Adaptation of shipment consolidation and distribution network design to omni-channel retailing

Johan Deniz & Martin Månsson

LUND UNIVERSITY

Faculty of Engineering

Department of Industrial Management and Logistics

Joakim Kembro - Supervisor, LTH

Dag Näslund - Examiner, LTH

Thomas Persson – Company Supervisor, IKEA

Acknowledgements

This thesis is conducted during the spring of 2019 as a final part of our master's degree in Mechanical Engineering at Lund University, Sweden. The thesis has been conducted on behalf of Lund University and IKEA of Sweden AB. This thesis has been a complete collaboration between the two authors. Each author has been involved in every part of the process and contributed equally.

Firstly, we would like to express our sincere gratitude to Thomas Persson and Panagiotis Kouleris who initiated the project and has helped us on the way. Additional thanks go to the employees of IKEA that helped us through interviews and with additional support throughout the process, and a special thanks to Martin Dürango from Optilon AB who always took his time to assist and tutor us. We would also like to thank our supervisor Joakim Kembro at the Department of Industrial Management and Logistics, Lund University for valuable feedback, comments, and approaches during the project.

Lund, May 2019

Johan Deniz

Martin Månsson

Abstract

Title: Adaptation of shipment consolidation and distribution network design to omni-channel retailing

Authors: Johan Deniz, Martin Månsson

Supervisor: Joakim Kembro, Department of Industrial Management and Logistics, Faculty of Engineering, Lund University

Problem description: Global retailers tend to have complex distribution networks. A part of the complexity stems from trade-offs in deciding which distribution mode to choose when transporting goods from the suppliers to the customers. Using the right distribution mode for a specific situation is key to reduce costs and increase efficiency in the distribution network. With the rising need for flexibility in fulfilment methods and distribution channels due to omni-channel retailing, the need for consolidation of goods from multiple suppliers may rise to maintain efficient transportation. Furthermore, to attend to the increasing need for flexibility in the supply chain, retailers need to restructure their distribution network design.

Purpose: The purpose of the thesis is to identify and analyse the role of consolidation points within a distribution network and provide potential distribution network designs for IKEA to support omni-channel retailing.

Research questions: What is the role of a consolidation point within a distribution network and how will it change to adapt to omni-channel distribution? How can the distribution network, in terms of nodes and links, be designed to adapt to omni-channel retailing at IKEA?

Methodology: To find solutions that align consolidation points, distribution network design, and omni-channel retailing, a frame of reference for distribution networks, omni-channel retailing and distribution optimisation was created. The frame of reference ended in an analytical framework which was applied through a mixed methods research strategy at IKEA. The two methods lead to triangulation of qualitative and quantitative data through interviews with senior employees and practical optimisation within a distribution network model. Thereby, achieving validity and reliability throughout the research process.

Conclusion: The role of consolidation points within IKEA is to store and merge goods close to the suppliers before being sent to another node in the distribution network. The consolidation points function excels with an increased number of logistical nodes since it consolidates smaller flows and creates better product mixes in the distribution. Different fulfilment methods do not need to increase in tandem or correspond with the number of different sales channels within omni-channel retailing. Instead, the fulfilment methods need to be integrated from separate distribution nodes for each channel into nodes that can provide the product with minimum cost at enough speed, service level, and quality to all sales channels. In future distribution network design, there need to be a higher focus on multi-functionality which implies that solutions are integrated in fewer variants of nodes, to support and align with the omni-channel concept. Logistics nodes need to be closer to the end customer, providing shorter last mile distribution and reaching the customer quicker.

Keywords: Consolidation point, distribution network design, omni-channel retailing, distribution modes, delivery solutions, sales channels.

Sammanfattning

Titel: Anpassning av fraktkonsolidering och distributionsnätdesign för omni-kanaler inom detaljhandel

Författare: Johan Deniz och Martin Månsson

Handledare: Joakim Kembro, Institutionen för teknisk logistik och ekonomi, Lunds Tekniska Högskola vid Lunds universitet

Problembeskrivning: Globala aktörer inom detaljhandel har en tendens att ha komplexa distributionsnät. Delar av komplexitetens ursprung kommer från avvägningar i beslut kring vilken distributionsmetod man ska använda vid transport av varor från leverantör till kund. Att använda rätt distributionsmetod är avgörande för att reducera kostnader och öka effektivitet i distributionsnätverket. Med ett ökande behov inom omni-kanalhandel för flexibla uppföljningsmetoder and distributionskanaler, kan det uppstå ett behov för att konsolidera varor från flera leverantörer för att upprätthålla en effektiv transport. Vidare, för att uppnå det ökande kravet på uppföljningsmetoder kan det även behövas omstruktureringar inom distributionsnätdesignen.

Syfte: Syftet med studien är att identifiera och analysera konsolideringspunkters roll inom distributionsnätverk och bistå med potentiella distributionsnätdesigner för IKEA som stödjer omni-kanalhandel.

Forskningsfrågor: Vad är konsolideringspunkters roll i ett distributionsnätverk och hur behöver rollen anpassas för omni-kanalsdistribution? Hur kan distributionsnätverk, i termer av noder och länkar, designas för att anpassa sig till omni-kanalhandel inom IKEA.

Metod: För att hitta lösningar som lierar konsolideringspunkter, distributionsnätdesign och omni-kanalhandel, skapades en referensram för distributionsnätverk, omni-kanalhandel och distributionsoptimering. Referensramen avslutades med ett analytiskt ramverk som applicerades genom en blandad studeringsmetod på IKEA. De två metoderna ledde till en triangulering av kvalitativa och kvantitativa data genom intervjuer med seniora medarbetare och praktisk optimiering inom distributionsnätverksmodellering. Därigenom uppnåddes validitet och tillförlitlighet genom studieprocessen.

Slutsats: Konsolideringpunkters roll inom IKEA är att lagra och slå ihop varor nära leverantörerna inom de skickas vidare till en annan nod i distributionsnätverket. Konsolideringspunktens roll blir viktigare med ett ökande antal logistiska noder eftersom den konsoliderar mindre flöden och skapar en bättre produktmix i distributionen. Olika uppföljningsmetoder behöver nödvändigtvis inte öka i samma takt som olika säljkanaler inom omni-kanalhandel. I framtida distributionsnätdesigner behöver det istället vara ett högre fokus på multifunktionalitet, vilket betyder flera olika lösningar blir integrerade i ett mindre antal varianter av noder, som stödjer och går i samma riktning som omni-kanal konceptet. Logistiska noder behöver ligga närmre slutkunderna för att möjliggöra snabbare ”fram till dörren” leverans och nå kunderna snabbare.

Nyckelord: Konsolideringspunkter, distributionsnätdesign, omni-kanalhandel, distributionssätt, leveranslösningar, säljkanaler

Table of Content

List of Tables

List of figures

Abbreviations

3PL – Third party logistics

BA – Business area

CDC – Customer Distribution Centre

CP – Consolidation Point

DC – Distribution Centre

FUL – Full Unit Load

HFB – Home Furnishing Business

LUL – Less than Unit Load

LSC – Local Service Centre

MRR – Mid Receiver near Receiver

MRS – Mid Receiver near Sender

POD – Product offer development team

RfQ – Request for Quotation

SCG – Supply Chain Guru

VRP – Vehicle Routing Problem

1. Introduction

The introduction chapter begins with a background for this thesis followed by problem formulation, purpose, research questions, focus and delimitations, and finally the overall structure of this thesis.

1.1. Background

The retail industry has in recent decades undergone major changes. Moving from regional- and national markets to a global market has increased competition and decreased profit margins. To cope with the changes, multinational corporations have pursued global sourcing in their supply chains to secure market shares and increase profits (Tyan, et al., 2003). The emergence of a strong online channel has further pushed retailers to rethink their over-all strategies when the brick-and-mortar stores are no longer sufficient as a sole sales channel (Hübner, et al., 2016; Chopra, 2015). By doing so, the demand and focus on supply chain efficiency has increased. However, the retail market has not only been challenged by globalization and e-commerce, but it has been challenged through new technology which has created a demand for multiple integrated sales channels, also known as omni-channel retailing (Wollenburg, et al., 2015).

Omni-channel retailing introduces a range of new logistic problems across the supply chain. For example, distribution to a single customer, a small city store, and a mega store may have significantly different attributes, but should all be integrated into a single distribution network (Hübner, et al., 2016). Omni-channel retailing urges companies to coordinate order management, fulfilment, and logistics processes to align the physical stores and online channels. Realigning the retailer's distribution processes requires thorough planning and execution given its complexity in the current environment (Ishfaq, et al., 2016). Retailers who manage this successfully can reduce cost and gain competitive advantages (Lang & Bressolles, 2013).

In a global distribution network, transportation carries a big cost and the goal is therefore to optimise the transport through full unit loads (FUL) instead of less than unit load (LUL). The optimisation of transport carries a trade-off with stock and handling costs that arise by over purchasing to fill the transports (Cheong, et al., 2007; Chopra & Meindl, 2013). Smaller companies usually need to use LUL frequently since they do not have the time and quantity to make it worthwhile with FUL. Large companies, on the other hand, may have other possibilities (Tyan, et al., 2003). These companies can invest in consolidation of goods that do not reach the necessary volume. Through utilisation of a consolidation point (CP) it could be possible to reap the benefits of both having FUL and not overstocking products, thereby reducing cost. However, this comes with investment costs and the handling required for consolidation may outweigh the benefits.

1.2. Problem formulation

Global retailers tend to have complex distribution networks. A part of the complexity stems from deciding which distribution mode to choose when transporting goods from the suppliers to the customers. There are many authors discussion the trade-offs between different distribution modes in various settings, see (Chopra, 2003; Coyle, et al., 2013; Hübner, et al., 2016). Using the right distribution mode for a specific situation is key to reduce costs and increase efficiency in the distribution network. Therefore, a retailer should carefully consider which modes that fit their distribution network before choosing. When the possibility for FUL is apparent, this is preferred to lower the transport costs. However, with the rising need for more flexible fulfilment methods and distribution channels, the need for consolidation of goods from multiple suppliers may rise to maintain efficient transportation. Furthermore, to attend the increasing need for flexible fulfilment methods, retailers need to restructure their distribution network design. Historically, retailers have mainly focused on efficient transports to their large brick-and-mortar stores, henceforth called stores. Economies of scale were easily achieved by ordering bulk shipments to few locations. However, the level of customer satisfaction achieved by just focusing on stores will no longer be sufficient. The need for new fulfilment methods and more urban stores may result in sales cannibalisation, thus, splitting up the flow of goods. There exists a theoretical gap on how global retailers should utilise shipment consolidation in an omni-channel context, and how to put it in a bigger perspective. Namely, how retailers should transition their distribution network design to adopt to omni-channel retailing. A company who finds itself in the transition of moving from the stores into omni-channel retailing is IKEA.

IKEA is the biggest furniture retailer in the world, with a main market in Europe followed by North America, and Asia. IKEA is most known for their flat packages and “assemble-at-home” furniture at a low price. At IKEA, CPs are currently being utilised for a minor part of their shipments, but IKEA believe that the need may increase in the future. Shipment through a CP is a delivery solution called mid receiver near sender (MRS). Other delivery solutions are full loads, mid receiver close to receiver (MRR), and milk runs. The delivery solutions are variants of the distribution modes: direct delivery and DC. The distribution network for these modes and solutions are presented in Figure 1.

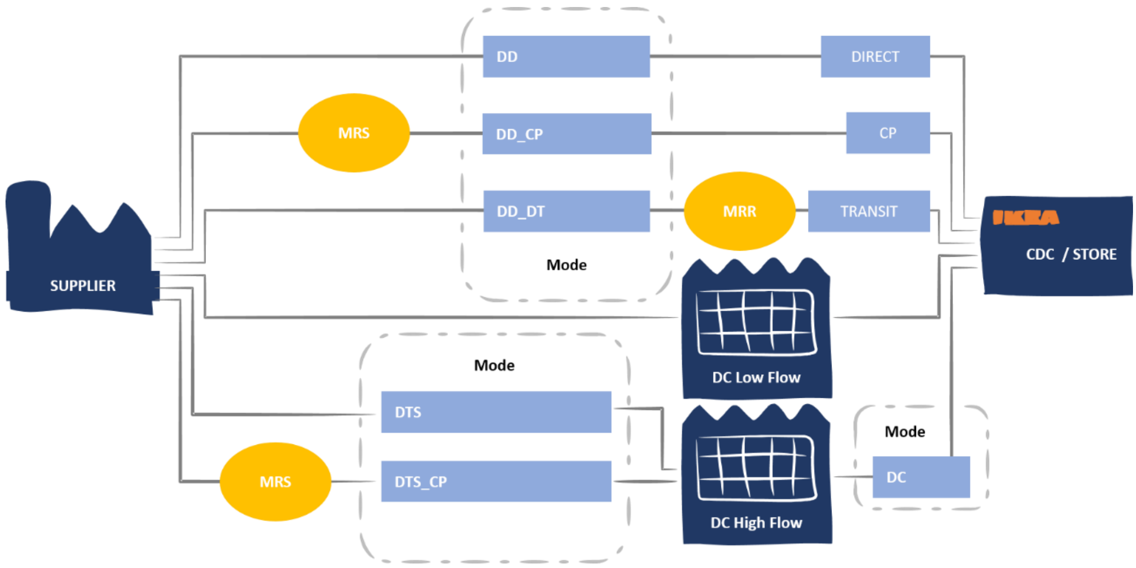


Figure 1: IKEA's current distribution network

For a long time, IKEA has focused only on their brick-and-mortar stores. Partially due to its previous culture, but also, due to the profitability. However, during the last years a transformation has started. IKEA has opened its web shop and plans to expand on other concepts stores, such as small city stores and showrooms. These sales channels present new challenges to the distribution network design and utilisation of different delivery solutions. To support the transition from large flows to few locations into separated flows to many locations, the role of the CPs may need to change. Depending on the role of the CP, the distribution network design also needs to be challenged and aligned with the new sales channel setup. The role of the CPs and the overall design of the distribution network in an omni-channel perspective were, therefore, the main subject of this thesis.

1.3. Purpose

The purpose of the thesis is to identify and analyse the role of consolidation points within a distribution network and provide potential distribution network designs for IKEA to support omni-channel retailing.

This thesis contributed with examples of how the distribution network design was affected by changes within retail. Its main contribution focused on the possibilities of consolidation of goods and how the trade-offs were affected by new requirements from the customers. Furthermore, it considered different approaches to consolidation. It also proposed how these consolidation points could be integrated in an overall network design, to support multiple types of sales channels and integrations.

1.4. Research questions

Following the purpose, two research questions were developed to frame the challenges and created a direction for the research of this thesis.

Research question 1: What is the role of a consolidation point within a distribution network and how will it change to adapt to omni-channel distribution?

Research question 2: How can the distribution network be designed to adapt to omni-channel retailing at IKEA?

The first research question framed the role and potential functions of a CP in the future. It started with how CPs works currently, and then analysed how it needed to change when the sales channels changes or becomes integrated, as with omni-channels. Once the role of the CP was established, it was placed within the bigger picture of distribution network design. Based on the changes made to CPs, there could exist other beneficial changes to be made within the distribution network design, earlier presented in Figure 1. Therefore, research question two considered overall design changes that supports the upcoming sales channels.

1.5. Focus and delimitation

The focus of this thesis was to analyse how the function and usage of CPs may need to change when store setups and sales channels changes within a distribution network. Through a combination of qualitative and quantitative knowledge from interviews and a software model, this thesis was meant to provide an understanding to the role of CPs, and suggest changes of to the distribution network design. The interviews focused on providing an understanding of IKEA's distribution network design, the role of the CPs, and their sales channels. The software model focused on cost and transportation time for CPs, which also contributed to fill rates. The results from this was then analysed to find potential distribution network designs.

The project focused on two regions instead of the global perspective for the modelling. These two were the Iberian Peninsula, including Spain and Portugal, and the region of Belgium and the Netherlands, which was a delimitation. Both these areas were small, which simplified the modelling.

1.6. Structure of the thesis

In chapter two a literature review was performed. The first section presented was distribution network design, and distribution operations in general. Then, the distribution network was angled towards retail, including omni-channel distribution, sales channels, and strategy. Moreover, distribution optimisation was introduced as a foundation for how the software model operated. Finally, an analytical framework was presented in chapter two for this thesis. This thesis' research strategy, research process, and how reliability and validity was achieved was explained in the methodology chapter. After the methodology was presented, the empirical data from the interviews and modelling were presented. Shipment consolidation for the retail market and distribution network design were investigated in the analysis chapter. The results from the research and the answers to the research questions along with potential future research were concluded in the final chapter. In the end of the report, references and appendix can be found.

2. Frame of reference

The frame of reference is composed by a literature study and the analytical framework. The literature study includes three parts: distribution network and operations, omni-channel retailing, and distribution optimisation, which is visualised in Figure 2. The first part, distribution network design and operations, lays the foundation of the logistical operations described in this thesis. Omni-channel retailing gives insight regarding the market this thesis focuses on. Distribution optimisation aims to add another dimension to the thesis and is needed as a groundwork for the modelling to help answer the research questions.

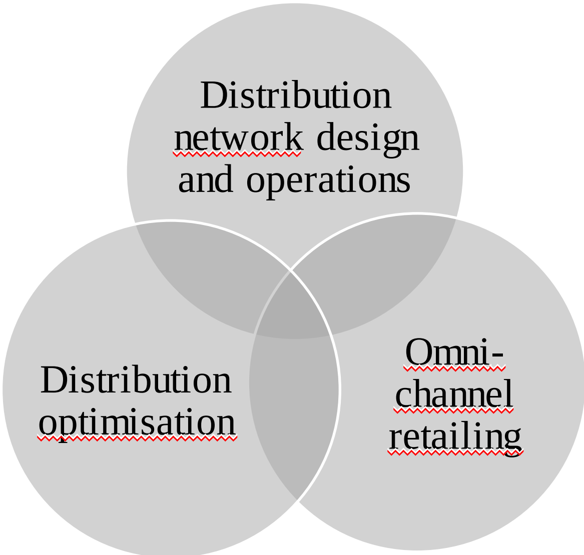


Figure 2: Scope for the literature study

2.1. Distribution network design and operations

2.1.1. Representation of distribution networks

A distribution network can be presented as a web of nodes and links as shown in Figure 3. The nodes are destinations where the goods are handled in some way, for example, production, warehouse, and store. The links (modes within IKEA), on the other hand, represents the transportation of goods between nodes with for example airplane, boat, train, and truck (Lumsden, 2007).

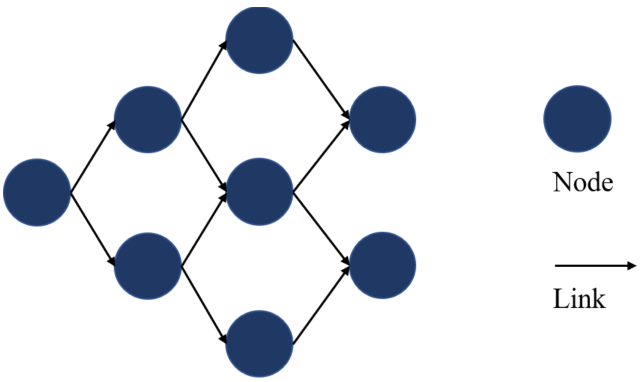


Figure 3: Example of a distribution network with link and nodes

2.1.2. Load types

To reduce cost factors, it is common to bring goods together in larger consignments of different sizes. The consignment is usually called consolidation. Normally, consolidation is done directly at the manufacturer when they ship products together, but, can also be performed within the transportation chain with products of variating origin (Lumsden, 2007). For example, the goal of a carrier service is to have as high fill rate as possible while minimizing labour, fuel, and vehicle cost. To make this possible, carriers coordinate pickup and delivery times to consolidate different freights and achieve economic of scale (Bowersox, et al., 2007). According to Lumsden (2007) the efficiency of transportation is generally based on how well the goods are consolidated regarding weight or volume.

To create efficient transportation systems with minimum handling, goods are loaded into load carriers. These load carriers are often standardised trailers or containers (Coyle, et al., 2013). If the carriers are filled up, they can usually be transported directly as full loads. This leads to a shorter and cheaper network. These types of transports are typically called Full Unit Loads (FUL). An unfilled load, which typically has a fill rate below 60 percent, is called Less than Unit Load (LUL) (Lumsden, 2007). Shipping LUL drastically increases the transportation cost and is, therefore, often consolidated. By consolidation, goods are linked within the network and needs to accept and adopt to the existing traffic. Consolidation is still more expensive than FUL, but, decreases the cost compared to sending LUL (Bowersox, et al., 2007; Lumsden, 2007). Since transportation carries a big cost in global networks, the goal is usually to optimise the transport through FUL instead of LUL. The optimisation of transport carries a trade-off with stock and handling costs that arise if unnecessary procurement is performed to fill the transports. Smaller companies usually have to use LUL frequently since they do not have the time and quantity to make it worthwhile with FUL while bigger companies often can wait until transports are filled (Cheong, et al., 2007).

2.1.3. Distribution nodes and modes within the distribution network

For most consumer products, it is completly impossible to match supply and demand. Production and consumption are not perfectly synchronized, transportation of individual units is too costly, and coordination of many individual activities are complex. To overcome these issues, logistical nodes such as distribution centres, warehouses, cross-docks, and retail stores are established (Coyle, et al., 2013).

Distribution operations within the logistical nodes help create time and place utility. Positioning the goods within the right range to the customer shortens lead time, increases product availability, and reduces delivery cost. Except for increased customer service, it also brings other possibilities such as (Coyle, et al., 2013):

- Balancing supply and demand – Stock piling of inventory that might be seasonal or unbalanced production.
- Protecting against uncertainty – Protect against forecast errors, supply disruption, and demand changes.
- Allowing quantity purchase discounts – Incentives for large quantity purchases.
- Supporting production requirements – Increased production efficiency.
- Promoting transportation economies – Utilisation of FUL.

Direct delivery and milk run

Direct delivery is when the transport is sent directly between the manufacturer and the customer. The customer does not necessarily have to be the end customer and could for example be the retail store. Direct delivery is almost always the cheapest way of transport if it is FUL (Lumsden, 2007). If the demand decreases, it might therefore no longer be best alternative since it creates high inventory levels. Chopra & Meindl (2013) gives an example of this at Home Depot. They went from only having large stores to also opening smaller stores. The smaller stores did, then, not have the volume to justify a direct shipment and the delivery mode therefore needed to be changed.

Transportation can be done through combining one shipment to multiple suppliers or customers. This means that a truck either collects products from multiple suppliers in one run and then brings it to the customer or that it picks up multiple orders from one destination and brings it to multiple customers. These routes are called milk runs. Through milk runs the transportation cost is reduced since total distance is reduced through the consolidation of products (Chopra & Meindl, 2013).

Distribution Centre

Distribution centres can, depending on the requirements, provide an array of positive functions (Coyle, et al., 2013), as shown in Table 1. According to Chopra & Meindl (2013), storing products at a DC is usually justified in two cases. Firstly, if it is required to have inbound shipment to achieve economies of scale within transport. Secondly, if shipments going to customers cannot otherwise be coordinated (Chopra & Meindl, 2013).

Table 1: Functions a distribution centre can perform (Coyle, et al., 2013).

Functions	Description
Accumulation	The DC acts as a merging point for products of multiple origins and provides required transfer, storage or processing services. The accumulation function allows companies to consolidate orders and shipments for production and fulfilment processes.
Sortation	Products are segmented depending on characteristics to increase the efficiency of shipping and consolidating of goods in the warehouse.
Allocation	Matching inventory to customer order. For example, the DC can receive a full pallet while the store only needs one box.
Assortment	Assembly or joint orders can be performed. If the customer orders multiple products in one order, the products can be sent from one single location and thereby to simplify the process.
Other value-adding roles	
Assembly service, Inventory management and visibility, Product kitting, Product postponement, Production sequencing, Recycling, Repair, and Return management.	

The distribution centres should not solely be considered a positive function. Distribution centres are a costly operation that interrupts the flow of goods. There is a trade-off between the number of DCs and the transportation cost. The DC decreases the transportation cost due to the increased FUL shipments, but at the same time it increases the handling costs, and if not fully utilised it can become costly. There is also a trade-off between inventory and distribution. In general, the more centralised DCs are, the less inventory is carried in total. The total inventory increases with each new DC but in a decreasing rate. A common strategy is to pool slow moving goods in one centralised distribution centre and decentralise the other products through multiple DCs (Coyle, et al., 2013).

