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The environmental impact of omnichannel distribution

A case study of the changes in distribution to consumer

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Abstract

To meet customer demands of fast deliveries and a wide product assortment, many companies decide to implement an omnichannel (OC) supply chain. Through this, different channels become integrated and physical stores can be interconnected with online stores. In previous literature it was found that this kind of implementation can entail both advantages and challenges, where the reduction of emissions is one of the drivers alongside the transportation costs. To investigate the impact of implementing OC distribution, Nudie Jeans was used as a case company and London, UK as well as Sydney, AU were the focus markets. Based on data provided by the company, calculations were made where the results showed that there is a clear relationship between volumetric weight and the emissions which indicates that making larger shipments results in lower emissions per kilo. In addition to this, it was found that the final parts of the delivery form London or Sydney to the end customer, stays approximately the same as before the implementation of OC. In comparison to the literature, the results of this thesis showed that several aspects aligned with previous studies, although some differences were found which could be related to the specific case.

Keywords

Omnichannel, emissions, distribution, fashion retail, transport modes, environmental impact

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1. Introduction

In this section there will be a short introduction to the subject and research field of transport within B2C e-commerce. Additionally, there will be an introduction to the concept of omnichannel (OC) distribution, which is the core of this research project, to get an understanding of the purpose behind the research question and to establish the important concepts that is needed to understand the foundation of this research.

1.1. Background

E-commerce is a part of the retail industry which has had a rapid global expansion over the last decade. However, when going back further to before the introduction of the internet, the term online shopping and e-commerce was unknown. Though, today, online shopping is a part of many people's lives; according to Walker Sands (2019) report, *the Future of Retail,* showed that around 61% of US consumers had made an online purchase over the last year (2018-2019). Today the retail industry is getting more and more global, and as reported by UPS (2018), most online shoppers from Europe, the US, and Asia are buying from international retailers. In addition to this, the delivery speed and options are getting more important for the customers, and free shipping is one of the main drivers for the choice of shopping online (Walker Sands, 2019). Since customer satisfaction is one of the driving forces for retail companies, they need to offer faster deliveries, next-day or same-day deliveries, free deliveries, and free returns (UPS, 2018).

The transport industry is known to account for substantial emission outlets (IEA, 2021). Furthermore, when it comes to international trade-related freight emissions, The International Transport Forum (2015) estimates that these transports account for approximately 7% of all global emissions and around 30% of all transport-related emissions. The increasing demand for faster and cheaper deliveries is a problem as it may come with higher emissions due to for example more use of air freight and less consolidation of goods. To act against climate change and reach the goal for The Paris Agreement of "*limit global warming to well below 2°, preferably to 1.5 degrees Celsius, compared to pre-industrial levels"* (UNFCCC, 2015, p. 3), and the EU goal of being climate neutral by 2050 with zero net greenhouse gas (GHG) emissions (European Commission, 2021), companies must act and lessen their environmental impact. The existing trends of global CO_2 emissions will lead to devastating effects on the environment with changes in ecosystems and loss of biodiversity (IPCC, 2022). Reducing the carbon footprint may be one of the most significant ways for a company to minimize its environmental impact, and one way to do this is to start monitoring the CO_2 emissions (Bernoville, 2020). There are three different scopes that many companies use as guidelines when acting against GHG emission outlets. Scope 1 and 2 concern the emissions coming from inside the company, where scope 1 is about direct emissions and 2 is about indirect emissions. However, when it comes to scope 3, it does not concern the emissions created within the company, but emissions created indirectly from upstream and downstream activities in the value chain, including transportation to customers (Deloitte n.d.).

One option that could help retailers get closer to the customers and be more alert to customer needs is adapting an OC strategy, which refers to when many interconnected channels are used to interact with customers. For the customers, this means that they have more options regarding where they can buy or order products, e.g., web shop or physical store. In an OC, the customer can also choose more freely where and how they want to receive or return their goods (Montreuil, 2016). In OC retailing, the flows of information are interconnected to give the customer more options in terms of shopping platforms, distribution channels, and in some cases even returns (Hübner, Holzapfel, & Kuhn, 2016). This strategy allows the retailer to act on multiple platforms and optimize the distribution chain to satisfy the customers. Furthermore, it may make the organization of last mile distribution easier as physical stores can act as local mini distribution centers, increase transportation efficiency, and lower transportation costs (Lee & Wang, 2001). According to Yadav, Tripathi, and Singh (2017). OC has thus been a sort of revolution in how business is conducted. It brings the customers back to the stores while providing retailers with more information on customer shopping behavior and how they can give the customers what they want.

The emergence of OC solutions seems to have been propelled forward by technology and information systems, enabling the technology used by customers and retailers to interact, and for the retailers to be more responsive to the customers' needs and wants (Saghiri, Bernon, Bourlakis, & Wilding, 2018). In a paper by Montreuil (2016), they discuss that in business-to-consumer (B2C) distribution, retailers often must send smaller orders, maybe only containing one or a few items to the consumers. Moreover, by having an OC solution for distribution, the retailer may have a wider variety of options from where the items can be sent—allowing retailers to combine their different channels while also meeting customer demands by providing shorter delivery time, reliability, and maybe even having lower transportation costs by sending it from a store closer to the customer compared to a distribution center for example. By having the distribution more localized, Rai, Verlinde, and Macharis (2018) mean that the relationship between the LSP and retailers has become more critical for retailers as they are an essential connection between the retailer and the customer. If the parcel is delivered to a customer’s home the LSP has the physical contact with the customer, not the retailer.

1.2. Problem statement

As it is becoming increasingly important to offer fast deliveries to meet customer demand while also developing a sustainable supply chain, using OC as an approach is more and more common. The needs of the customers and environmental effects from retailing create their own set of challenges, as fast deliveries may entail high emissions of CO_2. Therefore, it is crucial for companies to look over their retail strategies, distribution networks, and transport modes to find new ways to minimize their environmental footprint. To study how this problem could be approached, this report will evaluate which distribution system is most environmentally sustainable while investigating two different markets: Australia (AU) and the United Kingdom (UK). This is based on the case company Nudie Jeans which is an international retail company based in Sweden, that is designing and selling clothing and apparel, primarily denim.

1.3. Purpose and research question

The purpose of this master thesis is to investigate the environmental impact of a multi-channel network that utilizes a centralized warehouse compared to an OC approach and identify which is the most favorable for the investigated company Nudie Jeans. Hence, the focus lies on Scope 3, which implies the indirect emissions found upstream and downstream in the supply chain, including transport. Therefore, the following research question has been developed:

How can a change in distribution channels impact the CO_2e emissions of a company's B2C logistics when moving from centralized warehousing to an omnichannel distribution system?

In addition to this question, this report aims to explore different levels of OC integration and seek out the optimal percentage of products being distributed through the new solution compared to the baseline year of 2018. The initial percentages of omni-distribution considered for the report are the following[1]:

1. The percentage of omni-distributed orders are at *25%,* compared to the baseline.
2. The percentage of omni-distributed orders are at *35%* compared to the baseline.
3. The percentage of omni-distributed orders are at *45%* compared to the baseline.

As described in the introduction and the problem statement, the change to an OC distribution can entail multiple opportunities for a company. In this thesis the objective is to solve a problem/question that the case company Nudie Jeans have: is the change impacting their CO_2e emissions[2]? This problem/question is also something that could be found within other retailers that utilize multiple channels, and the results of this study might also be of help to other companies in the same situation. The importance of minimizing emissions to slow down the climate change cannot be stated enough.

To make the research manageable during the given time, the scope of the thesis is limited to investigating one company, Nudie Jeans, collecting data for only Q3 and Q4 for 2021 and historical data from 2018. The scope covers the online orders from B2C customers located in Australia and the UK, and only the transportation from the DC in Borås, Sweden to London, UK and Sydney, AU is included in the primary research[3]. Some additional investigation about the last part of the transport chain is only covered in a limited way. A further debriefing on the scope of the study can be found in section 4.1.

[1] These percentages have been chosen together with Nudie Jeans as they wish to get an understanding of how the level of integration affects the emissions.
[2] The difference between CO_2 and the CO_2e is that the CO_2e contains the total greenhouse gases instead of just the CO_2: including carbon dioxide equivalents, fossil carbon dioxide, nitrous oxide (N_2O), and methane (CH_4) (NTM, 2015).
[3] The cities will be referred to as Borås, London, and Sydney hereafter.

1.4. Outline of the study

The disposition and outlines of the thesis report will help support the actualization of the research purpose and the answering of the research questions. In chapter two, the literature review discusses and justifies the main areas in OC brought up in the literature, providing the base for the theoretical framework. Chapter three specifies the theoretical framework of the thesis derived from the literature review, explaining the theoretical foundation and key concepts. Chapter four discusses and explains the study research design and process. The following chapters, five and six, presents the empirical foundation, the findings of the data analysis from the case study on Nudie Jeans are shown, presenting both qualitative and quantitative results. Due to this being a mixed method study, the decision was made to split the result section in to two parts: one qualitative and one quantitative. In chapter five one can find the qualitative results from the interviews with employees at Nudie Jeans as well as secondary data from company documents. The qualitative results are there to give context about the company, its processes, and the background to why they made the decision to change to an OC distribution. Furthermore, this section also explores what challenges and possibilities they have found with the implementation of the OC system. In chapter six, one can find the quantitative results. Where data on transport and emissions, different scenarios are provided, and then in the end of the chapter there is a summary of the collected results. Chapter seven discusses and analyses the research questions through the theoretical framework, literature review, and possible future implications for Nudie Jeans and other retail companies. The last chapter, eight, presents the thesis' conclusions, as well as limitations and possible contributions and recommendations for future research.

2. Literature review

In the next section, the result from the literature review is presented, the results of 17 empirical scientific articles focusing on OC, emissions, transport, and distribution channels. The review consists of five major themes: *Distribution channels, Omnichannel supply chain, Transport & emissions, Challenges in OC distribution*, and finally, *Advantages in OC distribution*.

2.1. Conducting the literature review

The literature review in this thesis will investigate what the research field has to say concerning OC distribution, focusing on changing distribution channels and transport emissions, primarily CO_2. This was done to get an understanding of the field.

2.1.1. Literature search

When conducting the review, the first step was casting a broad net to capture the different aspects of OC distribution. However, only papers that investigated OC, distribution channels, supply chain channels in combination with channel change, and emissions were included to keep the review's focus narrow and help build up a theoretical framework which acts as a guide towards answering the research question. To capture the essentials of OC, different search terms were used; "Distribution channels," "Emissions, Retail, Transport," "Omnichannel," and "Sustainable." Various constellations of these terms were used when conducting the search. The only inclusion criteria were that the articles needed to be written in English to understand them. The search was conducted over several days and in various steps to end up with 17 articles included in the final review. In the initial search, titles were scanned through to only include titles that were within the scope and ended up with 28 papers for abstract reading. After abstract reading, 11 papers were excluded, and during this process, the papers' reference lists were also searched through for more articles that could be of interest for the literature review; additional 12 papers were found. However, 7 of these were rejected after reading the abstract. Leading up to the final read-through where 23 articles qualified and after reding these, 19 papers were left. However, two more papers were excluded during the writing of the review, landing at 17 articles that ended up in the final review (see Table 2.1).

The literature search was conducted in January 2022 in Scopus and Google Scholar, as well as the University of Gothenburg Library search function GU Supersök, a database for all articles in e-journals available at the University of Gothenburg, was used. In addition to this, both forward and backward snowball selection was used.

2.1.2. The included literature

In the reviewed literature, five major themes were found: (1) Distribution channels, (2) Omnichannel supply chain, (3) Transport and emissions in OC distribution, (4) Challenges in OC distribution, and finally, (5) Advantages in OC distribution. In addition to the five major ones, the first theme Distribution channels have two subcategories: various channels/ networks

and integration. Most of the included articles cover at least two of the five themes, and the two larger themes are Distribution channels and Transport & emissions OC distribution. The 17 included articles cover many different areas of OC and distribution channels, and the majority are conducted in Europe or the US; however, there are exceptions to this, e.g., one study focuses on retail in Brazil. All papers were published after 2016, even though there was not an exclusion criterion for publishing year. However, there are some articles published before 2016 on OC though they were screened out in the literature search. OC distribution is a rather novel area of retail and distribution, and this may be the reason for most of the articles on the subject only being published in the last few years.

Table. 2.1: The included literature in the literature review.

Articles	**Themes**				
	Distribution channels	OC supply chain	Transport & Emissions in OC distribution	Advantages in OC distribution	Challenges in OC distribution
Chopra (2018)	X	X	X	X	X
Saghiri et al. (2017)	X			X	X
Wollenburg et al. (2018)	X	X		X	X
Prabhuram et al. (2020)	X				
Zhang et al. (2016	X				
Bernon et al., 2016)	X				
Hübner, Wollenburg & Holzapfel (2016)	X		X		
Frei et al. (2022)	X				
Melacini & Tappia (2018)	X		X		
Jones et al., (2021)	X		X	X	
Hübner, Kuhn & Wollenburg (2016)	X		X	X	
Niranjan et al. (2019)		X			X
Adivar et al., (2019)		X	X	X	
Sousa et al., (2021)			X	X	
Giuffrida et al., 2019)			X		X
Buldeo rai et al., (2019)			X		X
Jaller & Pahwa (2020)			X		

2.2. Distribution channels

In an OC approach, three main flows go between the retailer and the customer: information, money, and products, and to adopt a well-functioning OC, Chopra (2018) explains how a retailer needs to make extensive changes in their networks, both logistics and supply chain. Besides this, Saghiri, Wilding, Mena, and Bourlakis (2017) distinguish four different stages of integration in OC systems; pre-purchase, payment, delivery, and returns. There are possibilities for integration within these various stages and functions, which should exist among them all to have an ideal OC system.

2.2.1. Various channels/networks

According to a study on retail and logistic OC network configurations by Wollenburg, Hübner, Kuhn, and Trautrims (2018), there seems to be a pattern and direction of how retailers develop their OC logistic networks over time in relation to online order volume. Their results show three main OC configurations which retailers have adapted, depending on their online order volume; when the volume is low, the orders are usually fulfilled via *Bricks-and-Mortar*[4] logistics networks. Nonetheless, with rising volumes, a network of DCs dedicated to online orders fulfills a significant share of all orders instead. Furthermore, retailers go more towards fulfilling all orders from channel-integrated DC when the volume is high. On the other side, when Prabhuram, Rajmohan, Tan, and Johnson (2020) compared different Multichannel and OC networks, their analysis found no significant difference between the networks when it comes to service level and cost factors, including subfactors as, e.g., transportation cost, returnability, and response time. However, when the authors looked solely at the OC systems, a fully integrated warehouse and transport system which delivered from all nodes was the highest-ranked system (Prabhuram et al., 2020).

Besides OC networks, other networks also utilize more than one channel, e.g., multichannel that has no or little integration between channels but uses more than one channel. When looking at the advantages of multichannel supply chain network, Zhang, Lee, Wu, and Choy (2016) found that the performance of this type of network model passed conventional supply chain network significantly on three objectives: (1) Transportation and operational cost, (2) customer service and coverage, and finally (3) environmental impact. Their results indicate that a multichannel approach is a better option than a conventional network on those three objectives. However, it seems that the savings are more visible on smaller-scale networks, as larger ones come with complexities that can cause problems. They especially point out that crowded urban areas may weaken the positive effects of the network. Aside from that, on a regional level, the reduction of environmental impact can reach up to 20.24% using the network model, averaging a 14% reduction of environmental impact (Zang et al., 2016).

One part of OC retailing management that is not fully developed yet is returns of goods (Bernon, Cullen, & Gorst, 2016). In a multichannel retail approach, returns usually must go back via the same channel as it was bought. Still, an OC approach can be more flexible, and online delivery may be returned via another channel, e.g., a local store (Hübner, Wollenburg, & Holzapfel, 2016). However, as Bernon, Cullen, and Gorst (2016) mentioned, there may be challenges ahead to reach seamless OC returns; one must consider that their article was published in 2016 and that new technologies and approaches maybe have been developed since then. However, even in a more recent study by Frei, Jack, and Krzyzaniak (2022), returns within the multi and omnichannel still inhabit vast amounts of complexity. According to their results, much of the complexity results from the multiple stages, channels, and players involved in the returns, pointing out that one of the main problems seems to have to do with outdated legacy IT systems

[4] The decision of *Bricks - and - Mortar* according to the Cambridge Dictionary English Dictionary (n.d) is *"used to describe a traditional business that operates in a building, when compared to one that operates over the internet*:"

in many stores. Therefore, a solution to having fewer complications is to have better integrated systems.

2.2.2. Integration

One element of distribution networks and channels brought up in the literature is the concept of integration in OC; this refers to the cross-channel connections that make channels interact with each other. According to a study by Melacini and Tappia (2018), using a dedicated online network with no integration between distribution and retail channels offers a lower level of complexity and no need for a retailer to redesign their existing network. However, when using a dedicated network where online orders always are delivered from a DC, retailers may miss capturing synergies that exist in an integrated approach, making the dedicated approach more expensive. Furthermore, there seems to be a difference in sales, growth, and competitive position between retailers with high integrated OC services and retailers with lower integration between channels. The lower the degree of OC integration, the lower the performance; partial integration is better than none (Jones, Miller, Griffis, Whipple, & Voorhees, 2021). Hübner, Kuhn, and Wollenburg (2016) show that if a retailer has physical stores, an OC integration can help the retailer expand faster to lower investment. By using existing facilities there is no need for new warehouses and picking facilities; this approach may also bring the online retail closer to the customer enabling shorter transportation. Also, Melacini & Tappia (2018) show that there are economic benefits of integration between the online shop and offline channel, both in the case of warehousing and transportation. Their results indicate a cost reduction of 24% per order with integration between channels compared to no integration. Even though an integration seems to be more economically beneficial compared to a single or multichannel, the environmental benefits are lesser than the economic ones. This mainly seems to depend on the extra handling of the goods that comes with an integrated network (Melacini & Tappia, 2018). Although, to achieve integration between channels in an OC, a real-time ERP system that connects all channels is needed. Compared to a multichannel approach where independent ERP systems for the different channels can be used (Hübner, Wollenburg, & Holzapfel, 2016). Besides this, integration between channels from a logistic perspective is also important to offer a seamless experience for the customer (Melacini & Tappia, 2018).

Channel integration seems to lessen the environmental impact and economic cost. Thus, choosing an integrated strategy could be a means towards more environmental and economic efficiency for a retailer (Melacini &Tappia, 2018). However, it is essential to note that the retailer's product type may impact what type of channel system works best. According to Wollenburg et al. (2018), there are significant differences in an OC logistic network involving groceries and non-food items. This is due to the unique needs of food items, e.g., temperature control and expiration dates. They also point out that most OC logistics refer to non-food logistics in the literature, leaving out the complexity of perishable food items in their research.

2.3. Omnichannel supply chain

Integrating OCs into an organization's supply chain entails integrating different activities to satisfy customer demands. Niranjan, Parthiban, Sundaram, and Jeyaganesan (2019) discuss how the customers' expectations on availability continuously grow as technology provides more and more opportunities. Therefore, it is necessary for companies to evaluate their different channels to determine what options are most profitable while also taking sustainability measures into account. These growing demands are also highlighted by Wollenburg et al. (2018), who emphasizes how fast deliveries, a wide product assortment, and availability are becoming a priority for retailers. To approach this, Niranjan et al. (2019) and Wollenburg et al. (2018) explain how both online and offline channels are being used. Here, the difference often is that online channels require warehousing closer to the customers to be able to offer fast deliveries, while offline, or traditional retailing, often uses a more centralized approach. However, Niranjan et al. (2019) further points out that using an OC approach can result in increased costs. In their study, it is displayed how OC retailing has a higher total supply chain cost in comparison to using offline channels only. This is primarily due to the need for more warehouses, manufacturing, and a more extensive range. But it also stated that in one case, the costs end up higher if sustainable options were to be taken into consideration. Although, the authors do explain that the studies might have different results if performed during another period as human behavior and demand tend to be uncertain (Niranjan et al., 2019). These outcomes were also brought up by Chopra (2018), who displayed costs related to inventory and facilities tend to increase while the decentralization is increasing. Yet, the one cost that is mainly decreasing is regarding transportation as the transportation distances to customers are reduced. Though, when looking at OC retailers compared to traditional and online ones, these effects can look quite different depending on the company. Based on how many retail stores and warehouses the costs can shift immensely. Chopra (2018) discusses how few warehouses entail high transportation costs, and by having several retail stores, the facility costs will be higher, and thereby the allocation of this must be optimized.

In contrast to the previously stated negative implications, Adivar, Hüseyinoğlu, and Christopher (2019) see that an OC supply chain can positively impact a company's costs, claiming that it can help create efficiency in different dimensions. As regards to the previous statements, Chopra (2018) mentioned that "*retail channel can be successful only if the value created by the channel exceeds the cost incurred in serving the customer"* (Chopra, 2018, p. 7). Indicating that the chosen channel must provide some added value that helps mitigate the additional costs related to the customers. This is strengthened by Adivar, Hüseyinoğlu, and Christopher (2019), who suggests that efficiency and integration regarding all aspects of the supply chain can benefit the relationship with the customers. The customers will essentially have more of their needs satisfied while the company can improve their costs, as explained by Chopra (2018).

2.4. Transport and emissions in OC distribution

In an OC network, the delivery options when shipping goods to customers offer flexibility not achieved in a multichannel. This flexibility comes from integrating offline and online stores

and creates an opportunity for retailers to provide more delivery options (Hübner, Wollenburg, & Holzapfel, 2016). An OC logistics approach can also be a significant lever for a retailer to help reduce distribution emissions related to transport, as well as increase transport efficiency (Sousa et al., 2021). Furthermore, an OC distribution network usually gets the retailer closer to the customers resulting in shorter transportation to the final customer (Hübner, Kuhn, & Wollenburg, 2016). A consequence of shorter distance for home delivery is that customers may get the goods faster, enabling quick home deliveries. According to Chopra (2018), enabling of fast deliveries may increase customers' need for instant gratification, forcing retailers to perform faster deliveries, possibly resulting in higher costs of transportation, inventory, and facilities. In addition, the transportation costs for the costliest part of the distribution, the last mile, will likely be even higher from a lack of consolidation of parcels.

