HONG KONG JOURNAL OF SOCIAL SCIENCES

香港社會科學學報

最新第 62 期 (2023 年秋/冬季) Vol. 62 Autumn/Winter 2023

Open Access Article **https://doi.org/10.55463/hkjss.issn.1021-3619.62.27**

Development of a Green E-Commerce Model and Analysis of Carbon Footprints Adoption

Thanarak Prasertwit[1], Kanchana Kanchanasuntorn[2], Varin Vongmanee[1]

[1] *School of Engineering, University of the Thai Chamber of Commerce, Bangkok, Thailand*

[2] *School of Engineering, King Mongkut's University of Technology North Bangkok, Prajinburi, Thailand*

Received: August 18, 2023 ▪ Reviewed: September 11, 2023

▪ Accepted: October 16, 2023 ▪ Published: November 30, 2023

Abstract:
The growth of E-commerce has continually increased because of the change in customer behavior. The business is required to meet customer expectations and protect the environment simultaneously. The research aims to find a solution that reduces the carbon footprint value. The green E-commerce model is drawn and explained in detail how to decrease emissions from the material receiving to disposal. It helps businesses understand how to implement the green concept to raise awareness, increase efficiency, reduce logistics costs, satisfy customers' needs, and improve economic performance and competitiveness. The selected E-commerce product is used to evaluate the carbon footprint value compared between current and green E-commerce. The research found that shortening transportation and eliminating unnecessary packaging are critical processes that reduce the carbon footprint value. The carbon footprint value was reduced by 0.1116 $kgCO_2$ equivalent or 3% per order. The carbon footprint value can be reduced by 781,398 $kgCO_2$ equivalent because of an estimated 7 million orders per day of E-commerce in Thailand. However, businesses can consider green production and alternative energy vehicles for further carbon footprint reduction.

Keywords: e-commerce, green supply chain management, life cycle assessment, carbon footprint, green e-commerce.

绿色电子商务模型的开发和碳足迹采用分析

摘要：
由于客户行为的变化，电子商务的增长不断增加。企业需要在满足客户期望的同时保护环境。该研究旨在找到一种降低碳足迹值的解决方案。绘制了绿色电子商务模型，并详细解释了如何减少从物料接收到处置的排放。它帮助企业了解如何贯彻绿色理念，提高意识，提高效率，降低物流成本，满足客户需求，提高经济效益和竞争力。所选电子商务产品用于评估当前电子商务和绿色电子商务之间的碳足迹值。研究发现，

缩短运输和消除不必要的包装是减少碳足迹值的关键过程。每个订单的碳足迹值减少 0.1116 二氧化碳千克当量或 3%。据估计，泰国电子商务每天的订单量为 700 万个，碳足迹值可减少 781,398 千克二氧化碳当量。然而，企业可以考虑绿色生产和替代能源汽车，以进一步减少碳足迹。

关键词：电子商务、绿色供应链管理、生命周期评估、碳足迹、绿色电子商务.

1. Introduction

Thailand's business-to-consumer (B2C) E-commerce business has risen since 2017. The expected growth rate is 7.7 percent by 2023. The growth in online sales has increased with mobile phone and Internet usage, and improved electronic payment and logistics systems. The Covid-19 pandemic is another reason why shopping online is a solution to avoid crowded people. Therefore, this caused an increase in E-commerce sales in Thailand.

To achieve in the E-commerce competition, a brand that operates an E-commerce business must put more emphasis on meeting customers' expectations. One of the essential issues for E-commerce business is to deliver the product in good condition as fast as possible directly to the customer. As a result, an E-commerce business generates pollution from vehicles and waste from additional protective packaging.

2. Research Methodology

This study aims to find a solution that reduces the carbon footprint value in Thailand. An academic literature review is conducted to acknowledge the concept of green supply chain management. In-depth interviews with experts in Thailand are key to finding out the best practices for the e-commerce process. Then, the researcher analyzes all activities to create a green e-commerce model. Evaluation of carbon footprint value is calculated in terms of kgCO2 equivalent refer to Life Cycle Assessment discipline. Finally, the study compares the carbon footprint value between the current E-commerce and green models. The research methodology is shown in Figure 1.

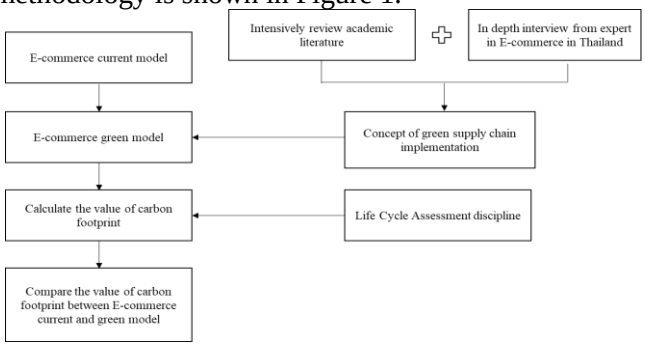

Figure 1. The research methodology

3. Research Results

To achieve the research objective, there are 4 parts of research result which are E-commerce process analysis, E-commerce process and how its impact the environment, green supply chain management implementation, a carbon footprint evaluation, case study, and conclusion.