Cross-docking

Cross-docking is a way to consolidate shipments (Rodrigue, 2006). With cross-docking, products on all inbound trucks contains orders meant for multiple customers while the outbound truck contains products to a single customer. The trucks can perform milk runs both on the inbound and outbound transports to further increase the consolidation (Chopra & Meindl, 2013).

In cross-docking, the goods move from receiving to shipping without storage or order picking. Thereby, two costly distribution functions are eliminated (Coyle, et al., 2013). Inbound trucks to a facility are immediately unloaded and merged with other inbounding goods, to be sent directly with a new outbounding truck (Rodrigue, 2006). The process can in a simple setup be described in four steps: receive, stage, load, and deliver (Coyle, et al., 2013). Through cross-docking, multiple sources are merged together to create economies of scale within transportation and reduce inventory holding. The costly inventory function of a distribution centre is minimized while the positive effects of consolidation and shipping are upheld. Cross-docking can also improve synchronization between distribution and demand. The goods are typically distributed within 24 hours and sometimes much faster. In a traditional distribution system, products are often stored in a distribution centre until ordered. By doing so it is often hard to create shipments which are full truck loads. This problem is often avoided through consolidation which creates full truck loads (Rodrigue, 2006).

Cross-docking has different purposes for different entities. For distribution it can consolidate inbound products from different suppliers and then deliver when the final inbound goods are received. Within transportation cross-docking creates economies of scale through the consolidation of shipments from several LUL batches. Cross-docking is common in retail, especially within large retail companies. Cross-docking within retail usually means that products from multiple suppliers are sorted and shipped to multiple stores (Rodrigue, 2006).

Tailored operations

Companies can tailor different distribution networks based on customer and product characteristics. Considering customer density and distance, there are two suggested approaches. If a high density of customers is located close to the DC, it is suggested to use milk runs from the DC with an internal fleet. If customer density is large and the distance is large, it is usually better to use public carriers since they can consolidate loads. The size of the customer is also important for the network. Large customers can usually take FUL, while smaller customers need LUL or milk runs. If a milk run delivers to both large and small customers, there is a mismatch in the transportation since the delivery cost per weight is lower for the large customer. Instead of having multiple costs this could be engaged through spreading out the orders. The large customers are, then, included in every milk run while the smaller customers only gets some of the loads. This results in higher frequency to the large customer and thereby, most likely, an increased service level (Chopra & Meindl, 2013).

It is also possible to tailor the transportation and inventory based on product demand and value, which is presented in Table 2 below.

Table 2: Matrix of demand versus value (Chopra & Meindl, 2013).

Product type	High Value	Low value
High demand	Disaggregate cycle inventory. Aggregate safety inventory. Inexpensive mode of transportation for replenishing cycle inventory and fast mode when using safety inventory.	Disaggregate all inventories and use inexpensive mode of transportation for replenishment.
Low demand	Aggregate all inventories. If needed, use fast mode of transportation for filling customer orders.	Aggregate only safety inventory. Use inexpensive mode of transportation for replenishment cycle inventory.

2.1.4. Trade-offs at distribution nodes

When choosing between distribution facilities and direct delivery, it is crucial to analyse inventory, transportation, and service trade-offs. Naturally, a combination could be the best way of controlling distribution efficiency and customer satisfaction (Chopra & Meindl, 2013). In Table 3 below, different network structure trade-offs are presented.

Table 3: Pros and cons with different network structures (Chopra & Meindl, 2013).

Network structure	Pros	Cons
Direct shipping	No intermediate warehouse Simple to coordinate	High inventories (due to large lot size) Significant receiving expense
Direct shipping with milk runs	Low transportation costs for small lots Low Inventories	Increased coordination complexity
All shipments via central DC with inventory storage	Lower inbound transportation cost through consolidation	Increased inventory cost Increased handling at DC
All shipments via central DC with cross-dock	Low inventory requirement Lower transportation cost through consolidation	Increased coordination complexity
Shipping via DC using milk runs	Lower outbound transportation cost for small lots	Further increase in coordination complexity
Tailored network	Transportation choice best matches needs of individual product and store	Highest coordination complexity

Inventory aggregation decreases the distribution network cost if the product has a high-value-to-weight ratio, high demand uncertainty, low transportation cost, and customer orders are large. If the properties on the other hand are reversed, inventory aggregation may increase cost (Chopra & Meindl, 2013).

Temporal aggregation mean that companies are creating larger shipments through postponement of orders for a set of day. This reduces the transportation cost since it creates bigger shipments. However, temporal aggregation postpones the orders, thus, reducing customer response time. The benefit of temporal aggregation is biggest in the beginning but decreases over a longer time span (Chopra & Meindl, 2013).

Coyle, et al. (2013) elaborate on the trade-offs between distribution centres (warehouses in Figure 4) and the total cost further, with the comparison of inventory cost, warehousing cost, transportation cost, and cost of lost sales, as shown in Figure 4. Introducing more, or reducing, the number of warehouses could have both positive and negative effects on the total cost, since the individual changes for the different parameters are not linear (Chopra, 2003).

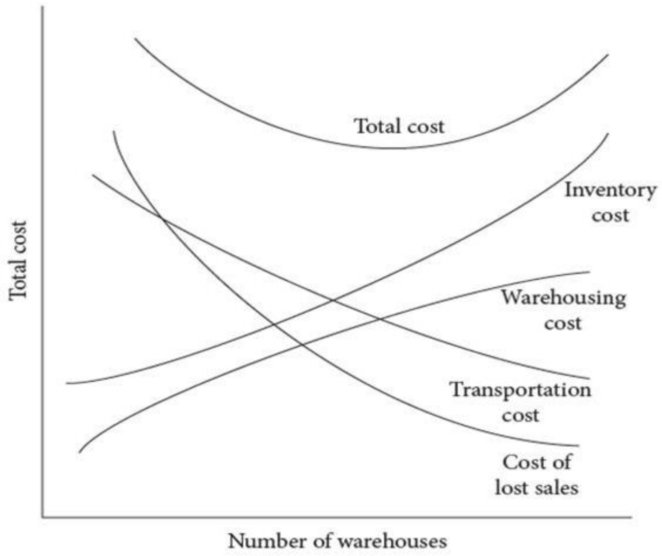


Figure 4: Relationship between number of facilities and logistics costs (Coyle, et al., 2013).

2.1.5. The connection between distribution networks and customer service

Global distribution networks are bound to the connections between supply and demand to unite the customer needs with the supply. The network should create the possibility to have "the right product, in the right quantity, at the right price, at the right location, and at the right time" (Rodrigue, 2006). The performance of a distribution network can, at the highest level, be evaluated in two ways. Customer needs that are met and cost of meeting customer needs. In turn, this affects the company's revenue and network profitability (Chopra, 2003). There is often a trade-off between lead time and cost, since multiple distribution centres shortens the time but increases cost. High outbound transport costs will often create a decentralised network while a high inventory cost will centralise it. Another perspective that often influences the network are value density and packing density. The higher value, the more it should lean towards centralisation (Steele & Hodge, 2011).

Chopra (2003) provides a description of how the distribution network affects customer service in multiple way, see Table 4. Depending on the type of product the customer usually has different requirements for each area which in turn is related to cost.

Table 4: Customer service components affected by the distribution network (Chopra, 2003).

Customer service components	Description
Response time	Time between order placement to delivery
Product variety	Number of different products that are requested from the distribution network
Product availability	Stock availability at order point
Customer experience	Ease of ordering
Order visibility	Order tracking

Returnability	Ease and ability of the network to handle return flows

2.1.6. Key decisions for distribution networks

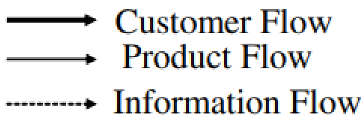
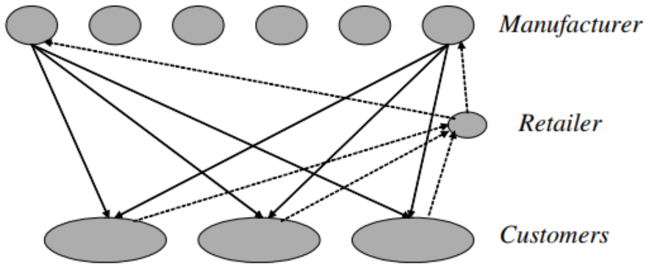
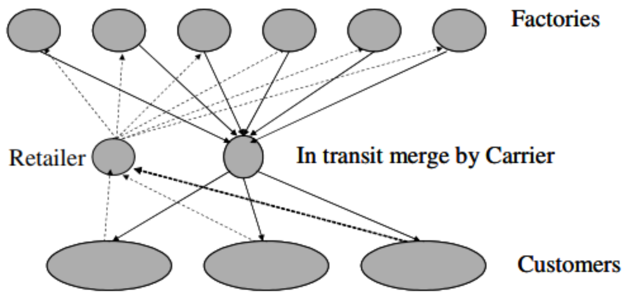
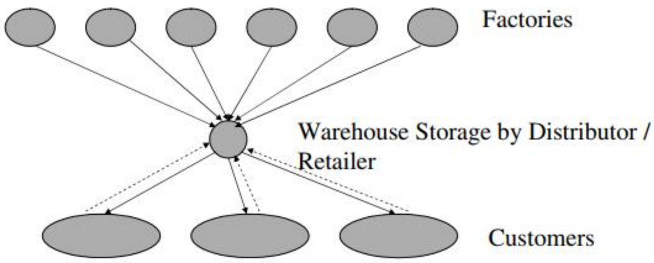
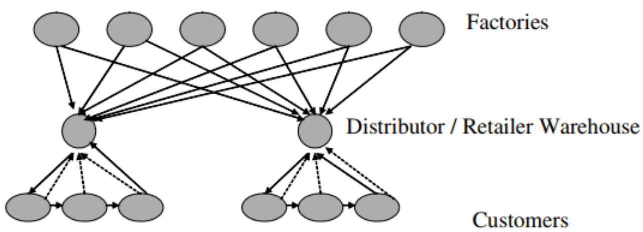
According to Chopra (2003) there are two key decisions when designing a distribution network.

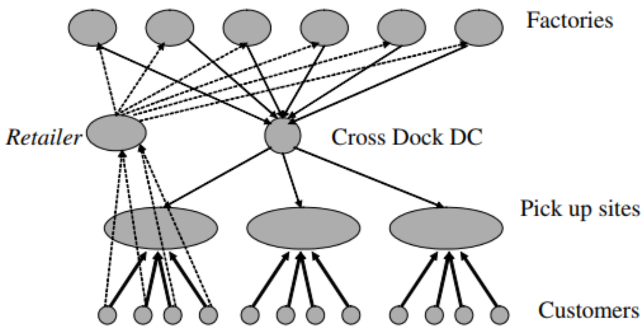
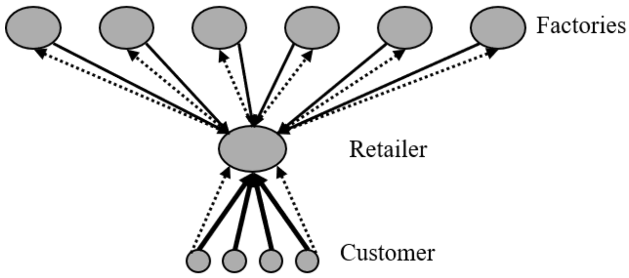
1. Will the product be delivered to the customer location or picked up from a preordained site?

2. Will the product flow through an intermediary (location)?

Those two decisions are then divided into six distribution networks as shown in Table 5 below.

Table 5: Description of shipping modes (Chopra, 2003).

Shipping mode	Description	
Manufacturer storage with direct shipping (drop shipping)	Direct shipment from manufacturer to end customer with a carrier Information goes from the customer to the retailer and then to the manufacturer	
Manufacturer storage with direct shipping and in-transit merge	Multiple manufacturers get their products merged through a carrier to a single delivery for the end customer Information goes from the customer to the retailer and then to the manufacturer	
Distributor storage with package carrier delivery	All products are stored at a warehouse and directly shipped to the customer when requested by a carrier Information flows between the customer and the retailer only	
Distributor storage with last mile delivery	All products are stored at a warehouse and shipped by the retailer/distributor to the customers home The information flows between the customer and the retailer only	

Manufacturer / distributor storage with customer pickup	Products are stored at both distributors and manufacturers. When requested they are then shipped to pick-up points where the customer comes and picks it up Information goes from the customer to the retailer and are then sent to the distributor/manufacturer who performs the shipment	
Retail storage with customer pickup	The retail store keeps the inventory which are picked up by the customer directly Either the customer orders it and then picks it up or just directly goes to the store	

The six different distribution presented in Table 5, are then compared by Chopra (2003) within the aspects of customer service components and product characteristics which are shown in Table 6.

Table 6: Transportation mode compared to different characteristics (Chopra, 2003). Ranging from -2 = very unsuitable to 2 = very suitable

	Retail storage with customer pickup	Manufacturer storage with direct shipping	Manufacturer storage with in-transit merge	Distributor storage with package carrier delivery	Distributor storage with last mile delivery	Manufacturer storage with pickup
High demand product	2	-2	-1	0	1	-1
Medium demand product	1	-1	0	1	0	0
Low demand product	-1	1	0	1	-1	1
Very low demand product	-2	2	1	0	-2	1
Many product sources	1	-1	-1	2	1	0
High product value	-1	2	1	1	0	2
Quick desired response	2	-2	-2	-1	1	-2
High product variety	-1	2	0	1	0	2
Low customer effort	-2	1	2	2	2	-1

2.1.7. Supplier selection's impact on the distribution network

Sourcing and selecting suppliers are time consuming. This is due to the broad range of specifications and requirements that must be met before an agreement is made (Van Weele, 2018). Cheraghi, et al., (2004) discusses how critical success factors when selecting suppliers have changed from the sixties up until the millennial shift. The most critical criterion are quality, delivery, and price, while the best trending is repair service, information systems, and financial position. On a more recent note, Ho, et al., (2009) provide a literature review on the most popular multi-criteria decision making approaches and evaluation parameters for supplier selection. It is found that, based on 78 articles, the three most popular evaluating criterion were: quality, delivery, and price. This implies that not much have changed over time regarding the evaluation criterion. Furthermore, Sharma, et al., (2008) argue that the distribution is a key driver of the overall profitability, thus making the delivery criteria of supplier selection vital. Delivery can be defined in many ways, some of those are: delivery efficiency, delivery reliability, on-time delivery, and geographical proximity (Ho, et al., 2009). Although, delivery from supplier's as a function of the distribution network can have different objectives, ranging from low-cost to quick responsiveness. Meaning, a network designer must consider its characteristics and requirements when setting up an appropriate delivery network for the suppliers (Sharma, et al., 2008).

2.2. Omni-channel retailing

2.2.1. Introduction to retailing

For a long time, retailers were the passive recipients of products, allocated to stores by manufacturers in anticipation of demand. Consumers in these stores had to endure a limited product range on the shelves since the focus of their strategy was production, and not consumption. This have now been changed. The retailing industry have recognized the need to have more involvement in the supply chains, and noted that benefits can be achieved in both service levels and cost reduction (Fernie & Sparks, 2009).

Traditional retailing refers to stores where customers have face-to-face interactions with products and salespeople. A customer also leaves the store with the product once the purchase has been made. Traditional retailing often has a lot of facilities to support the face-to-face information flow and product pick-up. Furthermore, these facilities tend to carry high levels of inventory since products must be available at each store. This results in high investments in facilities and inventory (Chopra, 2016).

The consumers' willingness of waiting to be satisfied or served has been reduced over time, and they now expect instant product availability. Consumers will seek out the lowest possible product price in an increasingly transparent retailing market (Aubrey & Judge, 2012). This pressures companies to obtain presence in more distribution channels, for example, online retailing, than just traditional retailing (Chopra, 2016).

Online retailing is one of the smallest segments of the global retail industry. However, it is growing at a faster rate compared to offline sales channels. Today, clothing accessories is the greatest source of revenue regarding retail e-commerce and furniture is fifth. Previously, the high transportation cost of heavy furniture has deterred companies from pursuing online sales channels. However, that has begun to change (Laudon & Guercio Traver, 2016).

De Koster, (2003) discusses that traditional retailers should integrate the distribution of their e-commerce customers with their traditional distribution. With growing importance of online sales, the need of new fulfilment methods is sought after (Wollenburg, et al., 2015).

2.2.2. E-commerce

Back in 1994, e-commerce did not exist. It has since then grown to €1.96 billion business-to-consumer and a €14.2 trillion business-to-business industry in 2015. This has impacted businesses, markets, and consumer behaviour (Laudon & Guercio Traver, 2016). Furthermore, it has created changes in the structure and processes of distribution and its network (Skjott-Larsen, et al., 2008).

E-commerce refers to the use of the internet to transact business. There are several different types of e-commerce, where B2C is the most commonly discussed. B2C operates by online businesses selling retail goods, travel services, or online content to private customers (Laudon & Guercio Traver, 2016). Today, this is most commonly done through a website combined with a fulfilment system. The fulfilment system provides a broad range of functions such as: communication with the customer about the order, where the product is sent from and where to receive it, providing status information while it is being distributed, and any possible post-sale support information (Chopra, 2016; Skjott-Larsen, et al., 2008).

To enable the fulfilment systems, transportation services and fulfilment centres are needed. Transport services could be 3PL companies, such as UPS or DHL. The fulfilment centres could be DCs and are designed for flexibility and speed. Flexibility supports peaks in demand while still maintaining operational infrastructure during lows. Unlike traditional warehouses where items are picked, labeled, and stored, fulfilment centres focus on single process flows to rapidly get products from picking to shipping (Skjott-Larsen, et al., 2008; Biederman, 2013).

Moreover, Laudon & Guercio Traver, (2016) discusses that e-commerce has reinvented itself. Since the beginning of 2007, to the present day, e-commerce has been transformed due to increasing popularity in new technology that enables local goods and services that was not easily accessible in the past. For example, a smartphone app such as Uber, allows the consumer to check availability for taxi services and ordering it. This era of e-commerce could be seen as technological and business driven, as well as a sociological phenomenom.

The sociological aspect refers to the defining characteristics of this period such as the "social, mobile, and local" online world. Entertainment content has developed as a major source of e-commerce revenues and mobile devices have become on-the-go shopping devices for retail goods and services. Marketing has been transformed by the increasing use of social networks, word-of-mouth, viral marketing, and much more powerful data repositories and analytic tools for truly personal marketing (Laudon & Guercio Traver, 2016). This puts high logistical and information performance pressure on businesses that provides e-commerce services. Thus, retailers need to refine their means of distribution to satisfy the new customer trends (Hübner, et al., 2016; Davenport, et al., 2012).

2.2.3. The transformation of distribution network design in retail

Sparks (1985) describes that the retailers have grown bigger than their suppliers and can, thus, exert their power to control the distribution network in order to cut costs by utilising regional distribution centres. Although, controlling the distribution network introduces challenges since the fundaments of logistics are expensive. Holding stock or inventory in warehouses is a costly activity. The stock itself contains value and might not sell or run the risk of becoming obsolete (Fernie & Sparks, 2009).

On a global scale, Tyan et al. (2002) argues that increased competition and declining profit margins makes multinational corporations pursue global sourcing in their supply chains to secure market shares and increase profits. With the emergence of a strong online channel and changing technology, there has been a major transformation in retail distribution over the last decade (Hübner, et al., 2016; Chopra, 2016). Due to the changing landscape of retail distribution, new challenges arise. Hübner et al., (2015) describes that one major challenge is to effectively combine the handling and shipment of small online orders with large store replenishment orders, which previously were handled in separate channels. For retailers acting globally, controlling these flows by expanding delivery modes, increasing delivery speed, and service levels, are key factors to succeed in omni-channel distribution. However, operating as an omni-channel retailer presents an increased complexity in terms of logistics (Hübner, et al., 2016). To meet customer expectations, retailers increasingly integrate their physical stores and online channels into an easily accessible way of shopping (Kembro, et al., 2018).

2.2.4. From multi-channel to omni-channel

Chopra (2015) discusses that changing technology and the growth in online retail is responsible for the changing landscape of retail. However, this might just be a part of the whole picture. Retailers currently face challenges in maintaining a combination of online and physical channels. In a customer's perspective, both channels set their own unique requirements. Since the consumers now expect greater levels of service and availability, multi-channel strategy has been used by retailers to accommodate these changes (Aubrey & Judge, 2012; Verhoef, et al., 2015). When retailers supply goods over store outlets and directly through the internet, this is termed multi- or omni-channel retailing. However, what distinguishes multi-channel retailing is that channels are separated from each other. The customer can not trigger channel interaction and/or the retailer does not control channel integration (Wollenburg, et al., 2015).

Omni-channel retailing is distinguished from multi-channel through that all actions and business units are integrated between channels. Thus, the customer can trigger full channel interaction and/or the retailer controls full channel integration (Beck & Rygl, 2015). Because of new technologies and the development of e-commerce (for example, integrated social media and instant smart phone access), omni-channel involves more channels than multi-channel. Additionally, the natural borders between channels start to disappear in omni-channel retailing, leading to changes in competitive strategies (Verhoef, et al., 2015; Laudon & Guercio Traver, 2016). Furthermore, customers are interchangeably using different channels during the search and purchase process. To control the usage of different channels is seemingly impossible for retailers. For example, a customer can see a product he or she likes in a store when shopping, while simultaneously looking for better offers for similar products online on their phone. Retailers need to consider that using different channels and devices simultaneously to create a seamless shopping experience (Verhoef, et al., 2015).

In conclusion, the main differences between multi-channel and omni-channel retailing are summarised in Figure 5.

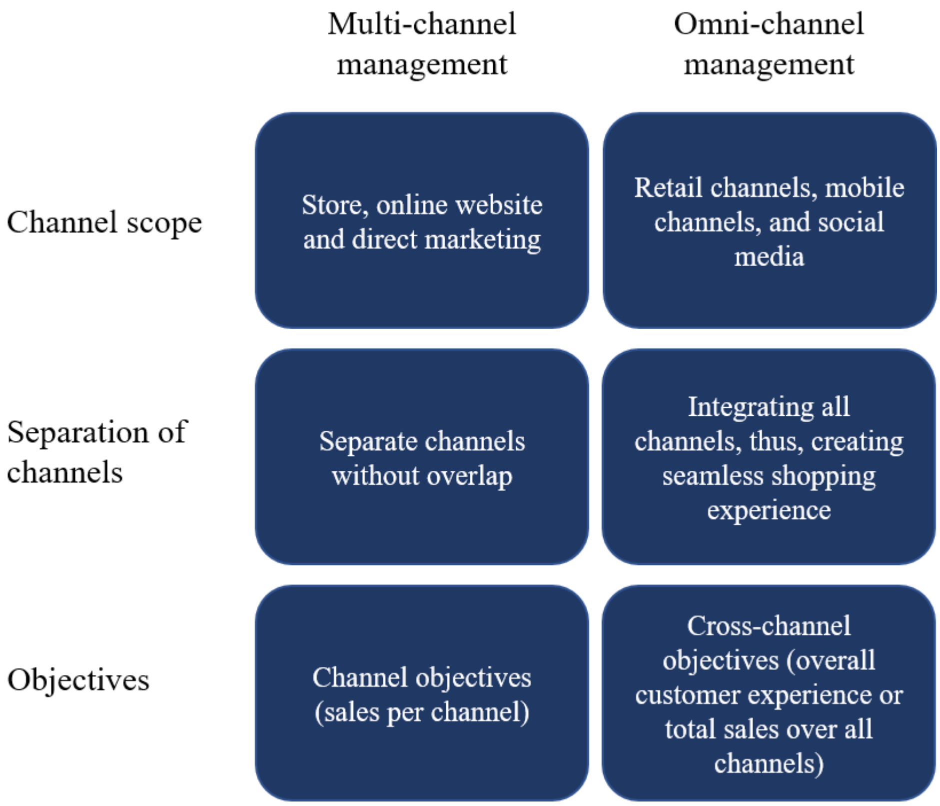


Figure 5: Differences between multi- and omni-channel management (Verhoef et al., 2015)

2.2.5. Fulfilment methods of omni-channel retailing

Omni-channel retailing urges companies to coordinate order management, fulfilment and logistics processes to align the physical- and online channels. Realigning the retailer's distribution processes requires thorough planning and execution given its complexity in the current environment (Ishfaq, et al., 2016). Retailers who manages this successfully can reduce costs, as well as, gaining competitive advantages (Lang & Bressolles, 2013). Bell et al., (2014) describes the different alternatives in omni-channel retailing through a matrix. The information and fulfilment matrix decide whether the consumer seeks information online or offline (as face-to-face in store) or whether the physical goods is transferred by home delivery or picked up at the store. The Matrix results in four types of retailing, seen in Figure 6.