A relevant area regarding OC supply chains that are brought up in several articles is the environmental impact from supply chain activities. Emissions from transport and logistics activities are a considerable contributor to the rising global emissions (Giuffrida, Tumino, Miragliotta, Perotti, & Mangiaracina, 2019). Therefore, it is vital to consider the delivery of the last mile and logistics partner doing the deliveries as it can affect overall emissions for the transportation (Buldeo Rai, Mommens, Verlinde, & Macharis, 2019). According to Jaller and Pahwa (2020), there are indications that online shopping can help lessen the vehicle miles traveled from transport compared to traditional shopping. In addition to this, the authors also suggest that there is a potential to reduce the vehicle miles traveled by up to 87% of all customers changed over to online shopping. However, their study was conducted in larger cities in the US, which may not apply to less urban areas. Furthermore, it is also pointed out by Buldeo Rai et al. (2019) that pure online customers tend to have the least CO_2 impact.

Different distribution channel strategies come with their own set of difficulties as unique needs must be met. When it comes to the OC, Giuffrida et al. (2019) discusses how the two approaches *click & collect* and *mobile shopping in-store* affect the environment. These are two common integrations of OC as they combine the traditional stores with online stores. *Click & collect* gives the customers the possibility of shopping online and thereafter picks up the order in-store, while with *mobile shopping in-store,* the customer visits the store or showroom where the customer can order the item online with the help of QR codes and have it delivered home. Within both, transportation is the highest source of CO_2 emissions along the entire supply chain. However, Giuffrida et al. (2019) explain that both strategies rely on the customer visiting a physical store or showroom either before or after the purchase online, which entails additional transportation routes. Another approach where the customer does not need to visit the physical store is *ship from store,* which is brought up by Jones et al. (2021). This is a concept where retailers with physical stores can use the stores as nodes to fulfill customers' online orders instead of using a DC for the fulfillment. Thus, it allows the customer to order online and get it delivered to their home, but instead of shipping it from a distribution center, the order is shipped from a store located closer to the customer. Not only does this entail shorter transportation routes and thereby lowered CO_2 emissions, but it can also result in faster deliveries. Implementing a concept such as *ship from store* makes the distribution more decentralized, and as Chopra (2018) explains, requires a more significant focus on last-mile deliveries, which

could cause higher costs. In contrast to this, Buldeo Rai et al. (2019) highlights that delivering to postal offices or collection points has a low impact on the environment. Still, the customer needs to travel to get the package, which ends up higher than home deliveries. This aligns with Melacini and Tappia's (2018) findings, who could see that the distribution strategy plays a vital role in environmental and economic efficiency. From their calculations, Buldeo Rai et al. (2019) could see that customers who travel to a physical store and later order it online have a vastly larger impact than pure online shopping, with approximately eight times more CO_2 emissions. This concept also has double emissions compared to traditional retailing. Utilizing *Ship from Store* in the network has many benefits for the retailer. However, the recent downsizing to fewer stores that many retailers have been doing may limit the positive effects of an OC distribution network; it can be an essential factor to consider before downsizing (Jones et al., 2021). Especially for many retailers' OC strategy, having physical stores can be a critical component for success (Adivar, Hüseyinoğlu, & Christopher, 2019).

Apart from the lower transport cost per order in an OC system, Melacini and Tappia (2018) show that greenhouse gas emissions from transportation can be reduced up to 50% depending on the distribution network configuration, with the lowest emissions when using an integrated warehouse and transport system. This is due to the aggregation of flows between DC and stores. The merger of flows between DCs and stores is something that Sousa et al. (2021) also mention as an enabler for more efficient shipping, primarily due to fuller vehicle loads and the advantages of the natural route between stores and DC. They also mean that having the stock closer to the customers is a more efficient way of utilizing logistics capacity by enabling better scheduling of deliveries instead of having a fragmented delivery system. Also, Hübner, Holzapfel, and Kuhn (2016) mention that shorter deliveries to the end customer are an opportunity for retailers to stand out from the competitors by offering faster deliveries or even *Click & collect.* Moreover, Melacini and Tappia (2018) mention that there are possibilities for significant reductions in the delivery cost when using physical stores as a consolidation point and picking facilities for home deliveries to customers. They show figures of an approximate 30% decline, which could be done by, e.g., organizing distribution routes on a local level, similar to what Sousa et al. (2021) mentioned.

When evaluating the environmental impact of transport in an OC, Buldeo Rai et al. (2019) explain that it is essential to look at trips made by the customers as well as the logistics transport. If the customer trips are not accounted for, it is difficult to achieve an accurate representation of each delivery approach, whether it is traditional or online retailing. In the article by Melacini and Tappia (2018), other factors were also considered, such as emissions caused by warehousing and store activities, but here the customer trips were not used in the calculations. However, it could be seen from Giuffrida et al. (2019) that the choice of parameters necessarily does not have to be the same in all cases but rather be modified depending on what delivery method is being investigated. Throughout the different articles that have been investigated, some of the most shared parameters are customer profile, internal deliveries, home deliveries, and the customer's location.

2.5. Challenges in OC distribution

Besides the different advantages of using an OC distribution, there are also challenges and barriers. From the various articles investigated, it could be found that if the design of the OC does not fit the customer demands and other factors such as the use of traditional retailing, etc., it could potentially have a negative impact on costs and the environment. It is described by Saghiri et al. (2017) that an OC system is developed to simplify the customer experience, which can entail developing distribution networks, e.g., with new DCs. Although by adding new DCs closer to the customers might lead to lowered CO_2 emissions, it can also result in higher costs related to inventory, facilities, and transportation which is brought up by Chopra (2018)—also highlighted by Wollenburg et al. (2018), who can see that setups with several warehouses result in lower economies of scale. Based on Niranjan et al. (2019) calculations, it could be seen that using solely traditional retailing has approximately 35% lower costs than when using an OC strategy. Through this, depending on the case and development of the OC, there might be negative implications related to cost, which must be considered before implementing new strategies. However, through Wollenburg et al. (2018) study, which focuses on grocery retail, it was described how research that focuses on OC networks for non-food necessarily does not apply to OC networks for food items. Furthermore, Chopra (2018) means that centralized warehousing is sometimes a better option due to the cost of inventory when scaling up; this includes products, e.g., designer clothing and jewelry.

There are also challenges related to sustainability, especially the environmental dimension. It is argued by Giuffrida et al. (2019) that the environmental impact is at its highest in OC approaches where the customer must travel to the store, such as *click & collect* or *mobile shopping in store.* Therefore, companies need to look at all possible alternatives to find which lowers the environmental impact. The issues with customer trips are also highlighted as an essential factor by Buldeo Rai et al. (2019) as a large portion of the customers travel by car to get their order, whether it's in a store or at a pickup point. This might make it difficult for companies to balance the need of meeting customer demand, which is the sole purpose of OC, with achieving environmental activities and cost-efficiency.

2.6. Advantages in OC distribution

In the next section, different drivers and advantages of OC distribution that is brought up in the literature will be explored. According to a study by Adivar, Hüseyinoğlu, and Christopher (2019). there are four key dimensions to what is the factors for retail OC success; the dimensions they are considering are Sustainability, Efficiency & Effectiveness, Flexibility, and Responsiveness. However, Chopra (2018) mentions that the evolution of the following factors will greatly impact the development of different distribution channels, including OCs: Customer preferences, Experimental technologies, Production technologies, and Transportation Technologies. Jones et al. (2021) mean that the higher the integration of channels offered, the better the performance, e.g., growth and sales. They indicate that OC integration can be a key component in retail performance and the future of retail. Chopra (2018) imply that the development of the future of the perfect OC will depend on customer preference and innovation

technologies in transportation and production, indicating that it is the customers that drive the channel decisions. In addition to this, Wollenburg et al. (2018) list some of the advantages a retailer can get by having an OC, and the main advantages seem to be the closeness of the customers making transportation shorter, and the possibility of joint transport from DC to stores. There seem to be synergies in having a common inventory between stores and DCs. E.g., an OC approach may enable a faster expansion without further investments by utilizing lag capacity in physical stores and reducing transportation distance by coming closer to the customer (Hübner, Kuhn, & Wollenburg, 2016).

In a total OC, there needs to be full integration of all or multiple channels with visibility throughout the same channels. Without total integration of the flow of information and products, the full advantages of an OC will not occur (Saghiri et al., 2017). However, it seems essential to consider channel configuration that fits best depending on the type of product and the retailer's type of customer (Chopra, 2018). According to Chopra (2018), the key to a successful channel network is to be flexible and agile, take advantage of the different channel strengths, have the customer in the center, and fulfill the customer's needs. Also, Sousa et al. (2021) mention that a critical success factor of an OC model is always to have the customer in the center, but also that it is vital to have the same goals throughout the company; all areas need to work towards the common goal of the OC implementation.

3. Theoretical framework

In the following section, the theoretical framework is presented which is the foundation of the research. This foundation is derived from the literature review in the section above and describes some of the core parts of OC. The framework has four main themes: *Distribution networks, Integration*, *Emissions*, and *Transportation* then further subheadings under the main ones.

3.1. Conceptualization of the theoretical framework

In the theoretical framework, the driving forces behind a functional OC is conceptualized to provide an understanding of the different concepts that later will be applied in the case study. The different areas explored in the theoretical framework have been derived from the central concept of OCs found in the literature. In addition to this, all the different areas and concepts are in some way related to each other, and all of them play a vital part in this report, as the theoretical framework is the foundation needed to answer the research question. Why these concepts and topics were chosen, and not others, depends on that these were the most re-appearing throughout the literature review, and after brainstorming sessions and analyzing the result of the literature review, this was concluded. A vital area derived from the literature review, that can be seen as one of the main concepts of OC, is *Integration* as it is the foundation of OCs. From this point, there are three main themes: *Distribution networks, Transportation,* and *Emissions*. Under the category of distribution networks, there are retail, but also third-party logistics (3PLs) which are directly linked to the area of transportation. From this, there are the areas of transport modes and emissions, which is also the next big theme. The link between integration and emissions is being investigated in this report to determine if a higher level of integration helps minimize the environmental effects.

To simplify the conceptualization of the theoretical framework and the links between the different concepts and areas, a mind map is provided. The map was conducted after multiple sessions and discussions of which several versions of the framework were presented until the final version, as can be seen (see Figure 3.1) below. Figure 3.1 attempts to explain the thought process behind the framework and the connections between the concepts.

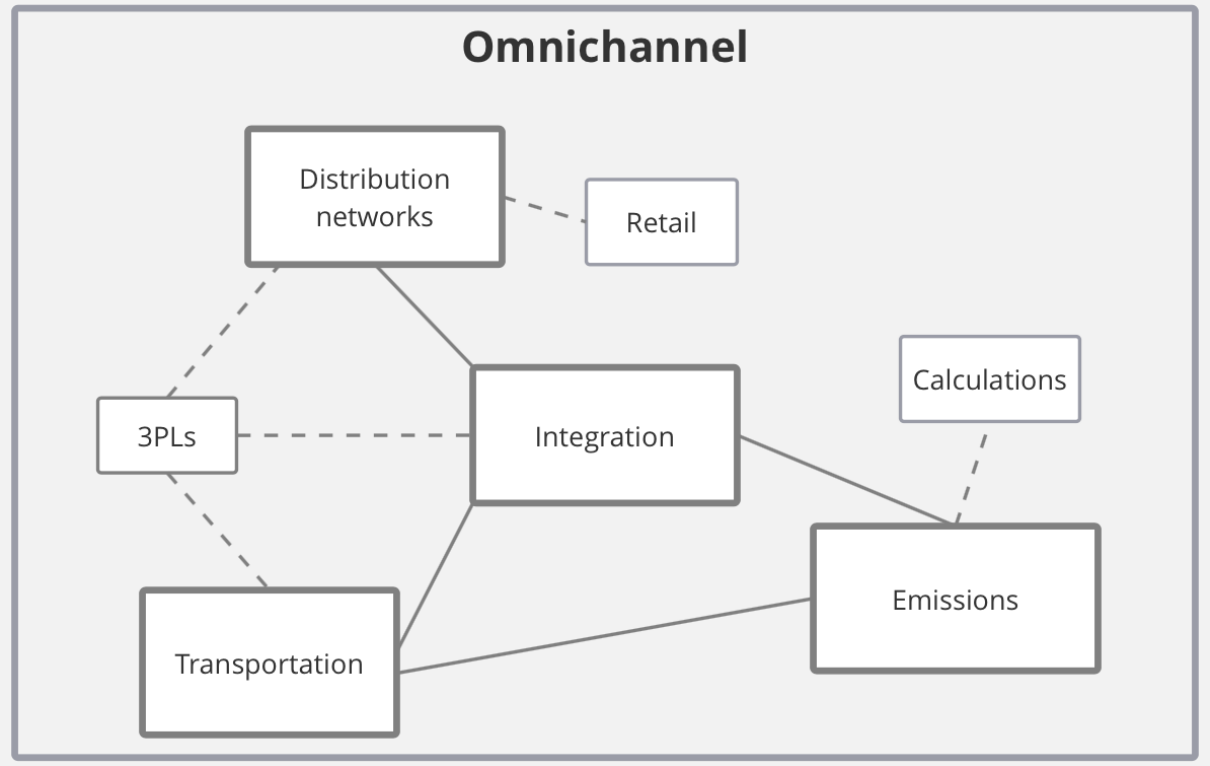

Figure 3.1: Mind map over thought process for the theoretical framework and the connections between the concepts (own illustration).

3.2. Integration between channels

When looking up the meaning of the word integration in the Oxford Learner's Dictionary (2022), it is described as "*The act or process of combining two or more things so that they work together"* and in OC retail, it refers to the integration across different channels and processes in a retailers' distribution network. By having integration, synergies, and utilization of more aspects of the retailer's network may be enabled (Beck & Rygl, 2015). When having a full integration between all channels, the retailer can utilize all their channels when shipping to a customer, e.g., online orders being fulfilled via a retailers' physicals store, sometimes called *ship from store,* by using the store as a smaller distribution center (Jones et al. (2021). This depends on that cross-channel integration enables access to information about inventory and location of the products, which in turn creates the possibility of the product being sent from a physical store close to the customer instead of from a distribution center. There may even be an option for the customer to pick up the order as a *Click and Collect* order in the physical store (Montreuil, 2016; Hübner, Holzapfel, & Kuhn, 2016). Integration is dependent on data sharing of, e.g., inventory between channels (Melacini & Tappia, 2018); therefore, having interconnected information systems between channels is key to enabling an integration. As described by Hübner, Holzapfel, and Kuhn (2016), a real-time ERP system connecting all channels is needed to have full integration and have the advantages on an OC. Without integration, one can still use multiple channels; however, it is not an OC as the central idea of an OC is the connection and integration of various channels (Beck & Rygl, 2015).

3.3. Distribution networks

There are several different approaches for retailers when it comes to distribution and sales, two common being traditional physical stores and online stores. These two have their advantages and disadvantages, where the physical store enables products to be transported in bulk from the warehouse, which minimizes costs. In contrast, online stores can achieve a higher accuracy regarding inventory (Metters & Walton, 2007). Nevertheless, it is becoming increasingly common for companies to combine these two sales channels and thereby adopt a multichannel strategy (Metters & Walton, 2007).

It is not only a question regarding which channels should be used but also what distribution strategy is the most appropriate. According to Harrison, van Hoek, and Skipworth (2014), a centralized approach can be favorable to minimize potential costs related to inventory and warehousing. A centralized warehouse enables the inventory to be concentrated in a few locations, thereby bringing down logistics costs related to transportation and unnecessary stock keeping, which is displayed by Harrison, van Hoek, and Skipworth (2014) as one of the advantages of centralization. In addition to this, there are also downsides to the strategy, one being the time from warehouse to the customer. In contrast, it is brought up by Wen, Choi, and Chung (2019) that using a decentralized approach could be more beneficial in circumstances where the retailer is offering a smaller variety of products. However, the use of decentralized warehousing can help ensure fast deliveries, but it also creates a larger focus on last-mile deliveries, which can create higher costs (Chopra, 2018).

3.3.1. Retail

Retail refers to the selling of products or services to a customer, which makes the customer one of the most important stakeholders. This person, however, does not necessarily have to be the consumer, which is the person who ends up using the goods, although the consumer can also be the customer (Yerpude & Singhal, 2020). In recent decades, new forms of retailing have emerged alongside the rise of the internet and globalization, thus extending the retail channels from solely traditional to combining them with an online presence (Wen, Choi & Chung, 2019). It is explained by Grewal, Roggeveen, and Nordfält (2017) how different technologies and business models can help a company reach out to its customers and create customer engagement. This can be achieved as retailers can provide more information, and with multiple channels, it is possible to generate added value (Grewal, Roggeveen, & Nordfält, 2017). However, besides being present at several channels, it has become increasingly important from a consumer perspective to offer sustainable products. Vadakkepatt et al. (2021) highlight the importance of retailers needing to involve their entire supply chains to ensure sustainable practices, which in turn leads to consumers having the option of choosing more sustainable products.

When looking at fashion retailing, the products usually have relatively short life cycles as trends are continuously changing. In addition to this, fashion retailers need to provide a wide assortment of products, e.g., different colors and sizes (Wen, Choi & Chung, 2019). This itself

is unsustainable, however as described by Wen, Choi, and Chung (2019), there are different approaches to mitigate some risks, such as using green shipment, choosing manufacturers located closer to the DC, and selling products directly from the suppliers. Not only are sustainable practices of importance regarding the environmental and social dimensions, but they can also entail competitive advantages and attract a younger customer base, to mention a couple of benefits (Vadakkepatt et al., 2021).

3.3.2. Logistics service providers

When referring to a LSP, one generally refers to a company that provides logistics services for another company; the LSP could conduct all logistics functions for a company or parts of them (Delfmann, Albers, & Gehring, 2002). These logistics functions could, e.g., by the transportation of goods and warehousing, but also more complex activities such as, e.g., tracking and tracing and custom clearance (Krauth, Moonen, Popova and Schut, 2005). One type of LSPs is 3PL providers. A 3PL is an external company that provides logistics for a shipper; these logistic services often include managing, controlling, and delivering. One definition of 3PLs was given by Sink et al. (1996)" *Third-party logistics services are multiple distribution activities provided by an external party, assuming no ownership of inventory, to accomplish related functions that are not desired to be rendered and/or managed by the purchasing organization."* LSP is often an important part of a retailer's OC strategy as described by Rai, Verlinde, and Macharis (2018) that the relationship between the LSP and retailers has become more critical for retailers. As they are an essential connection between them and the customer, e.g., if the parcel is delivered home to the customer, the LSP is the one that is in contact with the customer.

3.4. Transportation in retail

Transport in distribution and retail plays a vital part related to costs, inventory, and order fulfillment. Not only are transport essential between warehouses, stores, and manufacturers, but the customers are also demanding faster deliveries, creating new challenges for retailers (Yerpude & Singhal, 2020). It is explained by Wen, Choi, and Chung (2019) how distribution and transport as part of the production can enable a higher level of customer gratification and should therefore be considered when planning. In addition to this, Brito (2008) highlights the importance of meeting customer demand concerning delivery time, and this entails that not all transport modes might be beneficial when transporting the goods from the warehouse to the customer. Therefore, using transport modes such as rail is rarely used for this purpose due to the long transit times and unpredictability. When deciding a shipment strategy, several aspects are to be considered, such as costs, transport time, and environmental impact. Wen, Choi, and Chung (2019) discuss how the environmental impacts from transport by truck account for an immense part of the world's transport emissions, which is crucial when developing a sustainable supply chain. Besides these transport modes, air freight is commonly used in industries where the demand is uncertain and can change quickly, allowing retailers to meet these challenges (Orcao & Pérez, 2013). This mode of transport is more common when transporting goods from

a distribution center to a store or end customer. In contrast, transport via sea, for example, is commonly used between manufacturer and warehouse (Shen, 2014).

3.5. Emissions

When talking about emissions, the main greenhouse gas in focus is carbon dioxide (CO_2) which mainly come from the burning of fossil fuels and industrial production, e.g., the countries with largest CO_2 emissions per capita in the world are the ones that produce oil (Ritchie & Roser, 2020). CO_2 emissions are, according to Ritchie and Roser (2020), one of the main divers of the changing in the global climate and to reduce or avoid climate change, including all the impacts that may come with that, the global emissions need to be decreased. In addition to CO_2, there are also other greenhouse gases that are contributing to climate change, e.g., nitrous oxide and methane. The different greenhouse gases do not have the same effects on the climate, and to make emission calculation easier, one can use a carbon dioxide equivalent (CO_2e) it is the standard metric used for quantifying emissions from greenhouse gases, where the greenhouse gases are converted into one measurement (Ritchie & Roser, 2020). The transport sector is one of the larger producers of CO_2 emissions; according to International Energy Agency (IEA) (2021), the sector accounts for about 37% of CO_2 emissions.

3.5.1. CO_2 emissions from transportation

Around one-third of all CO_2 emissions from global trade come from the freight transport part of trade (Cristea et al., 2013). When talking about the CO_2 emissions from the transportation sector, it often refers to emissions from both passenger and freight transportation. The emissions are also often divided into different modes of transportation; Road, rail, air, and sea (Ritchie, 2020; IEA, 2020). The different modes have contributed in different measures to the global emissions. According to Ritchie (2020), road transportation accounts for about three-quarters of total global transportation emissions, and most of it comes from passenger transport, but around 30% of global road transport emissions comes from road freight. When it comes to air transportation, international shipping accounts for around 11% of all transportation emissions. Rail and sea seem to have lower contributions to emissions in general (Ritchie, 2020; IEA, 2020).