3.1. E-Commerce Process Analysis

E-commerce is a new trend of commercial in Thailand recently. E-commerce can be classified into three types: Business to Business (B2B), Business to Government (B2G), and Business to Customer (B2C). Referring to Thailand E-commerce sales value in 2021 was 3.78 trillion Baht. The biggest share came from B2C or 2.17 trillion Baht, B2B was 0.84 trillion Baht, and B2G 0.77 trillion Baht respectively (EDTA, 2021). In the past 3 years the B2C E-commerce sales growth was 26%. In 2023, E-commerce sales is predicted to grow 4-6% with 16% share from retail sales (Kasikornresearch, 2022). It can be seen that the more potential sales of B2C E-commerce, the more attention and concern on impact of the environment.

Environmental issues are one of the most important topics that businesses face currently. The challenge of environmental protection is to protect the environment and improve a company's economic performance (Jones and Kurian, 2021).

Considering the current E-commerce model, the customer places an order on the E-commerce platform. The product is then picked and repacked at the seller's warehouse. The product is picked up from the seller's warehouse to the E-commerce platform distribution center. After the third-party logistics provider receives the order details, it goes to the E-commerce platform to collect the product back to their distribution center. The order is sorted and routed, then sent to the depot. Finally, the depot dispatches the product parcel to the customer. The current E-commerce model is shown in Figure 2.

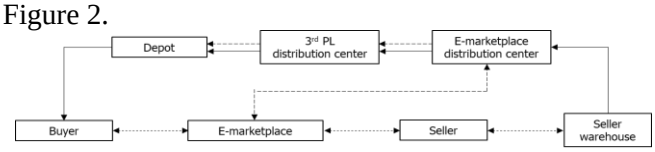

Figure 2. E-commerce current model

3.2. E-Commerce Process and Its Impact on the Environment

Internet users in Thailand have increased from 44.3 million users in 2017 and are expected to reach 59.3 million users in 2026 (Statista, 2023). An average internet usage is around 8 hours and 6 minutes per day leading to Thailand is number 1 in ASEAN of total E-commerce sales in B2C. Thailand combines international and national E-commerce platforms to provide shoppers with more options when shopping. The device that Thai uses for buying a product is a smartphone. Moreover, Thailand is the world's third

ranking in using smartphones to shop online (Thegrowthmaster, 2023).

The COVID-19 pandemic led to 81% increase in E-commerce retail business sales value growth from 2019. As a result, it is creating value in the supply chain. Many services have been set up to support these activities. The product is protected through special packaging, cardboard boxes, and bumping to be delivered as an individual parcel directly to the customer's house. Logistics providers have been established to support the growth of last-mile delivery. Many online platforms have been established to serve alternative customers. As a result, the customer's expectations rose from waiting for a week to be tomorrow or even the same day delivery to fulfilling their expectations. Many transaction orders from buying products online mean many individual packages, and mass traffic sharply rises in home delivery.

This can be seen from the sales growth and the amount of packaging, which increases yearly. In 2017, online retail sales in China reached 1.1 trillion U.S. dollars, with the number of parcels exceeding 40 billion orders and is projected to reach 70 billion parcels in 2020 (BLT, 2019).

As noted by Duan, et al. (2019), the COVID-19 pandemic also caused a significant increase in online transactions. The more often customers shop online, the more packaging waste is generated, which contributes to 1/3 of the household waste generated. Meanwhile, it is estimated that 2-3% of this packaging waste comes from e-commerce operations and will double by 2025.

A result of E-commerce activities is to satisfy a new trend of customer's lifestyle, causing an environmental impact such as global warming, rising the earth's temperature, waste, and pollution. The responsibility of taking care of the environment and sustainability for E-commerce must be a concern.

3.3. Green Supply Chain Management Implementation

Green supply chain management has gained attention over the past 10 years. It is a combination of environmental management and supply chain management. Green supply chain management (GSCM) is proposed as a potential solution for improving environmental performance (World Wide Fund for Nature, 2022). The focus is on managing and reducing the environmental impact of logistics activities throughout the supply chain. It can help achieve business objectives by increasing efficiency, reducing logistics costs, satisfying customers'' needs, and improving economic performance and competitiveness (Tseng et al., 2019).

Meanwhile, it is necessary for a business to comprehend and concentrate on the individual operating process. Referring to the 2019 Salesforce report, 56% of customers say that sustainability and ethical business are essential (Swami and Shah, 2013).

There are six keywords of green concept, including green design, green supply, green manufacturing, green consumption, green reverse logistics, and green transportation. The concept of green can be implemented in E-commerce processes, which are divided into seven processes. It has to focus along the supply chain process from material, manufacture, seller, E-marketplace, packaging, warehouse, third-party logistics distribution center, transportation, customer, and disposal. Therefore, it can draw a Green E-commerce model, as shown in Figure 3.

