



Impacts of e-commerce last-mile modes on the environment and the mediating role of sustainable logistics technology:

A case study of selected Finnish cities

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Bachelor's thesis

March 2021

Technology, communication, and transport

Degree Programme in Logistics Engineering

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Title and possible subtitle

Jyväskylä: JAMK University of Applied Sciences, September 2020, 40 pages.

Technology, communication and transport. Degree Programme in Logistics Engineering. Bachelor's thesis.

Permission for web publication: Yes/No

Language of publication: English

Abstract

With the flooding and sickness impact of the COVID-19 pandemic, most businesses have seen the need for online or virtual trading and products' delivery to the point of order. Whether through their channels, sub-contracted, or third-party agents, the process of delivering items to the customers has gained significant attention over the years. Therefore, referred to as the last-mile delivery process, and the growth of e-commerce activities has enhanced it. Though it comes with an additional fee, the last-mile logistical system is a convenient and sustainable distribution mode, which provides a competitive advantage to companies. The current study analyses the effect of e-commerce last-mile modes on the environment and the mediating role of sustainable logistics technology. Contextually, this study took in the city of Helsinki and Oulu. The study highlights four critical issues linked to the last-mile logistical modes to incorporate a qualitative research methodology a thematic analytical process. Such as convenience due to fewer traffic jams and fuel savings, cost-cutting for distribution functions minimized queuing problems, improved ecological environment due to suppressed carbon emissions, and improved quality of life of consumers. It is recommended that firms adopt technologies that minimize substantial waste pollution, which can be addressed through the last-mile logistical option.

Keywords/tags (subjects)

E-commerce growth, Last-Mile delivery, Impacts, Mediation [See Project Reporting Instructions, section 4.1.2](#)

Miscellaneous (Confidential information)

For example, the confidentiality marking of the thesis appendix, see Project Reporting Instructions, section 4.1.2

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1 Introduction

The concept of e-commerce has gained traction over the last two decades. It is corroborated by information from the China Internet Network Information Center (CINC), which places China second in the online shopping market (Wang et al., 2014). Concisely, online trading in the country broke past \$1.2 trillion in 2012. However, the execution of e-commerce needs e-logical support with the ‘last mile’ delivery, accounting for roughly 30 per cent of the overall e-logistics cost (China Enterprise News, 2013). Some of the ‘last mile’ delivery modes that have been applied in more significant markets like China include the collection and delivery points (CDPs), the reception box (RB), and attended home delivery (AHD). A report by the United Nations Conference on Trade and Development (UNCTAD) discloses a spread in the intensity of e-commerce and websites in organisations with small countries and Northern Europe being more inclined to apply websites compared to larger

southern states. Concisely, Sweden and Finland are near saturation at more than 90 per cent levels (Falks and Hagsten, 2015).

However, despite the general trend observed concerning e-sale and e-commerce, it seems that a high application of websites in organisations does not necessarily imply a high proportion of engagement in pure e-sales or e-commerce activities (Falks and Hagsten, 2015). For instance, the Austrian firms have extensive usage of websites and are generally keen on matters e-commerce, albeit it is not commensurate with the low performance of online sales. While the industry structures may vary across various countries to reflect variations in online trading, other domestic factors include firms' age and size. A 2011 survey conducted by Civic Consulting covering twenty-seven EU member countries showed that the total value of online B2C (business-to-consumer) trade in goods amounted to approximately \$274 billion (current value), 80 per cent of the business being domestic. The rest being cross-border trade between the member states (Cardona et al., 2015). Having gotten a preview of the general market outlook of e-commerce and online trading in the EU, this proposal also focuses on Finland's e-commerce scope. As per Nordeau (2016), the country has an internet penetration rate of 92.5 per cent, ranked as among the highest globally. Notably, internet usage is widespread among various age groups ranging between 16 years and 55-plus years. Regarding B2C e-commerce, the turnover estimated to be around \$11.4 billion in 2017, reflecting a 15 per cent growth compared to the previous year.

As of 2017, the e-commerce users in Finland were roughly 3.3 million, with a projection of about 530,000 users being added by 2021. It is worth noting that the Finns depend heavily on foreign merchants as far as online buying is concerned, and almost half of the purchases made abroad. Last-mile logistics significantly drives e-commerce since goods have to move from the transportation hub or pick-up point to the final delivery location. Therefore, the last mile entails the final stage of the supply chain management that ensures products delivered to a warehouse packaged adequately and safely delivered to the clients. A 2016 market assessment conducted by ATK showed that most

firms spent approximately \$65 billion in 2016 on picking, packing, and last-mile delivery. Additionally, McKinsey and Co. revealed that UPS e-commerce generated an estimated \$35 billion from domestic parcel deliveries in the US, where orders were delivered directly to customers.

1.1 The motivation of the study

Supply chain management has evolved significantly in the last century with the advent and growth of e-commerce platforms. Consumers and entrepreneurs continue to embrace this type of business, given the mutual benefits attributed to it. In essence, goods and services have to move from production to consumption (Cardona et al., 2015). The modern production practices and distribution models have significantly driven by consumer and market demands. Of critical note, commerce and supply chain management's evolution has increased baseline expectations of present-day consumers. The reality of same and next-day delivery has developed a new kind of demand among firms; thus, the whole supply chain is quickly changing from having a functional perspective to an interconnected global network of data and processes (Kazemi, 2019). Businesses have developed several new models for renovating their supply chains to cope with modern clients' demands. Modern technologies and concepts, including automation, blockchain, and artificial intelligence (AI), which are part of Industry 4.0, continue to be "integrated into the digital supply network, which integrates data and information" (Kazemi, 2019, para 1) from various sources to propel the supply of manufactured products across the value chain. While demands for products continue to outpace firms' capacity to deliver, about 50 per cent of retailers provide same-day delivery services. Interestingly, the same customers expect that this particular model's products to bear the exact cost. The final delivery of the commodities

from the transportation hub or warehouse to the consumer location, also known as the last-mile, is experiencing growing challenges, especially the urban centres. At the same time, customers are still expecting flexible and fast delivery services. To mitigate the overhead costs while meeting consumer demands, strategic firms have had to invest in automated last-mile delivery systems. Small distribution centres are being set-up within the proximity (about 6 to 9 miles) of major metropolitan towns. The process of delivering packages is being performed by combining conventional and modern shipping methods. Other than the traditional shipping methods, non-conventional shipping technologies like drones and autonomous vehicles are being harnessed. Having specialised and small last-mile supply points being developed for various goods and needs, it is possible to diversify even more the means with which such products are being delivered. This is in addition to modern shipping technologies' benefits, lessening the road infrastructure and the environment. Thus, on this basis, the research explores the effect of e-commerce last-mile modes on the ground and the role of sustainable logistics technology in the same context.

1.2 Research Purpose and Objectives

This study's primary purpose is to investigate the bearing of e-commerce last-mile modes on the environment and the mediating role of sustainable logistics technology in delivering goods directly or indirectly to customers.

- To explore how different last-mile logistics impact the e-commerce and direct delivery of packages to clients in Oulu and Helsinki.
- To explore some of the impacts of sustainable e-commerce last-mile logistics on Oulu and Helsinki's environment.

- To investigate the mediating role-played sustainable logistics methods concerning the last-mile impact on Oulu and Helsinki's environment.

The central questions that seek to address the research mentioned above aims and objectives are.

- 1) How is the development and growth of the e-commerce industry?
- 2) In what ways do last-mile logistics affect e-commerce and delivery methods in Helsinki and Oulu?
- 3) What are some of the effects that last-mile modes have on the environment of Oulu and Helsinki?
- 4) What adaptable and mediating role do sustainable logistical methodologies play in Oulu and Helsinki's environment?