3.5.2. Calculation of CO_2e emissions

There are several ways to calculate CO_2e emissions for shipment transportation, e.g., weight, volume, volumetric weight, and tonne-kilometre. Moreover, depending on what the calculations are based on there will be various results as the parameters used are different. If only weight is considered, there is the problem that the volume can differ considerably even if it is the same weight, and thus the volume is not considered as a factor. Likewise, the opposite will occur if it is only based on the volume. However, the volumetric weight is a combination of the two factors where the value usually is approx. 0.25 tonnes/m3 for truck transport and a little less regarding air transport. If the calculations were to be based on a tonne-kilometers model, the emissions and energy from the transport of the shipment would be summarized, and

the weight of the shipment would be multiplied by the distance. This type of model is, however, not possible to use when including air transport as the aircraft uses a different amount of energy in the takeoff and landing compared to the rest of the transit. In addition, there are also other forms of models one can use when calculating emissions of transport, e.g., looking only at the vehicle operation or fuel consumption (NTM, 2015). There are also other calculators, e.g., EcoTransIT, which the calculator uses almost the same parameters; however, it also includes slightly different ones, e.g., gross weight in tonnes and containers/pallets (EcoTransIT, 2020). Another part of the calculations is what kind of emissions that will be calculated, where a common alternative is the CO_2e. The difference between the just the CO_2 and the CO_2e is that the CO_2e contains the total greenhouse gases instead of just the CO_2: including carbon dioxide equivalents, fossil carbon dioxide, nitrous oxide (N_2O), and methane (CH_4) (NTM, 2015).

4. Methodology and Methods

The following chapter presents the methodology and methods of the study, a mixed research methodology was applied, using a case study to answer the research question based on theoretical and empirical results. The research methods include details on data collection and analysis of the data and the quality of the research. According to Dietrichs (2018), it is important to distinguish the differences between methodology and methods as they are not the same. The methodology is the framework of the research and explain why the methods that are used and the expected outcome of the methods. The methods are the instruments and procedures used to conduct the research, how the data is collected and analyzed.

4.1. Research design

It is explained by Bryman and Bell (2011) that a case study differs from other research designs by solely focusing on a specific situation or system. Within this approach, both qualitative and quantitative methods can be used; however, it can be argued that qualitative is more beneficial in the specific setting (Bryman & Bell, 2011). It is explained by Collis and Hussey (2014) that a case study often consists of the following steps: (1) case selection, (2) preliminary investigations, (3) data collection, (4) analysis of the data, and (5) writing the report.

As this thesis focuses on one specific issue and situation from one company, it can clearly be linked to a case study research design. This paper aims to find a solution to a problem that is individual to the case company, although similar challenges and questions almost certainly can be found at other companies. Nonetheless, as Bryman and Bell (2011) explained, both qualitative and quantitative methods can be used, which it has been in this study. To get a deeper understanding of the case company: how they work and the problem they want help with solving, semi-structured interviews were conducted. These were essential to get an overall picture of how the company works today and previously has, but also over their ambitions. Besides this, there was a continuous exchange of emails throughout the process of writing this paper, as well as additional sources being used such as sustainability reports and reports of emissions and transport. Yet, to reach a conclusion to the research question it was vital to analyze numerical data related to transport and emissions, thus including quantitative methods. Prior to this data collection, existing literature and reports were investigated to better understand the investigated area. This indicates that the applied approach aligns with the steps explained by Collis and Hussey (2014).

Besides different research designs, there are also several research types where two are analytical and predictive. Based on the description of these made by Collis and Hussey (2014). it can be found that these two align with this thesis as analytical research aims at finding a relationship between different variables and data, and predictive research generalizes data analyzed. In addition to this, this report uses a deductive approach as it moves from general to specific, i.e., previous studies were investigated first followed by an analysis of the case company (Collis & Hussey, 2014).

4.1.1. Scope of the thesis

To make the assignment feasible the scope of the study had to be mapped out. Firstly, the time frame of when the paper was written was limited to the length of the specific course. Similar to this, the thesis had a frame of how long it should be; thus, some areas could have been further investigated if more time and space were presented. In addition to this, the scope is connected to the choice of topic and the case company. The thesis is investigating solely one company as it would have been too extensive to look at several, which entails that the data cannot be generalized. Moreover, the data received needed to be limited to certain time periods to keep it manageable but also due to the limited availability as OC still is in the initiating stages for Nudie Jeans. The emission data was also generalized to make the objective achievable.

The scope of the data only including Australia and the UK, as well as only Q3 and Q4 for both 2018 and 2021 was decided in cooperation with Nudie Jeans. The reason for this scope was that Nudie Jeans wanted to investigate one market that have an operating (the UK) OC strategy since 2020 and one that was launched later during 2021 (Australia), to get data of two markets in different stages of the OC process. In addition to this, the UK and Australia have the advantage of having vastly different locations geographically, one market that is near the Borås warehouse, and one that is far away. Which provides the precondition for applying the analysis to two different geographical markets, and then get an idea of the different that geographical distance can add to the equation. As when it comes to the chois of only including Q3 and Q4, the reason for that is that during Q1 and Q2 the implementation of the OC in Australia was in the startup phase and did contain that much data that it would be interesting to use as a basis for the analysis. And to keep the analysis consistent and within the scope it was decided that only Q3 and Q4 would be included for all the years and markets. In addition to this, both inbound and outbound deliveries are explored, where inbound refers to order within the company (e.g., to stores) and outbound refers to deliveries to customers.

It can be seen in section 1.3 of this thesis that the research question is *How can a change in distribution channels impact the CO_2e emissions of a company's B2C logistics when moving from centralized warehousing to an omnichannel distribution system?* However, there is also the addition of investigation of different percentages of OC distributed orders e.g., *The percentages of omni-distributed orders are at 25%, compared to the baseline*. The reason for these specific percentages depends on it being asked by Nudie Jeans in the proposal received from them, and after discussing it with supervisors both at Nudie Jeans and at the university, it was added to the thesis research question.

4.2. Data collection

In this section of the methods, the data collection is explained in detail, what type of data was collected and how it was collected. According to Bell, Bryman, and Hardly (2019), data collection is one of the more important parts of a research project as it is essential to conduct the research. There are many ways one can collect data; some of the more common ones are interviews and questioners (Bell, Bryman, & Hardly, 2019). In this report, both qualitative and

quantitative data were used, and thereby the collection of said data was conducted in different ways.

4.2.1. Qualitative data

Literature review

A literature review could be described as an analytical summary of the research that has been conducted within a field and linked to a particular research question, where the main purpose is to understand what has been done and is known within that area. It is an analytical approach to get a rounded understanding of the question in focus (Easterby-Smith, Thorpe, & Jackson, 2015). According to Easterby-Smith, Thorpe, and Jackson (2015, p.13), a well-conducted literature review *"Provide a context for a research project and helps to refine its topics."*. The methods used and details on the data collection for the literature review are described in section 2.1 of the report.

Interviews

In this report, three semi-structured interviews were conducted with different individuals in various positions within the case company Nudie Jeans. This was done to collect data on the company's processes, how and why they work with OC, and in addition to that, get a more detailed picture of the organization and the work they do. Semi-structured interviews allow the researcher to be more open on what may be important and what they need to know, allowing for a more open approach to what may be important and of value to the researcher (Bell, Bryman, & Haley, 2019)

During the semi-structured interviews, interview guides was utilized to maintain the timetable and information topics. A copy of the questions was supplied to the participants in advance to support the study's dependability and give the respondence time to think about the questions and their answers before the interview; the interview guide can be found in Appendix 1. According to Bell, Bryman, and Hardly (2019), semi-structured interviews are often adjustable and can shift significantly from the initial interview guide. Therefore, the guide was only used as a form of structure in interviews, meaning it was not necessarily followed to the letter. Allowing more flexibility in the questions may result in the participants giving more rich and detailed answers. Follow-up questions were also asked when more detailed answers were needed from the participant. The participants were free to elaborate on the questions, and any spin-offs from the questions that may be of interest were encouraged.

Table 4.1: List of interviewees within Nudie Jeans

Interviewee	Focus area	Date and duration	Type of interview
Environmental manager	Sustainability and future development	2/3-2022 (30 min)	Online interview via Microsoft teams
Omnichannel coordinator	OC and future development	2/3-2022 (30 min)	Online interview via Microsoft teams
COO	Operations, supply chain and future development	13/4- 2022 (30 min)	Online interview via Microsoft teams

The first two interviews (see Table 4.1) were conducted via Microsoft Teams on the 2nd of March 2022; both interviews lasted about 30 minutes each, and the interviewees had been sent the questions beforehand. The questions were different for both these participants as they work with different areas of the company. The interview with the environmental manager focused on the sustainability work of Nudie Jeans and how they are trying to develop the company to be more sustainable in the future. Most of the interview questions to her were somewhat general about Nudie Jeans' sustainability work (see appendix 1) to get a deeper understanding of why they do the work they do. And then there were also questions about the future and where they are going. As described earlier in the methods section, the interviews were semi-structured, meaning it allows for additional questions that may arise during the interview. The second interview was with the omnichannel coordinator; the questions to him were more focused on the actual operation of Nudie Jeans, how it works and what the steps towards greater integration of the OC system will look like. On the 13th of April the third and final interview was conducted with Nudie Jeans' COO who answered questions regarding the company's operations and intentions with the implementation of OC distribution. All the participants were asked in the beginning of the interview about anonymity, if it was ok to use their names or titles and if it was ok to record the interviews.

In addition to interviews, primary qualitative data was also received through meetings and email conversations, where they answered questions on how they were working with OC distribution and sustainability. But also, more detailed information about emission data, calculations, and LSPs, along with other important information needed to get the larger picture of how they work with distribution and OC. The data collection from meetings and emails started in November of 2021 when they presented their research proposal, after that between 5 and 10 meetings have been held where additional information have been given. However, the content of the meetings is not included in the results from the interviews as the information provided during the meetings was not recorded or transcribed. These meetings acted as a foundation to get a better understanding of Nudie Jeans' processes and working methods.

Organizational documents/ reports

In addition to primary qualitative data, secondary data was also used. Secondary data refers to data collected from an already existing source, published data, e.g., reports or data from

databases that can be available in print and or online. Furthermore, when using secondary data and analyzing it, it is important to remember that the data is published for another audience and purpose. One must look at the data objectively and understand that it might be biased (Collis & Hussey, 2014). The secondary data used in the result section of this report were primary sustainability reports and documents found on Nudie Jeans webpage. The secondary data was mainly used to get a picture of Nudie Jeans as a company and how they work with sustainability, emissions, and transportation. Their first sustainability report was released in 2015 with the data on the sustainability work they do and ever since they have released one every year, the latest one in 2020 the one for 2021 will be published later this year, and thereby by will not be included in this thesis.

4.2.2. Quantitative data

The quantitative data used in this thesis was collected directly from Nudie Jeans as the required data is internal quantitative data on their B2C OC and online orders from Australian and UK customers, as well the freight data on these orders. See Table 4.2 for more details on the parameters of the data. The order and transport data were collected for Q3 and Q4 of the baseline year of 2018 and for Q3 and Q4 of 2021. The reason to only investigate Q3 and Q4 depended on there not being full data for earlier quarters regarding both UK and Australia. Therefore, it was decided to only have half year data for both years to keep the basis for the analysis similar for both regions. The data was provided by the case company Nudie Jeans after they derived based parameters needed to conduct the analysis to answer the research question and to explore different levels of OC integration as well as seeking out the optimal percentage of products being distributed through the new OC solution. The parameters of the data from Nudie Jeans were decided after discussions with the supply chain manager at Nudie Jeans and the thesis supervisor. The data was given in the form of an Excel file that contained all the above-mentioned data.

Table 4.2: Parameters of the outbound order and transport data from Nudie Jeans

Year	**2018 (Baseline)**	**2021**	**2018 (Baseline)**	**2021**
Country	UK	UK	AU	AU
Distribution type	DC-customer	OC& DC-customer	DC-customer	OC & DC-customer
Transport	Outbound	Outbound	Outbound	Inbound and outbound
Transport Mode	All available	All available	All available	All available
Customer Info	Location (zip code & city)	Location (zip code & city)	Location (zip code & city)	Location (zip code & city)
Order Info	Weight, nr items	Weight, nr items	Weight, nr items	Weight, nr items
Carrier info	yes	yes	yes	yes

Three different data files were provided in Excel format, one of all B2C orders to the UK and Australia Q3 and Q4 2018 and 2021, one of all inbound deliveries for Q3 and Q4 to the UK Seven Dials store in London that is used in the OC operations, as well as the inbound deliveries for Q3 and 4 to the Zetland store in Sydney. To make the data easier to handle the three data files were combined into one, that now include six different sets of data. The details on the variables in the B2C orders is described in the Table 4.3. When it comes to the inbound orders the dataset included the following variables: *Order stock number, Delivery number, tracking number, Receiving warehouse, In stock order quantity, Stock order delivery date, Product class*, and *Delivery method.* In addition to the data set given by Nudie Jeans, additional information was granted via their online SaaS-system Asana where more information about the deliveries and other aspects of the project was seared. The usage of Asana resulted in fast answers to questions and directions to the most suitable person to answer the questions, this facilitated the otherwise rather complex work of navigating unknown data.

During the data receiving proses there was communication with Nudie Jeans about the different variables and what should and should not be included in the data sets. Continued communication during and after the process was conducted to ask questions about the data and other issues and questions that arrived. This to avoid misunderstandings and miscommunication, that could make the thesis project and analyzing of the data more difficult.

4.3. Data analysis

In the next section the methods and instruments used when analyzing the data is described, in addition to that it also included the preset assumptions set to keep the scope of the analysis at a reasonable level of detail to make the understanding and the results of the analysis relatable to the research question.

4.3.1. Qualitative data

To get the background information on the company and the processes, qualitative data was included in the report. By analyzing the results from the interviews, information was received about the background and where the company stands in comparison to the literature on OC but also an overview of how they work with OC, transport, and emission. In addition to this, information on how the changes from multichannel to OC network have looked like was used, and what the challenges and opportunities are to them. The analysis was conducted by listening to interviews and transcribing them, to make the information more manageable and be able to use the answers from the participants in the result to get an understanding of how they work with the processes. After listening and transcribing the interviews a thematic analysis was made. The content of the interviews was grouped in to three major themes that was found throughout all the interviews. The transcriptions were then merged and re-written into a cohesive text using citations when needed to highlight the participants voice. The three major themes that was found in the interview transcripts was: *Why a distribution change*, *Challenges and barriers*, and *Future possibilities*. Through these three themes the processes behind the OC change at

Nudie Jeans are deeper investigated, to get an understanding of the thought process as well as the barriers and drivers.

4.3.2. Quantitative data

The first thing that was done after the quantitative data was provided form Nudie Jeans, was to do a visual inspection of the data sets, e.g., look for data errors and missing data. The four different sets of B2C data did not contain the same number of rows as some sets was very big in comparison to the others.

Data errors and additional variables

In the B2C data sets around 0.5% of the order lines where data errors; orders containing 0 pieces, orders that was not going to UK or Australia, return orders as well as empty order lines. These lines were removed for the calculations. There was also many different formats and spelling mistakes for the city and zip code, this was fixed by manually going through the data and changing to the same format and correcting spelling errors. In addition to fixing the data of city and zip code to be in the same format, these variables were used to give an approximate geo location (longitude and latitude) of the end customer, by adding this an approximate distance from both the OC store and the Borås warehouse could be calculated, providing a basis for the distance groups that is used in the calculations.

NTMcalc Advanced 4.0 Environmental performance calculator

For the calculations of transportations, the NTMcalc (NTMcalc Advanced 4.0) was used. This is a tool that calculates emissions from transportation and is developed by The Network for Transport Measures (NTM). NTM was funded in 1993 and is a nonprofit organization that aims to set and establish a common ground for the values of how to calculate the environmental impact of freight and passenger transportation regarding all different modes of transpiration (NTM, 2022). The calculator was primarily developed for sellers and buyers of transport services to be used as method of measure the environmental performance of their own transportation. The NTMcalc is a tool that delivering data on GHG and air pollutants from the different modes of freight and passenger transportation – road, rail, sea, and air.

For this project a temporary access to the advanced version of the NTMcalc was granted to the authors, however NTMcalc Basic 4.0 is always available for everyone on the NTM webpage. The difference between the two calculators is that in the advanced version there is access to more functions and one can change the settings for the average parameters to customize to a certain project, e.g., in the advanced calculator there is the option of calculation emissions by weight, volume, volumetric weight, and tonne-kilometre. There are also more options for the different vehicle types, as well as 14 different road options instead of five as in the basic calculator.

The information presented in the next section of this chapter is on specific parameters and assumptions of the NTMcalc that is of interest for the calculations of this report. This

information is derived from the NTM webpage, where they provide some information about the calculator and its methods. The method behind the calculations is according to NTM (2022) up to CER standard EN 16 258, that is a current standard for calculations of energy and GHG from transport of freight and passenger, the tool is also according to themself consistent. The calculations are based on several variables (see Table 4.3), and this is the general formula the NTMcalc used when allocating emissions. Where the *Shipment size* is the size of the shipment, the *Cargo carrier capacity* is the maximum load capacity of the vehicle used, and the *Cargo load factor* is the utilization of the vehicle's cargo carrier capacity (%).

*Allocation factor = Shipment size / (Cargo load factor * Cargo carrier capacity).*

When given the allocation factor of the shipment, the gross emission of the specific vehicle is multiplied by the allocation factor to calculate the share of the shipment, and if it is greater than one (1) this indicates that more than one vehicle can be used for the single shipment transport.

In the calculator it there is different types of calculations one can make, in this thesis there are predominantly one that is used: Shipment size – Volumatic weight, however also the measurements of Shipment size – weight and Shipment size – volume is used in some cases primally to show why these are not applicable for the calculations in this thesis. The calculation method that the NTMcalc call *Shipments size – volumetric weight*, is the cargos volumetric weight (kg and m^3) are used instead of e.g., only its weight. The allocation factor in this case is the volumetric weight. This is calculated by the NTMcalc by multiplying the volume with the volumetric factor (often 0,25 tonnes per m^3), (see Table 4.3 for different transportation modes), then the result of this is compared to what the actual weight of the shipment is, whatever is the highest weight is what determine the allocation factor (NTM, 2022).

Table 4.3: Summary of the transport modes, vehicle types, and average settings (in the NTMcalc) used in the report,[5].

	Capacity weight	Load factor	Fuel consumption	Range factor (km)	DWT (dead weight tonnage)	Volumetric factor (tonnes/m3)
Road transport						
Van	1,5t	20% kg/ 30% m3	0,085 l/km			0,25
Rigid truck < 7,5 t	5t	40% kg/ 50% m3	0,124 l/km			0,25
Rigid truck 14-20 t	12t	40% kg/ 50% m3	0,217 l/km			0,25
Truck with trailer 28-34 t	22t	50% kg / 60% m3	0,317 l/km			0,25
Truck with trailer 50-60 t	40t	50% kg / 60% m3	0,501 l/kg			0,25
Air transport[6]						
Intercontinental	91937kg	65% kg / 75% m3		> 3000		0,167
Continental	41146kg	65% kg / 75% m3		3000		0,167
Reginal	5327kg	65% kg / 75% m3		1000		0,167
Sea transport						
Container ship		70%			160 000	

However, the parameters seen in the table (4.3) is the default given by the NTMcalc system and if other parameters are included the values will be updated. The main parameters that the emission calculations are based on in the calculations is the properties of the cargo, the vehicle, and the operations of said vehicle. In the system, the NTMcalc gives options for these parameters as it allows one to select the transport mode and the type of vehicle used, however with some limitations. Further, the calculation model is in the case of this thesis the shipment transport by weight. In addition to these parameters there are the cargo load factor the factors that can affect the fuel composition of the truck, road type, truck class, fuel type and gradient of the roads etc. In this case, the parameters of the calculator are set to default in all the options that is not transport mode, vehicle type, weight, and distance this for both air and truck, the default options can be seen in Table 4.3. when it comes to the default options. The NTMcalc

[5] Note: This is the default settings and measurements set by the NTM calculator, for the road transport the calculations are made on the setting that the fuel is diesel, and that the road is average (motorway, urban road and rural road) with a gradient of ±2%. In the advanced calculator there is a plethora of different transport modes and vehicle types to choose from, this is just the once included in this report.

[6] Freight aircraft range based on averages

have set these as a default based on them being an average for that specific transport mode or vehicle type (NTM, 2022).

When it comes to the type of emissions coming from transportation the NTMcalcvreports several different types of emissions form transport (NTM, 2022), including along others: CO_2*fossil* (carbon dioxide of fossil origin), CO_2*biogen* (carbon dioxide of non-fossil origin), CO_2*total* (total CO_2 (CO_2*fossil* + CO_2*biogen*)) CO_2*e* (the total greenhouse gases measured as carbon dioxide equivalents, this also includes fossil carbon dioxide, methane, and nitrous oxide), SO_2 (sulfur dioxide), NO_x (nitrogen oxides). However, in this report the only emission that will be reported in the result is the CO_2*e* emissions, the calculator provides the CO_2*e* grams per kilogram.

4.4. Research quality

In the following part of the methods and methodology, the quality of the research methods will be discussed, focusing on reliability, replicability, validity, generalizability, and trustworthiness.

4.4.1. Reliability

Bell, Bryman, and Hardly (2019) describe the concept of reliability as to whether the results of a study are repeatable or not if the results will be the same or repeated. Reliability is most connected to quantitative research as it is connected to the measurement and the stability of the measurement. Meaning if there are fluctuations in repeated results, the measurement would be considered unreliable, and the consistency of the result could not be trusted. In this study, the reliability of the used measurements that need to be considered is going to be done by adding references to earlier use of similar measurements and controlling the results by running the calculations multiple times to investigate the consistory within the measurement. In the case of this study, the measurement would be the emissions calculations based on data provided by Nudie Jeans as it is the measurement they and their consultants use when calculating emissions for transportation.

When doing the calculation of the emissions from transportation's the NTMcalc was used, the NTMcalc have been used in research projects on similar topics e.g., transportation mode shift and emissions or external costs from transportations (Van Fan et al. 2018; Petroa, & Konečnýa, 2017; Vierth, Sowa & Cullinane, 2019), and seem to have reliable results when analyses are being replicated.