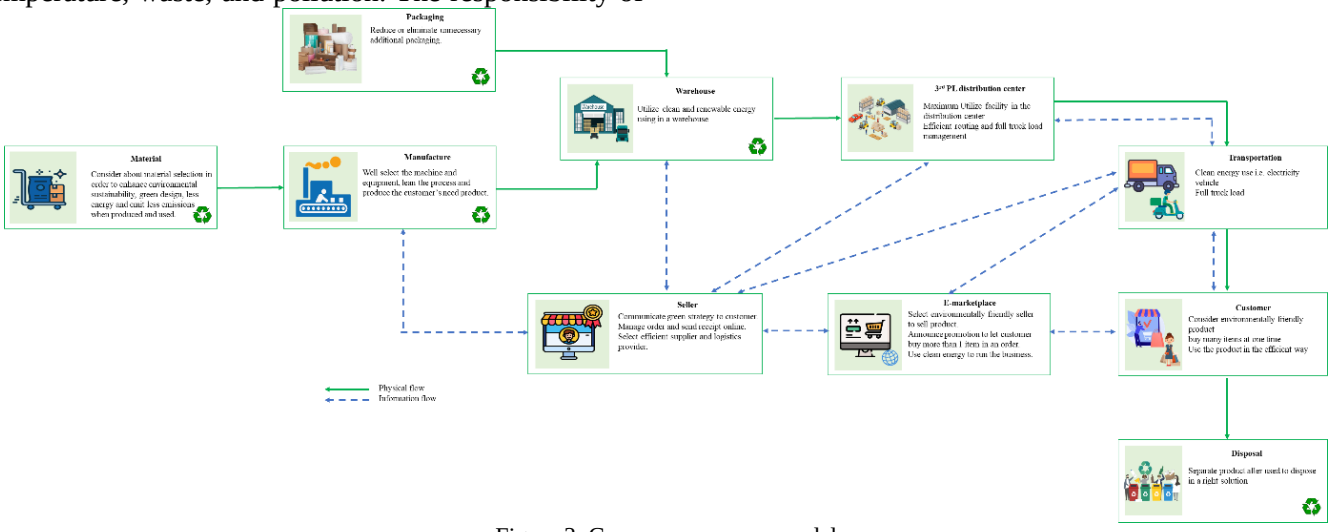

Figure 3. Green e-commerce model

3.3.1. Material

Material receiving is the first step of the production process. It is the core process that the seller has to consider using environmentally friendly materials and equipment. To improve environmental sustainability, the high carbon footprint intensity of materials must be reduced (Wearesuperb, 2023). This process can be considered a green design process. The seller's responsibility is to design ecologically sustainable products that produce fewer emissions in the manufacturing process, which can reduce the environmental impact when used. Material can be

divided into two parts which are: 1). Material input to be used for producing the product. It can encourage organizations to innovate, improve brand position, lean a process, improve business communication, reduce energy, and emit less emissions when produced and used. It also takes part in the end of the age of the product that can be reused, recycled, and reproduced. Thus, it can minimize the total waste that arrives at the landfill. 2). Material to be used as packaging. It is explained in the Packaging part.

3.3.2. Manufacturer

Green manufacturing is the process of transforming products from raw materials to finished products. The purpose of green manufacturing is to minimize the negative effects of the manufacturing process. As a result, waste can be reduced through emissions and product residues. The seller has to consider producing a product that meets the customer's need to avoid unwanted and dead stock. The process operation must be lean and select a green technology in the production process to reduce waste of time, scrap, and energy consumption. The seller must be concerned about using materials that can be recycled, reused, reprocessed, or upcycled. The machine or equipment must also be concerned with using renewable energy, which can help reduce the carbon footprint.

3.3.3. Seller

The seller plays a vital role in communicating all concern points to their beloved customer. Many solutions that sellers can communicate which are: 1). Promotion announcement to let customers wait for a considerable period and order at once to avoid split orders. The seller also can announce to let the customer know their vision and ambition if the business needs to go green. The seller can promote the recycling strategy to give customers points or incentives for joining this program. 2). Select an efficient third-party logistics provider who can send a parcel over a short route and consolidate all orders with a full truckload. On top of this, if the sellers have their contract with a third-party logistics provider, therefore it can shorten the process of sending the parcel to the marketplace distribution center but send it directly to a third-party logistics provider and help to print only one piece of air waybill applying for the whole transportation chain. 3). An invoice or receipt is one of the materials used in the E-commerce and retail business. However, refer to the ordering process of E-commerce. Therefore, the invoice should be sent online to reduce paper.

In addition, purchasing products with split shipments or often orders also impacts the environment. Bain's study found that purchasing a product online with two items per transaction and avoiding split shipment would reduce average per-item emission by 30% and cut shipping costs by 50% (Alvarez and Rubio, 2015).

3.3.4. E-Marketplace

The E-marketplace is an online marketplace where sellers gather to sell products, let buyers search for them, and transact via the Internet (Cheris et al., 2017). The E-marketplace is the primary channel for communicating the overall campaign to the customer. On this part, the E-marketplace can help sellers announce their green strategy on the platform. It may also advertise promotions on-top to convince customers to buy a product more than one item in order to avoid many packaging and shipping activities. The E-marketplace can play a crucial role in selecting the seller who sells the environmentally friendly product to join and sell the product on their channel by letting other unique benefits to that seller. Moreover, the E-marketplace platform provider also considers using clean energy to produce electricity to run the business.

3.3.5. Packaging

The top two environmental concerns are reducing packaging and using recycled packaging. The packaging has resulted in an increase in environmental impact (Mbaskool, 2022). It is important to consider using recycled material for primary and secondary packaging.

The use of tertiary paper packaging in E-commerce businesses is also a problem. It reached 2.6, 2.9, and 4.2 million tons in 2019, 2020, and 2021, respectively (Statista, 2022). Therefore, the seller should limit paper and additional packaging use in the package to make a green E-commerce. If the product is packed properly, the protective material is not required to add paper or even plastic to protect the product. If it is necessary, then consider using recycled material instead. The Body Shop is an example of avoiding plastic in its purchasing process, preferring to use corrugated cardboard and recycled paper for packing. The brand also considers if the product's packaging is made from plastic bottoms. They offer incentives to their customers to recycle them. Meanwhile, the shipped packaging is offered to be reused when returning the unwanted order or the product packaging for recycling'.

3.3.6. Warehouse

Efficient warehouse management is vital in contributing to the carbon footprint of supply chains (Sanyé-Menguala et al., 2014). The impact of the warehouse from carbon assessment has to be compared in terms of energy directly used and the emission of carbon dioxide (CO2), which looks at sources such as fossil energy and gas energy.