2 Literature review

According to Olsson et al. (2019), last-mile logistics is a new research area, especially in the last five years. As opined by Cardenas et al. (2017), the significant interest had majorly driven by growth in population and urbanisation, development of the e-commerce industry (Lim et al., 2018; Rai et al., 2019), increased attention to sustainable practices (Aljohani and Thompson, 2018), and innovation (Ranieri et al., 2018). Gevaers et al. (2014) claim that “the last mile is often described as one of the most expensive, inefficient, and polluting parts of the supply chain” (as cited by Olsson et al., 2019 p.1). It is worth noting that the costs associated with last-mile logistics account for between 13 and 75 per cent of the aggregate supply chain cost, albeit based on various factors (Gevaers et al., 2009). This chapter conducts an in-depth discussion of the concept and dynamics of e-commerce, last-mile logistics and associated factors to provide a suitable framework for subsequent research methods, findings, analysis, and discussion.

E-commerce Overview

2.1 Background overview of the arrival and growth of e-commerce

Despite some commentators arguing on the uncertainty of the eventual outcome and shape of the 'e-revolution', it is evident that the emergence of e-commerce has fundamentally altered the game's conventional rules on matters of the retail and distribution sector. E-commerce is a short form of electronic commerce, and it focuses mainly on process innovation by way of technological application to reconfigure the current business operations. The Internet has proved to be a virtual platform, which provides an electronic network linking up distributed information sources, superior collection and application of real-time information, and evolved distribution channels. Bhalekar et al. (2014) describe e-commerce as a paperless transaction of business data and information with an electronic system and applications. They add that other than e-commerce automates the manual processes, and it also helps businesses shift to a completely electronic environment, hence changing their mode of operations. For the last ten years, firms have engaged with e-commerce activities courtesy of internet technology. It claimed that electronic commerce had been around for more than 40 years, having originated "from the electronic transmission of messages during the Berlin airlift in 1948" (Bhalekar et al., 2014 p.25).

Salvatori and Marcantoni (2015) discuss the concept of social commerce, which integrates e-commerce and social networking. Modern internet users communicate the source for and share information and data using social networking sites. Succinctly, social commerce is a type of venture mediated by social media. Therefore, social commerce entails e-commerce transactions and activities through web 2.0 and social media technology (Salvatori and Marcantoni, 2015). Social commerce (SC) can be regarded as a subcomponent of e-commerce, facilitating social media users to perform commercial activities and transactions (Gonalves and Zhang, 2013). Other practitioners describe SC as an environment where customers shop and collaborate, similar to the social networking

environment (Chen et al., 2013; Kang and Park, 2009). Contextually, consumers and firms engaging in social commerce are bound to reap some benefits. On the one hand, customers leverage networking and collaboration abilities by looking up diverse information based on other consumers' purchase decisions. In contrast, on the other, firms rake in revenues from the current customers and new referrals. Generally, e-commerce has been divided into various types including business-to-business (B2B) model, business-to-consumer (B2C), and consumer-to-business (C2B). However, for this study, the B2C is discussed briefly in the next section.

Business to Consumer (B2C) model

The B2C is an e-commerce business model where firms sell their merchandise to customers, usually through catalogues that utilise shopping cart software. As per Brown and Jayakody (2008), B2C e-commerce encompasses a business undertaking where clients purchase goods and services through the internet medium. Drigas and Leliopoulos (2013) aver that B2C e-commerce makes use of the internet medium “as a retail market channel and in the case of information, as a product or service delivery channel” (p.1). Since the early 2000s, the B2C e-commerce niche has snowballed, and in 2005 it hit roughly \$190 billion in terms of business-to-consumer sales (Barkley et al., 2007). The Internet has shortened distances and made the world smaller, with its influence beyond technical computer applications to the general society. At the beginning of the 21st century, the population of internet users was about 304 million globally, about 5 per cent of the population. A decade later, the number soared to approximately 2.3 billion, accounting for more than 30 per cent of the global population (Drigas and Leliopoulos, 2013). In the US, a similar growth pattern was evident over the same period (1997 to 2010), as indicated by the figure below. Apart from the growth of internet users, the speed quality has seen a significant increase in driving the growth of B2C worldwide. Mahadevan (2000) corroborates by stating that,

“the meteoric growth of the Internet over the last decade and the B2C e-commerce services

are strictly united and the results have developed in several services, such as e-mail and search engines, which play a key role towards the growth of B2C e-commerce” (Drigas and Leliopoulos, 2013 p.2).

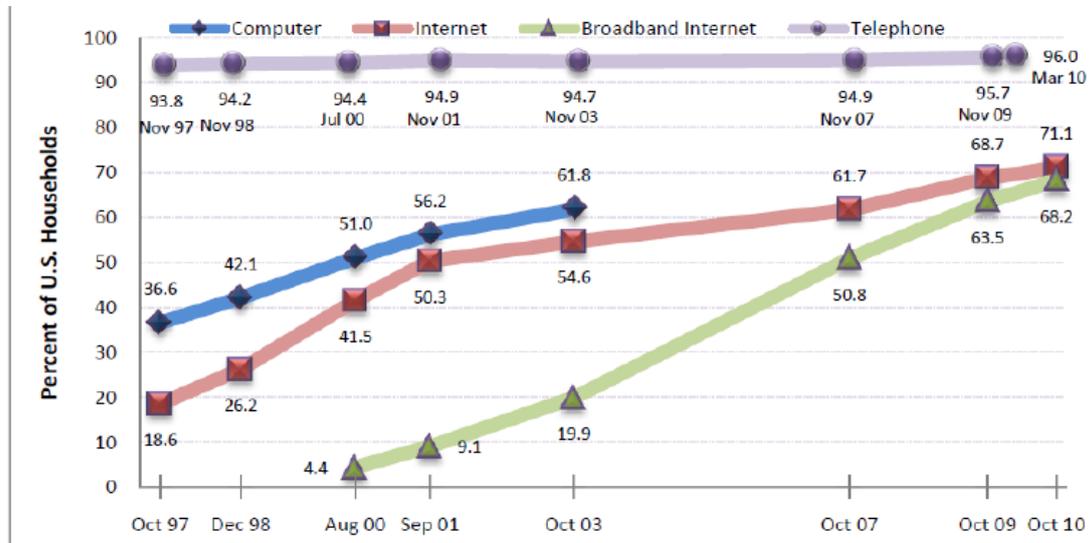


Figure 1: The growth of internet use between 1997 and 2010 in the US (Drigas and Leliopoulos, 2013)

The 2010 US Census shows that approximately 80 per cent of households had one or more internet users with the digital subscriber line (DSL) and cable modem connection accounting for 23 and 32 per cent, respectively; they were considered the most applied broadband technologies. Some other technological segments that have been developed and are still growing over the last two decades include fibre optics, mobile broadband, and satellite services. Precisely, internet access by users soared to more than 80 per cent by 2011 (Drigas and Leliopoulos, 2013). The figure below shows the quarterly sales performance of retail e-commerce in the US between 2002 and 2011. Notably, the meteoric growth of the quarterly e-commerce sales from a paltry 1.3 per cent in 2002 to 5.6 per cent in 2011 is proof enough to show the impact of the Internet on commercial activities.

