solutions: Reusable Systems and Biodegradable plastics are potential solutions that could make the packages less harmful to the environment, but there are numerous limitations in the scale and cost.

• Resource Consumption: "It is estimated that Data centres consume approximately 2 percent of the global electricity consumption, and saw deep energy resource consumption with online shopping."

• Product Returns: Due to high returns rates in the e-commerce business, carbon emission and resource consumption increase."

• Comparative Studies: E-commerce vs. Traditional Retail: E-commerce has potential to be a more sustainable solution because of the centralised distribution yet possesses environmental costs."

• Mitigation Strategies: Green Logistics: The environmental footprint of e-commerce can be mitigated with the help of optimizing the use of routes, the use of electric vehicles and the application of carbon offset programs.

• Energy-Saving Warehousing: The use of innovations, such as LED lighting, intelligent HVAC, and uses of renewable energy, can conserve much energy.

• Consumer Behaviour: In order to decrease the environmental footprint of online shopping, it is possible to educate consumers and promote sustainable shopping behaviour.

6. SUGGESTIONS REFERENCES

Enhance the sustainability of the e-commerce company by the following suggestions:

1. Redesign brand ethos: A sustainable brand makes a claim of what it imparts and commitment to environmental sustainability. This message will need to be spread through the rest of the site, on "blog articles, social media and content."

2. Implement "sustainable shipping practices: With the increase in demanded expedited shipping businesses in the sector of e-commerce it is important to consider the enormous environmental" impact of shipping. Buying the boxes prepared with greater dimensions and choosing materials with low ecological implications, your company can contribute to decreasing the packaging garbage and decreasing its ecological footprint, and inspire your staff with the sense of responsiveness and action.

3. Decrease the rate of returns: Retail returns play a harmful role in the environment and the ratio is going to the 16.6 percent level in 2021. To minimize the returns, it is important to make sure that all the product information must be right and up to date and create an appreciation of being committed

by being sustainable in your business.
4. Implement recycling guidelines: Use sustainable and eco-friendly materials and recycling materials like green cardboard boxes and mailers. An energy audit can identify particular areas where the use of energy can be reduced.
5. Integrate sustainable-related products: Add environmentally friendly products to the existing ones or products that promote the idea of sustaining lifestyles. This will widen the customer base of the business to a growing customer base.
6. Implement a carbon levy at the check-out: Purchase a carbon credit to compensate the externalities such as the cares on the environment by investing on projects to reduce the emission of greenhouse gas. Businesses are able to commit part of their budget to offset investments or alternatively this can be offered to the customers who can select to pay an optional offset fee.

CONCLUSION

Continuing to say that e-commerce has revolutionized the retail environment and provided a lot of convenience, there exist several environmental problems that it poses. The negative and positive effects can only be addressed by combining efforts of the e-commerce firms, policymakers, and consumers. The e-commerce industry can also become the way toward a more sustainable future through sustainable practices, investing in green technologies, and promoting responsible consumption. As consumers, we can also have a role to play in making deliberate decisions regarding our online shopping patterns, which will make the world greener and more sustainable.

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