The functions and activities within the warehouse are related to storage and transportation, including trucks as a transportation utility and energy use in the warehouse as light, air conditioner, or temperature controller.

Warehouse management can apply many techniques and technologies to achieve zero carbon by designing

and creating an efficient process plan. An example of reducing to zero carbon is alternative energy, electricity energy in Li-ion batteries used for forklifts, or hybrid energy such as hydrogen energy, ethanol, and biodiesel, which can be utilized for transportation such as hybrid trucks. Emitting hydrogen and oxygen will cause no environmental pollution from these types of energy. Considering warehouse or storage in terms of light, it is possible to change the roof to a sunroof that can save daylight energy or apply a solar system for clean energy. It may separate product sections by zoning to avoid unnecessary utilization in controlling temperature.

The benefit of producing energy used in business is environmental conservation and corporate social responsibility (CSR) through the most efficient management of energy resources. It is cost-effective and reduces the costs of energy expenses because the business does not have to spend money to buy or outsource energy. The sustainability of warehouse practices benefits the company's reputation and industrial leadership (Minashkina and Happonen, 2019). Moreover, a surplus of business energy can be sold to the government or other businesses, making money and profit for the business.

Therefore, concerning environmental issues, Tesco's store is the first zero-carbon store that generates renewable energy. Tesco's warehouse has also applied a practical design to meet the zero carbon. The design supports features and technology which are environmentally friendly, including applying a natural light roof that allows daylight into the warehouse area; changing light bulbs into LED; generating a solar system and wind turbine as a source of clean energy; collecting rainwater for toilet use; and choosing a friendly refrigeration system for air conditioners and refrigerators.

3.3.7. Third-Party Logistics Distribution Center

The distribution center is the station where product sorting refers to the postcode. Therefore, it has to utilize efficient routing and full truckload management. Truck selection and validation are also a main duty to guarantee truck quality and ready to dispatch a last-mile product to customers. Moreover, for energy and facilities usage, the distribution center has to consider a suitable design that is well utilized and generates renewable energy.

3.3.8. Transportation

According to a World Economic Forum study (Deloison et al. (2020), last-mile delivery emissions are expected to increase by 30% in the next 10 years. In addition to increasing pollution by increasing city traffic, the vehicles used are often polluted, mainly because of delivery trucks. Consumers are willing to pay more to access the fast delivery service. However, it is another reason that impacts ecology. To solve this issue, the seller can communicate with the customers and explain the reasons for abandoning the same-day/next-day delivery. Alternatively, the seller can allow free shipping for the customer that can wait longer for the delivery. Green solutions to offer this type of service, notably through eco-friendly solutions such as various electric or hydrogen-powered, which is green energy to help reduce or cut off the carbon footprint (U.S Department of Energy, 2022). A full truckload can increase efficiency of truck utilization and reduce the number of trucks dispatched from the station. Efficient routing management is vital to sequence customers' addresses as milk runs to generate smooth traffic. As a result, it can be reduced delivery costs by 25%, CO2 emissions by 30%, and congestion by 30% by 2030 (Ecommerce-nation, 2023).

3.3.9. Customer

Customers play a critical role in E-commerce activity. It is because the customer decides to buy or not to buy which product and which promotion. The first activity of a customer is searching for product information, comparing with other brands or prices or promotions then deciding and making an order. In this process, many devices, such as mobile phones, computers, and tablets, are optional for customers. Thus, information is a concern. The customer has to receive the correct information, which helps the customer to make the right decision. However, the price is still in customer consideration (Deloison et al. (2020). Therefore, a promotion announcement is attractive for customers to buy many items at once. It helps reduce waste from packaging. Moreover, the right way to use the product and packaging afterward also helps producers easily return it for recycling.

3.3.10. Disposal

The disposal process is the final step of the product life cycle. It is about separating the waste, including used, primary, secondary, and tertiary packaging. The customer has to be concerned about separating products after use, which can be divided into four types (Groening et al., 2015): 1) Biodegradable waste is waste that perishes and decomposes quickly. It can be composted to make fertilizer from vegetable scraps, fruit peels, food scraps, leaves, and meat scraps. 2) Recyclable waste is packaging waste or leftover materials that can be reused, such as glass, paper, cans, and plastic. 3) General waste is waste that is difficult to decompose. It is not worth reusing, such as plastic bags contaminated with food scraps. 4) Hazardous waste is contaminated waste that causes harm to people and the environment, such as flammable, contaminated, toxic, corrosive, contaminated with pathogens, explosive, and irritating.

3.4. Carbon Footprint Evaluation

A carbon footprint directly measures greenhouse gas

emissions attributable to a specified activity. The carbon footprint generally focuses on the processes and practices associated with CO_2 and other greenhouse gasses (DDproperty, 2021). A carbon footprint value is calculated from activity data multiplied by the emission factor (East, 2008). Therefore, the equation is:

Emissions = activity data emission factor

Life Cycle Assessment (LCA) is considered a method of analysis for quantifying an environmental load of a product, service, or production process (IPCC, 2006). It is used to evaluate the process that causes the environmental impact from the start to the end of the process (Roy et al., 2009) and to analyze environmental health, including the process of raw materials receiving, production, transportation, distribution, use, and disposal (Gungor and Gupta, 1999).

Green E-commerce supply chain management is key to reducing carbon footprint value. To implement the green model, the researcher applies the concept of green in the case study, which considers implementing a green concept into an applicable logistics process to compare the value of carbon footprint between the current model and the green model.