4.4.2. Validity

The meaning of validity is to get an understanding of to what extent the results, findings, and measures of the research are a good representation of what is supposed to be measured (Easterby-Smith, Thorpe, & Jackson, 2015).

According to Saunders, Lewis, and Thornhill (2019), semi-structured interviews can have a high level of validity if they are conducted using questions that attack the problem from many directions are clarifying and probing. And in addition, that gives the respondent ability to answer the questions from different perspectives, resulting in a higher validity and credibility of the results. The interviews are there to build up the trust and credibility of the research. They can be used to help collect the right data and give the researcher opportunities to ask questions about data and check whether the data is correct (Saunders, Lewis, & Thornhill, 2019). In this report, interviews are used to just that extent to give a more outlined perspective of the OC process and how the company works with emissions and sustainability to understand why they decided to change towards OC.

According to Bell, Bryman, and Hardly (2019), the different parts of validity of a case study are much up to the researcher to decide if it is applicable to the case design or not. However, they also mention that the external validity and or the generalizability of a case study is something that often is questioned, where one cause for this is: how one case can be a representation of how it might look like in general and if the results can be transferable to other cases. In the case of this study, it is hard to say to what extent the results may be generalizable as the data and procedures behind the research are very much linked to the company. However, the results will sourly provide contexed dependent knowledge on how it may look like. And as described in Bell, Bryman, and Hardly (2019), the goal of conducting a case study may not be to have generalizable results but to get a deeper understanding of the complexity within the case.

5. Qualitative Result

In the following section, the qualitative results of the study will be described. First out is a more detailed description of the case company, Nudie Jeans, and their work with sustainability. This section also includes the result from the interviews with three employees at the company and their view on e.g., OC, emissions, transportation, and the future of distribution for Nudie Jeans.

5.1. Introduction to the case company Nudie Jeans

The denim brand Nudie Jeans was founded in 2001 with the vision of becoming industry leaders regarding sustainability (Nudie Jeans, 2021b). This stems from a passion for denim as well as an ambition of minimizing the negative environmental effects related to the fashion industry. These aspirations have helped the company along the way towards their different objectives, where one of the most important has been to become an all-organic denim brand (Nudie Jeans, 2021f). In 2012, Nudie Jeans reached an important milestone regarding this as they produced their first collection using 100% organic cotton. After this, the company has continued improving their products, and today 98,6% of their products are sustainable, which in this context imply that the sustainable products are made from at least 70% sustainable fibers (in accordance with their own material tool). To achieve the sustainability goals, Nudie Jeans has selected partners who live up to their requirements regarding the use of sustainable materials as well as comply with their Code of Conduct (Nudie Jeans, 2021b). In addition to this, a large part of the products is produced in European countries such as Italy and Portugal, which helps minimize environmental effects caused by transportation (Nudie Jeans, 2021c).

The company is present all over the world through their Repair Shops and web shop, with the head office located in Gothenburg, Sweden. Besides the repair shops, there are also Repair Partners and Mobile Repair Stations to which the customer can bring their jeans and get them repaired, thus prolonging the life of the jeans (Nudie Jeans, 2021b). In 2020, 45 900 pairs of jeans were repaired, and although the number is lower than the previous year, it has a positive effect on the environment as fewer new jeans have been needed (Nudie Jeans, 2021e).

5.1.1. Environmental and social sustainability at Nudie Jeans

According to Nudie Jeans, they are trying to have as little impact on the environment as possible in an industry that is not usually considered sustainable. They are doing this by attacking the problems from different areas and are always trying to find better options. "*We believe that is it very important to look at every aspect of what we are doing and to assess if there is a better way of doing it. Thus, our environmental work is in a constant state of development, where we always try to find better alternatives"* (Nudie Jeans, 2017, p. 12). Furthermore, all their sustainability work is measured against the 17 Sustainable Development Goals (SDG) from United Nations, and Nudie Jeans have chosen to prioritize some of the goals over the others; 8, 12, 13, 15, and 17 (Nudie Jeans, 2019). Goal 13 and 15 are about *climate and the biosphere*, 8 and 12 is about *decent work and economic growth*, and *responsible consumption and production*. Finally, goal 17 concerns *partnership for the goals* and runs through all goals.

However, just because these are the prioritized goals does not mean they are not working with the other ones; according to Nudie Jeans, they are doing sustainability work connected to 16 of the 17 goals (Nudie Jeans, 2021b). As stated in their sustainability reports, Nudie Jeans are working on sustainability from many different areas and perspectives, and when focusing on the environmental perspective, they have four main areas in focus in the 2020 sustainability report. These areas are *Material*, *Production*, *Products and User phase*, and finally *Communication and Collaboration*. Under each main area, they have smaller subareas (Nudie Jeans, 2021b).

The textile and clothing industry significantly impacts the environment (Boström & Micheletti, 2016). Material choice is important as different materials impact the environment differently (Laitala, Klepp, & Henry, 2018). For Nudie Jeans, material selection and suppler selection are crucial as they want to control and transparency the material included in their collections (Nudie Jeans, 2021b). Apart from the focus on minimizing the environmental impact from *Material* and *Production*, they also focus on the emissions from their transportations.

The sustainability report on 2020 (2021b) reports the emissions from their total operations, including transport and the use of air transport, accounting for 14% of their total emissions in 2019. This is something they are working on to minimize by, e.g., transportation mode shifts and OC distribution. Nudie Jeans have many collaborations, certifications, and awards that show their sustainability work, e.g., since 2020, they are now a Global Organic Textile Standard (GOTS) certified brand and as of 2017 they only use 100% certified organic cotton in their products (Nudie Jeans, 2021b). As described in the quote from earlier, their environmental sustainability work is incremental, and they always strive to find better alternatives to how they do things today. One thing that Nudie Jeans have in focus is to try to close the loop which in this case refers to recycling, reusing, remaking, and giving materials and products a longer or second life. Nudie Jeans are doing this mainly through their Nudie Jeans repair shops, where customers can get their jeans repaired and recycled. The collected jeans are then resold as is or modified, recycled, used in repairs, or broken down to new material, stating "*We turned 600 pairs of jeans into 200 blankets made of recycled denim and recycled wool*" (Nudie Jeans, 2021b).

Another important aspect as a sustainable company is the social conditions. For Nudie Jeans, safe and fair working conditions throughout the supply chain are prerequisites (Nudie Jeans, 2021d). Within the SDGs there are several goals related to the social dimension, of which two that Nudie Jeans addresses are SDG 8; *Decent work and economic growth*, and 12; *Responsible production and consumption*. These focus on developing acceptable working environments and wages, along with influencing more sustainable consumption patterns. To approach these goals and other challenges, Nudie Jeans uses a Code of Conduct that all their partners and suppliers must comply with (Nudie Jeans, 2021b). Their Code of Conduct explains what is expected from the suppliers and what different regulations it is based on. Thereafter it is divided into different areas which includes *Employee rights*, *Child labor*, and *Safety and working environment*, to mention a few (Nudie Jeans, 2021a).

The choice of suppliers is vital for Nudie Jeans, and by making these careful decisions more people are offered employment where they get acceptable wages and working hours. One area which has been improved is overtime amongst permanent workers, which has been fully removed at some of their suppliers in India. Furthermore, to minimize the risk of child labor in India, Nudie Jeans has chosen Chetna farmers who produce Fairtrade and organic cotton (Nudie Jeans, 2021b).

5.2. Results from interviews

During the spring of 2022 three interviews with employees at Nudie Jeans was held to get a deeper understanding of how Nudie Jeans work with sustainability and especially OC distribution. The interviews were held with the company's environmental manager, omnichannel coordinator, and COO, and were about 30 minutes each (interview guides can be found in Appendix 1). A thematic analysis of the transcribed interviews was conducted, which resulted in three major teams where the first one was *Why a distribution change*, the second one *Challenges and barriers,* and finally *Future possibilities*.

As explained in previous sections, Nudie Jeans has had a big focus on sustainability from the start and has the objective of providing organic products that are ethically produced. This is something that is highlighted by the company's environmental manager who says that ensuring fair working conditions and producing high quality products made from good raw materials has always been the ambition. This also helps creating partnerships with suppliers that are long-term and beneficial for both parts. Although, in the past years it has become increasingly important for Nudie Jeans to look over and find new solutions to make their distribution more sustainable. The environmental manager explained that when they found that their sustainability work related to transportation were not as in the forefront as other parts of the company it came as a realization *"This is actually an area where we have not come that far, maybe this is something that needs to be highlighted in the future".*

Today, the distribution looks quite differently depending on the where the customer is located, regarding both inbound and outbound deliveries. Nudie Jeans' COO mentioned that when it comes to London all inbound deliveries go through Borås mainly due to storage space being expensive. When it comes to inbound deliveries to Sydney however, about 80% of the jeans are transported directly from the supplier. This is also possible since the stores in Sydney tend to be good at ordering the items in advance. Though, when it comes other garments, e.g., tops, all of it goes via the DC in Borås.

Besides their assortment of newly produced garments that can be found online and in store, Nudie Jeans also work with re-selling items second hand. This entails a whole new set of challenges as the item that is being sold is the only one looking specifically in that way, meaning it cannot be kept storage in several places and then sent from the nearest location. It was explained by the environmental manager that today these items are sent to the DC in Borås to be re-located if it is being sold online, and due to it only being one piece of each item it must

be handled in a different way than the assortment of new items. Therefore, there is not a way to include the secondhand garments in the OC distribution today.

5.2.1. Why a distribution change?

Making changes within a company can entail negative effects such as added costs, but it can also have positive outcomes, e.g., more satisfied customers and minimized environmental impact. For Nudie Jeans, making a change in their distribution system was a necessary development and investment to achieve these results. During the interview, it was explained by the omnichannel coordinator that by implementing OC it is possible to gain more control over their distribution as more of the orders will go through the company instead of through agents and other distributors. However, one of the most significant benefits of making changes to their distribution is the possible effects it can have on the environment and emissions. Nudie Jeans' COO said that *"We are painfully aware of how awful it is to fly to Australia",* indicating that they want to be able to change how B2C orders has been shipped in the past. This was also brought up by the environmental manager who explained how the company want to put a bigger focus on the environmental impact from distribution and transportation, as it previously has been a bigger focus on the manufacturing process. This will still be a top priority for the company, to ensure high quality and environmentally friendly materials while also upholding social sustainability, but a new aspect need to be added to develop as a company with high environmental standards.

In addition to the objective of minimizing the emissions from transportation, implementing OC distribution can help with achieving faster deliveries to the customer, thus improving the customer satisfaction. The omnichannel coordinator explained that the implementation entails faster local deliveries since less orders need to be sent from the DC in Borås and the customer can get more awareness regarding the location of the different stores. This can lead to more customers shopping in the physical store as well as returning the online orders there, which results in shorter transport distances.

Besides these drivers for an implementation regarding customer satisfaction and environmental aspects, other benefits can be seen as well. By implementing OC distribution, a higher level of integration within the company can be achieved, which was brought up by the environmental manager. It was stated that *"It is not that only the sustainability department can run this or just the supply chain department, but this will affect all departments"*, showing that all departments need to adjust and cooperate in a different way than previously. This was also highlighted by the omnichannel coordinator who emphasized how the communication, both internally and externally, has improved following the implementation.

5.2.2. Challenges and barriers

When it comes to implementing a new process or procedure it often comes with some challenges and or barriers, in the case of Nudie Jeans implementing an OC distribution there seem to be a few barriers and challenges in the prosses. As mentioned before, Nudie Jeans is a

company that have a strong environmental and sustainability focus, and according to their environmental manager the climate work is a huge challenge, and especially the emissions coming from transportation, maybe even their biggest challenge when it comes to lessen their emissions. And over the last three years they have mapped all the emissions from their supply chain and operations, and by doing so they could see that transportation are an area of the business where there is room for improvement. The implementation of the OC is an attempt to lower the emissions from their outbound B2C transport as well as inbound transport to the stores.

The change into OC distribution have seemed to go rather seamless according to Nudie Jeans' omnichannel coordinator, although they have of course encountered some smaller issues in the process. These problems seem to have more to do with new routines and systems, restrictions, and technological issues. However, they are working constantly from multiple departments to fix and solve problems that are encountered in the process as well as tying to optimize the operations towards a fully functional OC distribution. Nevertheless, the OC system that is being investigated in this thesis is rater small and in the beginning of its implementation, making the challenges of the implementation more manageable. But during the interview whit the COO it was mentioned that they have now during the spring of 2022 involved one additional store into the OC system in the UK, so the system is slowly growing. One challenge that comes with the change into OC distribution is the need for a larger inventory in the stores, in Australia this is less of a problem as they have a smaller DC connected to the store in Zetland, while in the London this is more of a problem. As the COO mentioned *"Retail area in central London is expensive*", hence they are limited to the storage capacity of the stores which can hold rather small volumes according to the COO. The result of this is that they must send smaller inbound shipments to the UK, making the OC distribution a bit harder as the London store may not have a full range of products. This could lead to some B2C orders that could have been sent from the OC store being shipped from the DC in Borås instead because of the limited store capacity in London. However, by opening another one of their London stores as an OC store they increase the storage capacity. Another challenge that could be turned into an opportunity is the case of the DC in Australia, which could be a provider to customers in other areas e.g., Asia or even the US as it is closer to many of these places. Although, as motioned by the COO *"It would probably be a bit complicated at the moment, but that's a smart idea of course"*. The complicated part comes from what the company structure looks like – the Australian subsidiary not being fully owned by Nudie Jeans.

One important part of e-commerce is the return of products, and this is somewhat disconnected from the OC system at Nudie Jeans currently. The COO mentioned that they are working on connecting the return system into the OC system, so when a customer sends back a return it goes the nearest store instead of back to the DC in Borås as it is now. Although, this entails a customs declaration for every return outside the EU and emissions from the single shipment back to the DC. However, implementing this is not possible now due to technical problems that will take some time to fix according to the COO, but they are working on the problem. The COO also mentions another thing that would simplify the returns that have to go back to SEden, as well as minimizing emissions and customs declarations, would be to bulk for example one

week of returns in Sydney and send it back as a larger shipment. However, there is some challenges with that too, e.g., when does the customer gets its refund in this process.

Since one of the main reasons behind Nudie Jeans implementing an OC strategy is to lessen the emissions, it would also be beneficial to look at changing the transportation mode of the inbound transport to the stores as they want to send larger shipments, which they are starting to look at. As mentioned by the COO that they could "*Look at alternative means of transport, for example sea freight to Australia especially, because we have quite large volumes going there"* It was also mentioned that *"When we can, we use trains instead of trucks".* However, there are some challenges with changing the transport mode e.g., according to the COO there are requirements of shipping full containers when using train. In addition to this, when using sea transport there is the consideration of the lead time which was mentioned by both the COO and the environmental manger *"The transport will take much, much longer time, going from 4 days to 45 days".* Both were discussing the implications of having longer lead times, indicating that they need to consider more parameters than just the mode of transport, such as having to think about collections and launches e.g., if they launch a collection on a specific date that collection need to reach all stores at the same time. However, they seem to have some thoughts about how they could work around this, as mentioned by the environmental manager "*It is perhaps more important that we have a larger part of the collections that are standard collection and that are not as collection or campaign-bound"* and the COO is also thinking about how they could solve this *"So, it's a challenge and we have and try to get a little more time between ordering and delivery really"* the COO also mentions that *"The more stores that can become omni channels, the more you can also send to the store well in advance and then distribute locally, which is also a big advantage, of course"*

In addition to changing the transportation mode there is also the question of the specific carriers and LSPs. When asked about what their demands on the LSPs are, the environmental manager anSEred "*We have not historically made demands on our carriers and do not make it today either. What we do today is try to understand their different types of sustainability work, emissions and so on*". Another factor is that Nudie Jeans is a relatively small company in the eyes of the large international carries so it is hard to come with demands, meaning that the market need to change and they need to get an understanding of what they want and can demand from a carrier "*Today we probably do not even know exactly what we should set as requirements, but it's much easier when you actually have a list of requirements that says this is what we want".* In addition to the hypothetical demands there is also the question of contracts and other things that might make the choosing of LSPs more complex.

5.2.3. Future possibilities

When talking about the future and possible opportunities for Nudie Jeans in connection to emissions and OC distribution, all the interviewees brought up the possibilities with sending larger shipments. By sending larger shipments to the stores, they would be able to use the full capacity of an OC distribution system, giving the costumer cheaper, faster, and more environmentally friendly deliveries. But as mentioned before there are some hinders and

challenges with sending larger volumes and according to the omnichannel coordinator there have not been a drastic increase in the volume of shipments to stores currently. However, the omnichannel coordinator also mentions that this could be connected to the covid-19 pandemic and that it is going to be exciting to see what happens when the pandemic is over. In addition, the COO talks not only about increasing the volumes of shipped goods to the stores, but also about changing the assortment and to have a larger standard assortment *"Our goal is that it will be more even and have a larger standard collection of products, and then we get completely different opportunities when it comes to change of transportation mode"*. Since if they have a larger standard assortment, they can handle the longer lead times that comes with sea transport and by this lessen the usage of air transport.

Nudie Jeans is still very early in the implementation of their OC system and according to the omnichannel coordinator "*It is still a very early process[...] but the goal is for us to start with this in all our countries and markets in order to be able to optimize inventory better".* Also, the COO talks about optimizing storage "*You can say, number one is that all our own stores should be able to act as hubs",* talking further about future goals of including their franchise stores and wholesalers in the OC chain. Moreover, as mentioned by the omnichannel coordinator it's not just about the environmental aspect, it is about customer service and being able to serve the customer in the best way. By having the orders shipped closer to the end customer they can get the orders faster, and that in the near future there will be a possibility for the customer to choose a click and collect service when ordering online. The further step for them is to connect more of their stores to the OC network, as expressed by the omnichannel coordinator *"For example, we do not have omnichannel for example in the US, and we do not have it in Germany right now"*, also pointing out that opening an OC in new markets comes with new and different problems both with carrier partnerships but also in other areas. Thus, according to the omnichannel coordinator the OC implementation in all their markets is going to take a while. However, it was further mentioned that they want to open more stores, and this would mean additional OC hubs and getting closer to more customers. Other future opportunities that were brought up during the interviews, especially by the COO, was e.g., the omni-fication of the returns and more collaboration with wholesalers in the OC network.

6. Quantitative Result

In the following sections there will be an introduction to Nudie Jeans' flow of goods and what transport modes are being used for the different routes. These are divided into two parts, London, and Sydney, and apply to both inbound and outbound orders. Furthermore, the average shipments are displayed alongside its CO_2e emissions which shows that there is a clear relationship between weight and volume when investigating transport, and that sending larger shipments tend to lower the emission per sent kilo. Following the average shipment, the final parts of the transport chain is being explored although it does not seem to have a direct link to the results of the research question. In contrary, the section regarding different scenarios shows how different aspects affect the emissions, and this displays that vehicle size and load factor clearly affects the outcome. Lastly, a summary of the quantitative results has been developed to get an overview of the results in a more condensed matter.

6.1. Flow of goods

To get an understanding Nudie Jeans' flow of goods from supplier to consumers, two flowcharts have been provided (see Figure 6.1 and Figure 6.2). These describe the different routes, both if it is sent directly from DC to customer or if it is sent as an OC order. As it can be seen in the figures (6.1 and 6.2) the flow differs depending on if the destination is an end customer in the UK or in Australia. However, the flows are in most perspectives quite similar.

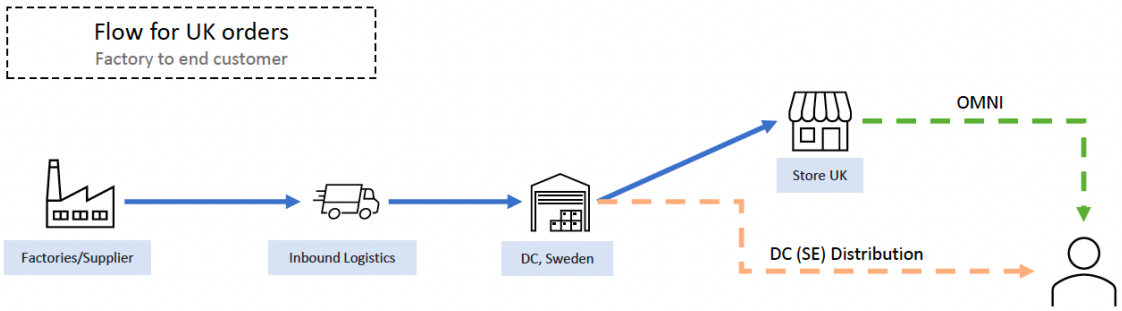

Figure 6.1: The different flows for UK orders from the factory to end customer [7] Source: Nudie Jeans (2022)

[7]Inbound shipments from the supplier are first sent to DC (SE) and then distributed to Store UK. For the UK, Nudie Jeans ship orders entire directly from DC (SE) or through OC with goods first supplied from DC (SE) to UK-store and then domestic to B2C-customer.

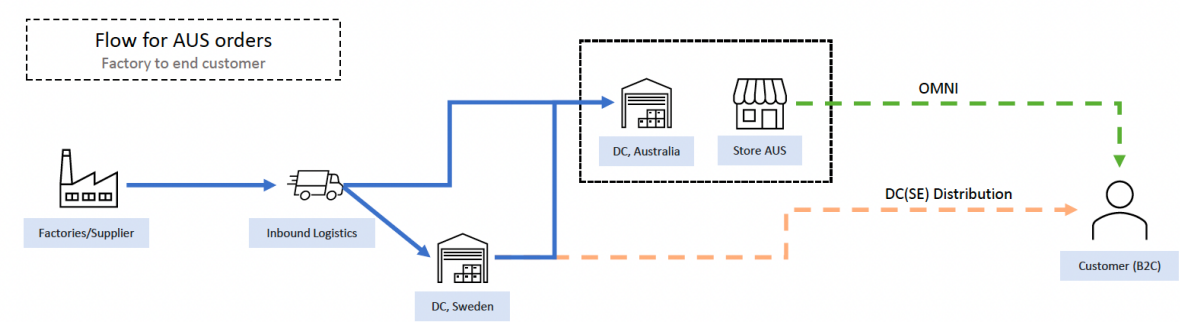

Figure 6.2: The different flows for AU orders from the factory to end customer [8] Source: Nudie Jeans (2022)

In the UK, at the starting point of this thesis, Nudie Jeans were only using one of their three London stores as a *ship from store* hub; the store is in the area Seven Dials in the central parts of London. However, as this implementation is an ongoing progress for Nudie Jeans, during the spring of 2022 they started using one more of the London stores as an OC hub. Nonetheless, as this was a change that came after the startup of the thesis, this store will not be included in any of the calculations. For transportation to London, there are two options for the customer to choose from: UPS Standard and UPS Express Saver, where the two options use different modes of transportation (see Table 6.1). Although, after inspections of the data it can be noted that the UPS Express Saver seldom is chosen by customers, as they seem to go for the UPS Standard. In Q3 and Q4 of 2021 only 8,5% of the UK customers chose the express service and in 2018 it was even less, with only 1,7%.