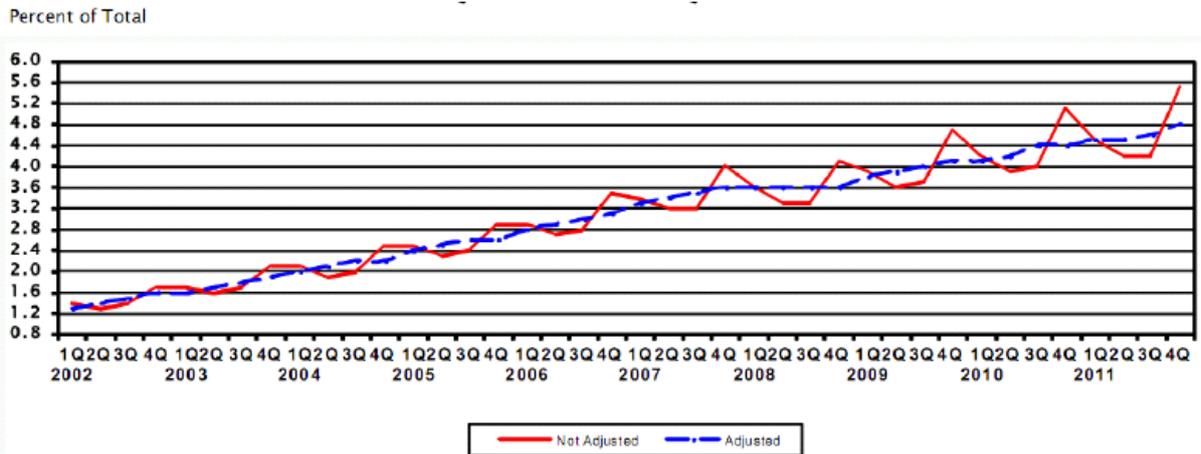


Figure 2: Quarterly retail e-commerce sales as a proportion of the US's total retail sales between 2002 and 2011 (Winters et al., 2011).

The e-commerce scope in Europe

Europe is considered one of the regions with a sharp growth in internet-based trading, especially the Western part of Europe. In Europe, electronic commerce has become essential in every market segment accounting for a significant proportion of the overall trade. Available statistical data from the E-commerce Europe Association indicated that as of 2010, the revenue growth in the UK, Norway, and Sweden ranged between 10 and 15 per cent, while that of Italy, Germany, Spain, and France ranged between 20 and 25 per cent (Jędrzejczak-Gas et al., 2019). Eastern and Southern Europe have recorded the most notable growths, ranging from 30 to 40 per cent annually. Some of the countries in this region that experienced significant growth include Turkey, Poland, Russia, and Greece (Weening, 2019). Sales data from E-commerce Europe shows that online sales in Europe had reached above \$500 billion by 2015 and more than \$600 billion as of 2016. The said change denotes the exponential growth of e-commerce in Europe. In terms of expenditures in respect to individual countries, the UK recorded the highest expenditure per person with estimates showing an average expenditure of \$4300 per person per year in 2015; the average e-consumer expenditure in Europe then was estimated to be about \$1800 per year (Jędrzejczak-Gas et al., 2019). Besides the online

shopping patterns portrayed by residents from the UK, shoppers' significant expenditure from Scandinavian countries, France, Ireland, and Switzerland. Considering that most of the countries aforementioned also form the largest markets, the development of e-commerce in such countries is bound to be significant based on the demand and supply factors. Ownership of internet-powered mobile devices has driven e-commerce in Europe because of convenience accessibility and real-time feedback. The figure below shows the average growth of mobile connection in 13 European countries from 2003 through 2010.

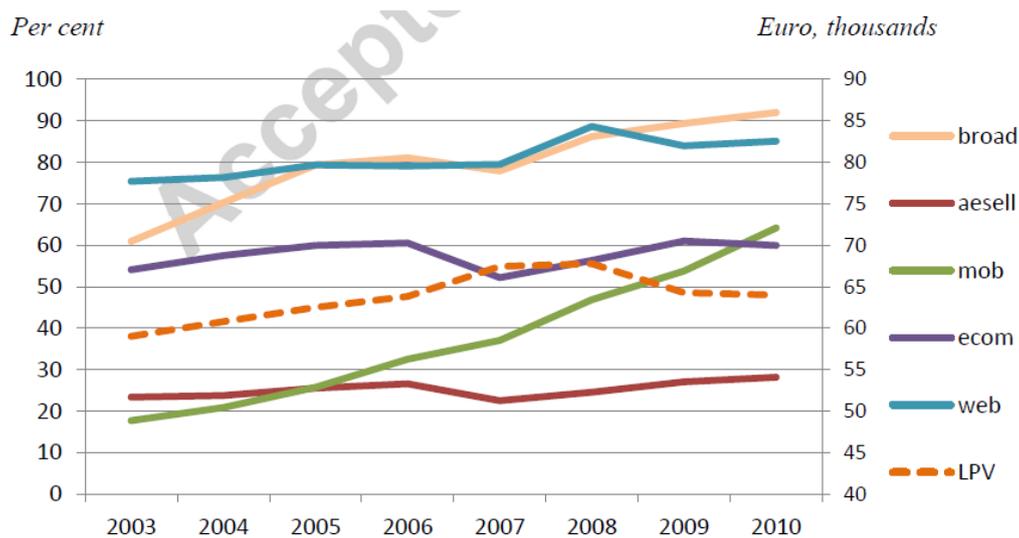


Figure 3: Average growth of mobile connection (denoted as mob) across 13 countries in Europe (Falk and Hagsten, 2015)

In 2011, Civic Consulting surveyed 27 EU member states. Results indicated that the approximate value of goods traded online on the B2C platform was about \$274 billion, where eighty per cent was domestic business while twenty per cent involved cross-border business (Cardona et al., 2015). Looking concisely at the prevalence of online trading and e-commerce scope in some countries such as Finland provides a clearer picture. According to Nordeau (2016), the rate of internet penetration in Finland is more than 90 per cent, ranking it among the world's highest. Demographically, there are discrepancies regarding internet consumption for age brackets ranging between teenage and older adults aged 50 years and more. Concerning e-commerce on the B2C platform, its

sales turnover in 2017 was roughly \$11.4 billion. That was a 15 per cent increment compared to 2016.

More than 3 million e-commerce consumers in Finland as of 2017 and a 2021 forecast showed that roughly 530,000 users would be added. Notably, the Finns' purchasing patterns rely significantly on external merchants, given that about 50 per cent of the items ordered come from abroad. On these grounds, the last-mile logistics and infrastructure prove essential in bolstering e-commerce in such countries. Factors such as sustainability, efficiency, and convenience of the last-mile logistical models utilised in developed regions like Europe are bound to drive up e-commerce trading in Finland. The business that leverages warehousing, packing, distribution, and last-mile delivery services are bound to invest considerably to meet the surging customer demands. For example, ATKearney assessed the market in 2016 and found out that around \$65 billion was invested by firms in picking products, warehousing, packing, and last-mile delivery services. The impact of last-mile delivery services is underscored by McKinsey and Co.'s revelation of the US UPS e-commerce's domestic parcel delivery services. The company generated a whopping \$35 billion from the said services, with goods being delivered directly to the consumers.

Sustainable Logistics

E-commerce in the context of a modern supply chain

Ahmed and Elkhatib (2019) assert that the main role of e-commerce in logistics in supply chain management is performing business activities over the internet platform. E-commerce is operationalised using various models and platforms. As aforementioned, logistics in supply chain management (LCSM) utilising e-commerce techniques involve two major categories of business models, that is, the business-to-business (B2B) and business-to-consumer (B2C) channels. More so, e-commerce provides an opportunity to subscribe to and use internet services and applications with online service providers (OSPs) or internet service providers (ISPs). Other electronic functions that have

strongly driven e-commerce applications in modern supply chain management are electronic fund transfers (EFTs), electronic data interchange (EDI), and debit and credit card processes. Trading has been made convenient with the development of mobile-based applications and websites that drive B2C business models. For such a model, consumers visit and interact with a business website to learn more about a product, place an order, and await delivery. In some cases, the payment may be cash on delivery or when the order is being placed (Mangiaracina et al., 2015). Other than the e-commerce system, some other techniques that facilitate e-commerce logistics include the warehouse management system (WMS) and the transportation management system (TMS). The growth of e-commerce as an enabler of new supply chain management for services and products was driven by expanded access to internet services by households (Kawa and Maryniak, 2018). Further, the mobility and popularity of hand-held devices such as tablets made it convenient for customers to visit online trading sites. In addition to security, customer value, and trust in businesses using online services, a real-time interactive experience cemented the significance of e-commerce in modern supply chains.