3.5. Case Study of Green E-Commerce Model Implementation: Logistics Process of Wacoal, an Underwear Industry

The existing E-commerce process starts with the product being produced and stored in the seller's warehouse. Once a customer orders, the product is picked and repackaged in the warehouse. The printed airway bill shows the order number, customer's name, address, order details, and payment method. The E-commerce marketplace platform comes to collect the product and go to their distribution center. The product is then allocated and separated to each third-party logistics provider to go to their distribution center and depot referring to the postal code. Finally, the product is dispatched to the customers. After the customer uses the product, the product is disposed of through the landfill method. It can explain the current E-commerce process referred to LCA discipline in Figure 4.

The carbon footprint value can be evaluated in each E-commerce process in terms of carbon dioxide equivalent, as shown in Table 1.

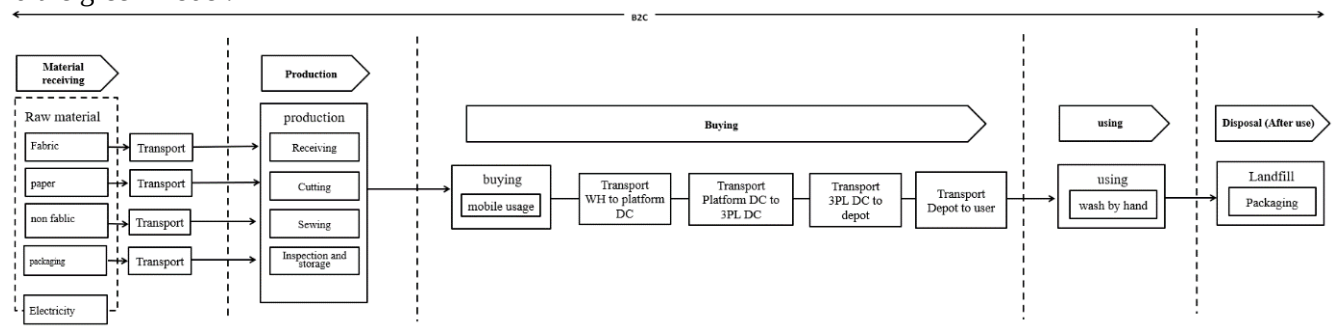

Figure 4. Current e-commerce process

Table 1. Carbon footprint value of current e-commerce process

	Receiving material	Production	Distribution center	Using	Disposal	Total
Carbon footprint value	2.1189	0.8605	0.0165	0.0002	0.6366	3.6327

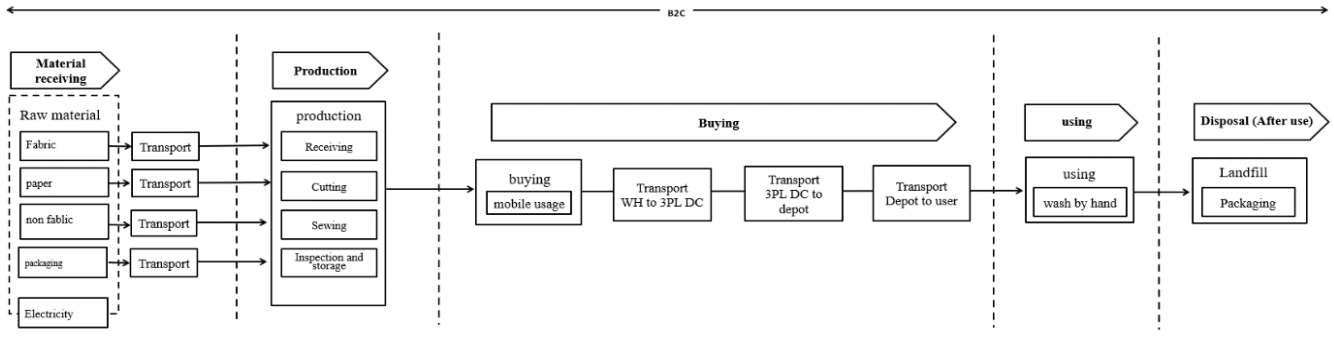

Figure 5. E-commerce green process

The green E-commerce process begins when the product is produced and stored in the seller's warehouse. After the customer orders, the product is picked and repackaged at the seller's warehouse. The third-party logistics provider comes to collect the product from the seller's warehouse to the third-party logistics provider distribution center, then transfers to the depot according to the postcode, and finally delivers it to customers. After the customer uses the product, the product is disposed of by landfill method. It can explain the current E-commerce process referred to LCA discipline in Figure 5.

The details of the E-commerce green process are explained below.

3.5.1. Material Receiving Process

The principal core value of this step is to reduce unnecessary packaging. From this green model, the plastic bag and plastic envelope are removed. The order detail paper is pasted directly on the parcel box. It is no need to use a plastic envelope sleeve.

3.5.2. Production Process

This process has remained.

3.5.3. Buying Process

The product is picked up and repackaged in the seller's warehouse. The seller links the system to the E-commerce platform and third-party logistics distribution center. The system linkage helps reduce the process from printing two airway bills to only one airway bill. Then, the shortening process by the third-party logistics provider comes to collect the product from the seller's warehouse to a third-party logistics provider distribution center directly. This chain cut the E-commerce platform distribution center from the loop to avoid double transportation. The product is carried by 4-wheel truck with 35 km measured by Google map. The product is then transferred to the depot referring to the postal code.

3.5.4. Using Process

Referring to the researched product, it is used for wearing. After using it is washed by hand.