Table 6.1: Transportation mode and LSP in the UK

	UPS Standard	**UPS Express Saver**
Domestic shipments (Omni)	Road	Road
Shipments from SEden to the UK	Road (tunnel)	Air and Road

Currently, in March of 2022, and since they started their OC distribution, Nudie Jeans only uses one of their eight stores in Australia as a ship from store hub, the store in Zetland, Sydney. The store is also a combined mini-DC for distribution to the other stores and B2B customers in Australia and Southeast Asia. When it comes to final shipments within Australia, Australia Post and their express service is the most used, while transportation from Borås to Sydney is provided by UPS. Different transportation modes are used, though air is almost exclusively used for both outbound and inbound transport (see Table 6.2), including the transportation to the stores as well. However, there are exceptions, e.g., in 2021 they had one large shipment going by sea from a supplier in Turkey directly to Sydney. The consequence of going more by sea is the longer lead times, even though there seems to be a willingness to go more towards

[8] Inbound shipments of goods are both sent directly from supplier to DC(AU) and from DC (SE) to DC (AU). For Australia, Nudie Jeans use the store connected to their DC in AU for OC orders to be shipped domestically in Australia.

shipping by sea in the future. In contrast, most domestic deliveries in Australia goes by road, with the exceptions of deliveries to western Australia were e.g., Perth is located.

Table 6.2: Transportation mode and LSP to Australia

	AU Post Express	**UPS Express Saver**
Domestic shipments (Omni)	Road, air for longer distances	
Shipments from SEden to Australia		Air and Road

As an initial stage it was important to get an understanding of how emissions are affected by the weight of the cargo. Therefore, several weights were chosen to see whether it would be linear or not. These weights, that can be seen in Appendix 3, does not stem from the data provided by Nudie Jeans but are purely fictional. However, the different distances within the routes are the actual ones used when transporting Nudie Jeans' orders. These standard routes were calculated for both UK and AU markets and are based on the exact transport routes and modes, which can be seen in Table 6.3 and 6.4. By using the NTMcalc, the different distances within each route could be calculated separately, and with the knowledge of what transport mode was used it was possible to get more accurate emissions data. The different transport modes have been provided as well but some assumptions had to be made, including size of truck, what type of aircraft, and the filling degree.

In Figure 6.3 there is a visualization of the three different main shipment routes. The red route shows the standard shipment route for both inbound deliveries to the stores in London and B2C orders in the UK coming from Nudie Jeans' warehouse Korallen located in Borås: *Borås (SE) – Mölndal (SE) – Glostrup (DK) – Stanford Le Hope (UK) – London (UK).* The blue route shows the express deliveries to B2C orders in UK: *Borås (SE) – Mölndal (SE) – Sturup (SE) – Stansted (UK) – London (UK)*. The final one, the green, is showcasing the shipment route to Sydney: *Borås (SE) – Mölndal (SE) – Sturup (SE) – Cologne (DE) – Sydney (AU).* However, in addition to these main routes there is the question about the last parts of the deliveries, the final legs of the shipment from London or Sydney to the final customer. The last parts of the deliveries not going to be displayed visually as the route varies depending on where the customer is, and this will be different for almost all orders.

Figure 6.3: Map over the different routes (the visual routes are approximate). Source: Adapted from Google maps.

6.2. Average shipments

To get an approximate of how much CO_2e emissions one standard B2C shipment cause, information of the standard packeting size and average weight was received from Nudie Jeans, which can be seen in Figure 6.4. The average weight of one pair of jeans is 0.7kg and the average B2C order is 1.2 pcs, with an average wight of 1kg. The numbers displayed were later used when making the calculations in NTMcalc, regarding the standard routes for both Borås to London and Borås to Sydney. This can be seen in Table 6.3 and 6.4, although it is important to note that this does not consider the final parts of the deliveries as it varies depending in where the customer is located. The calculations for last parts of the deliveries can be found in section 6.3.

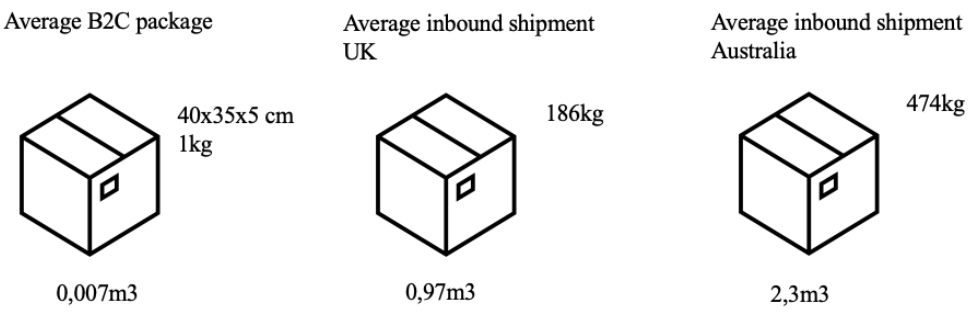

Figure 6.4: Visualization for average package sizes and weights for the different routes (own illustration).

As a disclaimer, the average weight and volume is based on deliveries that varies a lot in size, where one shipment could e.g., be 40kg or 1300kg. Thus, this is important to have that in mind when reading the results on this study. What is also important to keep in mind is that the result is based on the specific parameters used in the NTMcalc: the transportation mode, type of vehicle transportation route etc. Most of the choice of parameters is based on information given from Nudie Jeans, however some of is more based on assumptions e.g., vehicle size. There will come a section later in this chapter where different scenarios are explored to see what happens to the emission when changing some of the parameters.

The average shipment UK

What can be calculated from the figures in the table (6.3) is that Nudie Jeans is saving approximately 14,8kg CO_2e emissions when sending one larger shipment (186kg) versus sending the same number of kg/items as individual standard B2C shipments. Indicating that when choosing to transport a larger shipment the CO_2e emission per kg/pair of jeans is approx. 0,232 kg instead of 0,312kg. A more detailed calculation of this can be found in Appendix 2.

Table 6.3: Transport route and emissions for a standard outbound B2C shipment from Borås to London standard delivery. Specifying transport modes, distances, and emissions.

Borås DC --> London - Volumetric weight (m3*kg)					
Route	**Borås, SE - Mölndal, SE**	**Mölndal, SE - Glostrup, DK**	**Glostrup, DK - Stanford Le Hope, UK**	**Stanford Le Hope, UK - London, UK**	**Borås - London**
Distance (km)	64	318	1369	43	1794
Transport mode	**Rigid truck < 7,5 t**	**Rigid truck 14-20 t**	**Rigid truck 14-20 t**	**Rigid truck < 7,5 t**	
CO_2e (kg) for one pair of jeans 0.7kg* 0.007m3)	0.016	0.054	0.232	0.010	0.312
CO_2e (kg) 0.007m3 1kg (standard B2C shipment)	0.016	0.054	0.232	0.010	0.312
CO_2e (kg) 186kg*0,97m3 (average inbound shipment)	2.187	7.477	32.10	1.441	43.21

The average shipment AU

For Australia the calculations are quite different compared to the UK as the store in Zetland also acts as a smaller DC and thereby getting substantially more deliveries than the one in London. The average delivery was based on the number of deliveries, number of collies, and weight for these deliveries for one month.

Based on the numbers found in Table 6.4, Nudie Jeans have a saving of approx. 731,57kg CO_2e emissions when sending one larger shipment (474kg) versus sending the same number of kg/items in individual standard B2C shipments. The emissions per kg sent in a large shipment

is approximately 8,916 kg compared of 10,24 kg in individual shipments. If the calculations were made based on the weight of one pair of jeans, the reduction would be 6,24 kg CO_2e per kg sent.

Table 6.4: Transport route and emissions for a standard outbound B2C shipment from Borås to Sydney standard delivery. Specifying transport modes, distances, and CO_2e emissions.

Borås DC --> Sydney - Volumetric weight (m3*kg)					
Route	Borås, SE - Mölndal, SE	Mölndal, SE – Sturup SE	Sturup SE – Cologne DK	Cologne DK- Sydney AU	Borås SE - Sydney AU
Distance (km)	64	288	810	16 817	17 978
Transport mode	Rigid truck < 7,5 t	Rigid truck 14-20 t	Rigid truck 14-20 t	Air, Intercontinental	-
CO_2e (kg) for one pair of jeans 0.7kg* 0.007m3)	0.016	0.049	0.159	10.24	10.46
CO_2e (kg) 0.007m3 1kg (standard B2C shipment)	0.016	0.049	0.159	10.24	10.46
CO_2e (kg) 474kg * 2,3m3 (Average inbound shipment)	5.19	16.14	52.15	4153	4227

In addition to the CO_2e of a standard shipment, the tables (6.3 and 6.4) also show the CO_2e emissions for a shipment of one pair of jeans. However, as can be seen in the table there is no difference in the CO_2e emission for a 0,007m3 package weighing 1kg or 0,7kg, indicating that the standard shipment and the shipment of one pair of jeans have the same CO_2e emission for this specific route. This entails that it may be more efficient from a CO_2e emission perspective to send a heavier shipment if the box is the same size, i.e., to fill up the package instead of sending air.

When trying out different methods for calculating the emissions it was discovered that if the calculations was based on weight or volume only, the relationship was linear (see Appendix 3 for more details). So, instead of basing the calculations only on the weight of a shipment, as it would only result in getting the same result for all transports since the relationship is linear. The calculations for the rest of the CO_2e emissions in this thesis is going to be based on volumetric weight, if nothing else is specified. See appendix 4 for more information on the relationship when using volumetric weight as the basis for the calculations.

6.3. The final parts of the transport chain UK and Australia

After creating the average shipment routes, it was possible to look at the final parts of the transport chain to UK and Australia to the end customer from both London and Sydney. Since the data from Nudie Jeans differ depending on the year and market, averages where calculated and used, and the distance to the customers had to be scaled down to make it more approachable. To do this, the distance from both London and Sydney were based on radiuses within certain

distance spans, creating an average distance within each of the spans. Which was calculated with the following formula:

$$\sum_{i=1}^{n} \frac{x_i}{y_i}$$

x= the distance from London or Australia to customer for each order within the distance span

y= the number of shipments made to location at the specific distance

The CO_2e emissions for the final parts of the transport chain in the UK and Australia can be seen in Table 6.5 and 6.6 and are based on the average distances within the radiuses, the transportation mode, and volumetric weight. For the UK, three different distance radiuses are used, and in Table 6.5 it can be seen what transport modes are being used in the route. While in Australia five different distance radiuses are used, as displayed in Table 6.6. The results shown are a simplification of the last leg of the delivery chain as the assumption is that the shipment uses the same vehicle for the whole transport, that the shipment is not going via consolidation centers and that the shipment does not take any detours. The two tables also show a few options regarding transport modes to show how the emissions differ depending on the size of the vehicle.

Table 6.5: Averages of CO_2e emissions from final parts of the transport chain in UK and Australia based on different kilometer radius, transportation mode/type and volumetric weight.

Km from London	**0-20**	**0-20**	**21-300**	**21-300**	**21-300**	**300+**	**300+**	**300+**
Average distance (km) to customer	6.4	6.4	142	142	142	476	476	476
Transportation mode	**Van**	**Rigid truck < 7,5 t**	**Van**	**Rigid truck < 7,5 t**	**Rigid truck 14-20 t**	**Van**	**Rigid truck < 7,5 t**	**Rigid truck 14-20 t**
CO_2e (kg) for one pair of jeans 0.7kg* 0.007m3)	0.005	0.001	0.137	0.036	0.026	0.45	0.118	0.086
CO_2e (kg) 1kg 0.007m3, (standard order)	0.005	0.001	0.137	0.036	0.026	0.45	0.118	0.086

Table 6.6 Averages of CO_2e emissions from the final parts of the transport chain in Australia based on different kilometer radius, transportation mode/type and volumetric weight.

Km from Sydney	**0-20**	**0-20**	**21-300**	**21-300**	**301-700**	**301-700**	**700-2000**	**700-2000**	**2000+**
Average distance (km) to customer	6.7	6.7	86	86	657	657	808	808	3284
Transportation mode	**Van**	**Rigid truck < 7,5 t**	**Rigid truck < 7,5 t**	**Rigid truck 14-20 t**	**Rigid truck < 7,5 t**	**Rigid truck 14-20 t**	**Rigid truck < 7,5 t**	**Rigid truck 14-20 t**	**Air Continental***
CO_2e (kg) for 1 pair of jeans 0.7kg* 0.007m3)	0.006	0.002	0.021	0.016	0.163	0.119	0.2	0.146	2.87
CO_2e (kg) 1kg 0.007m3, (standard order)	0.006	0.002	0.025	0.016	0.163	0.119	0.2	0.146	2.87

* Note: The continental air transport is only one part of the final parts of the transport chain in the 2000+ km category, additional road transport will most probably be needed from the airport to the end customer.

When it comes to last parts of the transportation chain in both the UK and Australia, there will not be a distinct difference depending on it if it is a standard or OC order. This is since the order will be sent from approximately the same location for both delivery options. However, if electric or hybrid vehicles were to be used, the results would be different.

6.4. Different scenarios – what happens if parameters change

To get a better understanding of how different factors affect the CO_2e emissions for the different routes, some scenarios were investigated and compared. These scenarios provide further knowledge in how the transport mode and load factor affect the emissions, based on a standard inbound shipments to both London and Sydney.

6.4.1. Changes in transport mode

For the case of an inbound shipment from Borås to London the following package volume and weight was used: 0,97m3 and 186kg. These numbers were applied to four different examples where the transport modes where altered. In Table 6.7 there is a more detailed view of what transport mode was used for each part of the route and Figure 6.4 displays how they differ from each other.

Table 6.7: The different examples of changes in transport mode for the route Borås to London.

Inbound UK: changing transport modes					
Route	**Borås, SE - Mölndal, SE**	**Mölndal, SE - Glostrup, DK**	**Glostrup, DK - Stanford Le Hope, UK**	**Stanford Le Hope, UK - London, UK**	**Borås - London**
Distance (km)	64	318	1369	43	1794
Transport mode Example 1	**Van**	**Rigid truck < 7,5 t**	**Rigid truck < 7,5 t**	**Van**	-
CO_2e (kg) 0,97m3 186kg shipment	8.35	10.8	46.1	5.53	70.8
Transport mode Example 2	**Rigid truck < 7,5 t**	**Rigid truck 14-20 t**	**Rigid truck 14-20 t**	**Rigid truck < 7,5 t**	-
CO_2e (kg) 0,97m3 186kg shipment	2.19	7.52	32.08	1.44	43.23
Transport mode Example 3	**Rigid truck 14-20 t**	**Rigid truck 14-20 t**	**Rigid truck 14-20 t**	**Rigid truck 14-20 t**	-
CO_2e (kg) 0,97m3 186kg shipment	1.60	7.52	32.08	1.0	42.21
Transport mode Example 4	**Rigid truck 14-20 t**	**Truck with trailer 20-28 t**	**Truck with trailer 20-28 t**	**Rigid truck 14-20 t**	-
CO_2e (kg) 0,97m3 186kg shipment	1.60	6.82	29.25	1.0	38.67

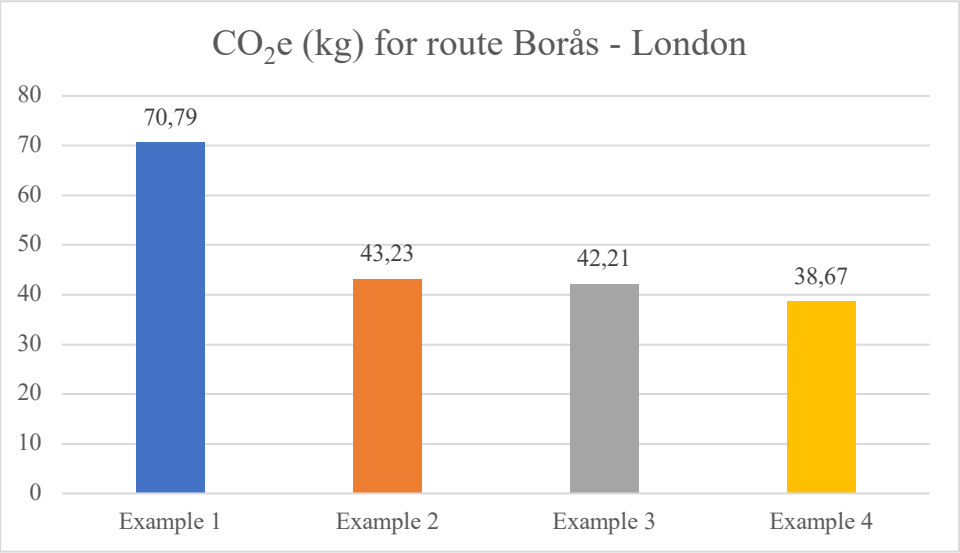

Figure 6.4: A diagram over how much CO_2e (kg) the different examples create for the transport route Borås – London.

From the calculations and as it can be seen in the Figure 6.4, the CO_2e (kg) emissions get lower as the vehicles get larger. Thus, by changing to a larger vehicle where the goods account for a smaller percentage of the total cargo the emissions per inbound order is reduced.

When it comes to the different examples of changing transport modes for Borås to Sydney two of the examples got changed routes to show how using sea fright would affect the emissions. Therefore, example three and four has the route *Borås, SE – Mölndal, SE – Sturup, SE – Rotterdam, NL – Sydney, AU*, as it can be seen in Table 6.8. However, it is important to note that switching the transport mode from air freight to sea freight would result in a considerably longer delivery time. Nevertheless, the emissions from sea freight are notably lower that using air freight, which is shown in the diagram in Figure 6.5. For these calculations the volume 2,3m^3 and weight 470kg was used as it is an average inbound order.

Table 6.8: The different examples of changes in transport mode for the route Borås to Sydney.

Inbound AU: changing transport modes					
Route	**Borås, SE - Mölndal, SE**	**Mölndal, SE - Sturup, SE**	**Sturup, SE - Cologne, DE**	**Cologne, DE - Sydney, AU**	**Borås, SE - Sydney, AU**
Distance (km)	64	288	810	16 817	17 978
Transport mode Example 1	**Rigid truck < 7,5 t**	**Rigid truck 14-20 t**	**Rigid truck 14-20 t**	**Air - Intercontinental**	**-**
CO_2e (kg) 2,36m3 470kg shipment	5.32	16.67	53.52	4118	4193.5
Transport mode Example 2	**Rigid truck 14-20 t**	**Truck with trailer 20-28 t**	**Truck with trailer 20-28 t**	**Air - Intercontinental**	**-**
CO_2e (kg) 2,36m3 470kg shipment	3.90	15.19	48.79	4118	4186
Route	**Borås, SE - Mölndal, SE**	**Mölndal, SE - Sturup, SE**	**Sturup, SE - Rotterdam, NL**	**Rotterdam, NL - Sydney, AU**	**Borås, SE - Sydney, AU**
Distance (km)	64	288	1 011	16 708	18 071
Transport mode Example 3	**Rigid truck < 7,5 t**	**Rigid truck 14-20 t**	**Rigid truck 14-20 t**	**Container ship**	**-**
CO_2e (kg) 2,36m3 470kg shipment	5.32	16.67	57.82	135.3	215.1
Transport mode Example 4	**Rigid truck 14-20 t**	**Truck with trailer 20-28 t**	**Truck with trailer 20-28 t**	**Container ship**	**-**
CO_2e (kg) 2,36m3 470kg shipment	3.9	15.19	52.71	135.3	207.1

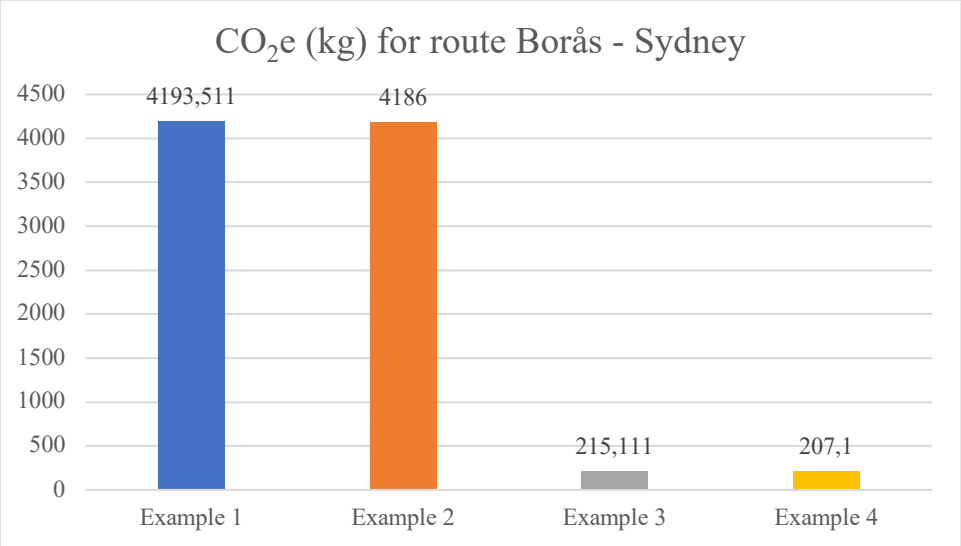

Figure 6.5: A diagram over how much CO_2e (kg) the different examples create for the transport route Borås – Sydney.