Comparison of e-commerce with conventional business models

Conventional retail stores are modelled as brick-and-mortar sites where consumers physically shop for products. Placed in strategic locations, such stores may provide specific goods or all types of goods under one roof. However, the consumers have to present themselves to these stores to access various products. Similarly, shoppers may be restricted in terms of the available brands from which to choose; a certain geographical area may have few stores. Traditional retail stores have remained strong because of their strategic expansion policies besides their brands being trusted. Nevertheless, the advent of internet technology and online trading systems' growth significantly disrupted the old purchasing trends. Traditional stores have had to rethink their business activities by adopting technological systems, tools, and channels to meet new customer preferences

and market needs. With several business ventures being driven by internet-powered devices, firms' responsibility is to deliver the shoppers' products. Additionally, shoppers have a wide range of products from which they can choose. Contrary to the traditional businesses where shoppers had to visit stores physically, the new mode of trading allows customers to purchase goods and services at the comfort of their home. Some online trading sites, such as Amazon and Alibaba, act as agencies on behalf of millions of merchants that want to trade their products globally. Apart from the actual goods purchased through internet technology, service providers in various sectors such as the medical, finance, and entertainment industry are increasingly using e-commerce to reach out to customers locally and globally. Therefore, Internet retailing provides a paradigm shift from classical channel sales because the traders are selling the product and fulfilling an obligation to deliver those goods at the right cost, time, and place. One of the key factors associated with online trading is logistics. Kawa and Maryniak (2018) aver that e-commerce allows the attraction of new customers and retains those who have used online trading sites. Some of the factors that have given modern e-commerce platforms an edge includes the availability of products, various delivery forms, low shipping costs, and timeliness. In the next sections, the process of distributing and delivering products to the consumer(s) looked at in-depth.

Strengths and challenges of setting up an e-commerce business

A PESTEL analysis of the performance of one of the renowned e-commerce establishments in the world, Amazon.com Inc., reveals that high capitalisation, popularity, and a wide market reach as some of the key benefits. First, retail e-commerce firms such as Amazon.com Inc. have been presented with an opportunity to expand their operations because of online business growth globally. From a political standpoint, most governments embrace and support the e-commerce industry, which is an opportunity for businesses to leverage online trading services (Greenspan, 2019). For that reason, the e-commerce business is projected to grow as governments continue to create an

enabling environment for investors in various markets. Until the Covid-19 pandemic, strong economies in Europe, South East Asia, China, and North America were strong, implying stable economies and high disposable incomes. Consequently, online trading companies experienced growth in sales, revenue, profit margins, and share price indices. E-commerce sites have been used increasingly because of lockdown measures meaning that customers have found it convenient to order items online and get them delivered to them. Based on the socio-cultural, firms engaged in e-commerce business have considerably reaped from changing social and cultural trends. Increased use of internet services, social media networking sites, and subscription to mobile applications among the young population has broadened the market base for online traders.

The entrenchment of modern cultural practices in developed and developing societies has seen the online purchasing trend gain traction because of increased internet penetration and social media networking platforms. Technological advancement played a crucial role in the said changes with the conventional business enterprises adopting internet-driven trading activities. Since the ICT industry and resources have enhanced the efficiency of processes, techpreneurs capitalise on expanding their market base. With increased IT investment, firms utilising e-commerce continue to boost their competitive advantage hence maintaining their market leadership position. One significant advantage of computing technologies that drive online trading firms like Amazon is to hoard vast information about products without a physical space requirement. For that reason, e-commerce platforms can maximise retail productivity at minimal operational costs. Concerning ecological impacts, e-commerce processes augur well with low-carbon lifestyles since shoppers' movement to physical stores is minimised. An emphasis on high sustainability standards by companies engaged in e-commerce activities positive impacts the ecological environment, which strengthens their brand image. Nevertheless, online trading has had its fair share of challenges, including stiff competition, cybercrime threats, unsustainable logistical costs, and economic shocks like recessions (Greenspan, 2019).

Sustainable logistics context

2.2 supply chain management (SLSCM)

Grant et al. (2015) intuit that logistics and supply chain management (LSCM) encompass activities that have a far-reaching effect on contemporary society's living standards. A definition of logistics management provided by the Council of Supply Chain Management Professionals (CSCMP) in the US states that it is:

“That part of supply chain management that plans, implements, and controls the efficient, effective forward and reverses flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers’ requirements” (Grant et al., 2015 p.8).

The consultants introduced the term supply chain management (SCM) in the 1980s, and since then, various definitions have emerged. According to CSCMP, supply chain management refers to the planning and managing function of all activities concerned with procurement and sourcing, conversion, and logistics management tasks. It also encompasses collaboration and coordination with the chain partners, including suppliers, customers, service providers (third party), and intermediaries. Fundamentally SCM integrates the management of supply and demand within and across firms. Thus, SCM is perceived to play an integrating role. Its primary function is to link the critical business process and functions within and across organisations to have a high-performing and cohesive business model. The figure below depicts a simplified supply chain framework from the supplier stage through the customer's point. It is important to note that the last-mile logistics services are on the right side, indicated by customers' tiers.

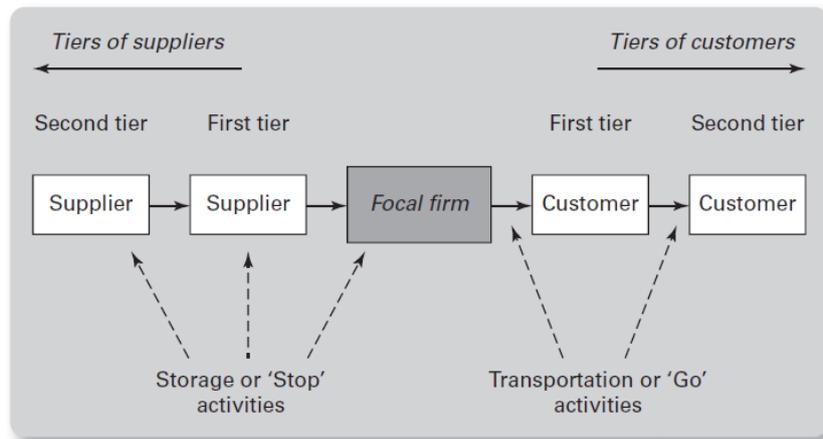


Figure 4: A simple supply chain framework (Grant et al., 2015)

Impact of last-mile modes on e-commerce

A definition of last-mile provided by Gevaers et al. (2009) states that it “is the last stretch of a business-to-consumer (B2C) parcel delivery to the final consignee who has to take reception of the goods at home or at a . . . collection point” (p.2). While some literature has considered order-picking as part of the last-mile, others do not take it into account. In a standard supply chain, raw materials are processed in the manufacturing plant and stored in a distribution centre (warehouse) before delivery. There are two ways to distribute products from the distribution centre; the normal channel to retail shops or supermarkets and a direct-to-consumer delivery (D2C) system. Succinctly the last-mile logistics model is inclined more to the D2C market.

Kawa and Maryanik (2018) intuit that e-commerce has moved the logistics system's pivot from the retail side to the customer side as a new set of expectations pop up. Notably, consumers are always trying to seek alternatives to optimise various factors like price, convenience, and choice, which gives them a completely different shopping experience. What is more, retailers must develop a seamless buying experience. Thus, looking for new possibilities to fulfil the client’s expectation is necessary. An agile supply chain fosters more flexibility and freedom to customise the product to the present needs (Cárdenas et al., 2017).