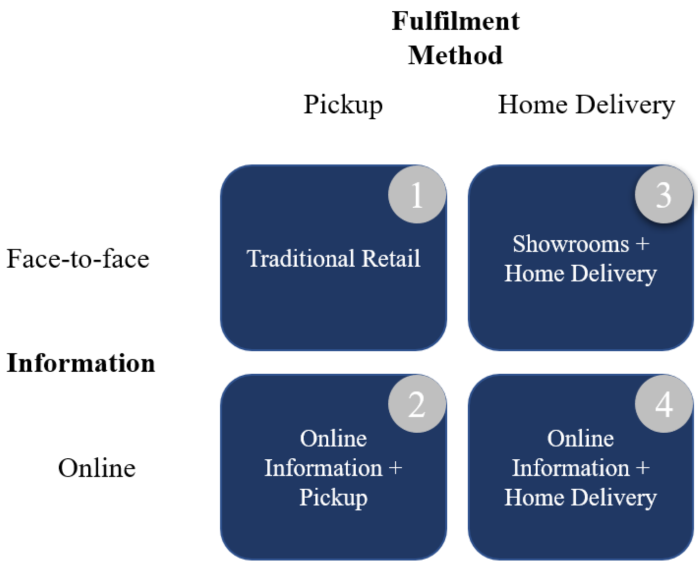


Figure 6: Omni-channel retail matrix (Bell, et al., 2014).

Traditional retailing has already been described in 2.2.1 and will not be commented further on. Showroom with home delivery (quadrant three) is physical stores with salespeople but they do not sell anything. Instead, customers can get direct information from salespeople or try different products. They distinguish themselves by providing face-to-face information but does not carry any inventory. Thus, reducing costs related to inventory and the size of the facility. These showrooms are effective when the product is of high value and has a significant need for customization. It is also suitable for products with "non-digital" attributes. Non-digital attributes are those who are hard to fully observe and asses without physical inspection. Such can be the fit and feel of furniture and related categories (Chopra, 2016; Bell, et al., 2014).

When retailers operate in quadrants two and four of the matrix, they mostly share their information through websites online. This information flow is best suited for products with as few non-digital attributes as possible. Uncertainty regarding these attributes may deter first time purchasers. However, once customers have experienced a brand or a product, they are more inclined to buy it again based on information online (Bell, et al., 2014). What distinguishes two and four is the fulfilment method. Online information and home delivery have the advantage of storing inventory on fewer locations compared to traditional retail (Bell, et al., 2014). The dispatching locations for home deliveries can be the retailer's store, retailer's DC, or the supplier. Goods sent directly from the retailer's DC or store is called DC- or store shipment. Direct deliveries from the supplier are called drop-shipment strategies, which have the benefit of reduced investments in facilities and inventory. However, last mile transportation costs that comes with home delivery tend to be a costly operation (Hübner, et al., 2016; Chopra, 2016).

To avoid the high costs of home delivery, more actors tend to give customers the option of picking up the products from a local store at a lower price (Chopra, 2016). The advantage with store pickup is lower transportation costs due to the store pickup orders being included in the replenishment of the store's inventory, thus, eliminating last mile costs to consumers homes. The store pickup can be conducted in two ways. The first one is click-and-collect, in which the order is prepared and sent from a retailer's DC to the store for the customer to pick up. The second one is click-and-reserve, in which the store inventory is used and reserved from the online sales-channel (Hübner, et al., 2016). This type of omni-channel retailing is likely to grow for retailers providing low value goods online (Chopra, 2016).

Hübner, et al., (2016) presents Figure 7 to account for the previously described fulfilment methods for omni-channel retailers. Note that (1) In-store buying refers to traditional retailing.

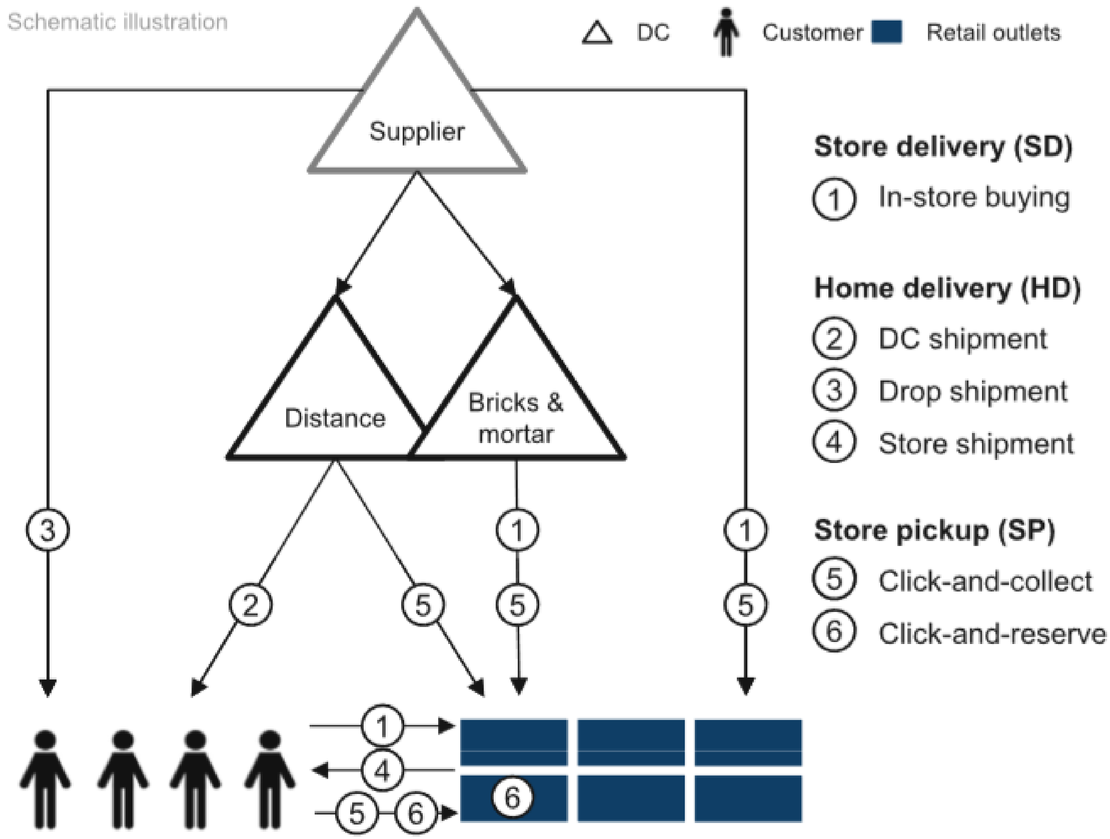


Figure 7: Front-end distribution methods in omni-channel retailing (Hübner, et al., 2016)

2.2.6. Strategies within omni-channel retailing

Brynjolfsson, et al., (2013) discusses that to succeed in the new omni-channel retailing environment, actors need to adopt new strategies in different areas. These areas could be pricing, designing the shopping experience, and building stronger relationships with customers. Furthermore, retailers should adapt short term and long-term strategies that suits the shifting landscape of the business. In short term, for example, all retailers should use big data analytics to obtain a better grasp of consumer needs (Davenport, et al., 2012). While in long term, retailers should focus on providing exclusive products with unique features in product-service bundles. The unique features and product-service bundles serves the purpose of protecting the retailer from direct price comparisons. Adding extra value to the consumer experience makes it harder to compare the retailer's service to its peers (Brynjolfsson, et al., 2013).

2.3. Distribution optimisation

2.3.1. Introduction to distribution optimisation

Business organisations face increased pressure to find new and efficient ways to distribute their products and services from concept phase to creation and delivery, and finally into the hands of the customers. High competitiveness forces actors to target inefficiency throughout the supply chain fiercely (Poirier & Reiter, 1996). During the last decade, utilisation of distribution optimisation to streamline management of distribution systems has steadily increased. The large number of real-world applications have widely shown that the use of computerised procedures for the distribution process planning creates substantial savings (generally from 5% to 20%) in the global transportation cost. Thus, the impact of these savings on the global economic system is significant (Toth & Vigo, 2002). The success of the utilisation of optimised distribution techniques is due to the development of computer systems, and to the increasing integration of information systems throughout the supply chain. A different factor of success, as important as the others, is the development of modelling and algorithmic tools implemented in recent years. These models take all the characteristics and constraints of the distribution problems into account, and the corresponding algorithms and computer implementations find good solutions for real-world instances within acceptable computing times (Talbi, 2009). A classical problem that have been used as a test object for this computer model is vehicle routing problem (VRP).

2.3.2. Vehicle routing problem

The VRP can be described as the problem of designing optimal distribution of goods. Concerning the service, in a given time period, of a set of customers by a set of vehicles, which are located in one or more depots, are operated by a set of drivers, and perform their movements by using an appropriate road network (Laporte, 1992). The routes must satisfy several operational constraints, which depend on the nature of the transported goods, the degree of the service level, and the characteristics of the customers and the vehicles. For example, these could be limited time frame for customer delivery or vehicle capacity (Toth & Vigo, 2002).

Eksioglu, et al., (2009) provide a mathematical definition of the VRP. The VRP can be represented as a graph-theoretical problem. Let $G = (V, A)$ be a complete graph where $V = \{0, 1, \dots, n\}$ is the vertex set and A is the arc set. Vertices $j = 1, \dots, n$ corresponds to the customers, each with a positive demand, d_j, whereas vortex 0 corresponds to the depot. A positive cost, c_{ij}, is associated with each arc $(i,j) \in A$ and represents the cost of traveling from vertex i to vertex j. If the cost values satisfy $c_{ij} = c_{ji}$ for all $i, j \in V$, then it is called a symmetric VRP, if the condition is not met, it is an asymmetric VRP. The VRP aims to find a collection of k simple circuits, each corresponding to a vehicle route with minimum cost, defined as the sum of the costs of the circuits' arcs.

The VRP plays a central role in the fields of physical distribution and logistics management. A common way of solving the problem is by using algorithms (Laporte, 1992). Little, et al., (1963) used an algorithm called "branch and bound" to solve a similar optimisation problem.

2.3.3. Branch and bound algorithm

Branch and bound is an algorithm for discrete optimisation problems, as well as mathematical optimisation. A branch-and-bound algorithm consists of a systematic enumeration of candidate solutions by means of state space search: the set of candidate solutions is thought of as forming a rooted tree with the full set at the root. The algorithm explores branches of this tree, which represent subsets of the solution set. Before enumerating the candidate solutions of a branch, the branch is checked against upper and lower estimated bounds on the optimal solution, and is discarded if it cannot produce a better solution than the best one found so far by the algorithm (Clausen, 1999). Land & Doig, (1960) was the first dated article that described how transportation problems could be solved by a computerised branch and bound algorithm. Since then, numerous articles featuring branch and bound algorithms solving fixed transportation problems has been published, see: (Haffner, et al., 2000; Paleka, et al., 1990; Cabot & Erenguc, 1984). Furthermore, the use of branch and bound models and software has increased dramatically. Today, these software can be handled by a personal computer and solutions for problems, with millions of binary variables can frequently be obtained in a matter of minutes (Atamtürk & Savelsbergh, 2005).

2.4. Analytical framework

In Chapter 2, three different literature sections were introduced and thoroughly explained. These were: distribution network design and operations, omni-channel retailing, and distribution optimisation. Distribution network design and operations introduced some basic knowledge within transportation and distribution nodes. The knowledge was then expanded upon, and investigated distribution trade-offs, relation to customer service, key variables when choosing distribution network, and supplier selections impact on distribution. Omni-channel retailing described the history of traditional retailing, and how it has developed over time in tandem with technology to meet increasing customer demands. This section also aimed to capture omni-channel retailing's impact on the distribution network, and what challenges an omni-channel retailer faces when adapting its distribution network design. Lastly, the section about distribution optimisation gave insight on how logistical problems can be composed, and how to solve those through mathematical models and algorithms. Distribution optimisation also worked as an explanatory section for how the software providing the model operated. The three sections in the frame of reference serves a theoretical foundation to answer this thesis research questions. To further illustrate the sections purposes, an analytical framework was created, see Figure 8.

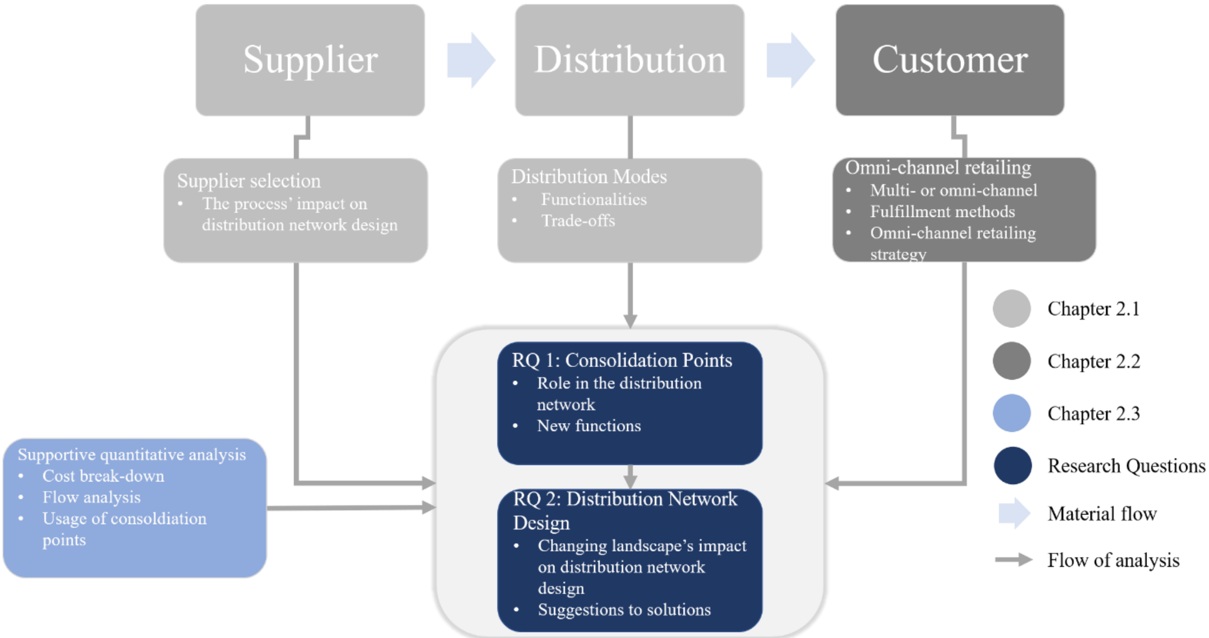


Figure 8: Analytical framework, 2.1 Distribution network design and operations in light grey, 2.2 Omni-channel retailing in dark grey, 192.3 Distribution optimisation in light blue, and research questions in dark blue

Figure 8 served as a frame of analysis for the research questions. On a high level, it framed distribution as the main focus. From distribution, it focused on the impact from its interconnected parts, suppliers and customers which are outer limits of the analysis. On a lower level, the outer limits were narrowed down to supplier selection and omni-channel retailing. Supplier selection referred to its process and how it impacted the distribution network. Omni-channel retailing referred to how increased customer demands resulted in new sales channels and fulfilment methods. New sales channels and fulfilment methods can potentially split up the distribution flows into smaller streams than previously. Thus, affecting the distribution network design. Meanwhile, different distribution modes were thoroughly investigated and trade-offs between them identified. In addition to distribution optimisation, all previously mentioned sections were used as a foundation to identify the role of consolidation within a distribution network, and how it will change due to the shifting landscape of retailing. The answer to the first research question regarding consolidation points helped to answer the second research question. Namely, how the distribution network design can adapt to omni-channel retailing.

3. Method

The methodology chapter introduces how the research of this thesis is conducted. Research strategies are explained and selected, followed by a research process that in more detail explains the research steps. The overall process steps are then mapped, and finally, research validation and reliability are elaborated upon.

3.1. Research strategy – mixed methods research

Mixed methods research is the common expression for collecting, analysing, and interpreting qualitative and quantitative data in a single study that investigates one topic (Leech & Onwuegbuzie, 2009). The focus of mixed methods research is on integrating the data to provide an analysis for the single phenomenon studied (Sandelowski, et al., 2006). Furthermore, Leech & Onwuegbuzie (2009) provide a typology for structuring mixed methods research. When structuring, the researchers need to know whether the study is partially or fully mixed, if data in gathered concurrently or sequential, and if emphasis is equally distributed between qualitative and quantitative data or one is more dominant than the other. This results in eight different types of mixed methods research models, seen in Figure 9. However, there are known pitfalls in using mixed methods research. One of them is the risk of not properly integrating the mixed methods within the study. This will lead to parallel methods that might conclude in multiple studies and not the mixing of methods within the single study (Yin, 2006).

Figure 9: Different mixed methods research models (Leech & Onwuegbuzie, 2009)

For this thesis, P4 from Figure 9 is adopted since this thesis was a partially mixed study where data gathering was made sequential, but the qualitative data gathering had a dominant status. It was also partially mixed due to the different data not being mixed before interpreting them in the analysis. The qualitative data was given the dominant status due to its potential of giving more accurate insight on this thesis' research questions. The qualitative study was collected through semi-structured interviews with employees at IKEA, while the quantitative data was collected through the data model, both are further described in 3.3.

3.2. Research process

This thesis research process was based on the mixed method research. A flowchart, Figure 10, visualises the process holistically from beginning to end.

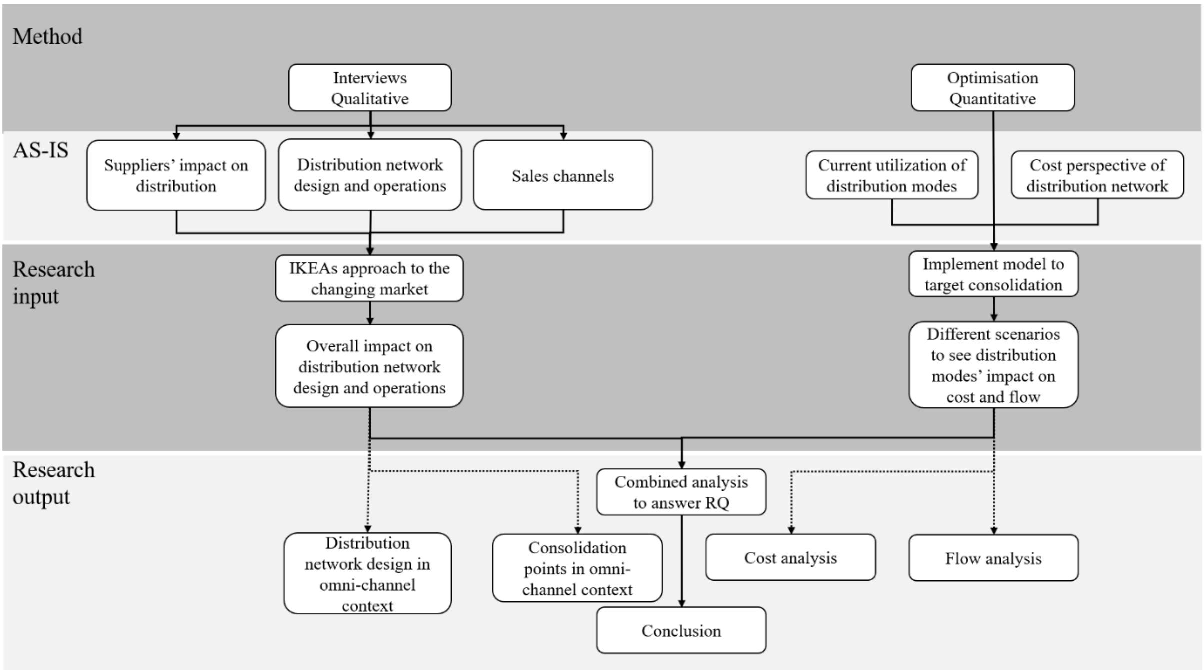


Figure 10: This thesis' research process.

The research process was done as a mixed methods research. The quantitative data was collected from a model in a distribution optimisation software, while the qualitative data was collected through interviews. Through combination of the two parts, a holistic and detailed understanding of the subject was achieved. The idea of the qualitative research was to map how IKEA currently operates in terms of sales channels, distribution network design, and distribution strategy. From there, an understanding of how IKEA is changing in terms of sales, and how that impacts the distribution network design and strategy was achieved. Meanwhile, an optimisation model of an existing distribution network within IKEA was run to provide context in terms of costs, where flows are heading, and which distribution modes and delivery solutions that were being utilised. Then, different scenarios were created in the model to see how the contextual variables changed, which is further explained in 3.3.1.

The results from both the qualitative- and quantitative data were analysed in a combined analysis to give answers for the research questions. The two different research strategies should not be considered as separated units. Instead they should be considered a mixed approach where the interviews support the quantitative research, and vice versa.

3.3. Data collection and analysis

3.3.1. Quantitative research – Modelling and optimisation

The quantitative research was performed as an optimisation task using a software called Supply Chain Guru (SCG). SCG tries to solve a VRP by deciding the cheapest and fastest route in fixed distribution. Since more than one feasible answer exist, SCG operates through branch and bound algorithms to provide the most optimal, yet, feasible solution to the given model. The model used for this optimisation was called DORS. DORS was a model that focused on the receiver perspective in a distribution network. The optimisation was done through using the preconditioned distribution network and delivery network. Meaning, that based on which supplier that can provide the best price or "best buy" for a product, the model would then suggest the solution that minimises total cost. For example, a product might be cheapest to ship through direct delivery but, in the same system, there was also a smaller product that was too expensive to send direct delivery in close approximation. Then, the system may find that it was better, in terms of the total cost, to send them both as direct delivery through a CP.

At a high level, the DORS model takes the following into consideration:

- All suppliers in the world
- All DCs within a Distribution Centre Group (DCG, predefined)
- All retailers replenished by the DCG
- All products that are sold at the retailers
- Forecasted need from the supply plan
- Business constraints on article and relation level
- Constraints from retail storage capacity

There are six categories of main data being used to create the models. These are: products, demand, transportation policies, sourcing policies, inventory policies, and sites (logistical nodes). They are illustrated in Figure 11: SCG's data model structure and its most important variables.

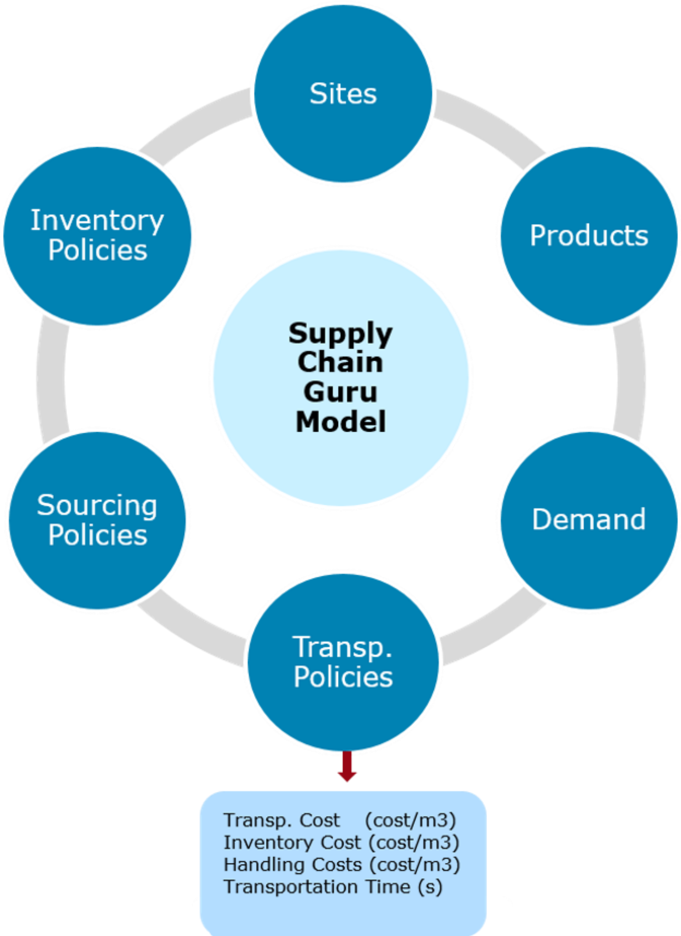


Figure 11: SCG's data model structure and its most important variables

To create different models that can analyse the usage of consolidation points, the authors focused on modifying the data in transportation policies. This is due to the fact that the category includes important parameters, such as: possible routes for a product (supplier to store), transportation cost, inventory cost, handling cost, and transportation time. Figure 12 illustrates the logic of the transportation policy.