3.5.5. Disposal Process

After receiving the parcel, it is unboxed, and then the packaging is unwanted. So, all the packaging material is disposed of in a landfill. After use or unconditional, the product is also disposed to a landfill.

The carbon footprint value of green E-commerce process is shown in Table 2.

Table 2. Carbon footprint value of green e-commerce process

	Receiving material	Production	Distribution center	Using	Disposal	Total
Carbon footprint value	2.0576	0.8605	0.0107	0.0002	0.5920	3.5211

The value of the carbon footprint of the E-commerce can be compared between current and green E-commerce processes and is shown in Figure 6.

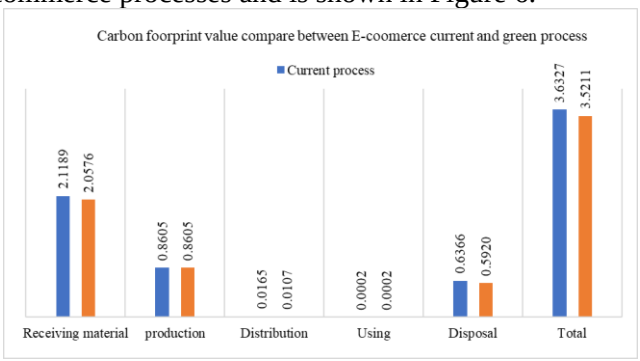

Figure 6. The value of carbon footprint both current and green e-commerce process

The carbon footprint value of current E-commerce is 3.6327 $kgCO_2$ eq. and green E-commerce is 3.5211 $kgCO_2$ eq. Referring to receiving process, after removing an unnecessary material such as plastic bag, order detail paper and plastic envelope can reduce the carbon footprint value from 2.1189 to 2.0576 $kgCO_2$ eq. Distribution process is shortened by eliminating the process to send the product from the seller warehouse to E-commerce marketplace platform distribution center and then third-party logistics distribution center. It is changed to send product from the seller warehouse to third-party logistics distribution center directly. This shortened process can reduce the carbon footprint value from 0.0165 to 0.0107 $kgCO_2$ eq. Finally, the carbon footprint value from the disposal process conforms to the receiving process. The carbon footprint value reduces from 0.6366 $kgCO_2$ eq. to 0.5920 $kgCO_2$ eq.

Referring to the E-commerce green model, the value of carbon has been reduced by 0.1116 kgCO2 eq. or 3% per 1 order. Thailand's E-commerce order quantity in 2022 is forecasted to reach 7 million daily orders (PPTV (2022). The carbon footprint can be reduced by 781,398 kgCO2 eq. per day.

4. Conclusion

The growth of E-commerce continually increases. At the same time, the E-commerce order quantity is getting bigger. As a result, waste has increased. It can calculate the carbon footprint value of $kgCO_2$ equivalent to evaluate the waste value from E-commerce activities. To do this, the researcher analyzes E-commerce processes all along the chains from the cradle to the grave. To reduce the value of the carbon footprint, the researcher uses the green supply chain management concept. The process of material receiving, distribution, and disposal are the processes that can be reduced from the reducing of using additional packaging and green delivery process. The research found that the value of carbon has been reduced by 0.1116 kgCO2 eq. per order or 781,398 kgCO2 eq. per day.

5. Limitations and Further Study

The limitation of this research is the researcher applies the concept of green in the case study, which considers implementing a green concept into an applicable logistics process which are material receiving, distribution, and disposal process. The researcher considers reducing the additional packaging and changing the delivery process, which influences the disposal process. Implementing the concept of green supply chain management also can do in the process of production, which is a second rank that generates the

value of carbon footprint. Therefore, the next step is to find more solutions to reduce the value of the carbon footprint of the process of production.

Acknowledgments

To complete this research the researcher would like to thank you to my supervisor, my family, expert in E-commerce who and the participants who cooperated and supported me with documents and information throughout the process of data collection. Non-financial support is given for the research.

Authors' Contributions

The authors would like to express their deepest gratitude to the supervisor, Associate Professor Dr. Kanchana Kanchanasuntorn, for the great consultations and review throughout the research process, and Assistant Professor Dr. Varin Vongmanee for helpful guidance and setting goals to finish the research.

References

[1] EDTA (2021). E-commerce sales. https://www.etda.or.th/th/pr-news/ETDA-Reveals-the-Value-of-e-Commerce-in-2021.aspx.

[2] KASIKORN RESEARCH (2022). B2C E-commerce sales. https://www.kasikornresearch.com/th/analysis/k-social-media/Pages/B2C-FB-02-12-2022.aspx

[3] JONES, F., and KURIAN, A. (2021). Sustainable Packaging: A Study on Consumer Perception on Sustainable Packaging Options in E- Commerce Industry. *Natural Volatiles & Essential Oils*, 8(5), pp. 10547-10559.

[4] STATISTA (2023) Number of internet users in Thailand from 2017 to 2020 with a forecast through 2026. https://www.statista.com/statistics/553730/number-of-internet-users-thailand/

[5] THE GROWTH MASTER (2023). Digital 2023 global overview report: Daily time spent using the internet Thailand. https://thegrowthmaster.com/trends/digital-trend-statistic-2023

[6] BLT (2019). The new generation shops online the most. Survey. https://www.bltbangkok.com/CoverStory/คนไทยชอบออนไลน์-แม่ค้า-ลูกค้า-ธุรกิจอีคอมเมิร์ซ2562.

[7] DUAN, H., SONG, G., QU, S., DONG, X. and XU, M. (2019). Post-consumer packaging waste from express delivery in China. *Resources, Conservation & Recycling*, 144, pp. 137-143.