To that, the distribution and logistics system dramatically determines the success of the e-commerce supply chain. As such, the impact of last-mile delivery cannot be overlooked because this is the stage where consumers get their product. As argued by Lim et al. (2018), last-mile delivery has turned out to be an essential “source for market differentiation, motivating retailers to invest in a myriad of consumer delivery innovations . . .” (p.308). Examples of consumers' delivery innovations include autonomous delivery models, lockers, purchasing online and picking up in-store, and free delivery once minimum purchase levels have been met. Consumers are mindful of last-mile logistics since it provides flexibility and convenience for them. For the same reasons, Lopez (2017) claims that on-demand and same-day delivery services are gaining popularity among grocery shoppers, customers for pre-prepared meals, and retail buyers. More so, McKeivitt (2017) alludes that there has been increased investment towards parcel carrier services, especially the automated distribution centres and urban locations; all that is meant to meet the consumer needs.

Unfortunately, some retailers have not been able to design and develop sustainable last-mile delivery channels, with some doing experimentations, which has led to scepticism from various observers (Cassidy, 2017). Some of the companies that tried to establish innovative pick hubs but shut them down after a few years include Asda, Somerfield, and Sainsbury's. Also, eBay launched a platform known as eBay now for same-day delivery in 2012 but closed the programme after three years. It was clear that the said last-mile logistics models were established in a cloud of uncertainty within a context of a more fragmented and complicated distribution network. Unless the provision of the last-mile services is founded on sustainable delivery economics, they are bound to struggle. The retailers have to balance consumers' expectations for new innovative models, pricing, and service levels (Lopez, 2017).

Gevaers et al. (2009) posit that the expansive growth and changes in the e-commerce market for various industries have led to a surge in direct-to-consumer (D2C) deliveries. Though

such deliveries are not a new phenomenon, such as mail order, the growth in e-commerce has significantly revolutionised the D2C delivery models. Unfortunately, the said growth has caused and continues to cause significant problems, particularly the last part of the supply chain, which is known as the last-mile. It is regarded as one of the most expensive, polluting, and inefficient portions of a supply chain. Some of these problems are enlisted here-in, with the first one being the 'not at home' challenge. For this particular problem, home deliveries experience a high likelihood of failure despite extra miles covered, emissions, and costs. There are also issues such as 'empty running' associated with door-to-door deliveries in addition to security challenges where the parcels being delivered require a signature. Small profit margins and inefficiencies pose difficulties for the last-mile delivery of a critical mass of goods in certain regions. The door-to-door deliveries done by small vans have a higher carbon footprint per kilogram compared to more giant trucks.

2.3 The impacts of sustainable e-commerce last-mile modes on the environment

Based on a definition by the European Science Foundation (2010), the environmental impact can be described as contributing to the management of the environment, for instance, environmental pollution, climate and meteorology, and natural resources. As a result of the boom in e-commerce, various studies have considered the environmental impact of last-mile logistics (Viu-Roig and Alvarez-Palau, 2020). According to Fakir (2018), companies have resorted to using algorithms in simulating the optimisation of routes in the urban freight distribution to realise savings in journey times, in-vehicle usage, distances travelled, in waiting times, as well as in energy consumption, and eventually, in CO₂ emissions. Additionally, Fakir (2018) notes that the idea for doing this is that optimised routes would entail both positive environmental impact and greater operational efficiency and sustainability.

In their study where they investigated the impact of e-commerce on last-mile light goods vehicle within the London urban areas, Allen et al. (2018) found that the increased use of light goods vehicles as a result of e-commerce positively impacts the environment. The light vehicles used to deliver products within the urban areas help reduce the harmful environmental degradation associated with heavy vehicles. However, Allen et al. (2018) also noted that given the numerous small vehicles delivering goods and parcels within the city, there had been an increase in traffic jams that result in more fuel consumption, thereby resulting in environmental degradation. Nevertheless, it was noted that online retailers had taken various steps to minimise the cost and efficiency associated with last-mile delivery (Allen et al., 2018). Accordingly, various initiatives have been undertaken to result in greater efficiency and reduce right light vehicle traffics. For instance, Jenson (2017) noted that online retailers use delivery services that do not entail delivery to residential areas, resulting in minimised field deliveries and traffic jams. The customers can pick them up or get delivered on foot or through cyclin. Similarly, Cherrett et al. (2017) arrived at a similar conclusion as Jenson (2017) and adding that the practice of avoiding light goods vehicle deliveries into residential areas has not only reduced the time involved and instead allowed larger volumes of goods to be delivered to remote locations thereby minimising the number of vehicles delivering goods per volume or unit.

While investigating the impact of e-commerce-related last-mile logistics on the various cities, Viu-Roig and Alvarez-Palau (2020) found that through cargo bikes and applications of cargo bikes energy-efficient vehicles, the last-mile logistics or deliveries have helped in minimising the environmental impact through a reduction in carbon emissions. As shown in figure 2.3 below, Viu-Roig and Alvarez-Palau (2020) identified carbon emissions reduction among other aspects as being the positive effects of last-mile logistics on the environment.

Areas	Aspects Analyzed
Use of urban distribution route optimization algorithms	Savings in journey times, distances travelled, vehicle usage, waiting times, energy consumption, and CO ₂ emissions
Use of more energy-efficient vehicles and/or processes	Cargo bikes Electric vehicles Delivery lockers or pickup/access points Crowd logistics Underground logistics
Conflicts of interest between the different stakeholders involved	Conflict between environmental and economic impacts Traditional channels vs e-commerce The role of the administration

Figure 5: Environmental impact of e-commerce-related last-mile logistics (Vui-Roig and Alvarez-Palau, 2020)

Bartram and Chi (2018) carried out a study where they sought to understand companies' responses to the environmental impact of e-commerce. In the study, they found that in most circumstances, online shopping, especially last-mile logistics, is better for the environment compared to in-store shopping. However, intervening factors tend to diminish those positive effects (Bertram and Chi, 2018). That is, factors such as apparel returns, and excessive packaging add more carbon footprint as well as waste to the environment. Nevertheless, these intervening factors can be reduced by adopting advanced technology that encourages eco-friendly deliveries (Vui-Roig and Alvarez-Palau, 2020).

Last-mile logistics also impact the environment positively through sustainable buying and procurement as it moves away from the traditional acquisition of goods and services through competitive bidding and tendering into buying and procurement that considers the environment (Meehan and Bryde, 2011). Sustainable procurement looked into the social, economic and ecologic environment and implications of the goods and services purchased. The intention of sustainable procurement is not to get the best price or offer but the most in sustainability (Meehan and Bryde,

2011). Based on this, Grandia et al. (2013) noted that sustainable procurement and buying involved in procurement with environmental concerns. Although sustainable buying is mostly concerned with purchasing products that conserve the environment, it also encourages bulk buying, thereby saving on multiple purchases if they purchase single products at a go (Meehan and Bryde, 2011). As opposed to employing resources and fuel when purchasing products from the nearby stores, customers can make a large purchase online hence minimising the fuel consumption that results in carbon emission.

According to Tan et al. (2009), last-mile logistics in e-commerce has encouraged sustainable warehousing, positively impacting the environment. Sustainable warehousing mostly involved having warehousing practices that incorporated the three pillars of sustainability into warehousing practices (Agyabeng-Mensah et al., 2020). As per Tan et al. (2009), various practices were being put in place by organisations to achieve sustainable warehousing practices. Among these practices included investment in the necessary equipment to minimise manual labour use within the warehousing facilities. Agyabeng-Mensah, et al. (2020) agreed that companies with sustainable warehousing practices move towards automated warehousing equipment to sort and transport packages within the warehouses. The other sustainable warehousing practice was employee training and development. This was very necessary to prepare the employee to use automated warehousing technologies.