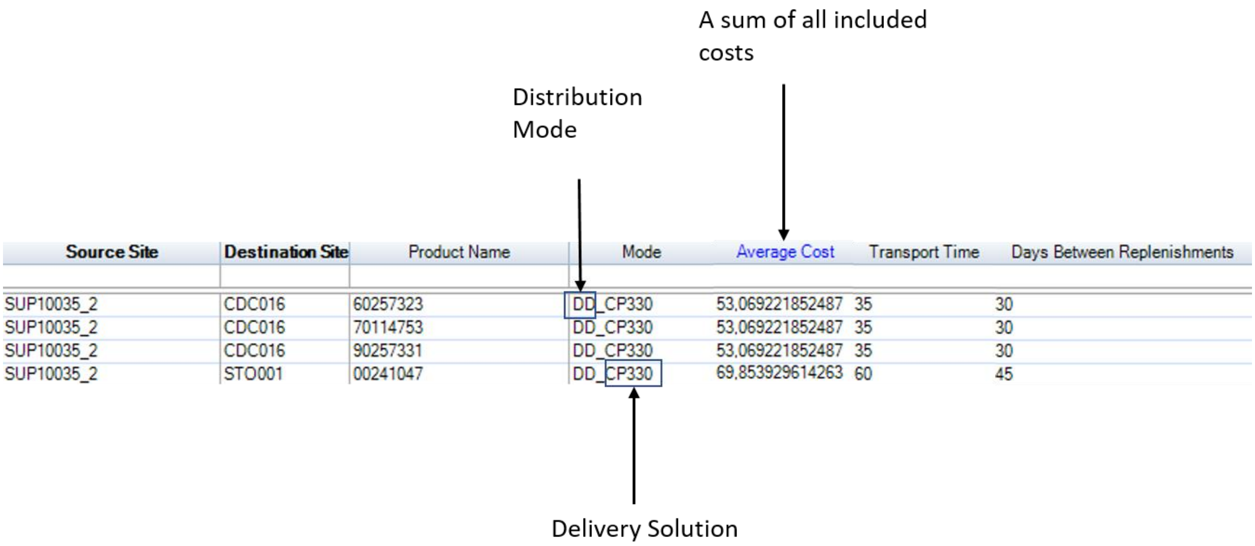


Figure 12: How data is entered into SCG

Each row corresponds to a "unique item route", which is the route for a specific item being sent from a supplier to a store with a specific distribution mode and delivery solution. Figure 12 does not include all the parameters in transportation policies, but only the most important ones. However, non-included parameters have a limited impact on the model.

To help answer the research questions, three different scenarios were created in SCG. Two of the scenarios were created to give a better insight of the usability and impact of CPs on the distribution network. The third scenario's purpose was to investigate what happens when IKEA's primary distribution mode and delivery solution was unavailable. Furthermore, a reference model was used. The reference model was IKEA's current optimised model for replenishment. The reference model does only allow a unique item route to choose one CP as a delivery solution. Its purpose was to compare if the three scenarios created did any impact on costs and flow in the distribution network. The different scenarios were implemented in the model and ran through the software. The results were then analysed and compared. Results of the quantitative research is presented as graphs in chapter 5. The results contribute to the analysis through providing validity, and to draw conclusions regarding costs, usage of different delivery solutions and distribution modes, and transportation time within IKEA's distribution network.

Scenario one – Exclude CPs

Scenario one aims to investigate what happens when CPs are not allowed in the distribution network, see Figure 13.

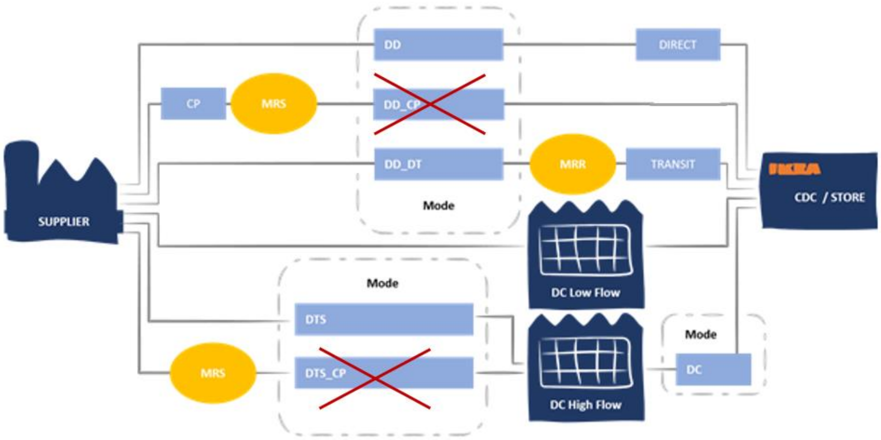


Figure 13: Illustration of scenario one - Exclude CPs

The purpose of this scenario was to find out how these flows are sent instead, and how the different costs are affected.

Scenario two – Include all CPs

Scenario two allows each unique item route to choose any of the 30 available CPs as a delivery solution, compared to being predetermined to one. See Figure 14.

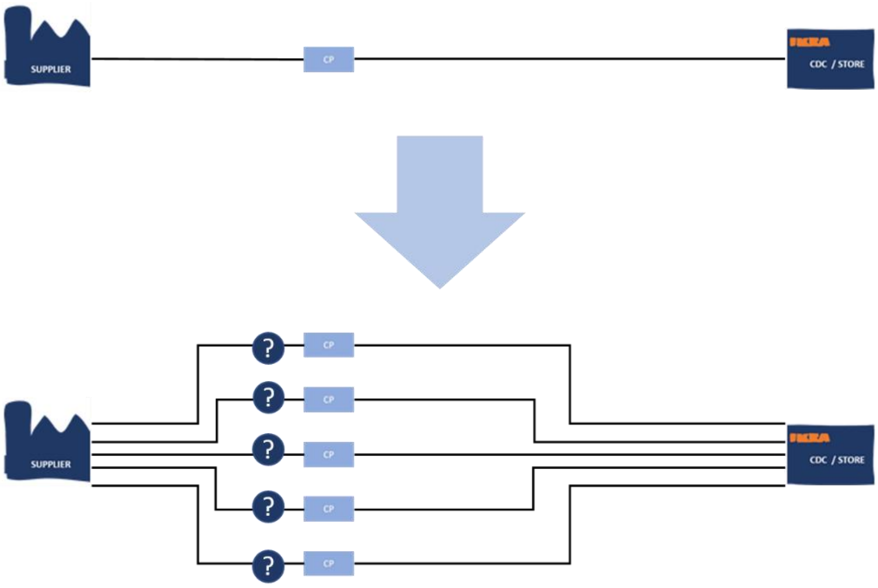


Figure 14: Illustration of scenario two - Include all CPs

The purpose of this scenario was to investigate if any of the unique routes preferred the new CPs instead of the one from the reference model. Furthermore, impacts on costs and flow were analysed.

Since the routes were new, there existed no direct data to satisfy the parameters previously mentioned. Thus, the data was created based on historic distribution data from IKEA. Transportation cost was given to the new routes through investigation of IKEA's historic transport data. To clarify, if a supplier was based in Czech Republic and the consolidation point was based in Poland while the final store was in Spain. The transportation cost would be the combined historic cost of sending products from Czech Republic to Poland, plus Poland to Spain. All types of handling costs, and inventory costs were put into the new scenario by finding the historically specific product cost at its assigned store/DC/CP. For example, comparing a store in Portugal and Belgium, the retail handling cost for product X might differ. Thus, the finding the correct cost for a specific product at its assigned store was important.

Scenario three – Include all CPs and exclude FUL with direct delivery

IKEA's point of focus in distribution strategy lies within sending direct delivery with FUL to stores. Therefore, a scenario where this specific combination of a distribution mode and a delivery solution was excluded in the interest of analysation, see Figure 15.

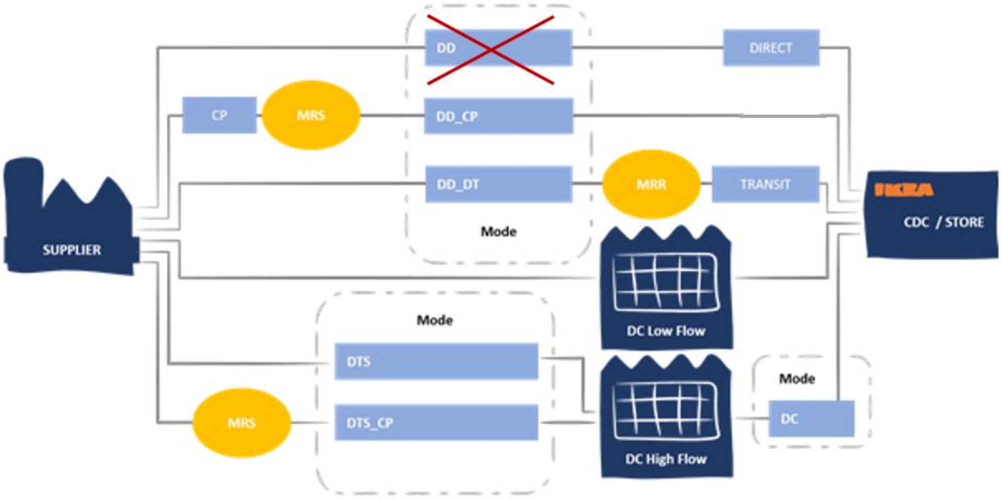


Figure 15: Illustration of scenario three – Include all CPs and exclude full unit loads through direct delivery

Scenario three was made to capture what happens with overall costs, and which distribution modes that are prioritised instead. Furthermore, the scenario was used to investigate if there was an increased usage of CPs when direct deliveries are excluded. If so, which CPs being used, were to be analysed and compared to scenario two.

3.3.2. Qualitative research – Interviews

Interviews are an important source of evidence when doing research. Interviews can help to gain insight of key events and give further understanding into the participant's perspective (Yin, 2018). Interviews can be either structured, semi-structured, or un-structured. A key element of semi-structured interviews is the resemblance of a guided conversation rather than structured survey. This becomes important for the researcher since their task is to in detail explore experiences, motives, and opinions of others and learn to use their perspective rather than the researcher's own (Rubin & Rubin, 2012). Moreover, to guarantee the validity and reliability of the research, the data gathering needs to follow a protocol. The protocol provides a suggested type of interview structure as well as how the interview questions should be posed. Beyond suggestions for interviews, the protocol also needs to address triangulation, collecting data from other people or sources (Voss, et al., 2002).

For this thesis, the interviews were performed in a semi-structured manner. The base consisted of an interview guide, see Appendix, but since the interviewee had important insight that was hard to foresee, it was crucial to keep the exchange open. The purpose of the interviews was to complement the more quantitative data from the optimisation with qualitative data. To create a better understanding of the consolidation, and ultimately, get a holistic view and understanding of IKEA's distribution network design and strategy, as well as, understanding IKEA current and upcoming sales channels. The interview guide also focused on the future of IKEA's supplier selection, distribution network design, and sales channels to investigate how they impacted each other. Furthermore, the questions in the interview guide was trying to be open-ended, and not leading. Thereby, avoiding unnecessary bias.

When the interviews had been conducted, the data needed to be documented, transcribed and interpreted. This was done closely after the interview since it increased the researcher's chance of keeping the information fresh, which is in line with Voss, et al.

The authors held four interviews with five different interviewees. All the interviews were held for approximately two hours, and more information can be found in Table 7.

Table 7: Interviewees for the qualitative research, all with previous experience with the DORS-model

Name	Position	Date
Interview 1	Solution Owner DORS	25/3
Interview 2	Business Developer Purchasing	26/3
Interview 2	Supply Planner	26/3
Interview 3	Sourcing Developer	27/3
Interview 4	Strategic Process Developer	5/4

The documentation from the interviews was used, as previously mentioned, to map out the current distribution network design and get an understanding of the future of IKEA. From there, the information was used, together with the quantitative data, to create an analysis that could act as support for answering this thesis' research questions.

3.4. Research validity and reliability

To maintain the overall quality of this thesis, it was required to achieve enough reliability and validity. Within empirical research there are four tests that are commonly used. These validity tests are; construct validity, internal validity, external validity, and reliability, which all work well with empirical research (Yin, 2018). In this case, mixed methods research. The four tests along with suggested tactics are presented in Table 8 below.

Table 8: Tactics to achieve research credibility. Adopted from (Yin, 2018).

Test	Research tactic	Phase of research	Tactic thesis
Construct validity	Use multiple sources of evidence Have key informants review draft research report	Data collection Composition	Triangulation through multiple interviews and modelling
Internal validity	Pattern matching Explanation building Address rival explanations Use logic models	Data analysis Data analysis Data analysis Data analysis	Focus on unbiased questions Multiple scenarios in modelling
External validity	Use theory in single-case studies Use replication logic in multiple studies	Research design Research design	Comparison and analysis between theory and IKEA Risk of lost generalisation due to only studying one company
Reliability	Use study protocol Develop study database Maintain a chain of evidence	Data collection Data collection Data collection	Interview guide Step-by-step modelling Interviewees reviewed transcription

As presented in Table 8, there are three types of validity. The first one is construct validity, which has two steps that needs to be covered to avoid failure. The first one is to define the subject in terms of specific concepts, and then, secondly identify operational measures that match these concepts. To achieve this, the tactics presented in Table 8 could be used such as using multiple sources of data, and have key informants review the report. It is also important to create a chain of evidence throughout the data collection (Yin, 2018). To strengthen the construct validity further, it is also good to seek out triangulation, through usage of multiple methods (Voss, et al., 2002). For this thesis, construct validity was achieved by using mixed methods research. Using different methods allowed this thesis to achieve triangulation by having qualitative data from the interviews confirming the results of the quantitative model and vice versa.

For research in general, internal validity mainly relates to the problem of inference. Inference is apparent in research each time an event cannot be directly observed (Yin, 2018). In other words, inference could lead to a discrepancy between the researcher's findings and the reality (Zohrabi, 2013). The researchers will then have to assume that an event resulted from earlier occurrences, based on for example information from interviews. When this is done, there is a risk that actions have been missed which leads to the wrong conclusions. To avoid making faulty inferences, it is suggested to use logic models, pattern matching and address rival explanations (Yin, 2018). Internal validity was assured in the qualitative research by having several interviews. Comparing these interviews to find patterns and logical reasoning reduced the risk of inference. The quantitative research was internally validated through the usage of different scenarios. If the results from each model was reasonable for its scenario, then the results as a whole were deemed validated.

The third test relates to the possibility of generalisation of the researcher's findings and is called external validity. The first risk in external validity is that the research question is not compatible with finding a generalised result. Without the proper formulation, an analytic generalisation becomes harder in many researches. Therefore, it is important to set this parameter in the research design phase, since it affects the ongoing process throughout the research (Yin, 2018). Since this thesis solely operated in collaboration with a single company, external validation was not achieved to its fullest. However, IKEA is a large company with a sophisticated global distribution network, thus, making it possible to draw general conclusions to some extent from the results.

The final test is the reliability test. Reliability refers to the consistency of a measure, and the objective of this test is to make sure that if another researcher follows the same path they will end up with the same finding and conclusions (Heala & Twycross, 2015; Yin, 2018). The goal of reliability is therefore to reduce the amount of errors and biases. To achieve the reduction in errors, it is important to document the procedures as explicit as possible, creating the possibilities of repetition (Yin, 2018). Reliability in the quantitative research was done by running the same model multiple times and see if the result differed. To assure the reliability for the qualitative research, an interview guide was created. This was made to always have the same type of questions for each interviewee, and thus, assure reliability. Moreover, the transcriptions of the interviews were reliability tested by having the interviewees read through them to see if they interpreted it the same way as the authors.

4. Qualitative empirics

The qualitative data gained during the data collection are presented in this chapter. The data is mainly collected from the four interviews performed on IKEA employees together with general information from IKEA. The chapter is moving through parts of the IKEA supply chain, starting with distribution network and sales channels, and ending with ideas of IKEA future from the interviewee's standpoint.

4.1. Distribution network

4.1.1. Different distribution modes and delivery solutions

IKEA's distribution network is spread across the world. In combination with a wide assortment that ranges from small articles, such as cheese slicers, to big sofas and kitchens, which requires flexible and efficient logistics to reduce the cost. To support the varying sizes and demand from the stores, IKEA uses three different distribution modes. These are direct delivery, distribution centre (DC), and combined supply. Together with these three modes, there are several delivery solutions that can be combined. These are full loads (similar to FUL), mid receiver near sender (MRS) or consolidation point (CP), mid receiver near reciever (MRR) or transit point, and milk runs. In Figure 16 below, the volume shares of the different modes and solutions are shown.

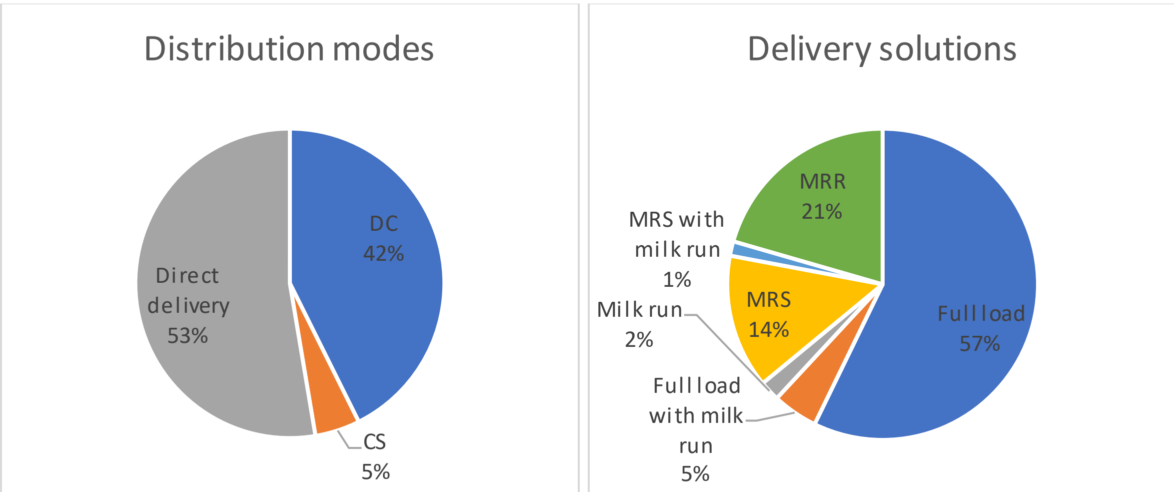


Figure 16: Volume shares for the different distribution modes and delivery solutions.

Direct delivery represents just over half of all deliveries while DC represent the rest, with only a small portion sent as combined supply (CS). It can also be seen that the main part of the loads is sent as full loads (or FUL) followed by transit points (MRR) and then CP (MRS). In Figure 17 the different distribution links between a supplier and a store is shown.

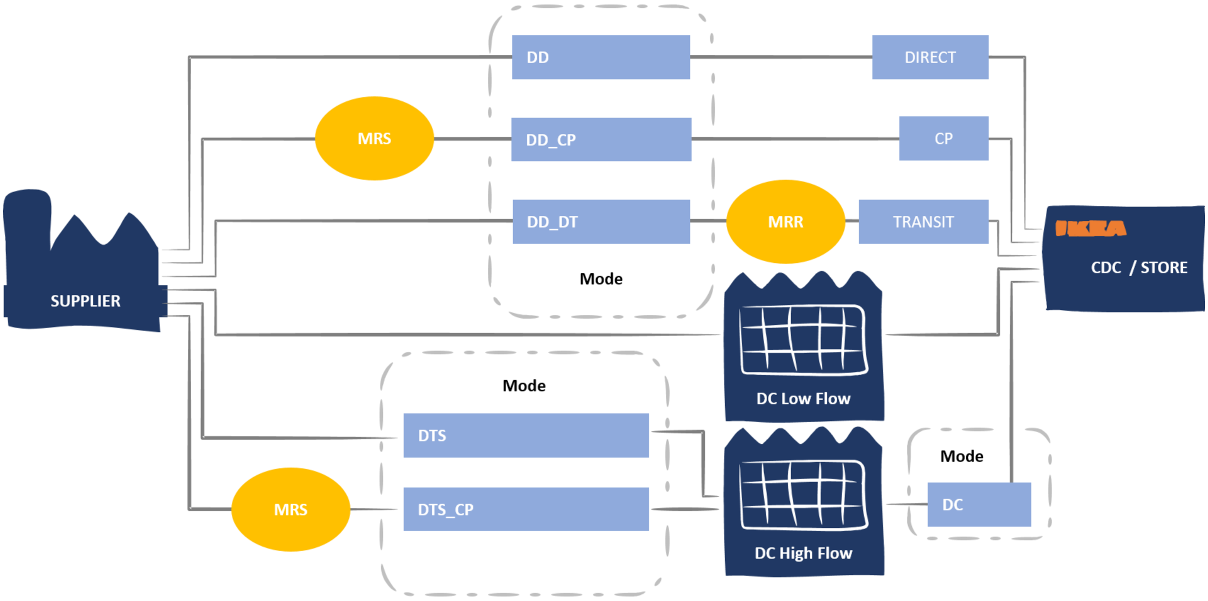


Figure 17: IKEA's distribution network with modes and delivery solutions.

The top three links are direct delivery with three different types of delivery solutions, namely full load (direct), MRS or CP, and MRR or transit point. The bottom three are distribution to a DC. Either directly to a low/high flow DC or with a MRS solution.

4.1.2. Distribution modes

Direct delivery

Direct delivery is the preferred mode within IKEA, and the most used as previously shown in Figure 16. Direct delivery means that the products are shipped directly from the supplier to the store. However, direct shipment does not necessarily mean that it is a no stop transport. A direct delivery transportation can go as a full load, meaning that a full truck is sent directly from supplier to store, but can also include a MRR or MRS connection as shown in the top three links in Figure 17. The main reason for using direct delivery is the price. If the trucks are filled to a certain degree, the price for direct delivery is always the cheapest. The fill rate for direct delivery is targeted to at least 60 percent, and transport do not start organising transportation before 40 percent is guaranteed. There are a couple of parameters that affect the decision on whether to choose direct delivery or not. The products vary in demand, size and packaging. Some products are, therefore, not possible to send in full trucks loads since it could be inventory for years. There is also a limit on inventory capacity, both on the supplier's and retailer's side. The suppliers may not have enough storage capability to keep products until full loads can be shipped. Keeping stock at the store, on the other hand, is not preferable either. Keeping stock reduces the sales area, and the fixed costs for the stores are usually higher than at the warehouses or at the suppliers. Because of this, the stores must balance the reduced transportation cost from direct delivery with increased inventory cost. Finding the best trade-off is important for the stores since they usually cannot receive direct delivery as much as wanted. Usage of direct delivery is also depending on where the supplier is situated, since the transport is slower for direct delivery than DC.

Distribution centre

There are two types of distribution centres within IKEA's network, low flow and high flow, as previously shown in Figure 17. All the DCs are owned and operated by IKEA. Low flow DC is used for slow moving goods that does not sell big volume. Examples of low volume goods could be variants of kitchen doors. High flow, on the other hand, are standard products that are sold in high volumes such as tableware or food containers. The low flow centres usually cover a much greater area, such as Europe, while the high flow DC covers on country level. The distribution centres are usually more expensive to send through than direct delivery for two reason. The transport cost is higher, and there are fixed costs related to maintaining a distribution centre. However, it allows the store to get mixed shipments since the DC ship multipacks (boxes), which reduces the inventory holding cost for the store and raises the potential sales area.

4.1.3. Delivery solutions

Mid receiver near sender and consolidation points

MRS relates to CPs that are situated close to suppliers. Multiple suppliers can send LUL shipments to the CP, which are consolidated into a FUL shipment for either a store or DC. Shipments through a CP could be either direct delivery, DC, or combined supply. The CPs are flexible to use since IKEA do not own the facility themselves or employ any staff. Instead, they contract actors with a warehouse in the specific region where a need for consolidation is identified. The functions at a CP are limited, since there is no picking performed or break-bulk action. The product shipped to the CP are permitted to be racked for about three days, so that all pallets meant for the same destination have time to arrive. However, sometimes the pallets can stay for more than two weeks in some situations. Once all the pallets have arrived, they are shipped to their destination. The decision of when to ship the pallets are up to IKEA. If, for example, a FUL delivery would not be possible within a wanted time frame, IKEA can decide to ship it anyways as a LUL shipment, or postpone to achieve higher fill rate.