Besides the fact that examples three and four has considerably lower emissions than the first two examples, Figure 6.5 also shows that the emissions are lower when larger vehicles are used, just as in Figure 6.4. From both calculations (Borås – London and Borås – Sydney) there seems to be a link between the size of the vehicle and the CO_2e emissions. By switching to a larger vehicle, the shipment will account for a smaller percentage of the total emissions from the transport, i.e., using a smaller vehicle will result in higher CO_2e.

6.4.2. Changes in load factor

In addition to investigating the relationship between transport modes and CO_2e emissions, the correlation between the load factor and CO_2e was considered. In this section, the original routes and transport modes were used, and the load factor was changed for the different examples. To calculate these, the relationship between *Cargo load factor – weight* and *Volumetric (dimensional) cargo load factor* was kept the same as the standard settings in NTMcalc Advanced. This entails that the volumetric load factor was 1,25 times higher than the load factor based on the weight. The only exception to this rule was regarding the air freight as this was kept at its standard settings for all the calculations.

From both Figure 6.6 and 6.7 the CO_2e emissions get lower when the loading factor gets higher. This correlates with the previous examples where the emissions got lower when the vehicle was larger as the goods account for a smaller percentage of the total weight and volume. A more detailed view of the emissions for the different routes and the load factors can be found in Appendix 5 - CO_2e (kg) emissions based on load factor.

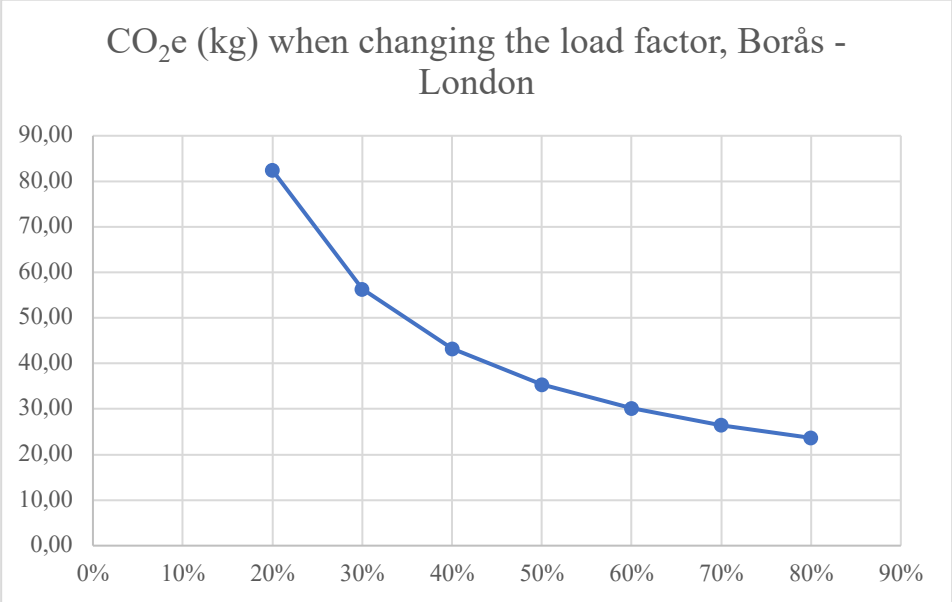

Figure 6.6 CO_2e (kg) when changing the load factor for a standard inbound shipment, Borås - London.

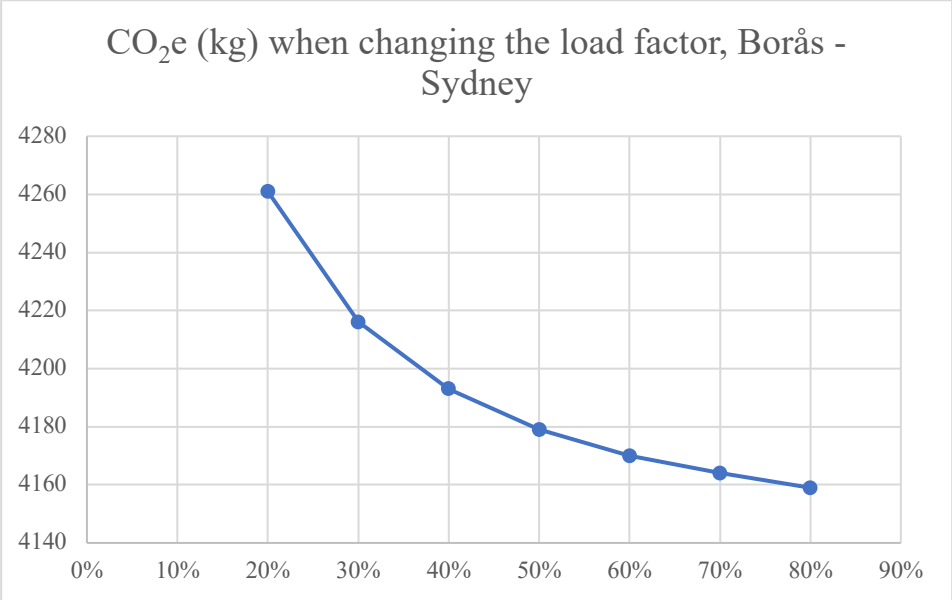

Figure 6.7: CO_2e (kg) when changing the load factor for a standard inbound shipment, Borås – Sydney.

In both Figure 6.6 and 6.7 it is visible that the emissions drop faster in the lower percentages and the differences lessens as the percentages get higher. This shows that is especially important to avoid the lower loading factors.

To conclude, both the transport mode and the load factor plays a vital part when looking at emissions deriving from transport of goods, no matter if it is to the end customer or to a store. By choosing to consolidate goods in larger vehicles while also maintaining a high load factor companies, such as Nudie Jeans, can drastically minimize their CO_2e emissions. There are,

however, other aspects to consider, e.g., costs, but from an environmental perspective this is vital.

6.5. Summary of quantitative results

Based on the different calculations made in the previous sections it is possible to see that implementing an OC distribution system can result in reduced CO_2e emissions. What is important to note is that both volume and weight need to be considered, as the two separately would result in a linear outcome. Thus, there would not be a difference between implementing and not implementing an OC structure, it would solely depend on the number of orders. In addition to this, it was found the last parts of the transport chain is the same for both OC and non-OC orders as these will be sent separately to each end customer. However, by changing the transport mode to e.g., electric or hybrid vehicles the emissions for the last parts of the delivery could be minimized as well.

Using the result in the previous sections, further calculations have been made that can be found in Table 6.9 and 6.10, and Figure 6.8 and 6.9. Here it can be seen how the emissions are affected when the omni-orders account for 0%, 25%, 35%, 45%, and 100% of the total orders to UK and Australia respectively. In the tables and figures, 20 000 orders are used as an example to demonstrate the difference, this does not represent the actual numbers of orders that Nudie Jeans send. From the data of Q3 and Q4 in 2021 it was found that approximately 6,3% of all orders from the DC to the UK were omni-distributed, and from the DC to Australia approximately 92%. This shows that Australia already has a high percentage of omni-orders, however this is only based on the orders sent from the DC in Sweden and does not include the orders sent from the warehouse located in Zetland, Australia. Nonetheless, the percentage of 6,3 omni-orders to UK results in a reduction of approx. 103,32 kg CO_2e emission compared to solely sending DC orders (20 000 orders).

Table 6.9: The change in CO_2e emissions on the total B2C orders (20 000) over different percentages of OC orders to the UK.

Percentage OC orders (20 000 orders) the UK					
	0%	**25%**	**35%**	**45%**	**100%**
CO_2e (kg) OC orders	0	1 150	1 610	2 070	4 600
CO_2e (kg) DC orders	6 240	4 680	4 056	3 432	0
Total CO_2e (kg)	6 240	5 830	5 666	5 502	4 600

Table 6.10: The change in CO_2e emissions on the total B2C orders (20 000) over different percentages of OC orders to Australia.

Percentage OC orders (20 000 orders) AU					
	0%	**25%**	**35%**	**45%**	**100%**
CO_2e (kg) OC orders	0	44 500	62 300	80 100	178 000
CO_2e (kg) DC orders	209 200	156 900	135 980	115 060	0
Total CO_2e (kg)	209 200	201 400	198 280	195 150	178 000

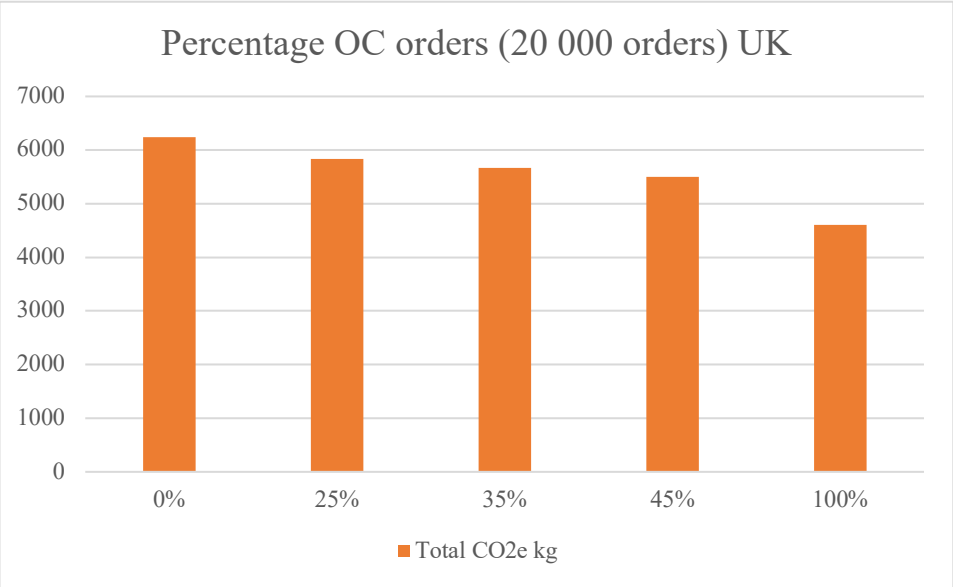

Figure 6.8: Showcasing the change in CO_2e emissions on the total B2C orders (20 000) over different percentages of OC orders to the UK. The y-axis shows the CO_2e/kg.

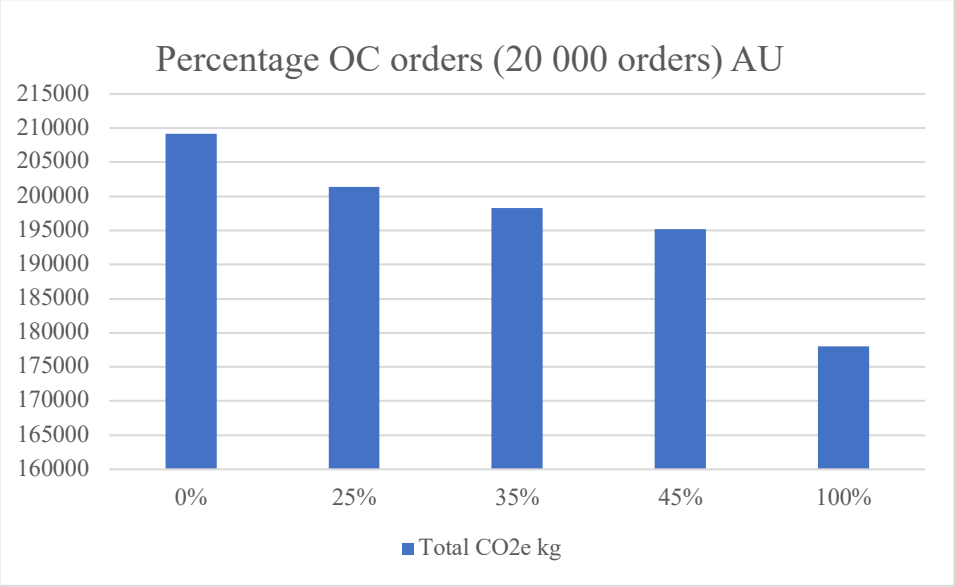

Figure 6.9: Showcasing the change in CO_2e emissions on the total B2C orders (20 000) over different percentages of OC orders to Australia. The y-axis shows the CO_2e/kg.

In addition to the CO_2e emissions that can be found in the tables (6.9 and 6.10) and figures (6.8 and 6.9) above, additional emissions will occur as the last parts of the transport chain are not accounted for in these calculations. As mentioned previously, the last parts of the transport chin do not differ depending on if it is a standard or OC order, therefore it was excluded from this section. Although, it could be beneficial to look over what transport mode has been used and through this reduce the emissions further.

It was also explored how different transport modes affect the total emissions, and by changing from air to sea freight it could be a drastic reduction. To explore this further, it was calculated how the emissions would be affected if the same percentage of OC orders would have been sent by sea freight (25%, 35%, and 45%) (see Table 6.11). This would imply that these percentages had been sent in advance to AU as inbound orders. In Figure 6.10 there is also a visualization of the difference in CO_2e emissions when using air or sea transport for the inbound shipments to Australia over the different percentage of the OC orders, which also shows that there is a drastic reduction when using sea freight contra air freight.

Table 6.11: The change in CO_2e emissions on the total B2C orders (20 000) over different percentages of OC orders to Australia when changing the inbound air transport to sea, the figures are based on 20 000 orders.

Percentage OC orders (20 000 orders) AU (SEA)			
	25% OC orders	35% OC orders	45% OC orders
CO_2e kg OC orders	2 250	3 150	4 050
CO_2e kg DC orders	156 900	135 980	115 050
Total CO_2e kg	159 150	139 130	119 100

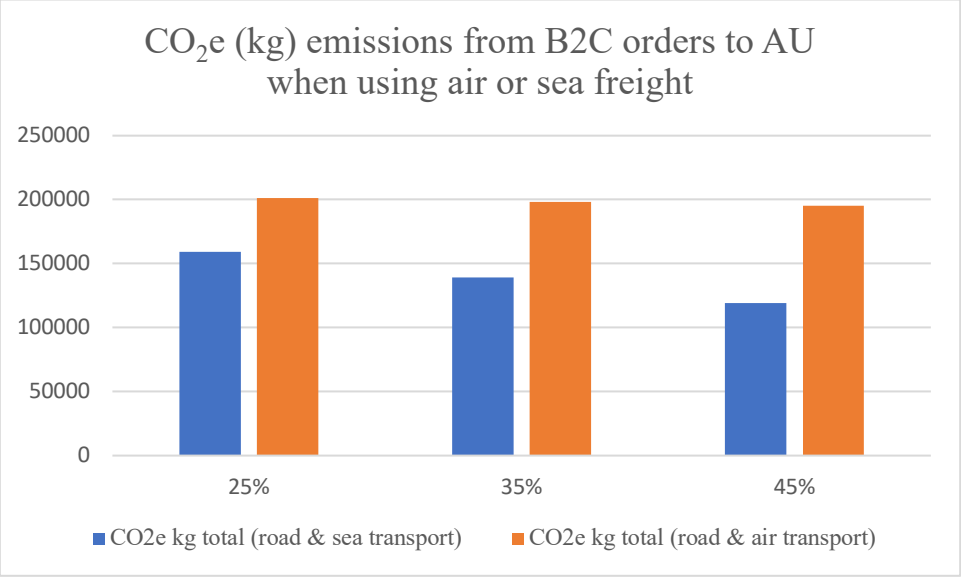

Figure 6.10: The change in CO_2e emissions on the total B2C orders (20 000) over different percentages of OC orders to Australia when also comparing the transport modes sea and air.

7. Analysis and Discussion

As it is explained by The International Transport Forum (2015), the demand from customers of fast and cheap deliveries has led to increases in emissions coming from the transport sector. This is something that the fashion company Nudie Jeans has started to investigate further, and to address these issues they have implemented an OC distribution system. The company has since its start had a big sustainability approach, but just as Bernoville (2020) states, companies need to monitor their CO_2 emissions to reduce their carbon footprint. Therefore, by looking over the current transport routes and modes, the company can make well-informed decisions that might lead to lowering their environmental impact coming from transportation. In the case of Nudie Jeans, it was found that there is a relationship between volumetric weight and CO_2e emissions regarding transportation. This showed that sending larger shipments results in lower emissions per kilo compered to sending individual shipments from the DC to the end customer. In the case it was also found that the last sparts of the deliveries do not have a clear effect unless the transport mode was to change. In the following sections the link between the literature and the results of the case study have been further investigated and discussed.

7.1. Distribution channels

As was mentioned by Chopra (2018), to adopt a well-functioning OC, a retailer needs to make extensive changes in its logistics and supply chain networks. According to Nudie Jeans omnichannel coordinator they have changed many parts of its processes and procedures during the implementation of the OC system. Furthermore, the omnichannel coordinator explains that due to the OC system they e.g., must work more intergraded between departments, change how they work in the stores, learning new systems and increase the inbound deliveries to the OC stores, etc. However, there are more things they can do, for example in the logistics part of the organization. Even though they are using LSPs for their transport, they have not done an extensive change in that area. Some changes have been made but they are, e.g., using the same routes and transportation modes as before the implementation for the larger flow of inbound logistics. This is a section of their logistics distribution where some changes could be made that would make an impact on the CO_2e emissions, as it can be seen in the results section with the different scenarios, but possible also make it less expensive for Nudie Jeans as they are lessening the number of shipments. However, there are some problems with making changes regarding transport mode, a change to, e.g., sea transport to Australia would come with longer lead times. It was mentioned both by the COO and the environmental manager that this would be a problem due to the planning and launches of collections. There are some things they could do about this; one thing would be to have a more extensive standard assortment, that is not changing over the seasons. Nevertheless, this affects other parts of the organization, such as the designers, and in that turn, the factories, and the suppliers. Thus, changing to a slower transport mode may require a more considerable change in other parts of the organization.

Saghiri et al. (2017) mention different stages in the retail process that the company should consider when it comes to integration in an OC system: pre-purchase, payment, delivery, and returns. They mentioned several possibilities for integration along all these stages, and that an

ideal OC system should have integration between all these stages. In the case of Nudie Jeans, now they have integration between most of the stages, but they are having some problems with "omnifying", as the COO calls it, the returns, indicating that the returns are not fully intergraded in the OC system currently. However, the deliveries also have more possibilities for integration; this could be, e.g., a *click and collect* system or other forms of delivery systems. According to their omnichannel coordinator, the *click and collect* delivery system is something Nudie Jeans will implement soon. They are working on and exploring more possibilities of integration in the different stages that are mentioned by Saghiri et al. (2017). When it comes to the case of the returns in OC retailing management, there seem to be some problems in the case of Nudie Jeans, and this is something that Bernon, Cullen, and Gorst (2016) also point out as being a weak spot of the OC and multi-channel delivery systems. The authors mention the problem is that the returns usually need to go back to the origin-destination. Moreover, this is precisely the problem that the COO of Nudie Jeans mentioned during the interview. However, Hübner, Wollenburg, and Holzapfel (2016) mean that there is some more flexibility in an OC approach than in a multi-channel approach, where the products could be returned in a store, which is something that Nudie Jeans use now. Also, Frei et al. (2022) talk about the problem with the returns in a multi or OC distribution system. As mentioned by them, much of the complexity seems to come from IT problems, and this was something that the COO of Nudie Jeans talked about; they are having problems with that some systems do not interact perfectly, and this is causing problems with the returns. The company is currently trying to fix the problem, but they explained that it is not an easy problem to fix.

Wollenburg et al. (2018) argue that a retailer's OC grow and changes with its volume of orders. This could be seen with the change to an OC system at Nudie Jeans; however, not in the same way that Wollenburg et al. (2018) mean it should grow. Nudie Jeans goes the opposite way, from a centralized warehouse solution to an OC with rising online volumes and not from a *Bricks and Mortar* logistics network to a centralized warehouse dedicated to online orders as described by the author. Something this could depend on is that the Wollenburg et al. (2018) study was conducted in one country and not on an international market as in the case of Nudie Jeans, but also that the goal for Nudie Jeans was to lessen the number of single shipments from the DC in Sweden to B2C customers which could not be done by the model suggested by Wollenburg et al. (2018). In the study by Prabhuram et al. (2020), it was found that there was no significant difference between the different distribution networks they presented in their study when it comes to factors such as service level and cost factors, including subfactors, e.g., transportation cost, returnability, and response time. However, even though this study does not look at these factors of a change to an OC system. The results show a difference in some areas, e.g., CO_2e emissions and possibly also transportation time, due to the shorter distance to the end customer. However, the parameters of Prabhuram et al. (2020) paper and the case of Nudie Jeans have its differences, but even though Prabhuram et al. (2020) do mention that of all different OC systems they investigated, the one that is fully intergraded and using all nodes for deliveries is the one with the best performance. Furthermore, this is what Nudie Jeans aims for; however, as mentioned before, Nudie Jeans is just at the beginning of the implementation of its OC system and has still some work before reaching full integration.

As mentioned in the literature review of this thesis, there is more than just OC distribution that utilizes more than one channel (Zang et al., 2016). In the case of Nudie Jeans, they have used a multi-channel system before implementing their OC system for the distribution of their products, with online stores, physical stores, and third-party wholesalers. Furthermore, as mentioned by Zang et al. (2016), a multi-channel system has many advantages over a conventional single or dual-channel approach when it comes to aspects such as (1) transportation and operational cost, (2) customer service and coverage, and finally (3) environmental impact. In addition to this, the result shows that an OC system outperforms a multi-channel system in the environmental impact, at least in the case of Nudie Jeans, based on the parameters used in the calculations. If applied to a different company, the result may look different; however, if the same parameters are used in the calculations, maybe not. Moreover, the other two aspects that Zang et al. (2016) mentioned could also be impacted by a change to an OC system; though, that is outside the scope of this thesis.