[8] WORLD WIDE FUND FOR NATURE. (2022). Transforming E-Commerce Management. Delivering on Circularity in Singapore. https://plastic-action.asia/transforming-ecommerce/

[9] TSENG, M.-L., Md ISLAM, S, KARIA, M. N., et al. (2019). A literature review on green supply chain management: Trends and future challenges. *Resources, Conservation and Recycling*, 141, pp. 145-162, https://doi.org/10.1016/j.resconrec.2018.10.009.

[10] SWAMI, S. and SHAH, J. (2013). Channel coordination in green supply chain management. *Journal of the Operational Research Society*, 64, pp. 336-351

[11] WEARESUPERB (2023) Green e-commerce: Embracing sustainability. https://wearesuperb.com/sustainability-green-ecommerce/

[12] ALVAREZ, S., and RUBIO A. (2015). Carbon footprint in Green Public Procurement: a case study in the services sector. *Journal of Cleaner Production*, 93, pp. 1-8

[13] CHERIS, A., TAYLOR, C., HAYES, J. and DAVIS-PECCOUD, J. (2017). Retailers' Challenge: How to Cut Carbon Emissions as E-Commerce Soars. https://www.bain.com/insights/how-to-cut-carbon-emissions-as-ecommerce-soars/.

[14] MBASKOOL (2022) What is E-Marketplace. https://www.mbaskool.com/business-concepts/marketing-and-strategy-terms/13326-e-marketplace.html

[15] SANYÉ-MENGUAL, E., LOZANO, R.G., OLIVER-SOLÀ, J, GASOLA, C.M., and RIERADEVALL, J. (2014). Eco-Design and Product Carbon Footprint use in the packaging sector. In *Assessment of carbon footprint in different industrial sectors*, 1 (pp. 221-245). https://doi.org/10.1007/978-981-4560-41-2_9.

[16] STATISTA (2022) Estimated consumption of tertiary paper packaging induced by e-commerce in the EU from 2019 to 2025 https://www.statista.com/statistics/1068445/consumption-of-e-commerce-induced-tertiary-paper-packaging-eu/

[17] MINASHKINA, A., and HAPPONEN, A. (2019). Decarbonizing warehousing activities through digitalization and automatization with WMS integration for sustainability supporting operations. *E3S Web of Conferences*, 158, 03002. https://doi.org/10.1051/e3sconf/202015803002

[18] U.S DEPARTMENT OF ENERGY (2022). Sustainability and Decarbonization Inside Warehouses and Distribution Centers. https://betterbuildingssolutioncenter.energy.gov/sites/default/files/slides/Warehouse%20Decarbonization%20-%20Slides.pdf.

[19] ECOMMERCE-NATION (2023). Green E-commerce: How To be a cleaner seller. https://www.ecommerce-nation.com/green-ecommerce/

[20] DELOISON, T., HANNON, E., HUBER, A., et al. (2020). The Future of the Last-Mile Ecosystem. Transition Roadmaps for Public and Private Sector Players. World Economic Forum.

https://www3.weforum.org/docs/WEF_Future_of_the_last_mile_ecosystem.pdf
[21] GROENING, C., INMAN, J.J., and ROSS, W.T., (2015). The role of carbon emissions in consumer purchase decisions. *International Journal of Environmental Policy and Decision Making*, 1(4), pp. 261-296. https://doi.org/10.1504/IJEPDM.2015.074719
[22] DDPROPERTY. (2021) Buying and selling guide/Sorting trash cans – Start separating waste from your home. https://www.ddproperty.comคู่มือซื้อขาย/ถังขยะแยกประเภท-เริ่มต้นแยกขยะจากบ้านคุณ-27934.
[23] EAST, A.J. (2008). What is a Carbon Footprint? An overview of definitions and methodologies. Horticulture Australia. Discussion Paper 1. https://www.daf.qld.gov.au/__data/assets/pdf_file/0003/59025/Hort-Fruit-Drought-Carbon-Report1.pdf
[24] IPCC (2006). 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 1 General Guidance and Reporting. https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/1_Volume1/V1_1_Ch1_Introduction.pdf
[25] ROY, P., NEI, D., ORIKASA, T., et al. (2009). A review of life cycle assessment (LCA) on some food products. *Journal of Food Engineering*, 90, pp. 1-10. https://doi.org/10.1016/j.jfoodeng.2008.06.016.
[26] GUNGOR, A., and GUPTA, S.M. (1999). Issues in environmentally conscious manufacturing and product recovery: a survey. *Computers and Industrial Engineering*, 36(4), pp. 811-853. https://doi.org/10.1016/S0360-8352(99)00167-9
[27] PPTV (2022). Parcel delivery grows to 7 million pieces per day. This year is expected to expand by 17%. https://www.pptvhd36.com/news/%E0%B9%80%E0%B8%A8%E0%B8%A3%E0%B8%A9%E0%B8%90%E0%B8%81%E0%B8%B4%E0%B8%88/173982

参考文:

[1] 乙二胺四乙酸 (2021)。电子商务销售。https://www.etda.or.th/th/pr-news/ETDA-Reveals-the-Value-of-e-Commerce-in-2021.aspx。
[2] 开泰研究（2022）。企业对消费者电子商务销售。https://www.kasikornresearch.com/th/analysis/k-social-media/Pages/B2C-FB-02-12-2022.aspx
[3] JONES, F., 和 KURIAN, A. (2021)。可持续包装：电子商务行业消费者对可持续包装选择的看法研究。天然挥发物和精油，8(5)，第 10547-10559 页.
[4] 统计数据库 (2023) 2017年至2020年泰国互联网用户数量以及到2026年的预测。https://www.statista.com/statistics/553730/number-of-internet-users-thailand/
[5] 成长大师（2023）。数字2023年全球概览报告：泰国每日使用互联网的时间。https://thegrowthmaster.com/trends/digital-trend-statistic-2023
[6] 培林（2019）。新一代在网上购物最多。民意调查。https://www.bltbangkok.com/CoverStory/คนไทยชอปออนไลน์-แม่ค้า-ลูกค้า-ธุรกิจอีคอ第 2562 章。
[7] DUAN, H., SONG, G., QU, S., DONG, X. 和 XU, M.（2019）。中国快递产生的消费后包装废物。资源、保护和回收，144，第 137-143 页。
[8] 世界自然基金会。（2022）。转变电子商务管理。在新加坡实现循环。https://Plastic-action.asia/transforming-ecommerce/
[9] TSENG, M.-L., Md ISLAM, S, KARIA, M. N. 等。（2019）。绿色供应链管理文献综述：趋势与未来挑战。资源、保护和回收，141，第 145-162 页，https://doi.org/10.1016/j.resconrec.2018.10.009.
[10] SWAMI, S. 和 SHAH, J. (2013)。绿色供应链管理中的渠道协调。运筹学杂志，64，第 336-351 页
[11] 我们是一流的 (2023) 绿色电子商务：拥抱可持续发展。https://wearesuperb.com/sustainability-green-ecommerce/
[12] ALVAREZ, S. 和 RUBIO A. (2015)。绿色公共采购中的碳足迹：服务业的案例研究。清洁生产杂志，93，第 1-8 页
[13] CHERIS, A.、TAYLOR, C., HAYES, J. 和 DAVIS-PECCOUD, J. (2017)。零售商面临的挑战：随着电子商务的蓬勃发展，如何减少碳排放。https://www.bain.com/insights/how-to-cut-carbon-emissions-as-ecommerce-soars/。
[14] 巴斯库尔 (2022) 什么是电子市场。https://www.mbaskool.com/business-concepts/marketing-and-strategy-terms/13326-e-marketplace.html
[15] SANYÉ-MENGUAL, E.、LOZANO, R.G.、OLIVER-SOLÀ, J、GASOLA, C.M. 和

RIERADEVALL, J. (2014)。包装行业的生态设计和产品碳足迹使用。不同工业部门的碳足迹评估，1（第221-245页）。https://doi.org/10.1007/978-981-4560-41-2_9。

[16] STATISTA (2022) 2019年至2025年欧盟电子商务引发的三级纸包装消费量估算 https://www.statista.com/statistics/1068445/conspiration-of-e-commerce-induced-tertiary -纸质包装-欧盟/

[17] MINASHKINA, A. 和 HAPPONEN, A. (2019)。通过数字化和自动化与仓库管理系统集成实现仓储活动脱碳，以支持可持续运营。乙3S会议网络，158, 03002。https://doi.org/10.1051/e3sconf/202015803002

[18] 美国能源部（2022）。仓库和配送中心内部的可持续性和脱碳。https://betterbuildingssolutioncenter.energy.gov/sites/default/files/slides/Warehouse%20Decarbonization%20-%20Slides.pdf。

[19] 电子商务国家（2023）。绿色电商：如何做一个清洁卖家。https://www.ecommerce-nation.com/green-ecommerce/

[20] DELOISON, T.、HANNON, E.、HUBER, A. 等.（2020）。最后一英里生态系统的未来。公共和私营部门参与者的过渡路线图。世界经济论坛。https://www3.weforum.org/docs/WEF_Future_of_the_last_mile_ecosystem.pdf

[21] GROENING, C.、INMAN, J.J. 和 ROSS, W.T. (2015)。碳排放在消费者购买决策中的作用。国际环境政策与决策杂志，1(4)，第 261-296 页。https://doi.org/10.1504/IJEPDM.2015.074719

[22] DD财产。(2021) 购买和销售指南/垃圾桶分类–开始将垃圾与家中的垃圾分开。https://www.ddproperty.comคู่มือซื้อขาย/ถังขยะแยกประเภท-เริ่มต้นแย กขยะจากบ้านคุณ-27934。

[23] EAST, A.J.（2008）。什么是碳足迹？定义和方法的概述。澳大利亚园艺。讨论文件1。https://www.daf.qld.gov.au/__data/assets/pdf_file/0003/59025/Hort-Fruit-Drought-Carbon-Report1.pdf

[24] 政府间气候变化专门委员会（2006）。2006年政府间气候变化专门委员会国家温室气体清单指南，第1卷一般指南和报告。https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/1_Volume1/V1_1_Ch1_Introduction.pdf

[25] ROY, P.、NEI, D.、ORIKASA, T. 等.（2009）. 对某些食品的生命周期评估(生命周期评估)的审查。食品工程杂志，90，第1-10页。https://doi.org/10.1016/j.jfoodeng.2008.06.016。

[26] GANGOR, A. 和 GUPTA, S.M.（1999）。环保制造和产品回收的问题：一项调查。计算机和工业工程，36(4)，第811-853页。https://doi.org/10.1016/S0360-8352(99)00167-9

[27] PPTV（2022）。包裹递送量增至每天700万件。今年预计将增长17%。https://www.pptvhd36.com/news/%E0%B9%80%E0%B8%A8%E0%B8%A3%E0%B8%A9%E0%B8%90%E0%B8%81%E0%B8%B4%E0%B8%88/173982