The CP has the ability of consolidating LUL shipments into FUL, which, reduces transportation cost and saves time for IKEA. It reduces transportation cost due to sending LUL has a higher cost per volume compared to FUL. The time saving is achieved by suppliers sending their LUL shipments immediately to a CP, instead of waiting until they have produced enough to fill a full truck. Then, all the LUL shipments sent at the same time can be consolidated, and thus, time is saved.

Choosing the location of a new CP

Choosing a new CP is done on a strategic level. The process is described in Figure 18.

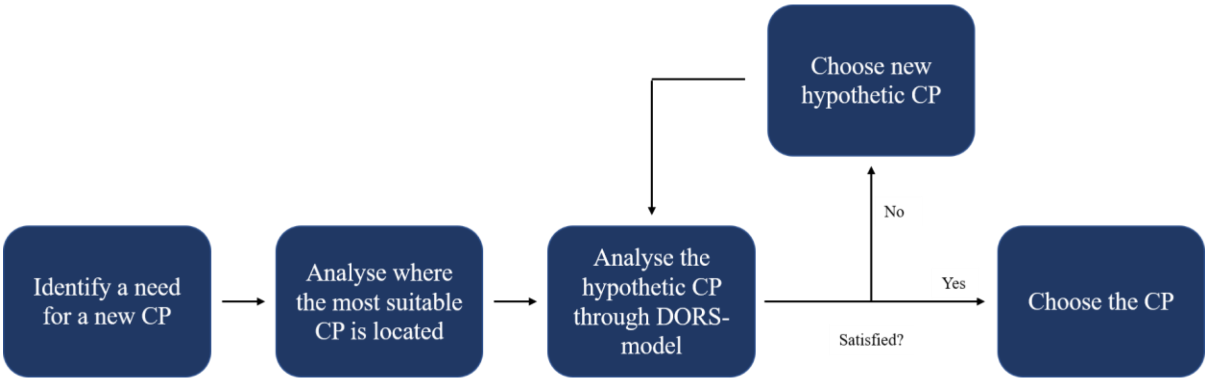


Figure 18: Process of choosing a new CP

The first step is to identify the need for a new CP. This is often identified through indications from different parts of the logistical organisation. For example, the transport organisation recognises that certain suppliers from the same region do not have the capacity to send full trucks and a CP could be useful to avoid sending LUL. A strategic process team, which includes many parts of the supply chain organisation, uses this information to further investigate if a new CP is needed. If so, the next step is to find the point of gravity for the flow of goods. The point of gravity indicates at which location a new CP should be opened, based on the flow of goods from the suppliers. However, the point of gravity does not take basic business rules in consideration and can, thus, be placed in the woods or at sea. Therefore, the team needs to add more parameters to the equation before choosing their first hypothetical consolidation point. These parameters could, for example, be: if the suppliers usually send their shipments by land or by sea, if one or more of the suppliers controls a warehousing unit as well, and so on. With all of this in mind a hypothetical CP is chosen.

The hypothetical CP is tested in the DORS-model to evaluate if it fits in the distribution network. The DORS-model will run a scenario over a year where the CP is included based on forecasted data. If the CP has enough traffic over the year, then it is deemed sufficient in the new network and the analysis is successful. The owners of the CP will be contracted and open it up for traffic within 6 months. However, if it does not attract enough traffic, a new hypothetical CP will be chosen and analysed until the results are satisfactory.

The CP will continuously be analysed over time through the DORS-model. If anything changes in the model that reduces the traffic through the CP below a certain threshold, the strategic team will start the process of ending the contract with the owners of the CP. Since IKEA does not own the CPs, it is possible to be flexible in opening and closing CPs.

CP on an operation level

On an operational level, CP is seen as a second-hand delivery solution. This is due to sending full truck loads from the supplier directly to the stores, is prioritised within IKEA. Meaning, that the transport organisation will mainly order trucks to pick shipments up at the supplier when it has produced enough for FUL. If transport believes that a certain supplier will not be able to produce enough for a truck load in time, then, using a CP will be considered. When CP is considered as the preferred delivery solution, transport organisation will contact the CP and give them instructions on what shipments are incoming and how to consolidate them. The shipments are not allowed to sit at the CP for more than three days. This means that the transport organisation has coordinated different part loads from different suppliers to be consolidated at the point in advance. Therefore, no shipments are sent to the CP to just wait until other shipments arrive by chance. However, it is not certain that the shipments arriving at the CP will fill up the truck evenly, and in many cases the pallets stay in the CP over three days, although it is not allowed. If that is the case, IKEA can either choose to let some of the goods wait in the CP and be consolidated with the next incoming shipments or send it LUL to the desired destination.

Mid receiver near receiver and transit points

MRR or transit points are in many ways like a CP. The main difference is that they are situated close to the stores instead of the suppliers. The transit points are usually an individual section of a DC that only handles full pallets. Furthermore, they do not rack it in comparison to consolidation points. Instead the pallets are directly sent from inbound to outbound. Transit can be done both as direct delivery and combined supply. This means that the handling at transit points usually is cheaper than at CPs. Shipments to a transit point often require FUL from the suppliers, since the distances often are long. However, due to the connection with a DC it easier to achieve enough volumes.

Milk runs
Milk runs within IKEA can be performed either between suppliers or stores. If the milk run is performed from the supplier it can then be sent as directly delivery either through a CP, Transit, DC or directly to the store. In the same way, if stores are close to each other they can coordinate shipments to receive enough fill rate for direct delivery from suppliers.

4.1.4. Supplier selection's impact on the distribution network

Supplier selection starts when a product is designed and confirmed for production by a Product Offer Development Team (POD). The POD sends information about the product and material to a purchasing unit. There are nine purchasing units in each zone (North Europe, China et cetera) who are responsible for different material, such as plastic and glass. Each zone analyses potential suppliers that may be able to supply at the right criterion for a specific product. Requests for Quotation (RfQ) are sent to the suppliers and the purchasing unit provides recommendations of suppliers to the POD. The RfQ is analysed further by the POD on parameters such as price per unit, lead time, and setup cost to find the most suitable supplier. Most of these parameters are provided through the RfQ, but some data, like lead time and transport cost, is based on historical data. Meaning, that the current distribution network setup is used for the analysis. Price per unit plays a big role in the decision, but the sourcing developer looks to find the "best purchase". This can be based on, for example, that IKEA believes in the supplier on a long-term basis, or what kind of geographical split they want.

A sourcing project could typically last between 1-2 years. During that time, the PODs do not coordinate with other PODs to find synergies when choosing suppliers. Instead, they solely focus on what is best for the specific product. There is also no connection between the PODs and functions such as transportation and distribution.

4.2. Sales channels

4.2.1. Current sales channels

IKEA has two types of sales channels, the retail stores and website. Up until a few years ago this was not obvious, as parts of the IKEA governance were strongly against e-commerce. However, over the last years, IKEA has started to work with more solutions and recently, other concepts have been tried, more on this in the next section 4.2.2.

Retail store
The retail stores are IKEAs biggest sales channel, representing 92.7 percent of the sales in 2018. The stores are working as a franchise within a standardised product range. One of the big benefits with the retail stores, according to IKEA, are that they create a lot of unplanned purchases, which adds sales that are hard to achieve through other sales channels.

The stores have their own responsibility for how to receive and order products. Thereby, the store balances their own inventory and can themselves decide in what time they want the goods to be delivered. This mean that they indirectly can decide which transport mode that should be used. Depending on their receiving capabilities they can move away from suggested approaches to what they believe are the best for them. Some stores have even bought separate areas which they use for warehousing. By doing so they can ship much more through direct delivery and thereby reduce the transportation cost.

E-commerce and its sales channels

The e-commerce within IKEA represents a small part of the overall sales (7.3 percent). The internet orders are delivered through a Customer Distribution Centre (CDC). The CDC is a customer touch point which usually is within the same building as the DC. However, with a possibility for customers to receive goods. In many situations the CDC targets just one country due to legal restrictions. For example, the DC in Italy serves Italy, Greece, Cyprus and Turkey while the CDC in Italy only service Italy. To reduce the lead time to customer some locations also have local service centres (LSC) that are placed between the CDC and the customers. These are often placed in close approximation to bigger cities. Except for the CDC and LSC, IKEA offers home delivery as a fulfilment method towards the customer. It is also possible reserve goods online and pick it up at the store.

The e-commerce can be accessed from various channels, such as website, mobile units, and social media. However, making purchases from the mobile unit or through social media directly is not possible. Instead, the customer is forwarded to an adjusted website where the purchase can be made. This means that mobile units and social media is mostly used for advertising and other support functions. Moreover, IKEA has never given e-commerce proper priority regarding development throughout the supply chain, due to prioritising retail stores instead. An example of this, is the forced adaption of e-commerce to suit IKEA's traditional supply chain strategy. The bulk of e-commerce goods are sent in the same numbers as goods reaching the stores, resulting in IKEA losing money on some products where breaking the bulk and repacking it at the CDC costs more for IKEA than it costs for the customer.

4.2.2. Upcoming sales channels

Recently IKEA has started two new store concepts, city stores and showrooms, that are targeting urban shopping. In Stockholm they have opened IKEA City – "Kök" (Kitchen) which is a showroom for inspiration and designing a kitchen. A similar concept has also been done with beds, which usually is something that shoppers want to try before they buy. The main purpose of these connections is to reach customers easier with smaller stores without direct sales functions. Instead, the stores showcase big and bulky products, that then can be ordered through the website and delivered home.

In the city stores, it is possible to buy certain smaller items directly. The product range is, however, limited and stock levels are low in comparison to the bigger stores. In the future, IKEA will open city stores which offer smaller items from all categories. The products would be displayed in different concept rooms where the customer would have the possibility to, in a similar way to the other showrooms, order the products home, but also make purchases directly from the store. In Figure 19 below, an extended distribution network design is presented with the two new store concepts included.

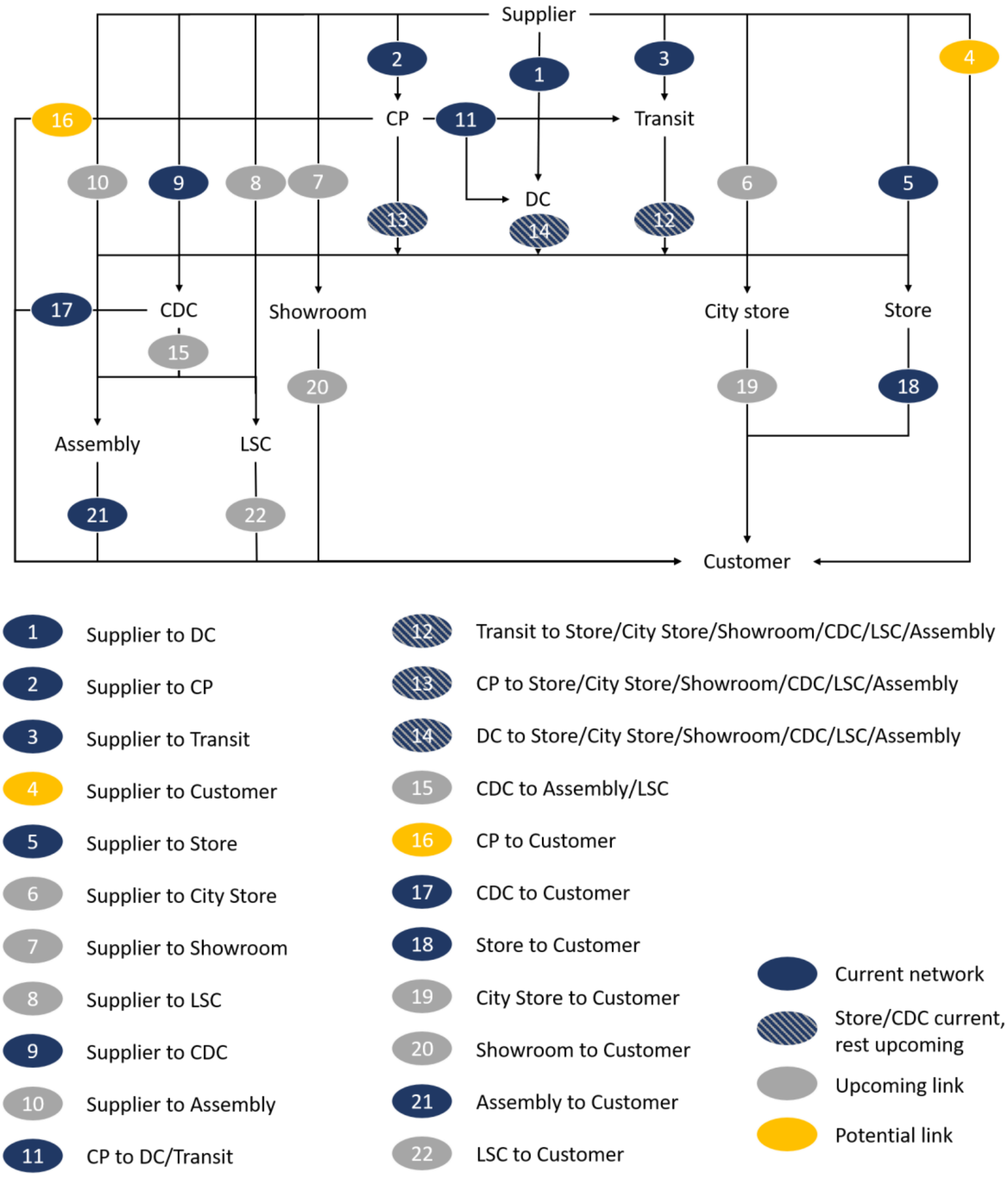


Figure 19: Expanded distribution network with old, new and potential nodes

It starts with the supplier in the top and the further down it gets, the closer it gets to the end customer. Depending on the colours of the bubbles, they are either existing, upcoming or potential links within IKEAs new distribution network. To easier and quicker reach the new urban customers, IKEA plans to open more LSCs. These are smaller distribution centres with high demand assortment to quickly reach customers ordering either through the website, showroom, or city stores. The LSC is meant to be a middle link between the CDC and city customers to reduce the lead time of shipment and creating the possibility to delivery within the same day or even hours. The LSC concept could also be provided directly from the existing stores in some situations.

In Table 9 below the new and old sales channels along with new nodes are presented in regard to flow size and functions. Overall, the flows are smaller for the new concepts with a higher focus on the customer experience.

Table 9: Comparison of new and old sales channels and nodes

	Store	Showroom City Store	Website (CDC)	Assembly	LSC
Flow size to logistical node	High	Low	High	Low/medium (sporadic)	Medium
Flow size from logistical node to customer	High	Low (potentially bulky)	Low/Medium	Mixed	Low/Medium
Function now	Direct pickup from customers in the store Handle returns from all channels Pick-up point for web shopping	Inspirational Show concepts that then can be ordered on sight Some products may be available directly in store One product category such as kitchen or beds	A way to target the customer outside of the stores range	Assembly of products for private or business customers Business customers is often massive orders (new hotels, offices etc.)	Provide fast deliveries for customers that are not within the range of regular stores. Node between the CDC and the customer
Upcoming or potential functions	Fast deliveries (same/next day delivery) of products order in other channels to customers in proximity to the store Assembly, either at customer or in store	Pick-up point	Central node for all none store flows		Assembly Pick-up point

4.3. IKEA's approach to the changing market

The data presented in this section are a combination of known developments that IKEA are working with, together with ideas and speculations from the interviewees on how the future of IKEA will be shaped.

To get an idea of how IKEA will change in the future, a table of key interview takeaways was concluded from the interviews. This is presented in Table 10. The most important bullet points were elaborated on further down in the chapter.

Table 10: Key take-aways of future ideas from interviews

Sales Channels	CP	Distribution Network	Sourcing and supplier selection
• Increased sales from online channels • City store concept to grow • Stores need to adapt to suit e-commerce, not the other way around	• Viable when small sized orders increase • Reduces risk of DC and transit overflowing • New functions • Currently not reliable as a prioritised delivery solution	• Increased focus on availability, fulfilment methods, and efficiency • Possibility of distributing assembled products • Local distribution centres to support smaller sales channels	• Fewer suppliers • More focus on geographical proximity • Renegotiate terms to enable smarter distribution

Sales channels

IKEA employees do not deny that IKEA was quite slow with the transition into e-commerce and internet shopping. However, there is a mutual understanding among all interviewees that e-commerce will play a much bigger role in the future and outgrow the retail stores. Moving from the retail store as the main sales channel to e-commerce will, however, not come without changed requirements and new challenges. Before, and even after, the market has moved over to the web, there is still a place for the stores. There is an increased focused on attracting customers to the stores and to make shopping at IKEA a full day experience. There is a fine line between the value of a retail store, through for example concepts, and what can be replaced by internet shopping. Customers outside of range of an IKEA store will not be affected by this, but customers within range of a store might move over to internet shopping. This may reduce the spontaneous purchases while IKEA, at the same time, keeps the high fixed costs of physical stores. This cannibalisation effect is considered a risk within IKEA today.

Over the coming years, IKEA will need to become experts in e-commerce to satisfy the increased service requirements from the customers. To satisfy the customers' demand, the requirements on planning and quality within products, logistics, and production will need to increase. If a product is out of stock in a store, it is easy to fill that area with something similar. This reduces the risk of disrupting the customer experience. On a website this is not possible to do in the same way. If a product is out of stock, the customer will notice and have a reduced customer experience. Becoming experts in e-commerce may also push IKEA to move into sales channels that are not their own, such as Amazon. However, the discussion around this are divided and do not converge with the business idea of IKEA as it stands today.

Consolidation Points

To support the move towards internet shopping, with smaller customer orders and a more divided flow, the distribution will most likely need to become more flexible. One of the main beliefs is that this is achieved through an increased usage of CPs. Previously, CPs have been chosen based on experience and historical data. In the future it should be based on the demand, which then, pushes the need for CPs. The introduction of city stores and showrooms are believed to further increase this need. Furthermore, this creates a need for the LSC, which supports delivery to e-commerce and the smaller concept stores. Along with more CPs, a need for more hybrid solutions at the locations is most likely required as well. The CPs should not only be capable of handling full pallets, but also, break bulk to potentially approach the customers directly. All last mile distribution is provided by carriers such as DHL which are believed to be the most efficient solution due to their already extensive network.

Distribution network

For bigger and bulkier goods, such as beds and sofas, there is also the possibility of moving the distribution all the way back to the suppliers and introduce drop shipments. Moving towards drop shipments would require higher flexibility and increased need for storage capacity at the supplier, which may not be possible. Asserting these demands on the suppliers would require new supplier agreements which would be a prolonged process.

Another aspect of e-commerce is that different flows have different logistical requirements. For example, e-commerce needs a different type of package compared to stores, or requires picking and handling further upstream in the supply chain compared to goods sold at the store. Multifunctional logistical nodes were suggested to cope with different logistical requirements. These nodes are supposed to turn old nodes, with limited functions, into nodes where different tasks can be performed. For example, being able to break bulk and pick at a CP, or a DC working as a CDC with assembly points. Having these multifunctional nodes could decrease the complexity in terms of transportation.

Sourcing and supplier selection

Moving away from traditional sales channels, and into more diversified channels, has impact all the way back to sourcing and supplier selection. Sourcing and supplier selection, as a function, may need to change its way of working to cope with diverted sales channels. One issue, moving forward is the agreements with the suppliers. To enable delivery solutions, such as drop shipping, IKEA need to create a new framework of requirements for the suppliers, which would require handling zones at the suppliers. There is also a risk of moving the customer experience to far back into the supply chain. Since cutting off IKEA’s distribution network may make it harder for them to control the quality of the products before they reach the customers.

IKEA will also have to change its strategy within supplier selection. Lowering the number of suppliers and increasing the capacity of their current suppliers, is a necessity to create a more efficient distribution network. Right now, there are too many small suppliers producing single items. Coordinating these suppliers with the larger suppliers increases the complexity. Therefore, it is believed that IKEA will put more emphasis on selecting suppliers with a broader production potential. To further enable this, more coordination is needed between PODs. Since PODs are divided based the products function in the home, such as living room and kitchen, and suppliers are mostly producing a single material group (plastic, metal, glass), there is a potential of finding synergies between different PODs, choosing the same material. Right now, the PODs are focused on which suppliers that suit their product the best. However, they do not take parameters, such as, geographical proximity or which suppliers other PODs has chosen for their specific material group into account. This is believed to be changed in the future to create a more efficient distribution network.

5. Quantitative empirics

The quantitative empirics is the second and final part of the empirics. The data and tables was gathered through optimisation and utilisation of IKEA's distribution network model. Through usage of multiple scenarios information about costs, changes in cost, utilisation, and effects of network changes can be quantified.

5.1. Cost comparisons

Figure 20 below shows the total cost for the reference model and the three different scenarios.

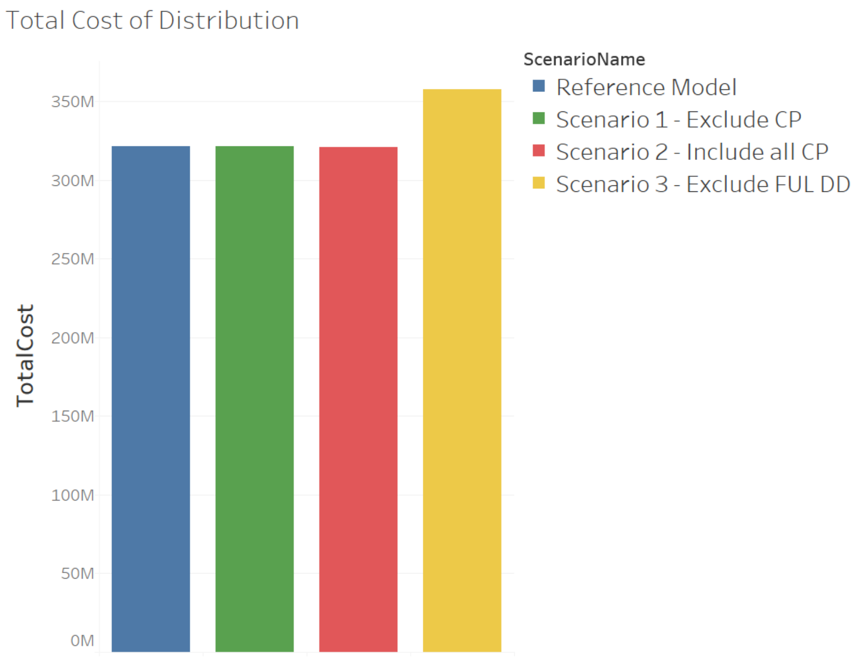


Figure 20: Total cost for the reference model and the three scenarios

From Figure 20, it can be concluded that there is no big difference between including and excluding the CPs. While excluding direct delivery with FUL loads to the stores increased the cost approximately 11 percent.

In Figure 21 and Figure 22 below, the average cost per cubic meter is presented for the different scenarios. Figure 21 shows shipment cost from supplier to DC and Figure 22 shows direct delivery to store.

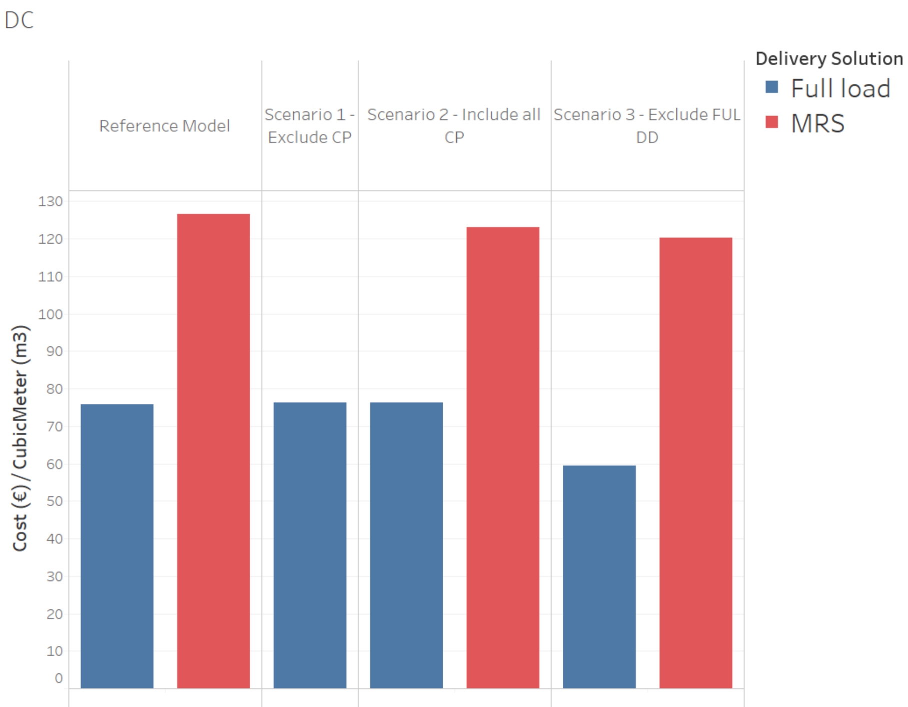


Figure 21: Comparison of cost per cubic meter for the different scenarios when shipping to DC

For shipments to the DC, the FUL costs was about 78 euro while shipments through CPs (MRS) was between 120-130 euro. In the third scenario, the FUL cost is reduced since more goods are sent to the DC.