7.1.1. Integration

As mentioned in the literature review, one element of distribution networks and channels that is brought up is the concept of integration in OC. However, the integration comes with complexity. As it was mentioned by Melacini and Tappia (2018), having a dedicated online channel with integration to other channels offers a low level of complexity, and the more integration, the more complexity. Furthermore, according to Melacini and Tappia (2018), the integration of channels is correlated to higher performance and often comes with synergies, higher sales, and growth. This is not something that was brought up that much during the interviews with Nudie Jeans; however, the omnichannel coordinator mentioned how the change to an OC has led to more integration and complexity over different business areas of Nudie Jeans, and they are now working in a more integrated way then they did before. Also, the environmental manager mentions that the change has led to more integration and collaboration within the company. Furthermore, it was also mentioned that the change has led to their finding that they may need to rethink how they work with some areas they did not think would be affected by the change. So, one could conclude that in the case of Nudie Jeans, the change to an OC adds more complexity to the organization and that it has also come with other aspects, e.g., integration inside the organization and widening of thoughts for future possibilities. This is in line with what was mentioned by Melacini and Tappia (2018).

As Nudie Jeans has many stores around the globe, an OC integration into their retail system is a way, according to Hübner, Kuhn, and Wollenburg (2016), for them to make a fast expansion of their business with low investment as they can use their existing facilities for picking and warehousing. They also mention that it allows the retailer to get closer to the customer and have shorter transport to the end customer. However, in the case of Nudie Jeans there will not be a difference in the length of the transport; if they send the shipments for the DC in Sweden or from the store closest to the customer, as products still need to be transported to the store. Moreover, currently with Nudie Jeans, the inbound deliveries and the outbound B2C deliveries from the DC in Sweden take the same route, this applies to both Australia and the UK. It might be different in their other markets, but that is outside the scope of this thesis. Nevertheless,

when it comes to serving the customer faster, it is true in the case of Nudie Jeans, as the shorter distance enables faster deliveries. Moreover, if they choose to use, e.g., electric vehicles for this part of the delivery, it will lessen the environmental impact even more than just the reduction that comes from using the OC system that can be seen in the result. In addition to the environmental benefit of integration, Melacini and Tappia (2018) show that there are economic benefits of integrating online and offline stores when it comes to warehousing and transportation. Furthermore, they also point out that the economic benefit is even larger than the environmental one; however, this is outside the scope of the thesis and the interviewees did not bring up the economic aspect of the OC change; one can only speculate if they have had an economic benefit from the change. One saving could, e.g., be the fewer single shipments sent, possibly reducing the cost per sent package, following the concept of economy of scale.

7.2. Omnichannel supply chain

In the literature review it is highlighted how an OC supply chain can entail both advantages and disadvantages. It was explained by Wollenburg et al. (2018) that certain customer demands are becoming increasingly important as technology is developing and more products are available. This is especially regarding the delivery times, product assortment, and availability, which is something that also was brought up during the interviews with the Nudie Jeans employees. They want to be able to provide fast deliveries to their customers, doing so in a sustainable manner, while also having the possibility to offer their entire range no matter where their customer is located basically. Both aspects have previously had their challenges as it is not realistic to offer all styles in all sizes in the different stores and due to the DC being in Borås the delivery times can vary depending on where the order is being shipped. As it was brought up by Niranjan et al. (2019), companies must evaluate what measures they are willing to take to meet the customer demand although also consider sustainability. It was argued in the literature review that OC supply chains often comes with increased costs, mainly from inventory and facilities. This was also highlighted during the interviews, as it was stated that store space, especially in central London, is quite expensive and by implementing this new distribution structure, it might be necessary to expand to be able to hold enough inventory. It is therefore a question of whether it is worth investing this money to be able to provide services to customers which could entail a higher customer demand. From the article by Chopra (2018) it was explained that this added value to the customer must somehow exceed the costs of performing the service, only then an OC supply chain can be successful. Thus, by implementing a distribution network where the customer can get their orders faster, and perhaps to a cheaper price, there will be a higher degree of customer satisfaction while also finding possibilities to lower costs.

Besides the complications related to costs regarding inventory and facilities, there is also the cost and environmental impact of transport. In contrast to the literature stating that an OC supply chain can see increased costs in some areas, it also showed that the costs related to transport often were decreased. Although this report has not focused on the costs in the case of Nudie Jeans, it is something that should be investigating as the results points at fewer long-distance transports. This is often due to having more warehouses, or hubs, which indicates shorter

transportation to end customers. However, it is mentioned by Chopra (2018) that there need to be a balance between the transportation distances and number of retail stores or warehouses, as both have a significant impact on the costs.

7.3. Transport and emissions in OC distribution

One of the factors that stood out in the reviewing of the literature regarding transport and distribution in connection to multi and OC distribution was the flexibility that an OC distribution offers compared to using a multi-channel distribution Hübner, Wollenburg, & Holzapfel, 2016). This is seen in the case of Nudie Jeans, where their distribution is in the process of going from a multi-channel to an OC. One can see that the change has offered more flexibility in the choice of how to distribute orders. This change means they now have more than one choice of point origin for their B2C shipments, allowing them to get closer to the end customer and opening up for more delivery options, as they are planning to do with the coming startup of the *click and collect* service. The possibility of having more delivery options that comes with implementing an OC system is also discussed in the literature, e.g., by Hübner, Wollenburg, and Holzapfel (2016) and Hübner, Holzapfel, and Kuhn (2016). Furthermore, as discussed earlier, this is something that Nudie Jeans is working on, and more delivery options may also attract new customers that possibly prefer to collect in-store instead of getting home delivery or picking up at a pickup point.

One part of why the change to an OC system for Nudie Jeans was the goal of reducing the emissions from the transportation, and as the result of this thesis shows, there seems to be a reduction in CO_2e emissions when changing to an OC system from a multi-channel system. Moreover, this is in line with the results of Melacini and Tappia (2018) and Sousa et al. (2021) studies that showed that an OC system is seen to have lower emissions compared to other forms of delivery systems they investigated. In addition to the lower levels of emissions, Sousa et al. (2021) also mean that an OC increases the efficiency of the transport. In the case of Nudie Jeans, they have not now made any more considerable changes in their transportation routes or modes, leaving the efficiency at that end of the transport chain somewhat unchanged except that the shipments contain larger volumes and are fewer in numbers. So, this is a step in the transportation chain where Nudie Jeans can work on increasing the efficiency and decrease their emissions by making transport mode changes or/and changing load factors, as can be seen in section 6.4 of the results. By doing changes in these areas, they will possibly increase the efficiency and lower the emissions. If one were to look at the other end of the transport chain, the outbound shipments they have made an increase in efficiency as they are now closer to the end customer and can ship things faster, and if Nudie Jeans choose vehicles with low or non-emissions outlet, e.g., electrical or bicycle for the last parts of the delivery they are able to lower the CO_2e emissions even further.

The question of the last mile is something that was brought up by Buldeo Rai et al. (2019) as it could possibly affect the transport chain emissions. Buldeo Rai et al. (2019) means that the choice of LSP for the last mile is an important decision and this was brought up during the interviews with Nudie Jeans. It was stated that they could make a change regarding the LSPs

but that they do not have the power to set demands on the LSPs and their emissions, when only being a smaller company. Nevertheless, perhaps when it comes to the last mile distribution, especially now when they are shipping from local stores to the end customer, they have a wider choice of what demands they can have on the transporter when it comes to the emissions from the shipments. When they are working on a local level through the OC system, there may be an opportunity to be more selective of what vehicles they use. However, there is always the consideration of contracts with LSPs and deals that may be more economically beneficial that may prevent the flexibility of choice.

One part of OC distribution that was brought up by Chopra (2018) was the possibility that an OC system would lead to higher transportation costs due to less consolidation of parcels and that it would lead to higher costs for inventory. When looking at the case of Nudie Jeans, the question about the cost of transportation and inventory is nothing that they have brought up. However, as they are using UPS and Australian Post as their LSPs in the case of the UK and Australia the problem with less consolidation does not seem to be as big of a problem, as both are big freight companies. The question of the increased cost of inventory, Nudie Jeans may have increased its inventory by moving it to maximize the storage capacity of the stores. By having more storage facilities, they need to have a more extensive inventory to handle orders from all the hubs. Nevertheless, as their channels are intergraded via the OC system, if one product does not exist in the nearest store, maybe it is in stock in the second closest, or at the DC in Sweden. By this integration, they can still satisfy online customers even if one of the OC hubs is out of stock. Another part of inventory costs is the cost of facilities and land. Nudie Jeans are with the OC change utilizing more of their already existing facilities. However, as the COO said in the interview, the storage capacity in London is small, and the cost of retail area in central London is high. Furthermore, if they were to need to have a larger storage capacity in London, this may come with higher facility costs. Though, currently they have three stores in London that they can use as hubs.

Regarding the distribution concept of *ship from store* that Nudie Jeans mainly use for the OC distribution, the literature is a little bit divided. For example, Jones et al. (2021) argue that the *ship from store* concept: not only does this entail shorter transportation routes and thereby lowered CO_2 emissions, but it can also result in faster deliveries. This is very much in line with the result of this study when it comes to the CO_2e emission at least, but also the faster deliveries. However, in the case of Nudie Jeans, the part about shorter transport is not true as the goods still need to get to the stores somehow. Moreover, the DC is still located in Sweden, so the distance will always be the same. Nevertheless, the distance of the actual B2C order may be shorter, even though the goods still have the same mile traveled if one considers the inbound shipment. Also, Adivar, Hüseyinoğlu, and Christopher (2019) and Sousa et al. (2021) seem to see that the concept of using the stores as hubs for distribution comes with benefits, Sousa et al. (2021) moreover mention the benefit of sending larger shipments to the stores as there already is a natural route between stores and DC. By sending larger shipments, one can take advantage of fuller vehicle loads and get more efficient shipping. This is also in line with the results, Nudie Jeans are taking advantage of the already existing route to the stores and just increasing the volume on the inbound shipments. It is by this increase of volume for the inbound

shipments that it was found a reduction of CO_2e emissions in the OC system compared to the previous multi-channel system. When looking at the less positive aspects of the *ship from store* concept, Chopra (2018) brings up that the distribution more gets decentralized and requires a more significant focus on last-mile deliveries, which could cause higher costs. However, in the case of Nudie Jeans, the decentralization may be a good idea as they are a global retailer and have their DC in Sweden, which is located far away from some of their markets, e.g., Australia, and by decentralizing they are getting closer to the end customer.

In the case of Nudie Jeans, the change to an OC system have according to the result helped them reduce the CO_2e emissions from transportation, minimized the number of individual shipments and instead send fuller vehicle loads. The change has also helped them getting closer to the online customer. In the context of transportation and emissions the change has been a good move for Nudie Jeans, however they still have some things they can work on regarding transport to lower the emissions even more e.g., looking into change the transport modes.

7.4. Advantages and challenges in OC distribution

When deciding on making an investment and implementing a new system, approach, or solution it is essential for the company in question to consider both the advantages and challenges that comes with it. In the case of OC distribution, the main objective for an implementation tends to be customer satisfaction, which is highlighted by Chopra (2018) who states that the customer is the main driver. Although, there are also other factors needed to be considered, e.g., costs and environmental impact. In the case of Nudie Jeans, the biggest reason of transforming towards OC distribution was to minimize their environmental impact through emissions. It was brought up during the interviews with the company's COO and environmental manager that, today, a lot of the B2C packages are being shipped from the DC in Borås by air freight. Which is something that results in a large amount of CO_2e emissions, and as it is company where sustainability is a part of their core values, the transportation needs to be considered alongside other factors. What could be found in the quantitative results is that by implementing an OC distribution system it is possible to lower the emissions in different ways. The first, that still utilizes the same transport modes as previously, is related to the volume and weight of the shipments, the volumetric weight. By shipping larger shipments where the load factor is high it was found that the total CO_2e emissions were lower than when shipping the B2C orders individually from the DC. Thus, by having smaller hubs closer to the end customer, the company in question can utilize larger shipments which later is distributed from the store in which the hub is located. Another possibility to lower the emissions, especially regarding the transportation to Australia, is by changing the air transports to sea freight, which would result in immensely lower emissions.

Besides the wish, and need, to lower the emissions coming from the transports, the omnichannel coordinator at Nudie Jeans stated that an OC can help achieving faster deliveries, which aligns with what was brought up by Chopra (2018); Wollenburg et al. (2018); Hübner, Kuhn and Wollenburg (2016). However, even though this is a driver for OC distribution, it is essential that it is well developed for the specific company in question and for the customer needs. It was

explained by Wollenburg et al. that expanding to several warehouses could lead to lower economies of scale, which makes it even more important to create the added value for the customer to balance the added costs. Although for the case company Nudie Jeans it should be possible to lower costs related to transport and shipping if the goods are sent in bulk instead of individual packages – though this has not been further explored in this study. However, what is special about the OC structure that Nudie Jeans has approached is that they utilize the concept of *ship from store* which entails that their already existing retail stores are used as a mini warehouse, or hub. Thus, depending on to which degree they will implement OC shipments, there are not any big changes in costs related to facilities if they do not need to expand to larger stores. Nonetheless, there will be an additional task for the store employees as they also will need to handle the orders that are shipped to customers from the specific store, which could result in higher costs.

In addition to the factors that can be affected by the company implementing an OC structure, e.g., costs related to facilities and emissions from inbound and outbound transportation, there are also some factors that are out of the company's reach to affect. In the article by Buldeo Rai et al. (2019) customer trips were highlighted as an important aspect to consider when utilizing certain OC approaches where the customer must travel to the store. The emissions from these trips are close to impossible to calculate due to the reason of not knowing what transport mode is used to get to the retail store. This can be connected to the struggle of last mile deliveries which can be found in the quantitative results, as there is not a clear difference in emissions between before using implementing an OC distribution system and after. The reason for this is that the last part of the transport chain will be the same in both scenarios as the orders will be packaged individually and shipped to the end customer, most likely in a relatively small vehicle depending on the distance from the hub. However, there are certain factors that can affect the emissions which have not been considered in this study, e.g., using hybrid or electric vehicles or simply using alternative transport modes that has a lower environmental impact than trucks or vans.

7.5. Method discussion

As mentioned in the methods and methodology section, semi-structured interviews can achieve a high level of validity under the right circumstances. In this case, the questions were formed to get an understanding of a certain topic and get as much information as possible from the interviewees. However, the validity could be questioned based on not using the same questionnaire for all interviewees. Nonetheless, this was a thought-through decision to be able to get all information needed, as the interviewed persons have different roles in the company. Additionally, validity refers to the generalizability of a study and how applicable it is to other situations and scenarios. Even though this thesis focuses on one company, the calculator used will provide results within the same scale if the same parameters are used, no matter the company. This entails that this study is generalizable to some extent, but it is essential to consider that another company will have a different outcome as different data is used.

Then it comes to the reliability of the results and measurement used in the calculation of this study, and it seems to be relatively reliable as the instrument used for the calculations of CO_2e is a well-known instrument. The NTMcalc has been used in research projects on similar topics, e.g., transportation mode shifts and emissions or external costs from transportation (Van Fan et al., 2018; Petroa, & Konečnýa, 2017; Vierth, Sowa & Cullinane, 2019), and seem to have reliable results when analyses are being replicated. However, as the calculator offers multiple choices of different parameters and models for conducting the calculations, the results rely heavily on the choice of parameters. To see how the results could be affected by changes in the different options of parameters, several tests were conducted. These can be seen in sections 6.4, Appendix 5, and Appendix 3. These tests provided a foundation of how the calculations would look like when using different models and tweaking the default parameters and giving an understanding of what method and parameters would fit for the calculations in this specific case. Another thing that could have improved the reliability of the study would be to try out other calculators and see if the results still were the same or similar.

In addition to the calculator itself, there is also the question of if the data provided to the calculator is reliable. Most of the examples and calculations in the result section are based on several assumptions and averages about the size and weight of the shipments. Some of these averages and assumptions were provided by Nudie Jeans, e.g., the average weight of a pair of jeans and the standard B2C shipment package. However, many of the assumptions and averages were calculated from the data provided. To get any clue if these averages were within reason for what the reality looks like, during the interview with the COO, these averages were brought up to get her opinion on them. Moreover, what it seemed like from her point of view, the assumptions on a standard inbound shipment to the UK and to Australia that was used in the result is a somewhat accurate representation of an average inbound shipment. As the interview with the COO was held after completing the calculations, this was, in addition to asking the interview questions (see Appendix 1), an opportunity to ask questions about how the operations look like and if the assumptions on them were correct.

When it comes to the choice of method for this thesis, a case study is probably one way to go as it offers an in-depth approach to the investigated problem. Furthermore, by having a mixed-method approach, there was an opportunity to go deeper into the underlighting reason for changing to an OC distribution, as it provides context to the results. Things that could have been changed with the methods would, for example, be to add more interviews, especially with the OC operation stores, as this would provide a more hands-on context to the OC operations. However, as this is outside the scope of what is needed to answer the research question, it would only be adding to the context and not to the actual results.

8. Conclusion

As the objective of this study was to get an understanding of how a change from a multi-channel distribution with centralized warehousing to an OC distribution would affect emissions coming from transportation. The following research question was used "*How can a change in distribution channels impact the CO_2e emissions of a company's B2C logistics when moving from centralized warehousing to an omnichannel distribution system?"*.

After analyzing the data provided by the case company Nudie Jeans with the aid of NTMcalc, it became clear that there is a connection between the volumetric weight related to the CO_2e emissions. By utilizing the already existing stores in London, and Sydney as distribution hubs, it is possible to send larger inbound shipments to the stores that are later distributed to the end customer. This entails that a higher load factor can be achieved, thus minimizing emissions according to the result of this study. Although, it was also found that the last parts of the transport chain to the end customer do not directly impact the outcome of this study if the transport mode or vehicle size stays the same. In this regard it could be beneficial to look at alternatives such as hybrid or electric vehicles. In addition to the alteration of existing routes and transport modes when changing towards larger shipments, other alternatives were also explored. Here it was found that not only the load factor plays an essential role, but also that the mode of transportation. By switching to a larger vehicle with and a higher load factor, the emissions can be lowered as the shipment, in this case by Nudie Jeans, will account for a smaller percentage of the total emissions caused by the vehicle. However, by solely switching to larger shipments the environmental impact from transport will lessen and the additional alternatives is something that case company can further investigate in the future. Though as discussed by the interviewees from Nudie Jeans there are other complications that may arise when changing mode or sending larger quantities. Some of the complications that was brought up concerned the problems with longer lead times that for example sea transport to Australia entails, as well as the potential problem with needing more storage space in London that may come with higher investments.

Further, different percentages of omni-distributed orders were investigated: 25%, 35%, and 45%. After making these calculations it showed that the curve is linear—implying that there is not an optimal percentage of omni-distributed goods but rather a question of capacity and level of centralization. Thus, it is more beneficial for Nudie Jeans to explore how the different percentages affects the company and based on that decide what is the optimal amount of omni-distributed goods.

Based on the analysis and discussion it could be found that many points align with what has been brought up in previous literature regarding OC distribution, its drivers, and barriers. However, there are some differences although most of these most likely is due to the context of this specific case. Both the literature and Nudie Jeans brought up that the implementation of OC is largely due to meeting customer demands regarding fast deliveries. Another aspect that was brought up from both sides was the potential increased costs related to facilities, as more warehouse space is required. However, it is important to note that this thesis is focusing on one

specific case regarding one company, Thus, if another company, case, or market would have been investigated the results might have been different although some results probably would have been similar. There is also the factor of what type of product the case is concerning, in this case being clothing items. There would have been other aspects to consider if other types of products had been considered, e.g., fresh produce or high value goods.

The final conclusion of this study is that the problem that Nudie Jeans wanted have solved could be achieved through analysis and calculations. These showed that utilizing multiple channels through an OC system could help in the quest of reducing emissions coming from transport. This is also something that other companies in similar situations could apply.

8.1. Limitations and future studies

Several limitations were identified when conducting this study, both in the initiating stage and throughout the process. A broader perspective on OC could have been achieved if additional markets had been investigated besides Australia and the United Kingdom. Although this is considered as the scope for this study, it has also limited the results. Besides just looking at two markets, the implementation of OC distribution at the case company is in its initial state, which entails that there could have been a different outcome if more data had been available, and the structure was fully integrated. E.g., what would the results be if a concept such as *click and collect* was implemented? Another vital aspect to consider is that this thesis only investigates one case company, and if another or several companies were to be studied, the results might have been affected. Thus, it is not certain that the results can be fully generalized as this study only looks from one perspective. However, as the NTMcalc is used, the results should follow the same lines if the same calculator and parameters are used.

Asides from the limitations related to the chosen case company, there are also some related to the choice of emissions calculator. Although it can be assumed that the results would be similar in a different calculator, this has not been tested. Several assumptions were made regarding transport mode, vehicle size, volume, and weight to do the calculations, limiting the accuracy of the results. The thesis was also limited in the sense that only shipments from the DC were included, thus excluding inbound shipments directly from the manufacturer to the stores. Lastly, there was not much information regarding the LSPs regarding, e.g., the location of the consolidation points.

As this thesis does not investigate all aspects of OC distribution, several other areas can be of interest in future studies. Firstly, by looking further into the OC process, an even deeper understanding of its drivers and barriers can be achieved. It can also entail a better foundation for companies contemplating changing their supply chain. In addition to this, it can be beneficial to explore how the last parts of the transport chain or how the last mile affects the emissions in an OC distribution by comparing different transport modes and finding alternative solutions. From a broader perspective, this study focuses on the distribution aspect of OC. Therefore, it could be interesting to look at other areas, e.g., costs and technology.

One thing that would be interesting to investigate in future studies would be to include other perspectives from other parts of the supply chain; one such example would be to include interviews with freight forwarders, LSPs, and employees in the stores included in the implementation. This would give more insight into how the process works and more detailed data from the LSPs on the type of vehicle, transport mode, and other vital aspects of the transport chain that could be included in the calculations. For the case company Nudie Jeans, it could be helpful to investigate what effects the implementation would have in different markets as they all come with their own set of challenges. This could be related to, e.g., transport modes or sales volumes.