Then there were the carbon emission practices in the warehouses—this entailed using various types of energy sources. Sustainable warehousing includes adopting sustainable carbon emission practices that included using renewable energy sources such as solar in the warehouses. These sources reduced carbon emissions significantly. As per Bartolini et al. (2019), renewable energy was a critical component of sustainable warehousing as the energy costs incurred in warehousing are usually high. The energy was used for lighting, sensors, and cooling of the warehouse; hence, sustainable energy sources enhance sustainable warehousing.

2.4 The mediating role of sustainable logistics methods on the relationship between last-mile and environment

In general, customers want to buy products from online vendors that incorporate environmental sustainability into their supply chain management. In that regards, Ducarme and Agrell (2019) contend that some customers, especially environmentally conscious ones, often want to know that they are purchasing from an online vendor concerned about the environment by the integrated green supply chain. A discussion on the trends of logistics and SCM during this millennium, as provided by Christopher (2011) and Strauhbe and Pfohl (2008), points to globalisation, technology, and relationships and outsourcing as some factors that impact environmental sustainability. Since the 1970s, globalisation has grown steadily mainly because of the development and extensive adoption "*of the standard shipping container, international trade liberalisation, the expansion of international transport infrastructures such as ports, roadways and railroads, and production and logistics cost differentials between developed and developing countries*" (Grant et al., 2015 p.12). Environmental issues regarding fuel consumption and emission become more protracted because of lengthy geographical supply chains. On relationships and outsourcing, companies that have outsourced logistical services of third-party logistics (3PL) do not control the sub-contracted services' sustainability efforts (Ducarme and Agrell, 2019). Even with that, 3PLs and sub-contracting have minimised adverse environmental impacts that may have resulted from the LSCM operations of individual companies. Computer technology has revolutionised communication, production, storage, and transportation of products on the technological front, given the development of longer and faster supply chains (Ducarme and Agrell, 2019). On this basis, the e-commerce firms operate since order processing involves the placement of orders by customers, checking the order status, confirmation of

the order availability, payment processing, and last-mile delivery to the customer. All these processes are done virtually without paperwork, which eventually helps in the ecological environment's sustenance.

The mediating role of green supply chain management is also essential because it improves the mode of transportation that, in return, positively influences the environmental impact of last-mile deliveries (Greviers et al., 2009). In the view of Weiss et al. (2015), vehicles used in the last mile can often impact the efficiency of the deliveries themselves, especially the fuel-efficiency. Green supply chain management or sustainable logistics ensures that the whole supply chain is eco-friendly, from the manufacturer to the end consumers (Ducarme and Agrell, 2019). The supply chain is not sustainable when fuel-efficient vehicles are used to transport goods that are not environmentally friendly or manufactured using raw materials that do not consider environmental effects. Furthermore, Mangiaracina et al. (2015) also note that the evolution of ICT and its introduction to the mean of delivery has made it easy to dematerialise goods delivery without the need for a physical channel, thereby contributing to sustainability of last-mile deliveries.

3 Research Methodology

3.1 Theoretical conceptual framework

The conceptual framework of this study is drawn from the literature review. The conceptual framework is drawn from the previous study by Reyers, Gouws and Blignaut (2011). They indicate that e-commerce had implications on the environment with the degradation of the environment and increased pollution. Sustainable logistics acts as a mediator of e-commerce practices by

providing the e-commerce business with alternate practices that can negatively impact the environment. Based on this, the conceptual framework used in this study would be as follows:



Figure 6: A conceptual framework consisting of e-commerce, last-mile, and the environment (By the Author)

3.2 Research Approach and Setting

Various research approaches can be applied in an empirical study to investigate how e-commerce models affect the environment and how sustainable logistic technology mediate this relationship (Denscombe, 2014). These approaches could either be the deductive approach or the inductive approach. The deductive approach was mostly applied in instances where there is a need to test existing hypotheses and determine whether they apply to the study's specific aspect. On the other hand, the inductive approach is applied in situations where the researcher is interested in obtaining new information and explanations about a new concept or an aspect that other researchers have not yet thoroughly investigated. This research chose to use the inductive approach. This is because the study intended to investigate a new area of study, the e-commerce models and their effect on the environment and sustainable logistics technology. The inductive approach enabled the researcher to collect new information and assess whether the study's outcomes could be generalised into the entire industry (Crowther and Lancaster, 2012). As per Victoria (2014), the theories of e-commerce models, and sustainable logistics technology, are in the development phase. Hence, there is a need to undertake an explorative study informed by actual practices rather than theories that are not yet fully developed. This means that the conclusions of the study are drawn from observational experiences.

This research applied qualitative research design as the design was consistent with the application of the inductive approach. The qualitative design was suitable for this investigation since it collected in-depth information about a phenomenon, thus enhancing the knowledge about the issue under investigation (Goertzen, 2017). The qualitative design collects data about a given phenomenon and garnered explanations about why the phenomena acted in a particular manner as was necessary for this study. It strove to investigate and find explanations on how e-commerce impacted the environment and the role that sustainable logistics played in mediating this relationship between e-commerce and the environment (Crowther and Lancaster, 2012). The qualitative design was also explorative nature and allowed the researcher to gain new perspectives on the phenomena. This study was necessary since the research would be interested in gaining insights and new perspectives on how sustainable logistics impacted e-commerce and the environment.

Considering the qualitative design, the research used interviews to collect data from e-commerce practitioners. The interviews had given preference because they allowed the researcher to collect in-depth details about the phenomena. Also, the interview tool allowed the researcher to obtain explanations concerning the phenomena being investigated in the study (Easterby-Smith, Thorpe and Lowe, 2008).

3.3 Sampling and Data Collection

Regarding the sampling strategy, various sampling strategies could be applied in an empirical investigation, and they were the probability sampling and non-probability sampling strategies. This study preferred non-probability sampling strategies since they were less costly and took less time necessary for this study as it is time and resource-constrained (Saunders, Lewis and Thornhill, 2008). Among the non-probability strategies, the possible strategies used in this study were convenience sampling, snowball sampling and quota-based sampling. This study used a convenience

sampling strategy. This is because the method enabled the researcher to collect data from readily available participants to manage the study, thus ensuring that it was completed on time (Yin, 2009).

The sample population selected from three logistics companies operating in Finland. The employees were included in the interview to represent the companies that were working in Finland based on their availability. The participants had to be employees of the logistics companies' operating in major cities in Finland as it was more aware with the last mile logistics practices of their companies as well as e-commerce.

Regarding the data collection process, semi-structured face-to-face and telephone interviews arranged with research subjects. The interview scripts included both close, and open-ended questions and each interview session lasted for about 15-20 minutes. With the consent of participants, the interview information was recorded verbatim in addition to written journals. To have access to the employees, the researcher wrote to the human resource managers of these logistic companies in Finland to undertake academic research on the effect of e-commerce on the environment and the influence that sustainable logistics had on the businesses. However, the request had remained unanswered as a granted permissions to the researcher, the researcher then reached out to the individual participants requesting them to participate in the study by indicating when they were available for an interview.

3.4 Data Analysis

The collected data was then analysed using a thematic analysis process. It involved analysing the interviews' content to identify particular themes and sub-themes related to the patterns observed from the interviewees' responses. The observed patterns indicated that the participants affirmed or rejected the research concept and whether such concepts provided new information

(Goertzen, 2017). Further, thematic content analysis was processed through data coding to identify whether there were recurring themes (and sub-themes) and what these themes were and how they meant regarding the effect of e-commerce and sustainable logistics.

3.5 Ethical Consideration

This research applied the ethical guidelines provided by the university. The researcher enhanced the participants' privacy by ensuring that the participants' names were anonymised to guarantee that their actual identity could not be revealed. The participants were asked not to provide their own identities. The written transcripts of the interviews were anonymised (Denscombe, 2014). Besides, the participant's consent sought since all participants signed a consent form indicating that they were of age and that they were not coerced to participate in the study in any way.