Figure 22: Comparison of cost per cubic meter for the different scenarios when shipping to DC

The FUL cost with direct delivery was 40 euros while direct delivery through transit points and CPs costs was 60 euro. Once again, although for MRR, the cost is lowered in the third scenario when the FULs are removed, increasing the flow through MRR.

In Figure 23, a cost break-down was performed for an average shipment within IKEA's distribution network.

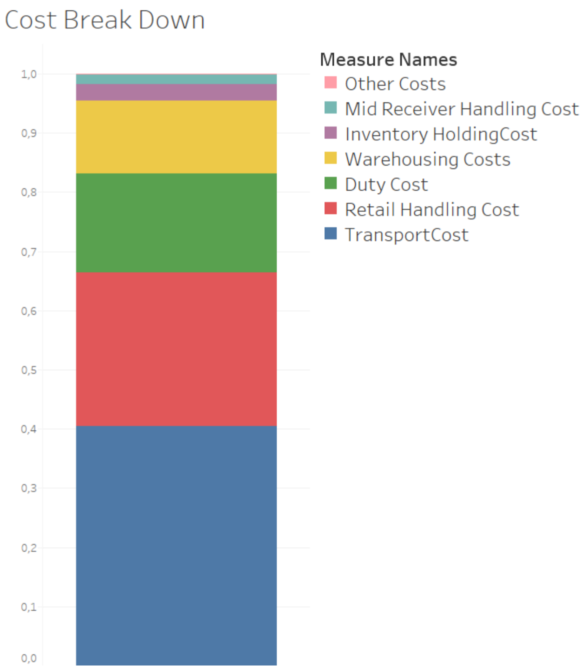


Figure 23: Cost break down for an average shipment

Transport cost was the biggest factor, contributing for about 40 percentage of the cost. The second biggest was retail handling cost, which is the cost of handling and inventory holding cost at the store. Warehouse costs was the handling at, for example, a DC while mid receiver handling cost is for CPs or transit points. The purple inventory cost was the in-transit inventory cost.

5.2. Flow comparisons

Figure 24 shows how Full load, MRR, and MRS is used in the different scenarios.

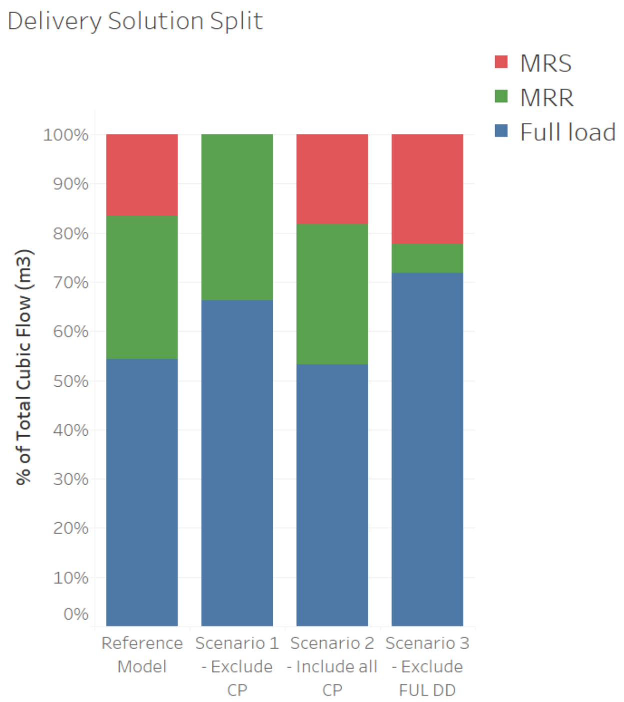


Figure 24: Comparison in percentage between delivery solutions. Note that shipments to DC means that the volume is counted twice for full load.

When investigating the flow of goods, it should be remembered that full load includes both shipments directly to the stores but also to and from the DC. This means that volume sent to the DC was counted twice when shipped as full load, and once when shipped as MRS or MRR to the DC. Therefore, scenario three is a little misleading since more goods are shipped to the DC in this solution than the other scenarios.

The changes in flow to the CPs is shown in Figure 25.

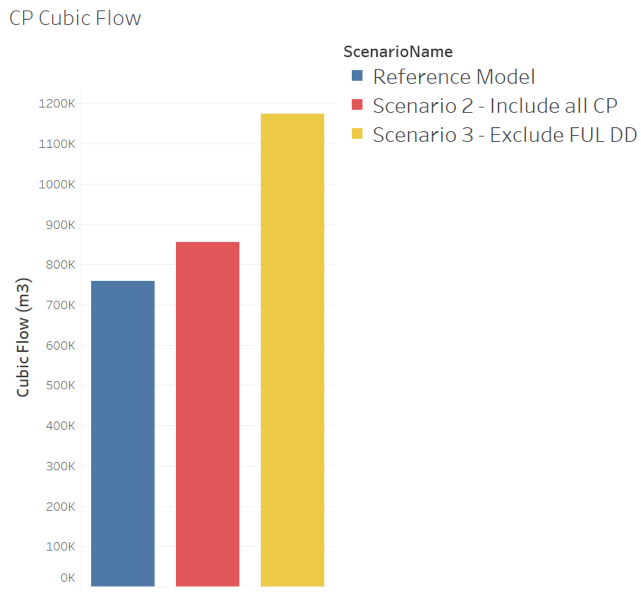


Figure 25: Comparison, usage of CP in different scenarios

The reference model only included one possible CP connection for each product-supplier combination. In scenario 2, all CPs in IKEAs distribution network is included opening new potential links that are used if was cheaper. Scenario 3 removes the unnecessary direct links to the stores meaning that flows are redirected to DC, CP, and transit points.

Another aspect to the flows through the CPs is how close they are to the suppliers. In Figure 33, the volume sent through a CP with the supplier within or outside of a country is displayed.

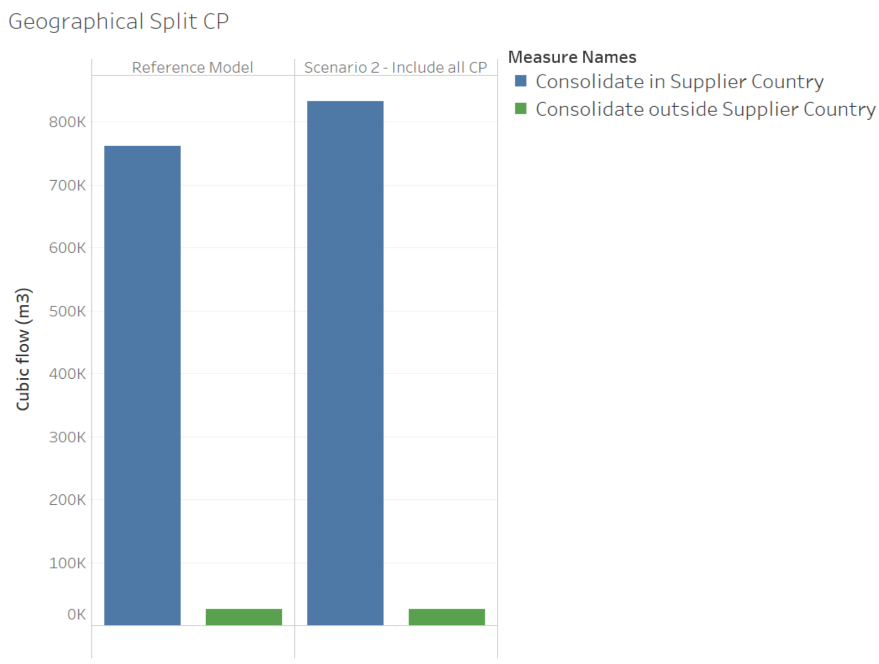


Figure 26: Consolidation within respectively outside of the supplier country

Although the changes are small, it can be seen, that when the possibility to send to more than one specific CP (Scenario 2), the flow to CPs outside of the supplier country does not increase as much as within the same country.

Figure 27 compares average transportation times for shipments.

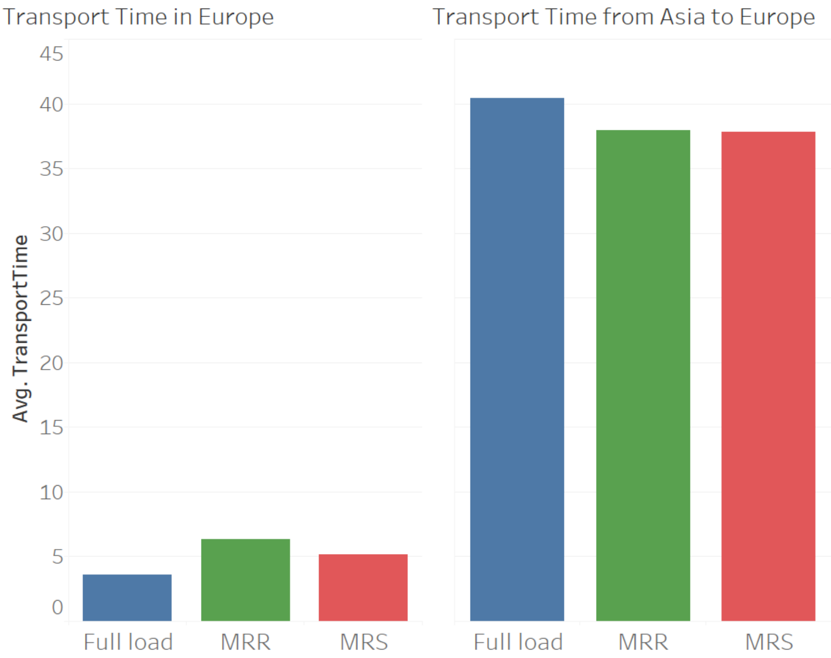


Figure 27: Transport times for shipment within Europe and from Asia to Europe

The three bars to the left shows transport times within Europe for full load, MRS and MRR which all are done through trucks. The three bars to the right show shipments from Asia to Europe which can be a mixture of boat and truck.

6. Analysis

6.1. Introduction to analysis

The purpose of this chapter is to provide an analysis that motivates answers for the thesis' research questions. The analysis follows the structure of the analytical framework, see Figure 28.

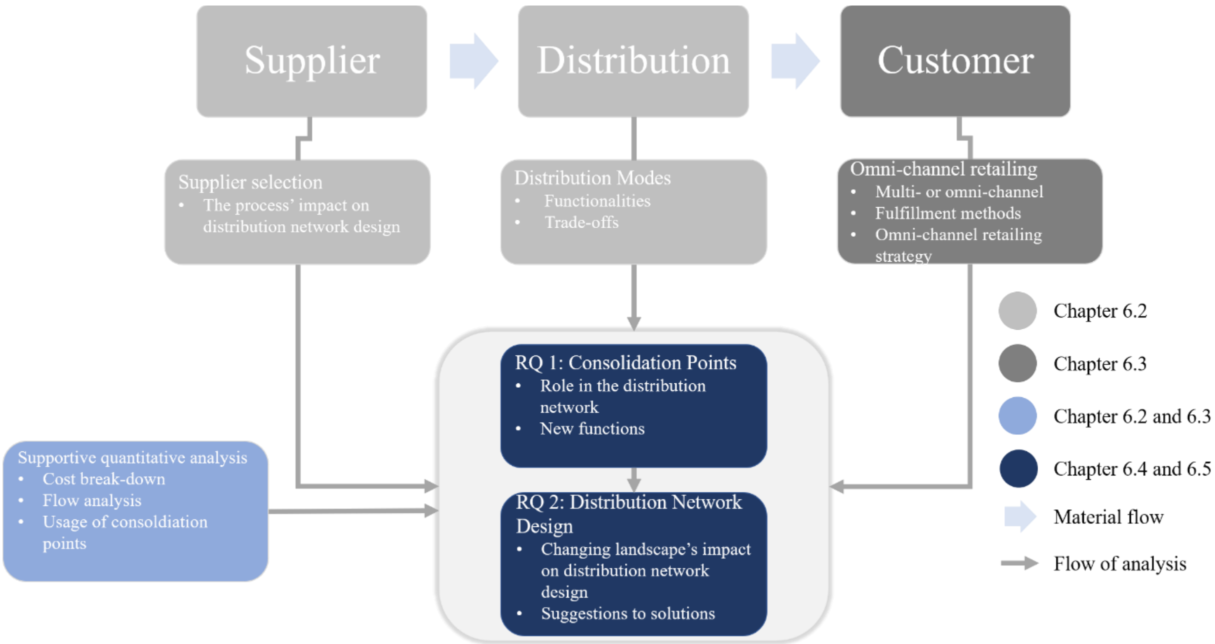


Figure 28: Analytical framework

The analysis is divided in two parts. The first part, section 6.2 and 6.3 focus on the connection between supplier selection and distribution, distribution networks, and coordination within omni-channel. It compares IKEA's network with theory and gives a broad understanding and discussion on the topic. In section 6.4 and 6.5, the analysis is narrowed towards research question 1 and 2. Consolidation points are analysed in depth, the impact of omni-channel retailing on distribution network design is analysed, and suggestions of an overall network design is proposed. The results from the model is used as a quantitative support for the claims made throughout the analysis.

6.2. Distribution network

6.2.1. Distribution modes

Direct delivery

IKEA's approach to distribution strategy is to send as much direct delivery as possible if it is a FUL. As shown by the division in Figure 29, it is in many situations their cheapest solution.

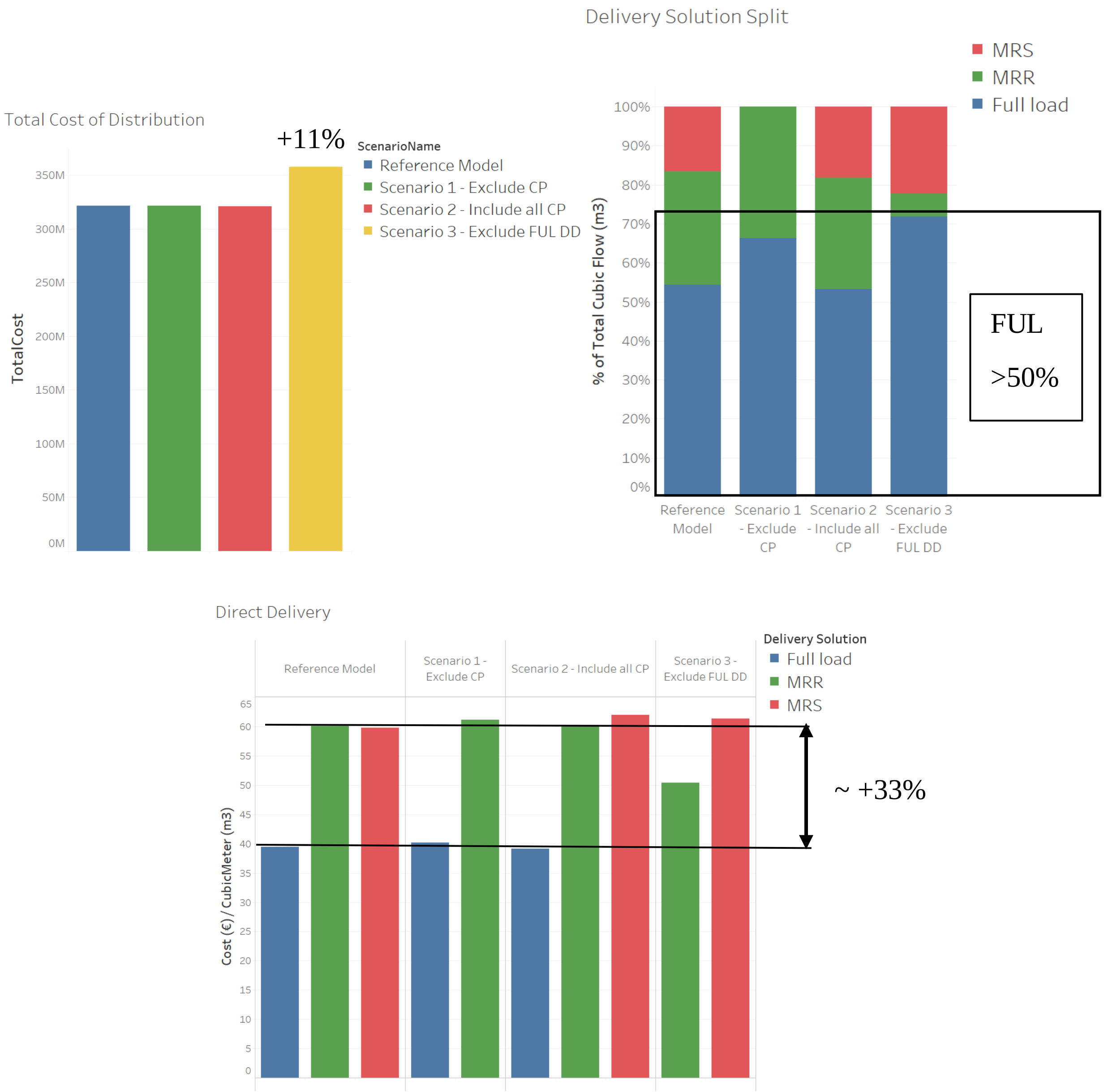


Figure 29: Top left: Total cost for different scenarios. Top right: Comparison of delivery solution. Bottom: Comparison between Full load, MRS and MRR.

On average, full loads are approximately 33 percentage cheaper than MRS and MRR. Through further analysing Figure 29, it can be shown that when direct delivery is prohibited, the total cost rises with about 11 percent. This is in line with Lumsden's conclusion for direct delivery. There are, however, close similarities between the case of Home Depot and IKEAs future direction. Chopra & Meindl discuss how Home Depot could not justify sending direct delivery when they opened smaller stores, compared to their previously very large stores. Home Depot needed to move away from sending direct delivery. IKEA finds itself in a similar transition, with their new concepts requiring a changed mindset from IKEA with more flexibility, and hybrid solutions. Changing this mindset will be challenging for IKEA. Not just because all changes within companies is hard to execute, the culture of IKEA is also circling around direct delivery being the most efficient shipping. Furthermore, packaging is developed to achieve a high fill rate for shipment.

Distribution centre
According to Chopra & Meindl, a DC is usually justified in two cases. If it is required to have large shipment inbound to achieve economies of scale within transport, or, if shipments heading to customers cannot otherwise be coordinated. Considering IKEA, the first statement is correct. Their setup of stores requires large shipments to create cost benefits. The second statement is also true, since the stores cannot have big safety stocks for all products and require short lead times within delivery. The suppliers are placed both in Asia and Europe, where it is not possible to maintain short lead times through direct shipments. Which require DCs in proximity to the stores. Furthermore, it creates the possibility for IKEA to send a lot of FUL to the DC. It is, therefore, relatively easy to motivate the existence of their DCs.

IKEA utilises segregation of products in relation to DCs. Slow moving goods is centralised to one location in Europe, while fast moving goods is decentralised to multiple locations, usually on land basis. This is as a common strategy according to Coyle et al. Furthermore, it also matches well with proposed solutions presented to the left in Table 11.

Table 11:Placement of IKEA in demand versus value matrix Adopted from Chopra & Meindl (2016).

Product type	Low value	Solution IKEA
High demand	Disaggregate all inventories and use inexpensive mode of transportation for replenishment.	**Now**: Send direct delivery to Stores and DC **Future**: Send direct delivery and CP to Store, DC, LSC
Low demand	Aggregate only safety inventory. Use inexpensive mode of transportation for replenishment cycle inventory.	**Now**: Low flow DCs which are centralised **Future**: Could be moved back to CPs but due to investments in low flow DCs there are barriers

Table 11 suggests that low value products, which most of IKEA's products are, with high demand should have disaggregated inventories with inexpensive modes of transportation for replenishment. While low value products with a low demand should have an aggregated inventory. In IKEA's current distribution network this is provided through the high and low flow DCs. In the future, the high demand products will be shipped in a similar way, but also include the LSCs. The low demand products could be moved towards the CPs to keep the stock closer to the suppliers. However, due to the investments in the low flow DCs, that IKEA has done, it is hard to shut them down, and therefore, the low demand products will still be shipped to the DCs.

The cost of shipping through DCs is in general higher than shipping directly to the stores. Comparing mode for mode (blue/blue and red/red) in Figure 30 and Figure 31 shows that shipping DC is on average double the price (40/80 for direct delivery, and 60/120 for MRS and MRR) of sending directly to the stores when considering transportation cost. However, since shipping direct delivery is not always possible, due to overstocking at the stores, this comparison becomes irrelevant in many situations.

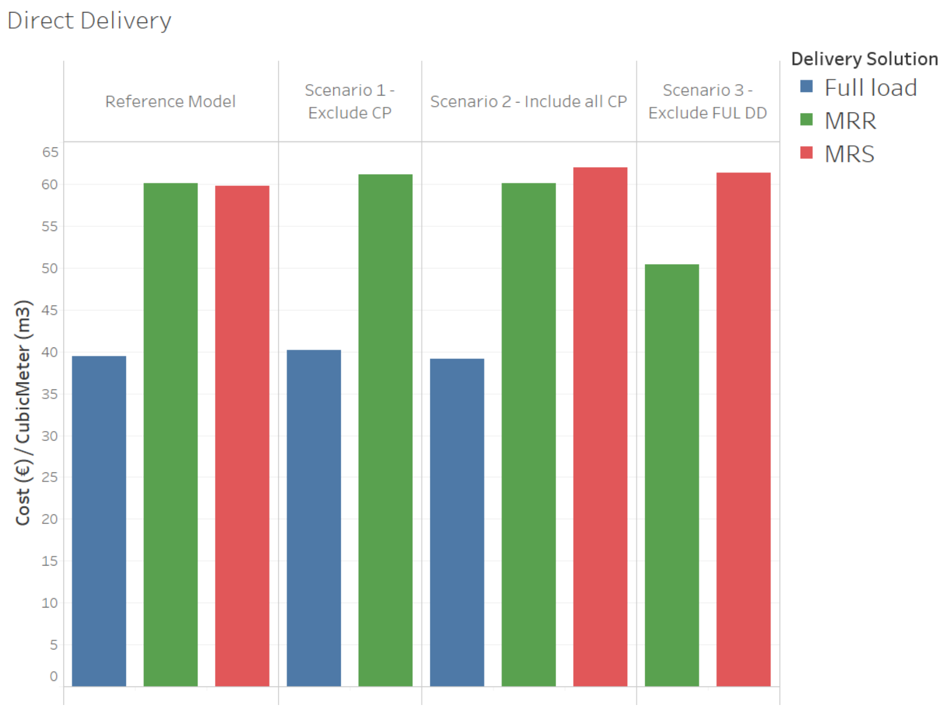


Figure 30: Transport cost for direct delivery

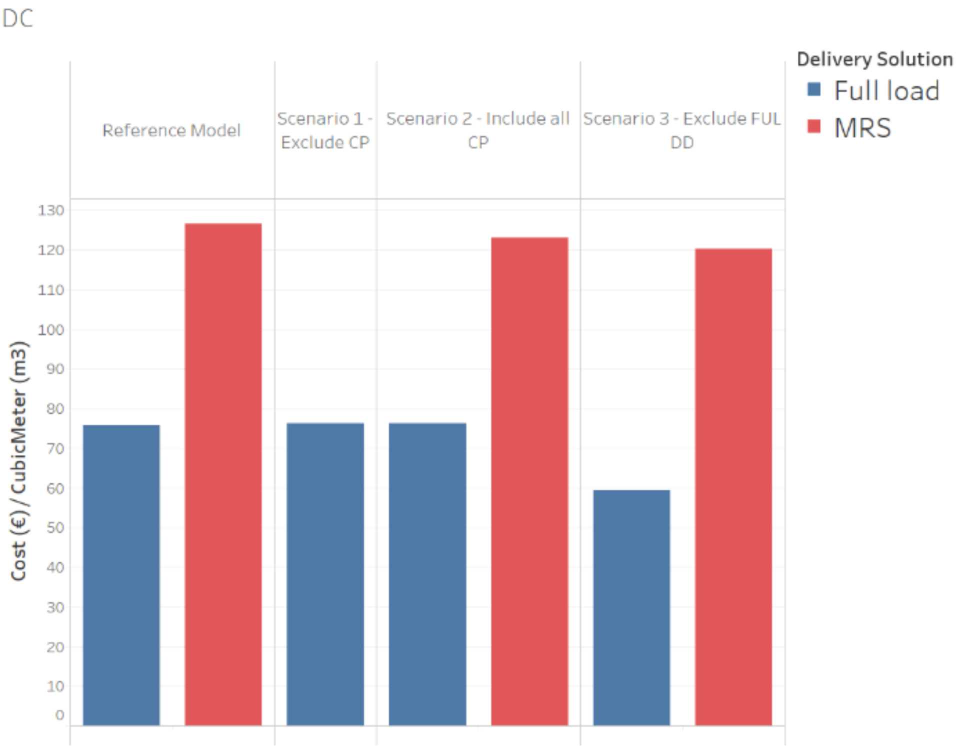


Figure 31: Transport cost for DC shipments

An overall view of the DC usage is provided in Table 12. Considering the suggested function by Coyle, et al. for DCs, the usage of the DC might be sub optimal, requiring unnecessary transportation that could had been avoided. The discussion regarding moving break bulk action and assembly will be discussed in short below and then further discussed in 6.4 and 6.5.