Moreover, even though the result of this thesis is derived from data from the case company, the result could possibly be generalized to other retailers that are doing an implementation of an OC distribution. The calculation could be applied on cases; however, this will need to be further investigation to see how the model stands if other data was inserted. This study can also act as a contribution to the literature regarding OC distribution and its environmental impact. Yet, the investigated area of topic could be further developed.

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Appendix 1 – Interview guides

Omnichannel coordinator: Omni & distribution

1) How does Nudie Jeans work with distribution and different channels today? (*Hur jobbar Nudie Jeans med distribution och olika kanaler idag?*)
   a) What did it look like a couple of years ago? *(Hur såg det ut för ett par år sedan?)*
2) Why did you choose to start with omnichannels? (*Varför har ni valt att börja med omnikanaler?)*
   a) What is Nudie Jean's goal in having omnichannels? *(Vad är Nudie Jeans mål med att ha omnikanaler?)*
   b) What is the biggest change now that you have switched to omnichannels? *(Vad är den största förändringen nu när ni har gått över till omnikanaler?)*
3) What are the plans for the future regarding omnichannels? (*Hur ser er planer ut för framtiden gällande omnikanaler?)*
4) Have you encountered any problems with the introduction of omnichannels? (*Har ni stött på några problem med införandet av omnikanaler?)*
   a) How have these problems been handled? *(Hur har ni hanterat eventuella problem?)*
5) What positive effect have omnichannels had so far? *(Vad för positiv effekt har omnikanaler haft hittills?)*

Environmental manager: Sustainability & The future

1) Can you tell us a little bit about Nudie Jean's sustainability work? *(Kan du berätta lite kort om Nudie Jeans hållbarhetsarbete?)*
2) What is the biggest challenge for Nudie Jeans in maintaining a sustainable business? (*Vad är den största utmaningen för er att upprätthålla en hållbar verksamhet?)*
3) How do you act as a company to attack scope 3? (*Hur agerar ni som företag för att angripa scope 3?)*
4) What does the future hold, what are the top priorities? (*Hur ser framtiden ut, vad är era största prioriteringar?)*
5) What are your requirements for you have on your carriers, regarding sustainability and emissions? (*Vad har ni för krav på era transportörer, gällande hållbarhet och utsläpp?)*
   a) Is it possible for you to make demands or are you bound to their offers? (*Är det möjligt för er att ställa krav eller får ni utgå från deras utbud?)*

COO: Operations & The future

1) What is the long-term plan for Nudie Jeans and the implementation of omni-channels? (*Vad är den långsiktiga planen för Nudie Jeans och implementering av omni-kanaler?)*
   a) What do you want to do for changes regarding transport and distribution? both inbound and outbound transports (*Vad vill ni göra för förändringar gällande transport och distribution? Gällande både inbound och outbound).*
2) Have you considered alternative means of transport for those you are currently using? (*Har ni funderat på alternativa transportmedel till dem som ni använder för tillfället?)*
3) Are there any plans to switch from flight to boat for transport to Australia? (*Har ni planer på att byta från flyg till båt för transporter till Australien?)*

a) Where is it because you have not used a boat that much before and what is the biggest difficulty? (*Var beror det på att ni inte har utnyttjat båt så mycket tidigare och vad är den största svårigheten?)*

4) How much of the shipments go directly from the factory to the UK and AU? (*Hur stor del av era sändningar går direkt från fabrik till UK och AU?)*

5) Is the idea that omni-orders in the future will reduce / replace express orders from DC to the UK, as these are shipped by air? (*Är tanken att omni-order i framtiden ska minska/ersätta expressorder från DC till UK, då dessa skeppas med flyg?)*

Appendix 2 – Calculations for the average shipment

Details on the calculations used in the calculations for the inbound average shipment to the UK

$$0{,}312\ (\text{kg})CO_2\text{e} * 186\text{kg}\ =\ 58{,}032\ (\text{kg})CO_2\text{e}$$

$$\frac{43{,}205(\text{kg})}{186(\text{kg})} = 0{,}232(\text{kg})CO_2e$$

$$\frac{43{,}205\ (\text{kg})}{266(\text{pcs})} = 0{,}16(\text{kg})CO_2e$$

Details on the calculations used in the calculations for the inbound average shipment to Australia.

$$10{,}46\ (\text{kg})CO_2\text{e} * 474\text{kg}\ =\ 731{,}57(\text{kg})CO_2e$$

$$\frac{4226{,}47(\text{kg})}{474(\text{kg})} = 8{,}9166(\text{kg})CO_2e$$

$$\frac{4226{,}47(\text{kg})}{677(pcs)} = 6{,}24(\text{kg})CO_2e$$

Appendix 3 – CO_2e (kg) emissions based on weight

The Figure 1 show fictional weights used in the NTMcalc for the UK standard route, as can be seen, the emissions are linear. Meaning that the emissions are continuously following the same line no matter the weight of the cargo. This entails that it does not matter if a shipment of one order every day or twenty orders each day is sent, as it would end up with the same number of emissions in the end. The tables (1, 2 & 3) are the basis for Figure 1.

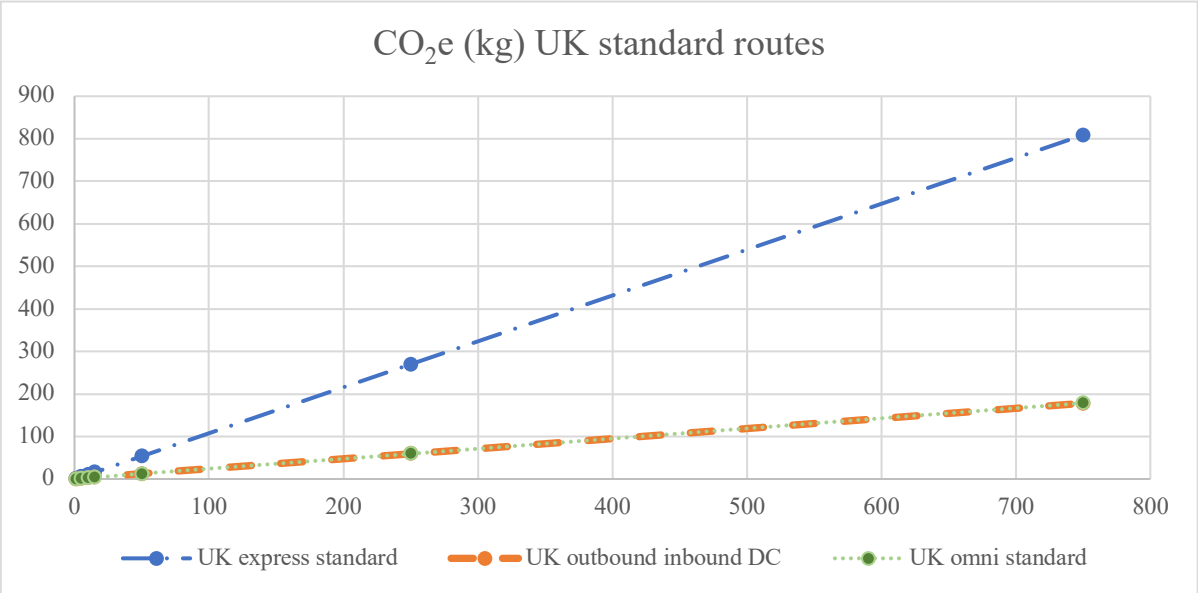

Figure 1: Diagram over CO_2e emissions from Borås to London for the different delivery options. The calculations are based only on the weight of the shipment.

Table 1: Transport route for outbound and inbound deliveries from Borås to London standard delivery. Specifying transport modes, distances, and emissions.

Borås, SWE --> London, UK (inbound and outbound from DC) KG					
Route	Borås, SWE - Mölndal, SWE	Mölndal, SWE - Glostrup, DK	Glostrup, DK - Stanford Le Hope, UK	Stanford Le Hope, UK - London, UK	Borås - London
Distance (km)	63,74	318,19	1 369,06	42,69	1 793,68
Transport mode	Rigid truck < 7,5 t	Rigid truck 14-20 t	Rigid truck 14-20 t	Rigid truck < 7,5 t	-
CO2e (kg) 1kg shipment	0,01127	0,0412	0,1773	0,007549	0,237
CO2e (kg) 5kg shipment	0,05636	0,206	0,8863	0,03774	1,186
CO2e (kg) 10kg shipment	0,1127	0,412	1,773	0,07549	2,373
CO2e (kg) 15kg shipment	0,1691	0,618	2,659	0,1132	3,559
CO2e (kg) 50kg shipment	0,5636	2,06	8,863	0,3774	11,864
CO2e (kg) 250kg shipment	2,818	10,3	44,32	1,887	59,325
CO2e (kg) 750kg shipment	8,453	30,9	133	5,662	178,015

Table 2: Transport route for outbound deliveries from Borås to London express delivery. Specifying transport modes, distances, and emissions.

Borås, SWE --> London, UK (express outbound)					
Route	Borås, SWE - Mölndal, SWE	Mölndal, SWE - Sturup, SWE	Sturup, SWE - Stansted, UK	Stansted, UK - London, UK	Borås - London
Distance (km)	63,74	318,19	1 015,00	63,38	1 460,31
Transport mode	Rigid truck < 7,5 t	Rigid truck 14-20 t	Air - Continental	Rigid truck < 7,5 t	-
CO2e (kg) 1kg shipment	0,01127	0,0412	1,015	0,01121	1,079
CO2e (kg) 5kg shipment	0,05636	0,206	5,073	0,05604	5,391
CO2e (kg) 10kg shipment	0,1127	0,412	10,15	0,1121	10,787
CO2e (kg) 15kg shipment	0,1691	0,618	15,22	0,1681	16,175
CO2e (kg) 50kg shipment	0,5636	2,06	50,73	0,5604	53,914
CO2e (kg) 250kg shipment	2,818	10,3	253,7	2,802	269,620
CO2e (kg) 750kg shipment	8,453	30,9	761	8,406	808,759

Table 3: Transport route for outbound deliveries from Borås to London OC delivery. Specifying transport modes, distances, and emissions.

Borås, SWE --> London, UK (inbound and outbound from DC) omni						
Route	Borås, SWE - Mölndal, SWE	Mölndal, SWE - Glostrup, DK	Glostrup, DK - Stanford Le Hope, UK	Stanford Le Hope, UK - London, UK	London, UK - Seven Dials Store	Borås - Seven Dials Store
Distance (km)	63,74	318,19	1 369,06	42,69	1,07	1 794,75
Transport mode	Rigid truck < 7,5 t	Rigid truck 14-20 t	Rigid truck 14-20 t	Rigid truck < 7,5 t	Van	-
CO2e (kg) 1kg shipment	0,01127	0,0412	0,1773	0,007549	0,0008672	0,238
CO2e (kg) 5kg shipment	0,05636	0,206	0,8863	0,03774	0,004336	1,191
CO2e (kg) 10kg shipment	0,1127	0,412	1,773	0,07549	0,008672	2,382
CO2e (kg) 15kg shipment	0,1691	0,618	2,659	0,1132	0,01301	3,572
CO2e (kg) 50kg shipment	0,5636	2,06	8,863	0,3774	0,04336	11,907
CO2e (kg) 250kg shipment	2,818	10,3	44,32	1,887	0,2168	59,542
CO2e (kg) 750kg shipment	8,453	30,9	133	5,662	0,6504	178,665

Appendix 4 – Visualization of Volumetric CO_2e emissions.

In Figure 1, the diagram shows the results from the NTMcalc calculations for UK standard route, Figure 2 the calculations for the UK express route and Figure 3 the calculation for the standard rout to Australia. The figures are a visualization of the CO_2e emissions in kg (vertical axis) and the weight of the shipment in kg (horizontal axis). The different lines represent the size of the shipment in volume (m3). The reason that most of the lines do not show all weights depends on that it would not be any reason for Nudie Jeans to send a shipment of e.g., 0.01m3 *50kg or 100kg. The different weights and volumes in the diagram are not representing actual orders sent by Nudie Jeans but are just to show what happens to the CO_2e emissions for the shipments of different sizes and weights.

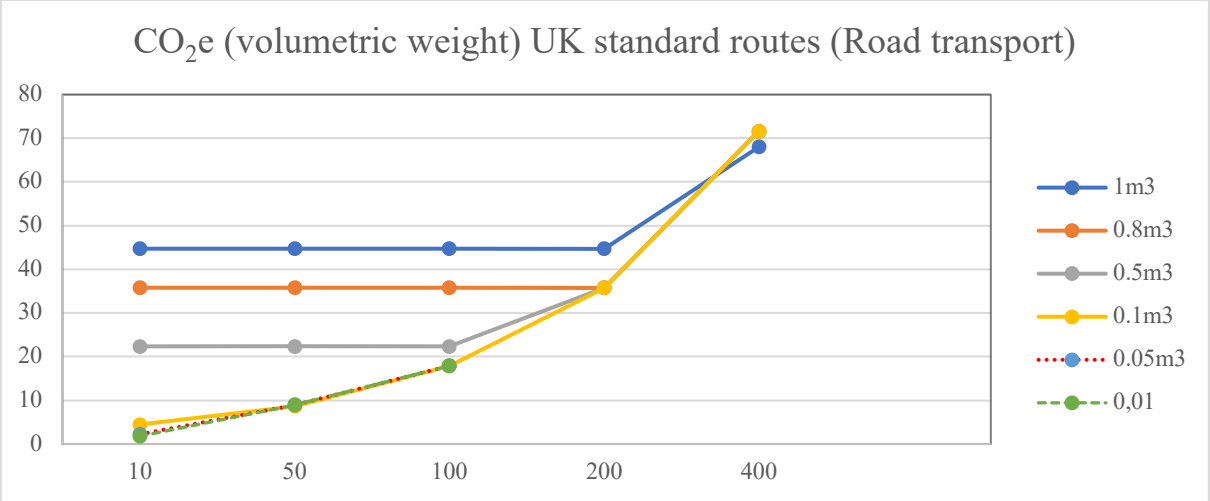

Figure 1: Diagram over CO_2e emissions from Borås to London for the standard delivery (road), using volumetric weight for the calculations.

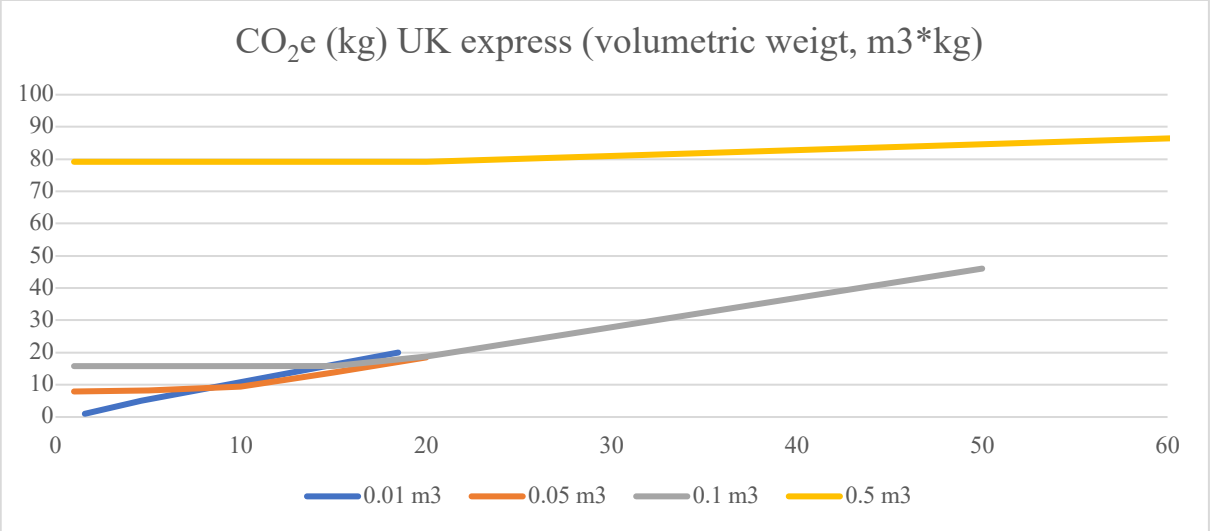

Figure 2: Diagram over CO_2e emissions from Borås to London for the express B2C delivery, using volumetric weight for the calculations.

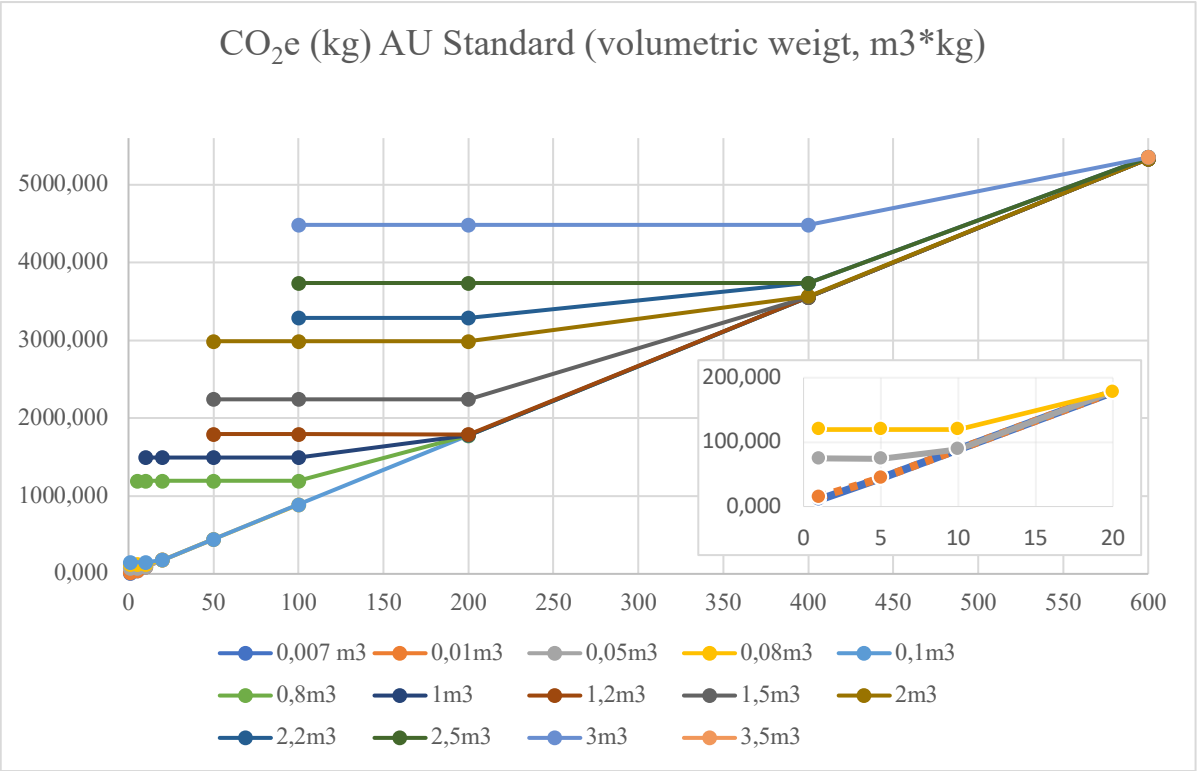

Figure 3: Diagram over CO_2e emissions from Borås to > Sydney for the express B2C delivery

Appendix 5 – CO_2e (kg) emissions based on load factor

The tables below display the detailed view of how the different load factors are affected throughout the entire routes.

Table 1: CO_2e (kg) emissions for transport from Borås to London with different load factors.

Inbound UK changing load factor					
Route	Borås, SWE - Mölndal, SWE	Mölndal, SWE - Glostrup, DK	Glostrup, DK - Stanford Le Hope, UK	Stanford Le Hope, UK - London, UK	Borås - London
Distance (km)	63,740	318,190	1369,060	42,690	1793,680
Transport mode	Rigid truck < 7,5 t	Rigid truck 14-20 t	Rigid truck 14-20 t	Rigid truck < 7,5 t	-
CO2e (kg) 0,97m3 186kg shipment 20% load factor	4,267	14,300	61,030	2,811	82,410
CO2e (kg) 0,97m3 186kg shipment 30% load factor	2,868	9,782	41,730	1,905	56,290
CO2e (kg) 0,97m3 186kg shipment 40% load factor	2,187	7,520	32,080	1,441	43,230
CO2e (kg) 0,97m3 186kg shipment 50% load factor	1,777	6,163	26,290	1,172	35,400
CO2e (kg) 0,97m3 186kg shipment 60% load factor	1,505	5,258	22,430	0,992	30,190
CO2e (kg) 0,97m3 186kg shipment 70% load factor	1,310	4,612	19,680	0,857	26,450
CO2e (kg) 0,97m3 186kg shipment 80% load factor	1,164	4,127	17,610	0,762	23,660

Table 2: CO_2e (kg) emissions for transport from Borås to Sydney with different load factors.

Inbound AUS changing load factor					
Route	Borås, SWE - Mölndal, SWE	Mölndal, SWE - Sturup, SWE	Sturup, SWE - Cologne, DE	Cologne, DE - Sydney, AU	Borås, SWE - Sydney, AUS
Distance (km)	63,70	287,75	809,55	16 817,00	17 978,00
Transport mode Example 1	Rigid truck < 7,5 t	Rigid truck 14-20 t	Rigid truck 14-20 t	Air - Intercontinental	-
CO2e (kg) 2,36m3 470kg shipment 20% load factor	10,380	31,490	101,800	4118,000	4261,000
CO2e (kg) 2,36m3 470kg shipment 30% load factor	6,979	21,540	69,610	4118,000	4216,000
CO2e (kg) 2,36m3 470kg shipment 40% load factor	5,320	16,560	53,520	4118,000	4193,000
CO2e (kg) 2,36m3 470kg shipment 50% load factor	4,325	13,57	43,86	4118,000	4179
CO2e (kg) 2,36m3 470kg shipment 60% load factor	3,66	11,58	37,42	4118,000	4 170,00
CO2e (kg) 2,36m3 470kg shipment 70% load factor	3,187	10,15	30,82	4118,000	4164,000
CO2e (kg) 2,36m3 470kg shipment 80% load factor	2,832	9,086	29,370	4118,000	4159,000