3.6 Limitations

The main limitation of this study was its use of a qualitative research design. This design was limited in that its results were not very accurate and measurable. This made it possible for the study to include the researcher's biases which could distort the study's outcomes. Also, the use of interviews implied that the study might collect much information, most of which may be irrelevant. To overcome the interview's limitation, the researcher pre-prepared the interview protocol, which was designed based on the research objectives to ensure that it asked questions that would provide appropriate responses to the research questions.

4 Findings and Analysis

This chapter explored how e-commerce activities and last-mile connectivity impacted the environment and the implications that sustainable logistics had on the environment. It presented

outcomes from the ten interviewees who participated in the study and explored how e-commerce, especially the last mile model, impacted the delivery of packages to customers. It also discussed the primary factors that determined the use of last-mile logistics in Finland. It also discussed the influence that sustainable logistics has had on the Oulu and Helsinki's environment.

4.1 There is tremendous growth and advancement in the e-commerce industry

When asked about their understanding regarding the growth and advancement of the e-commerce industry in the context of Finland and Europe, the theme that cut across from the responses seems to suggest that there is tremendous growth in the sectors, as can be witnessed by the number of e-commerce companies that seek their services for transportation of goods from the warehouses to the various locations for customer pick up or delivery. From the respondents, it is clear that all the participants agreed that the growth was not only exponential but also evident. For instance, interviewee D1 responded that,

“You do not need to look far to see how e-commerce has grown in the past few decades because it is visible in number of contracts, we received from the online vendors which has increased but also the number of new companies who come seeking transport services. These contracts have increased reflecting that there is growth e-commerce sector which is also positively affecting our logistics industry.”

Though respondent D5 also maintained that there had been growth, she admitted that the growth rate had not been as fast as expected. She said that,

“There was a certain hype about how a strong a wave the e-commerce industry would be as it was viewed as the next big thing. Don't get me wrong, the growth has been there, but it has somehow slowed or stagnated in the past 5 years and this is also reflected in our logistic industry as there are

not many new e-commerce firms coming to seek our services, to me, that is stagnation or slowed growth.”

Based on interviewees responses, this study argues that all the respondents agreed that there had been substantial growth in the e-commerce industry; however, some respondents maintained that there had been a stagnation of some sort. As such, the e-commerce industry has been growing exponentially, and it can be argued that more growth is expected. The argument maintained by the study, which is obtained from the findings, corresponds to the findings of other past studies. For instance, Jędrzejczak-Gas et al. (2019) found that e-commerce has experienced tremendous growth in past decades in Europe, especially in countries like Italy, Germany, France, UK, Norway, and Finland, among others. Similarly, Nordeau (2016) also found that e-commerce has experienced increased growth in Finland, especially in the past decade, with much growth being witnessed between 2014 and 2015.

4.2 The effects of last-mile logistics on e-commerce and delivery methods

When asked about some of the positive impacts that last-mile logistics have had on e-commerce and delivery methods in Helsinki and Oulu, most of the respondents identified moving the pivotal system closer to the customers instead of the retail side as one of the key advantages of last-mile logistics. In their view, last-mile logistics has made it possible for the logistic system to consider the end consumers in their deliveries. In other words, instead of delivering products to stores like in the case of brick and mortar, the logistics companies deliver products closer to the customers. This view was maintained by interviewee D1, D3, D4 and D6. For instance, interviewee D6 responded that,

“One of the positive impacts of last-mile logistics that automatically comes to mind is the fact that it has been able to bring the focus to customers as opposed to before where much concentration of

the logistics systems was given to the retailers. When delivering products, we used to think about the retail stores and make sure they are satisfied, however, nowadays in as much as we think about the retail stores, the end consumers are highly incorporated or given priority.”

Considering the responses above, this study maintains that last-mile logistics have been beneficial to the end consumers because the logistic companies have to consider their needs and preferences when delivering the products. In other words, the logistics companies have to ensure that the products are wrapped and delivered in a state that will make the end consumer happy. This assertion, as maintained by the study, is supported, or affirmed by Kawa and Mryanik (2018) found that last-mile logistics has helped in moving the pivot of logistics system from the retail side where they used to be in the past to the customer side where they have met or operate in accordance with the end consumers.

4.2.1 Convenience to both online stores and customers

From the respondents, it was also clear that convenience to both the customers and online stores can also be considered one of the impacts of last-mile logistics on e-commerce. In other words, last-mile logistics has made it possible for customers to access the goods purchased with many conveniences easily. Simultaneously, the online stores are guaranteed that the products bought online will safely reach the customers. In that regards, interviewee D3, D5, D6 and D8 identified convenience to customers and e-commerce firms as positive impacts. Specifically, interviewee D5 mentioned that,

“The last-mile logistics bring a lot of convenience to both customers and the e-commerce firms themselves. For instance, customers do not need to worry about the products they have purchased online as they are sure it will be delivered to their chosen address. At the same time, the online stores can rest easily as they are sure that the last-mile logistics will get the products to the customers.”

The above finding is an indication that convenience to customers and online retailers is one of the benefits brought about by last-mile logistics. In the absence of last-mile logistics, it would be very difficult for the goods to be delivered to customers with ease. Accordingly, Kawa and Maryanik (2018) confirmed these findings as their study also found that last-mile logistics has helped customers and e-commerce firms to optimise on factors like convenience.

4.2.2 Easy customisation of product in meeting the needs of customers

Easy customisation of products has also been identified as one of the themes or positive impacts that the respondents attributed to last-mile logistics. Particularly, interview D7, D8, D6, D3 and D2 identified easy customisation as one of the impacts they would link to last-mile logistics. For example, interview D9 responded that,

"In my view, the greatest benefits that can associated with last-mile logistics in e-commerce context is that it has made it easy for online stores to be able customise products to meet the specific needs of the customers. That is, the last-mile logistics enable the e-commerce retailers to be able to customise the products to meet the present needs of the customers."

Based on the finding, this study can argue that last-mile logistics positively impact e-commerce by enabling easy customisation of products to satisfy the customers' present needs. This finding is also affirmed by Cárdenas et al. (2015), who found that last-mile logistics have an agile supply chain that encourages flexibility and the freedom to the products to meet the current needs of the customers.

4.3 Essential source of market differentiation for the e-commerce firms

An essential source of market differentiation is also a common theme among the respondents regarding the impact of last-mile logistics on e-commerce and delivery to customers. In other words,

last-mile logistics has given online retailers to focus on differentiating themselves through innovation since they do not have to worry about delivery to the customers. For instance, interviewee D8 respondent,

“Since online retailers do not have to worry about delivery of products to customers because it is taken care of by last-mile logistics, they now have the time to refocus on their core functions thereby being able to come up with innovative ways of differentiating themselves in the market.”

The above response shows that last-mile logistics is beneficial to e-commerce because it enables them to focus on core functions and innovative ways of competing to make them differentiated in the market. The findings echo the view of Lim et al. (2018), who argued that last-mile logistics is a good source of market differentiation for e-commerce.

4.3.1 Impact of sustainable e-commerce last-mile logistics on the environment

To address the second objective of the research, the respondents were asked to identify some of the positive impacts that last-mile logistics have had on Oulu and Helsinki's environment. Notably, most interviewees identified the optimisation of routes through algorithms as one of the positive effects brought by last-mile logistics on the environment. As such, this was identified as a major theme from the responses. More importantly, it demonstrates that the use of algorithms in last-mile logistics has enabled optimisation of routes used by the good light vehicles, thereby minimising energy consumption. Respondent D7 mentioned the minimisation of vehicle usage and energy consumption, thereby reducing the environment's negative effects. These findings were similarly shared by interviewee D1, D2, D5 and D3. For instance, interviewee D3 responded that,

“Logistics or e-commerce companies that are involved in last-mile deliveries including our firm, have resorted to algorithms so as to simulate the optimisation of the routes especially in urban areas thereby reducing journey times, distance travelled and vehicle usage, which make me believe that it helps in efficiency and sustainability.”