Table 12: DC functions used at IKEA and how it could be divided in the future, adopted from Coyle et al. (2013)

Function	Used at IKEA DC?	Future implementations
Accumulation	Yes Merges suppliers through direct delivery or MRS to the DC. Consolidate orders for the stores, no direct shipments to customers which is provided by the CDC.	Accumulation are, also, provided through the MRS and MRR modes, which most likely will increase in the future. Accumulation will also be provided through the LSC as an extension to the current CDC.
Sortation	Yes Segmented through high and low volume DCs, and segments within the DC such as CDC.	As discussed in Table 11, sortation for high volume will be more spread out across the nodes. The low volume DCs will however most likely remain.
Allocation	Yes The DC is the only distribution node that provide this for IKEA	Could be provided by the CP, which is discussed further in 6.4. Also provided by the CDC and LSC for last mile distribution. CDC and DC flow could potentially be consolidated.
Assortment	Yes True for the stores while the CDC provides direct shipment to private customers.	Coordinated across the distribution network with different distribution nodes providing solutions for all sales channels.
Other value-adding roles Assembly service Inventory management and visibility Product kitting Product postponement Production sequencing Recycling Repair Return management	 Not at the DC Yes No No No No, however considered No Yes, for the stores	Assembly service could be moved from a specific unit to the DCs or LSC to avoid unnecessary transportation. Return management can be coordinated from all distribution nodes without correlation to specific sales channels.

The main function at DCs for IKEA is accumulation. Accumulation provides the possibility of matching supply and demand within requested lead times from the stores, protects against uncertainty, and increases customer satisfaction. The DCs are, also, the only distribution function within IKEA that currently provides allocation or shipment of less than pallets to the stores. This is a crucial function for the stores, since otherwise, there would exist a risk of overstocking certain products. Another function that IKEA has started with lately is assembly services. Assembly service is not provided at the DC, but, are instead provided through assembly centres. The sortation and assortment of products are done through usage of different DCs, at a high level. Sortation and assortment are also provided inside the DCs, for example, through the CDC function which often is placed next to a DC. As discussed under "Future implementations" in Table 12, many of the functions provided by the DC now, can in the future be provided by multiple nodes. For example, the CPs and the LSCs can provide accumulation and allocation. These concepts will be further discussed below in section 6.4 and 6.5.

6.2.2. Mid receiver near reciever and Milk runs

MRR, or transit points within IKEA has many similarities with cross-docking. Firstly, it is a way to consolidate shipments without storage and order picking which matches the descriptions from Coyle et al. and Rodrigue. Furthermore, it follows the steps: receive, stage, load and deliver. However, since a transit point often is a part of the DC, it is not as optimised as a warehouse singlehandedly focusing on cross-docking. Therefore, it lacks some of the efficiency obtained through regular cross-docking. Products going through transit points at IKEA can also often stay far longer than the suggested 24 hours by Rodrigue. Products staying longer than 24 hour means that the space efficiency is reduced, due to products being stored directly on the docks without stacking possibilities. Although, the transit points are not fully optimised towards cross-docking, they still manage to achieve economies of scale within transportation through the consolidation of products and reduce the need for storage within the DC. This makes it easier to achieve full loads and reduces the handling cost.

Milk runs represent a small fraction of the total distribution within IKEA at approximately 8 percentage of the flow. The main reason behind the low share derives from the volumes IKEA ships and how the stores are located. Considering milk runs for suppliers, most suppliers have enough volume to send full trucks, which is the preferred choice. Although, the suppliers often are placed within clusters, direct delivery is further anchored through IKEA consolidating production with bigger suppliers to increase the transportation efficiency. Therefore, the use of milk runs becomes limited and MRR or MRS are used instead. Considering the other side of the network, there are two major reasons behind not sending to much milk runs. First, the stores orders volumes that usually allows full loads, either from the DC or direct delivery with a variation of MRR and MRS. Secondly, many of the stores are not near each other, which therefore, reduces the efficiency of milk runs. However, considering the future direction of IKEA, with an increased presence in urban shopping with smaller stores and showrooms. There will be an increased number of stores or pick-up points that are near each other but cannot achieve volumes that fill a truck. This will then most likely lead to an increased usage of milk runs to achieve efficiency within the distribution network and not reduce the service level.

6.2.3. Mid receiver near sender and consolidation points

The process of choosing a CP within IKEA is conducted at a strategical level, trying to find the optimal solution out of a system perspective. The process is long and goes through rigorous testing and modelling. However, once a CP has been chosen, there is a lack of commitment and system thinking within IKEA that reduces the support and effect of this decision. The approach of having CP as a second-hand solution bolsters the effect of making it less viable in some situations. Although, if the system perspective at IKEA would change, reducing the focus on direct delivery with FUL, there is a possibility that the utilisation and benefits of CPs would increase. This is shown through the different scenarios in Figure 32.

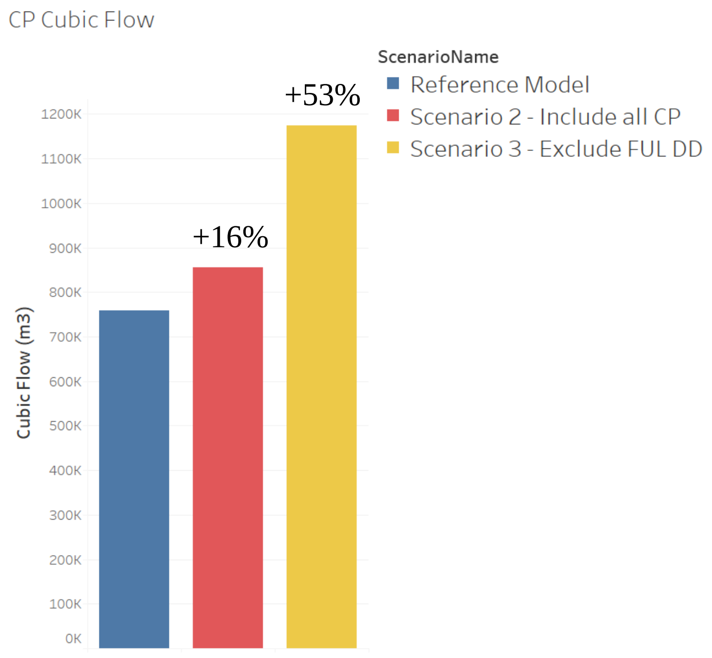


Figure 32: Comparison of flow through CPs, percental increase from reference model

For example, increasing the flow through a CP would reduce the storage time within the CPs since FUL would be achieved faster. Achieving FUL faster at the CP would not only reduce holding cost at the CPs, but also reduce the holding costs at the stores. This is due to the trucks consisting of a better mix of products and arrive in shorter time intervals, requiring less safety stock. Therefore, reducing some of the needed storage at the stores. The mixture of products could be further improved if the CP would support picking which, according to IKEA, most likely will happen in the future. This would move the concept of CP even further away from cross-docking, but, may allow flexible solutions that increases the customer satisfaction. On the other hand, an increased flow may create possibilities for actual cross-docking at CPs, which should reduce the handling and cost of the CP. Furthermore, since this would allow smaller shipments to be sent from the suppliers, the lead times could be shortened for CPs as a delivery solution. Therefore, using a CP could become more viable since lead times would be shortened. Especially since IKEA often delay shipments until they achieve FUL instead of considering delivery solutions such as CPs.

The flexibility provided with a 3PL could also be beneficial when new sales channels are tested and developed. Since there is a risk that new concept may not be successful, setting up new delivery solutions that creates a fixed cost for IKEA is an extra risk. The utilisation of 3PL and CP is, therefore, a good flexible solution when trying new concepts.

6.2.4. Connection between supplier selection and distribution

Choosing among new or existing suppliers for a product at IKEA is a relatively standardised process. The process consisting of many steps but has its focus around the RfQ process. The RfQ provides most of the necessary information to make an informed decision, which is in line with the Cheraghi, et al., that points out evaluation criterion as critical factors. The creation and evaluation of the RfQ involves both the PODs and the purchasing units. The collaboration between departments, however, ends here and misses important links to the distribution which are critical according to Sharma. The division of the purchasing units results in a great understanding for their specific category, and is beneficial for understanding and negotiation with suppliers, finding the best production solutions. However, dividing it in such a way, creates barriers for coordination between these groups. Thereby, they become unaware if there are suppliers of different categories within the same area, which could have created synergies within distribution. Finding these synergies, could have the good long-term effect. Reducing the supplier base or using suppliers within closer geographical proximity can lead to a less complex distribution network and easier coordination.

More geographical proximity between suppliers also eases the barrier of using CPs. These barriers towards CPs appears in a different context during the sourcing process. For example, the current distribution mode and delivery solution is used for the analysis of landed cost and "best buy". This means that the cost basis for a supplier is quite old once the products hit the shelves and is in general calculated as direct deliveries with full loads since that is the most common distribution mode. The potential mismatch between supply and distribution results in an underlying focus towards the physical stores which still requires continuous and big flows to few locations.

Considering the direction and beliefs that IKEA in the future is moving towards smaller more spread out flows, a more integrated approach could be beneficial. Meaning, that "best buy" in distribution does not necessarily mean the cheapest way of sending full trucks. Instead, other delivery solutions, such as CP, could be considered already in the supplier selection process.

6.3. Omni-channel retailing at IKEA

6.3.1. Multi- or omni-channel within IKEA

In the future, IKEA's aim to increase its presence online, opening more stores in the inner cities, and to differentiate their fulfilment methods. While this increases the number of links through logistical nodes, IKEA still wants to maintain an integrated distribution network and full control over their different channels. This is in line with Beck's and Rygl's definition of omni-channel retailing where the importance lies within the customer's ability to trigger full channel interaction. However, to get there, IKEA needs improvements within in channel management. Figure 33 illustrates how IKEA is performing in each area based on Verhoef, et al. comparison between multi- and omni-channel management.

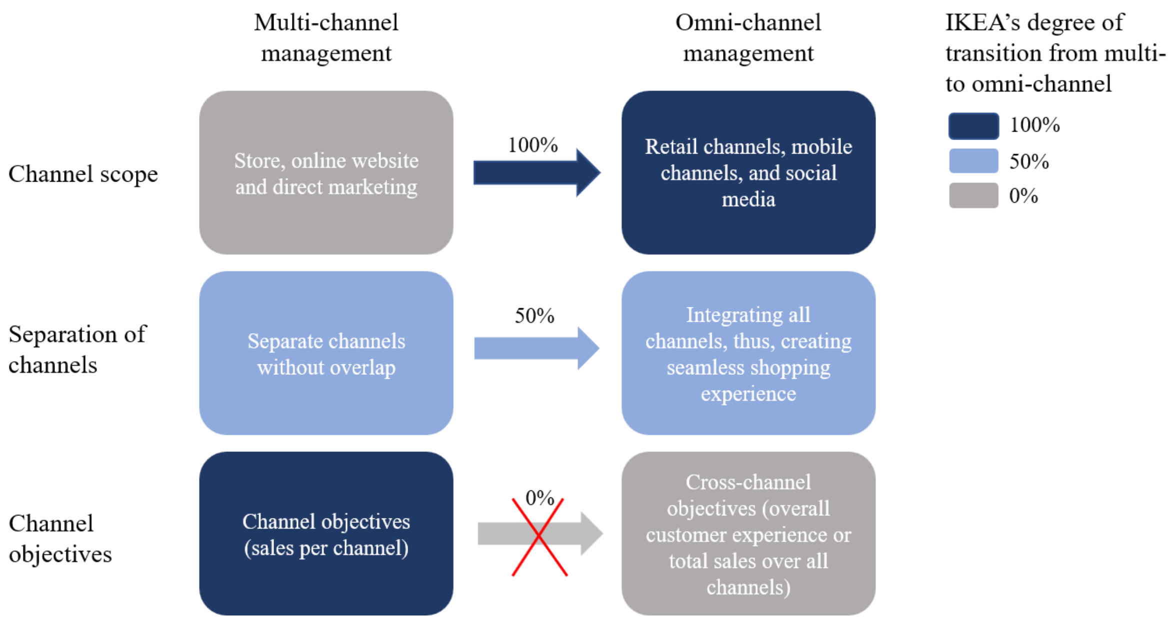


Figure 33: IKEA's transition from multi- to omni-channel management adopted from (Verhoef, et al., 2015)

IKEA is accessible through many different channels (stores, websites, mobile units, and social media) which means that the performance in the channel scope management is up to par. Although, since it is only possible to make purchases on the website and in store, it means that mobile units and social media is not completely integrated to the system. Not having completely integrated channels means that IKEA does not meet all the requirements for channel separation management. Channel objectives are not being prioritised within IKEA, which is apparent when comparing the sales data from the stores (92.7%) and website (7.3%). Not only, does the e-commerce represent a small fraction of the sales, but more importantly, IKEA's historic lack of interest has delayed the development of e-commerce. In the future, IKEA will have to change it perception regarding e-commerce and have a more integrated view on their different sales channel, which complements each other, to maximise customer satisfaction.

6.3.2. Fulfilment methods

In accordance to Bell, et al., omni-channel retail matrix, IKEA has moved from only providing traditional retailing to find itself in all of the four quadrants, see Figure 34.

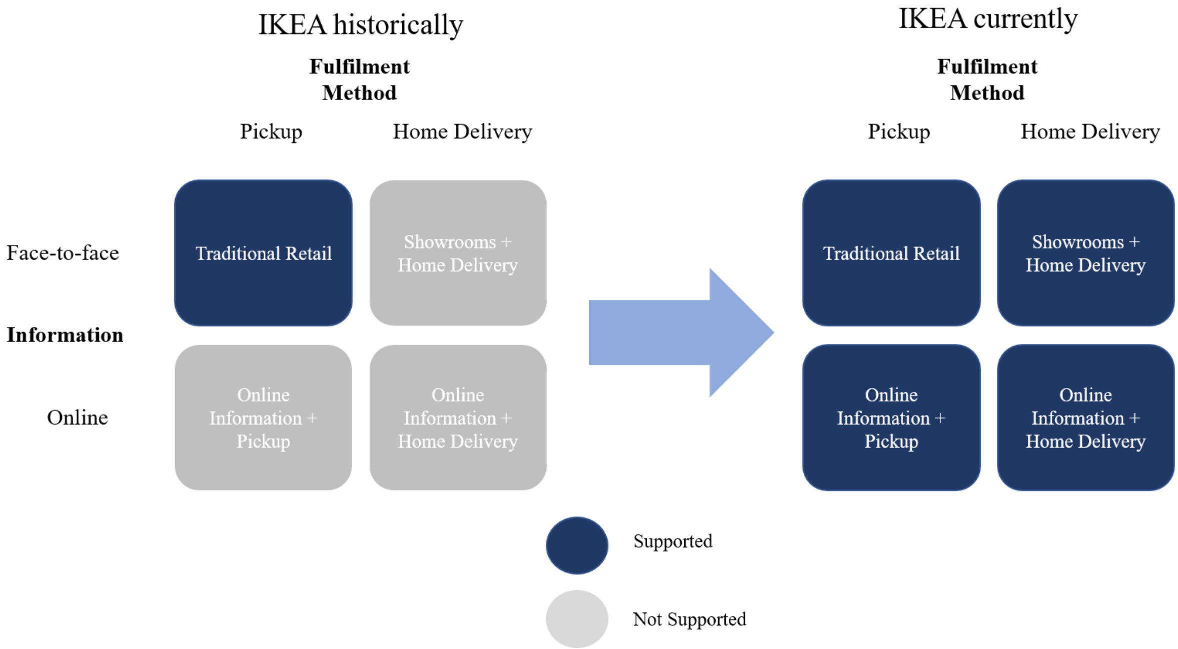


Figure 34: Omni-channel retail matrix and fulfilment methods adopted to IKEA, adopted from (Bell, et al., 2014)

Currently, IKEA provides traditional retailing, online orders within store pick-up, showrooms with home deliveries, and online ordering with home deliveries. This means that IKEA has already gotten a good grasp of how to provide a seamless shopping experience for the customers. Although, it should be noted that the showrooms are test projects and have not been implemented in all of IKEA's markets. However, IKEA's transition is another proof that solely adapting their distribution network to the big stores will not be sufficient in the future. IKEA will need to adapt their distribution network design to suit omni-channel retailing. How IKEA need to change is elaborated upon in 6.5. Moreover, to satisfy the fulfilment methods omni-channel retail matrix, IKEA provides four out of six distribution methods presented by Hübner, et al.,. See Figure 35.

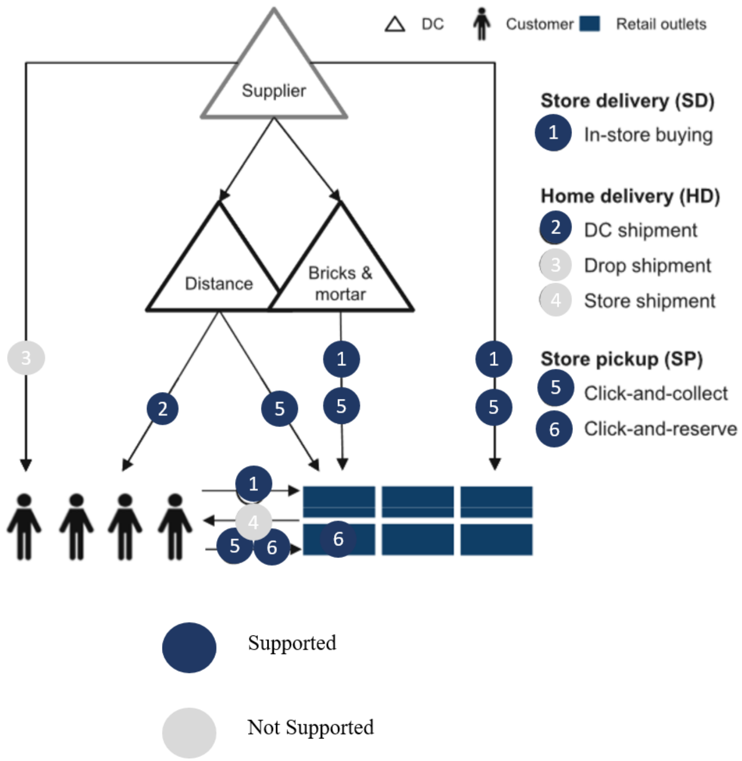


Figure 35: Distribution methods to satisfy the fulfilment methods within IKEA adopted from (Hübner, et al., 2016)

Comparing IKEA to Hübner, et al. illustration of fulfilment methods for omni-channel retailers, IKEA currently provides in-store buying, DC shipments, click-and-collect, and click-and-reserve. However, IKEA does not provide drop shipping and store shipments. Drop shipments will be elaborated upon in 6.5.1. Store shipments, on the other hand, might not be an optimal solution for IKEA. Partly because last mile distribution is an expensive operation, and partly because keeping stock at store for shipments to customers is more expensive than keeping it at a DC/CDC.

6.3.3. Omni-channel retailing strategy

IKEA's awareness of the shifting landscape of retail has forced them to rethink their business model. Looking at sales channels, they are expanding into city stores to give urban shoppers easier access. Furthermore, in accordance with Brynjolfsson, et al., IKEA has adapted a long-term strategy that gives a competitive edge to protect itself from direct price comparisons. IKEA's own product development is the key factor that adds extra value to the customer and, thus, makes it harder to compare IKEA to its peers. Product development does not only provide unique products to the market, but also makes it possible to sustain their flat-pack philosophy. The flat-packs enables two great advantages: assembly service and better efficiency in their distribution network. The assembly service is a unique feature tied to IKEA, it provides additional service for the customer by letting IKEA assembly the products before delivering them to the customer, thus, saving time and increases the convenience of shopping at IKEA. However, assembled products reduces the fill rate and increases cost for transport which must be considered. The better efficiency in the distribution network stems from the high fill rate and convenient handling of flat-packs. If IKEA was compared to Amazon, a global giant within distribution, it would be concluded that Amazon has a much tougher time to achieve higher fill rate since the size and form of the packages sent cannot be controlled. IKEA on the other hand, has the advantage of developing their own packages to go with a more efficient logistics, which is a key competitive advantage. Furthermore, this is also in line with Hübner, et al., proposing that a successful omni-channel retailer focuses on delivery speed, different solutions, and services. However, to implement these strategies, IKEA will need to develop its distribution network for the future.

6.4. Consolidation points in omni-channel distribution

6.4.1. The role of CP within IKEA's distribution network

MRS as a delivery solution is currently restricted within IKEA, thus, impacting how appropriate the usage of CPs is. Starting from IKEA's distribution focus, the role of CPs is diminished due to the focus on direct delivery and FUL. This is reasonable in the current state when the distribution network's end nodes are stores. However, this will change in the future when IKEA increases its presence in cities. In section 6.4.1, CPs are being compared to direct deliveries with full loads, barriers to using a CP are identified, and strategy in choosing a CP will be investigated.

Comparing CP to direct deliveries with full loads

To get a picture of the CP's role in IKEA current distribution network, a comparison of cost between CP and direct deliveries with full loads is made. Analysing the cost perspective, it can be concluded from the modelling results, that direct delivery with full loads is the cheapest solution overall solution for IKEA's distribution network, see Figure 36.

Figure 36 Cost comparison of full load (FUL) and MRS (CP)

Using a CP is, on average, 50% more expensive than using direct deliveries with full loads. This regard transportation cost, handling cost, inventory cost, and taxes et cetera from Figure 23 in section 5.1. When comparing transportation times, see Figure 37, it can be concluded that direct deliveries with FUL and using a CP are quite equal.

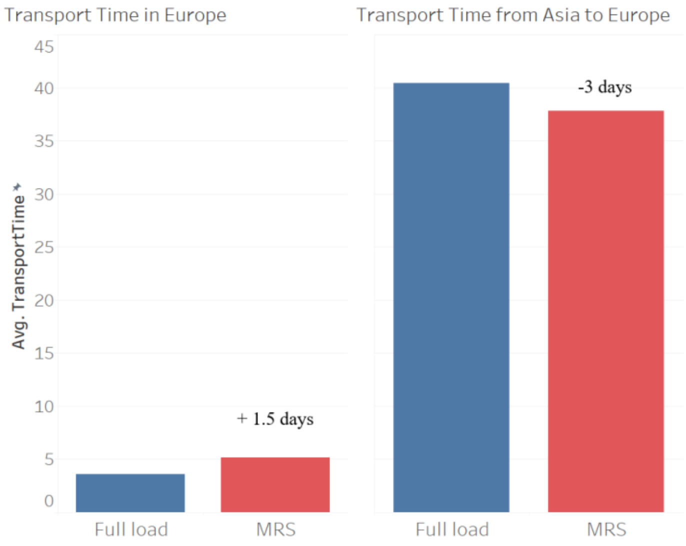


Figure 37: Transport time comparison between full load (FUL) and MRS (CP)

Direct deliveries with FUL and CPs being delivered in the same time frame reinforces the idea of prioritising FUL within IKEA, especially when considering the cost discrepancy. The reason for transport time being equal is partially due to that CPs are in proximity to the suppliers, which means that the transport time is even if the products would stand ready at the CP. However, this does only take transport time in account. Including the time for the production would probably give another result since producing FUL at a single supplier is more time consuming than producing LUL at several suppliers, and then, consolidating their shipments.