Route optimisation through algorithms helps with the reduction in carbon emissions and energy consumption within the cities. In other words, the algorithms can tell drivers the shortest route take or the ones with fewer traffic jams, thereby minimising the time and fuel consumption, resulting in a less negative impact on the environment. The finding of route optimisation through algorithms as a positive impact of sustainable last-mile deliveries is in line with the perspective offered by Fakir (2018), who notes that the concept of optimising routes through algorithms lead to positive environmental impacts as there is high efficiency and by extension sustainability, since less time and fuel is used.

4.3.2 Increased use of light goods vehicles that consumes less fuel

The interviewees also highlighted there is increased use of light goods vehicle, which consume less fuel. It was apparent that light vehicles have less fuel consumption than heavy vehicles that consume much fuel made from fossil. Consequently, the reduction in fuel consumption as a result of light vehicles usage resulting in sustainability. Particularly, interviewees D1, D2, D6, D7, D8 and D9 shared the same response regarding the benefits of using light vehicles on minimising environmental degradation. For instance, respondent D1 mentioned that,

“Our company uses light vehicle as opposed to heavy vehicles in urban areas which in turn reduce fuel consumption thereby positively affecting the environment positively in the process.”

The findings reflect the earlier conclusions reached by Allen et al. (2018) about the increased use of light goods vehicles. The author notes that the use of light goods vehicles minimises excess environmental degradation associated with heavy vehicles.

4.3.3 Limiting residential deliveries to minimise traffic jams that degrade the environment

Another positive impact of last-mile logistics on Oulu and Helsinki's environment was identified as a reduction of environmental degradation by limiting residential deliveries that also reduce traffic

jams within the cities. Respondent D9 explained that online retailers are using delivery services that do not entail delivery to residential areas, resulting in minimised field deliveries and traffic jams as the customers can pick them up or get delivered on foot or through cycling. The findings reflect the assertion of Cherrett et al. (2017) that through sustainable last-mile logistics, various initiatives have been undertaken to ensure a reduction in extreme environmental pollution. Some of the initiatives aimed at realising greater efficiency and sustainability are the use of minimising deliveries into residential areas.

4.3.4 Reduction in carbon emissions by using cargo bikes for last-mile deliveries

Another theme from the interviewee's responses was the reduction of carbon emissions in Oulu and Helsinki through cargo bikes in last-mile deliveries. The same theme was present from interviewee D2, D4, D5, D6, D7 and D9. Particularly, interviewee D7 reported that,

“Though the reduction in carbon emission is being thrown a lot when talking sustainability in transportation, I do believe that the use of cargo bikes in last-mile deliveries greatly help with minimisation of carbon emissions, given that the use of cargo bikes is a practice that is greatly taking effects in Oulu and Helsinki, I believe it will greatly help with minimisation of carbon emissions.

The findings agree with the conclusions of Viu-Roig and Alvarez-Palau (2020). They identified carbon emission reduction as being among the benefits brought by sustainable last-mile logistics through cargo bikes.

4.4 Adaptability and the mediating role played by sustainable logistical methodologies

According to Interviewee D3, the major role of sustainable logistical companies is reducing carbon emissions. *“The use of sustainable logistical methodologies implies reduced use of customers’ movements to go for small errands and shopping as this can be done using the sustainable last*

mile logistics. This can significantly reduce congestion, traffic on roads and results in better and cleaner cities with less carbon emissions.” Apart from the reduced carbon emission the use of last-mile logistics led to lower consumption of energy. As per Interviewee D4, *“the traditional business tended to consume more energy in the warehouse and retail shops compared to the ecommerce business thus making the ecommerce energy efficient.”*

Interviewee D3, however, was of a different opinion and noted that *“Use of last mile logistics negatively impacted the environment. This is mostly because it increased the private consumption of goods which increased wastage and due to number of items used in packaging for individuals thus increasing volumes of solid waste pollution in the city.”*

Other than the environmental factors, there was also an aspect of the last mile logistics' impact on the customer environment. The other role played by alternative technologies was the economic sustainability of the businesses. Interviewee D5 indicated that *“With the covid-9 many customers have been evading public spaces and who has the potential to minimise business sales significantly. However, it is easy to procure goods with the last mile logistics conveniently and have delivered at home conveniently.”*

The use of the last mile logistics also had impacts on the social environment. Interviewee D8 indicated that *“the use of tangible logistics meant that more customers were not visiting retail shops and that they were not stuck in traffic which significantly improved their quality of life.”* Interviewee D9 agreed that *“indeed there was increased convenience that came with last mile logistics that made lives in cities happier as there were reduced traffic and use of bikes minimised the accidents and loss of lives which was a good social impact.”*

Based on the above discussion, it was evident that sustainable last-mile logistics positively impacted the environment, especially the ecological environment, contributing to minimised carbon emissions. It also contributed to the economic environment by cutting on costs incurred in shopping and transport by customers and the logistics companies. Sustainable last-mile logistics

also improved the quality of life of customers. Correspondingly, these findings reflect the results of the research undertaken by Ducarme and Agrell, 2019; Christopher (2011) and Weiss et al. (2015).

5 Chapter: Conclusion and Recommendations

This chapter examines the study's strengths and weaknesses and the recommendations for the industry, and recommendations relating to future studies.

5.1 Strengths of this study

This study realised that last-mile delivery modes had various impacts on the environment. The study explored the impact of the B2C delivery model on Oulu and Helsinki customers and noted that the last mile delivery positively impacted the customers. The interviewees cited convenience as the main reason. Other impacts were reduced carbon emissions on the environment and reduced traffic.

The second strength of the study was achieving the second research objective an identifying the primary factors that determined the optimal sustainable last-mile delivery modes. The study noted that these factors mostly included economic factors, advances in technology and innovation in the last mile delivery system such as drones, data analytics and route optimising technologies. Others were the increased number of environmentally conscious customers and the government.

The research also attained the third objective of assessing the role of sustainable last-mile delivery logistics on the environment. The investigation realised that the last mile delivery positively impacted the environment through reduced carbon emissions. It also helped the business cut on costs through reduced energy use and new technologies that enhanced efficiency in last-

mile delivery logistics. It also positively contributed to the social environment by enhancing the quality of life of the city residents through reduced traffic, increased convenience, and saved lives through minimised accidents.

5.2 Recommendations

The following were the recommendations to the last mile logistic companies that would help the companies improve their operations in the cities and have positive outcomes in the environment. The first recommendation was for the companies to adopt technologies that would minimise solid waste pollution, resulting in last-mile logistics. This included the adoption of the latest technologies in last-mile delivery. Data analytics for route optimisations, the establishment of new factories, and drones should be at the heart of the last-mile logistics service providers.

5.3 Limitations of the study

The main limitation of this study was that the study applied the qualitative research design. This limited the study because it could not obtain concrete statistical data showing the actual measurable impact that the last mile delivery systems had on the environment. The outcomes were not measurable; hence it was difficult to establish which aspect of the last mile delivery had more impact on the environment and had the least impact on the environment.

5.4 Recommendation for further studies

Future studies should strive to overcome the weaknesses of this study by focusing on using quantitative research methods. This is to ensure that future studies' outcomes are comparable, making it easier to identify how each element of last-mile logistics impacted the environment.

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Appendices

Appendix 1. The interview questions

To what extent do customers in Helsinki and Oulu use last mile connectivity?

How do different e-commerce last-mile modes impact the direct delivery of packages to clients in the city of Oulu and Helsinki?

What are the primary factors that determine the optimal and sustainable last-mile logistical methods in Helsinki and Oulu's e-commerce industry?

What is the alternatives role played by sustainable logistical methodologies with respect to Oulu and Helsinki's environment?