Barriers in using CPs

As of 2018, the balance between store sales and web sales is 92.7 percentage to 7.3 percentage. Meaning, that an inefficient system for e-commerce will not have as much of impact on the total sales. Furthermore, the internet shopping is handled through CDC. The CDC acts like a "regular" big store, and orders in the same way as the stores do but provides packaging and last mile delivery through third parties. Working with the same approach as the stores for the distribution network means that the CDCs adapt the old system and approach. The stores can choose from different modes through requiring a specific lead time. Therefore, stores can favour either direct delivery or DC depending on if the stores have chosen a long or short lead time. Furthermore, this means that there is no easy way for the stores to choose CPs as a delivery solution. This is due to a missing link between the delivery solution and lead time. Instead, using a CP becomes a second-hand solution that is utilised if FUL from suppliers is not achievable within a certain time frame.

There are some additional barriers with using a CP in the distribution network. These are: the increased need for communication to consolidate LUL shipments from different suppliers, and the risk of shipments being stuck at the CP. Using a CP requires increased coordination and communication within, and between, different logistic functions. Comparing CP to direct deliveries with a FUL in terms of communication and coordination, it can be concluded that a CP requires more of the sort. The operational work required for direct deliveries with a FUL is to make the order, provide a truck to pick it up when the order is made, and deliver it to the desired destination. CPs, on the other hand, require several suppliers to hold their shipments until all the other suppliers are done. Then, several trucks pick up the shipments and drive to a predetermined CP. From the CP, an addition truck picks up the consolidated shipment and delivers it to the desired destination. The requirement for operational work, when using CPs, also includes a timing aspect when coordinating shipments from different suppliers, which does not exist for direct deliveries with FUL.

The risk of shipments being stuck at the CP is another disadvantage. The CPs are not supposed to have shipments stocked for more than three days at the CP. However, it is not easy to consolidate different shipments to fill up trucks evenly. This means that shipments run the risk of either being sent as a LUL or being stuck at the CP until the next shipments arrive, which creates uncertainty and inefficient distribution.

Strategy in choosing CPs

To get a grasp of which strategy to use when choosing a CP, it was sufficient to analyse how the flows through CPs changed based on the reference model and scenario 2, see Figure 38.

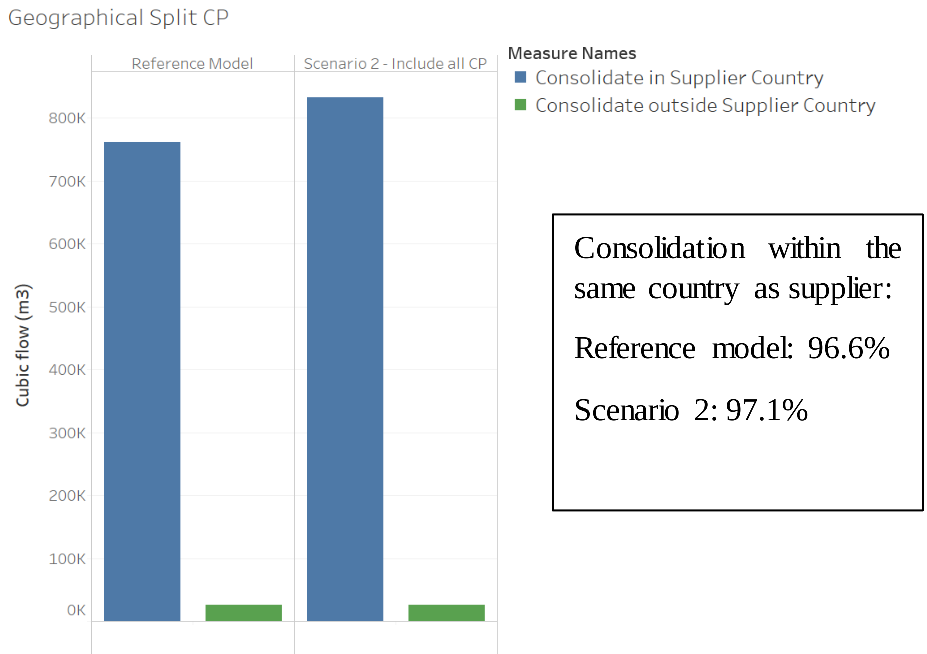


Figure 38: CP usage based on country

Figure 38 gives the insight of where it is the most beneficial to consolidate shipments. The share of volume being consolidated within the same country as the supplier increased in scenario two compared to the reference model. It increased even though scenario two gave the item routes the possibility of consolidating shipments anywhere in the world, compared to a predetermined CP in the reference model. Therefore, it is possible to conclude that the strategy when choosing potential CPs for an item route should be geographical proximity to suppliers. Choosing CP based on geographical proximity is currently done to a certain extent at IKEA. However, IKEA needs to redefine their CP choosing process to be more adapted for omni-channel distribution. Firstly, IKEA needs to start their work of choosing CPs earlier, namely, in the supplier selection process. As discussed in 6.2.4, suppliers need to be chosen in geographical proximity to each other. Geographical proximity between suppliers increases the prerequisites for a successful consolidation, since each LUL transport does not has to be sent far. Furthermore, the communication and coordination barrier, previously mentioned, is reduced. Fewer suppliers in proximity to each other, reduces the complexity of the distribution network and decreases the need for extensive coordination on a tactical and operational level.

Secondly, IKEA needs to allow an item route to choose from several CPs being close to the suppliers, rather than one predetermined. Figure 38 provides the information that letting an item route choose from several CPs in proximity to the suppliers rather than one, the overall volume of goods being consolidated increases.

6.4.2. Improvements for CPs

Before considering the effect of the new sales flows, there are a few functions that should be considered and improved at the CPs to increase the efficiency. Firstly, the strict FUL mindset at IKEA needs to be reduced. Due to the high focus on direct delivery with FUL, the other distribution modes and solutions becomes maimed. The fact that the CPs is considered a second-hand solution, as earlier discussed, further increases this. Secondly, there should not be many situations where a CP should need to rack the pallets. The main reason behind this is that the CPs are placed in proximity to a group of suppliers. The coordination of shipments should be done at the supplier level, making sure that inbound trucks have connecting outbound trucks within a short time span. The CP would, then, become more like a cross-docking site which should decrease the handling cost, and thereby reduce overall cost for CPs.

Therefore, the overall roll for a CP within the current network should be a cross-dock close to the suppliers. If the cross-dock function would be implemented, there are possibilities to reduce the transport time through CP, and give an edge compared to direct deliveries with FUL. The speed could be gained through suppliers, since they do not need to fill up full trucks, and therefore, can send shipments faster. However, this is dependent on the storage capabilities at the supplier. If they keep safety stock on products and have the capacity to fill orders when received, the potential speed benefits of the CPs would be reduced, or completely removed. There is also the need for balance within the distribution network. Some of IKEA’s transit points are heavily burdened, which speaks for an increased need of cross-docking and reduced storage. The suggested changes discussed in this section is a move towards streamlining the CPs, and to create a more efficient flow. CPs decrease the required shipping volumes to send FUL, thus, reducing inventory throughout the network. How CPs reduce inventory is further elaborated upon in 6.4.3.

6.4.3. Reasons to increase the usage of CPs in the future

Considering the future expansions of the sales channels and omni-channel, there are a couple changes that motivates an increased usage of CPs. As previously shown in Figure 19, section 4.2.2, there are a lot of upcoming links within the distribution network. The increased number of links will most likely spread the flow across the network. In return, this should reduce the volume shipped which reduces the possibilities to ship direct deliveries with FUL. In Figure 39 below this is illustrated, showing if a link is appropriate or not to use for distribution based on the previous discussions.

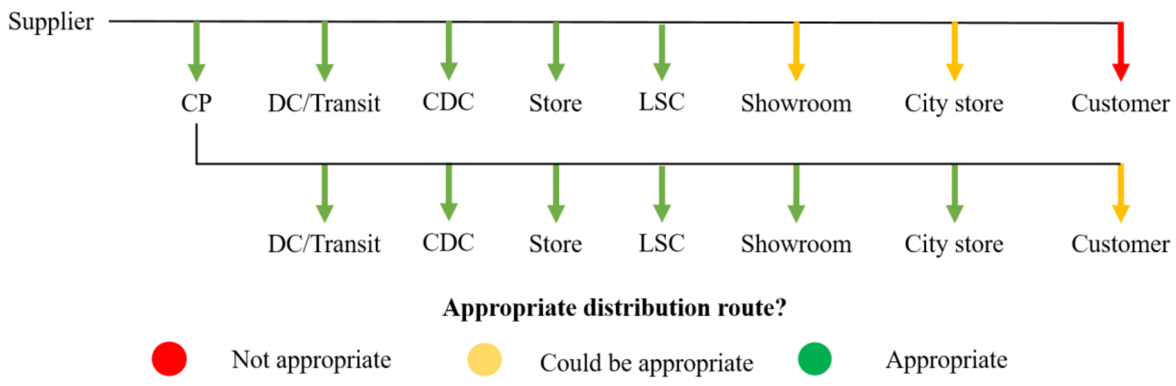


Figure 39: Comparison of how appropriate Supplier and CP shipment are to different nodes

From the suppliers, it is not appropriate to ship to all destinations. To mitigate this, one possibility is to increase the usage of CPs. The CPs could allow FUL with a better mixture of products and reduce the need for storage capacity which is more limited for the new concepts. A limitation for sending CP could be the lead time in comparison to the DCs. Therefore, the need for cross-docking is still a necessity. However, decreasing the lead time through cross-docking may not be enough to reach the end customers. A lot of the shipments are across continents, thus, the transport time is too long anyway since the DCs are placed in proximity to the stores. Therefore, the DCs and CDCs may instead be the ones that handle the new flow of goods. This will be further discussed in section 6.5.

Being able to reduce production cycles, and thereby, production time could be another benefit of increasing the usage of CP. Reducing production cycles for several suppliers so that they can produce smaller batches of goods, and consolidated it at a CP was discussed in 6.4.1. This reduce the overall lead time for products to reach the customer. Since omni-channel retailers should focus on delivery speed to be successful, which was discussed in 6.3.3, IKEA can use CPs as a competitive advantage to increase the speed throughout the supply chain.

6.4.4. New functions for CPs

As earlier discussed in section 6.3.3, omni-channel distribution usually requires a more integrated flow of goods instead of using multiple distribution methods. There are two solutions that potentially could be implemented at a CP to make it a more hybrid solution. The first solution is to allow break bulk shipments, and thereby picking. This means that products, which usually would have to go through a DC, now could be sent to a CP. At the CP, the outbound shipments could, then, be a mix of full pallets and repackaged pallets. Thereby, more advanced orders could be coordinated from multiple positions increasing the service level. However, this solution would mean that a CP becomes an outsourced mixture of DC and transit points (which now usually are within the same building). The second solution, that could be implemented at a CP, is drop shipments directly to the customers, which also would require picking at the CP. The shipments would, instead, be done through last mile distributors (e.g. DHL). Implementing drop shipment could most likely only be performed with big goods, such as sofas or kitchens, which are more expensive, and have a higher acceptance for longer lead times. An important factor to consider here is whether a CP brings any benefits for a drop shipment in comparison to doing it directly from the supplier. An advantage for the CP is that drop shipments are more easily coordinated through the more limited amount of CP instead of through all the suppliers. The possibility to change the functions within a CP is also more flexible than for a supplier based on the discussion in 6.2.4. Although, if changing a CP to allow shipments directly from the supplier to customers, handling and transport would reduce over time. Thereby, be more efficient. This will be discussed further in 6.5, where the distribution network design is discussed.

6.4.5. The role of consolidation points' transition in the distribution network

A concluding table of chapter 6.4, Table 13, was created to give a holistic overview of consolidation points' role in the current distribution network and future omni-channel distribution network.

Table 13: The role of consolidation points' transition in the distribution network

	Current Distribution Network	Transition	Omni-channel Distribution Network
When to use	When FUL cannot be achieved at the suppliers.		When flows split up to several destinations, CP becomes a useful node to consolidate the flows. Increases delivery speed throughout the supply chain
Functions	Storing, consolidating		Storing, consolidating, cross-dock, break-bulk shipment, drop-ship
Strategy when choosing CPs	CPs in geographical proximity to suppliers Predetermine which CP a supplier should consolidate shipments at		CPs in geographical proximity to suppliers Suppliers to be selected in proximity to each other Have the possibility for a supplier to consolidate shipments at several close by CPs
Barriers	Second-hand solution with no clear benefit compared to direct deliveries with full shipments Risk of shipments being stuck at the CP		Redefining its role Increased need for coordination and communication in the distribution network

Table 13, is to be seen as a conclusion of the analysis in chapter 6.4. In terms of usage, CPs has the prerequisites to become a beneficial node when moving into omni-channel distribution. This is due to the increase of smaller stores and split up flows that need to be consolidated to reduce transport cost and the potential of reducing lead times. Functions at the CP should increase in the future compared to the current setup of storing and consolidating. Instead, CPs need to be redefined to either include cross-dock or break-bulk and drop shipments. However, redefining CPs is a future barrier and will be further discussed in 6.5. Moreover, CPs need to break the barrier of being a second-hand solution that is only used when FUL cannot be achieved. To ease the barriers, CPs should be picked based on geographical proximity with the suppliers, and the suppliers to be picked in proximity to each other.

6.5. Distribution network design

6.5.1. Trade-offs between distribution modes

In Chopra's article and book, six different types of distribution modes are presented as previously shown in Table 6. In Table 14 the original table has been adopted, to show how different distribution solutions at IKEA would rank according to those parameters. Through summarising the points (ranging from -2 to 2), a total was given which gives a reference point.

Table 14: Adoption of Chopra's model to IKEA. -2 = very unsuitable to 2 = very suitable. The score is different depending on the four different types of demand, ranging between high, medium, low, and very low.

Product and customer attributes / Fulfillment method	Retail storage with customer pickup	Manufacturer storage with direct shipping	Manufacturer storage with in-transit merge	Distributor storage with package carrier delivery	Distributor storage with last mile delivery
High demand product	2	-2	-1	0	1
Many product sources	1	-1	-1	2	1
High product value	1	-2	-1	-1	0
Quick desired response	2	-2	-2	-1	1
High product variety	-1	2	0	1	0
Low customer effort	-2	1	2	2	2
Total score	3	-4	-3	3	5
Corresponding fulfillment method to reach customer (IKEA)	Store	Dropship	Dropship CP	CDC	CDC LSC

Product and customer attributes / Fulfillment method	Retail storage with customer pickup	Manufacturer storage with direct shipping	Manufacturer storage with in-transit merge	Distributor storage with package carrier delivery	Distributor storage with last mile delivery
Medium demand product	1	-1	0	1	0
Many product sources	1	-1	-1	2	1
High product value	1	-2	-1	-1	0
Quick desired response	2	-2	-2	-1	1
High product variety	-1	2	0	1	0
Low customer effort	-2	1	2	2	2
Total score	2	-3	-2	4	4
Corresponding fulfillment method to reach customer (IKEA)	Store	Dropship	Dropship CP	CDC	CDC LSC

Product and customer attributes / Fulfillment method	Retail storage with customer pickup	Manufacturer storage with direct shipping	Manufacturer storage with in-transit merge	Distributor storage with package carrier delivery	Distributor storage with last mile delivery
Low demand product	-1	1	0	1	-1
Many product sources	1	-1	-1	2	1
High product value	1	-2	-1	-1	0
Quick desired response	2	-2	-2	-1	1
High product variety	-1	2	0	1	0
Low customer effort	-2	1	2	2	2
Total score	0	-1	-2	4	3
Corresponding fulfillment method to reach customer (IKEA)	Store	Dropship	Dropship CP	CDC	CDC LSC

Product and customer attributes / Fulfillment method	Retail storage with customer pickup	Manufacturer storage with direct shipping	Manufacturer storage with in-transit merge	Distributor storage with package carrier delivery	Distributor storage with last mile delivery
Very low demand product	-2	2	1	0	-2
Many product sources	1	-1	-1	2	1
High product value	1	-2	-1	-1	0
Quick desired response	2	-2	-2	-1	1
High product variety	-1	2	0	1	0
Low customer effort	-2	1	2	2	2
Total score	-1	0	-1	3	2
Corresponding fulfillment method to reach customer (IKEA)	Store	Dropship	Dropship CP	CDC	CDC LSC

For the distribution storage with two types of shipment the score was the highest, ranging from 2 to 5 points. This type of shipment can be related to CDC and LSC shipments at IKEA, and thereby distribution for showroom and internet shopping. The second highest was the regular store concept which scored -1 to 3 points. In last place, the two types of drop shipments placed with negative scores -4 to 0. The in-transit merge (CP drop shipment) had only negative points but in a smaller range than the drop shipment directly from manufacturer. The drop shipment solutions should not target high demand products, instead it should be focused on low demand products which gives a higher score. The products should also be more expensive, which for IKEA could mean kitchens, beds, or sofas. Customers may also accept slightly longer lead times for such products, thereby reducing the need for quick response. Furthermore, the example products are all bulky, which makes them hard to store in regular warehouses without special solutions. If these factors would be taken into consideration, the total score for drop shipment would range from 1 to 4, instead of being negative. Therefore, the drop shipment solutions may be valid for some products, although, the initial score was low. Furthermore, considering the low volume products, these have a negative score for the CDC and Stores. It could, therefore, be beneficial to move some of those sales towards drop shipment to reduce high inventories across the network, and to centralise it. The centralisation could then be moved from the low volume DCs to the suppliers which reduces fixed costs, inventories, and handling. High demand products are instead beneficial to handle through the Store, CDC, and LSC according to Table 14.

The challenges with pushing the inventory both back and forth within the network are multiple. In a general perspective, Figure 39, which is an adoption from Coyle et al., analyses the total cost related to the number of warehouses in operation.

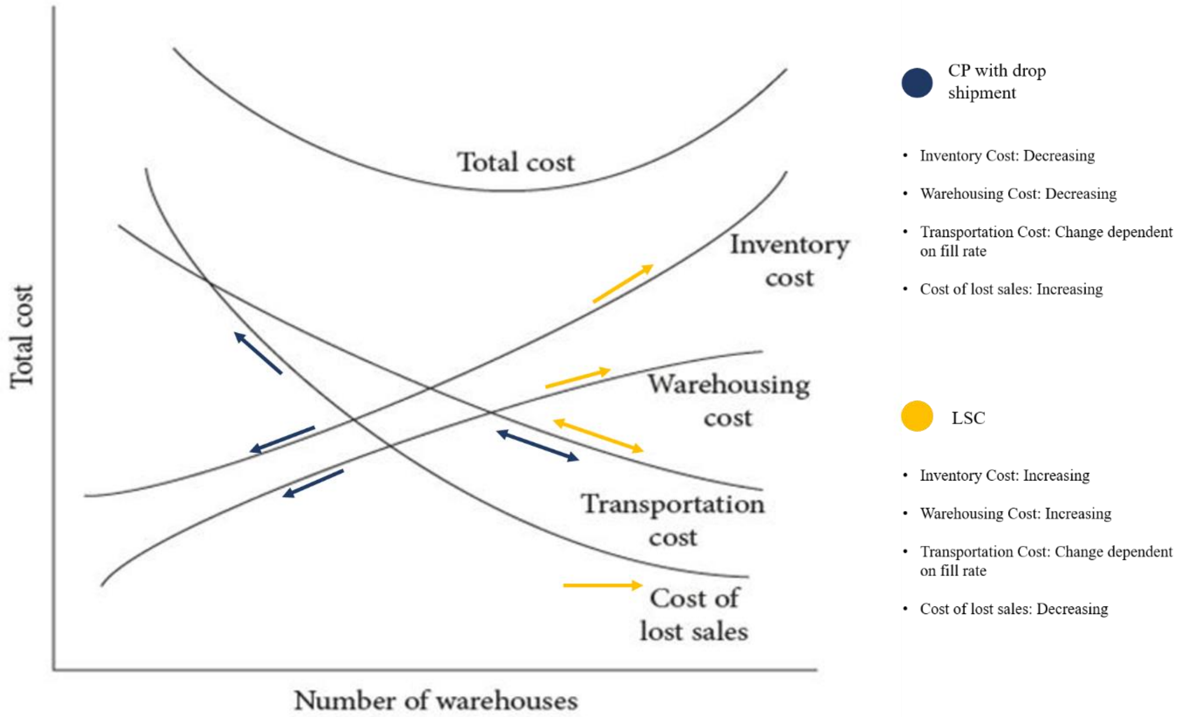


Figure 40: Trade-offs inventory, warehousing, transportation and lost sales. The positions of the arrows are not an indication of placement for IKEA. Adopted from Coyle et al. (2013)

Drop shipment reduces the number of warehouses, which thereby reduces inventory and warehousing cost, but, increases transportation cost, and potentially losses in sales due to increased lead times. Increasing the number of DC, CDC, or LSC, on the other hand, would do the opposite. There is, however, a couple of considerations regarding transportation cost and cost of lost sales. The cost of lost sales could be mitigated through providing multiple distribution options for the customer, which would require a more hybrid solution. Hybrid solutions will be further discussed in next section. Transport cost is also not black or white. Drop shipments could either be merged through the CPs, which would reduce the risk of sending LUL, and thereby, decrease the transport cost. The shipments could, also, be provided through last mile distributors, which usually have more optimised consolidation routes. Therefore, the cost does not necessarily become higher. The increased transportation cost can also easier be covered by the products that would be shipped through drop shipment, since they should be more expensive products.

Expanding the distribution network into multiple solutions is not suggested when working within omni-channel. The customer should see the sales channel as one united touch point, where they can interact anywhere to purchase or return products. Furthermore, there are challenges in splitting distribution. For example, if a sofa is drop shipped to a customer, and the customer wants to return it, independent of reason. Then, it is not reasonable to have the customer send the sofa all the way back to the supplier. Partially, because there is an unnecessary environmental impact, but mostly, because the customer has connected with IKEA and wants to have the possibility to return it directly to IKEA. Therefore, distribution cannot be segregated, only moving goods through one distribution channel is not sufficient as an omni-channel retailer. Thus, the distribution network often needs to be more flexible, and have different flow of goods integrated in the network.

6.5.2. Network of integrated flows

There are trade-offs with different network structures. The cons according to Chopra & Meindl are mostly due to the coordination complexity, which increases the more tailored a network is. At the same time, to keep the customers satisfied there is an increased demand of coordination through omni-channels. Maintaining a high flexibility towards the customer, requires a high flexibility within the distribution network, which then becomes harder to coordinate. A way to reduce the need for coordination is to reduce the number of different solutions. Instead, to provide the same services through a smaller array of nodes. Decreasing the number of or variants of nodes will, however, increase the complexity within the nodes which, as earlier discussed, increases the cost.

There are two main functions to consider regarding the increased complexity and functionality of the nodes. The capacity to send different types of shipments (for example, pallets, packages or assembled), and the increased number of sales channels that would be supported from the same logistics node. As earlier mentioned, it is only the DC within IKEA that supports shipments of both full pallets and smaller packages. The DC is often also closely linked to the transit points, making it a variant of cross-dock as well. Therefore, the DC has multiple functionalities with the possibility to support all types of sales channels and handle the potential returns of these flows. If this functionality was applied to the CPs and the CDCs, there would be a united approach within the distribution network, which may be easier to coordinate and match with the omni-channel approach. However, this may not be attractive when IKEA only has two real channels, and the stores are a heavy majority. Due to the increased cost across the network, especially at the CPs which would have to handle far more storage to support picking. Therefore, it may not be beneficial to introduce picking at the CPs due to the increased cost and the CPs being located closer to the suppliers than the end customers. Although, if picking is implemented, it would be easier to provide drop shipments from the CPs.

To include the CDC into the DC would require some changes within IKEA. The CDC is considered a separate store now, although, it is placed in the same building as the DC. The CDC should, therefore, be merged with the DC to provide a united function that can support stores, web shopping, city stores, and showrooms. Otherwise, the risk of insufficient coordination could become a problem, and the responsibility would be divided between multiple functions which increases the risk for mistakes. Further integrating the assembly to these points would remove a link completely to reduce transportation, simplify coordination, and reduce fixed costs. An example of the simplified links is shown in Figure 41.

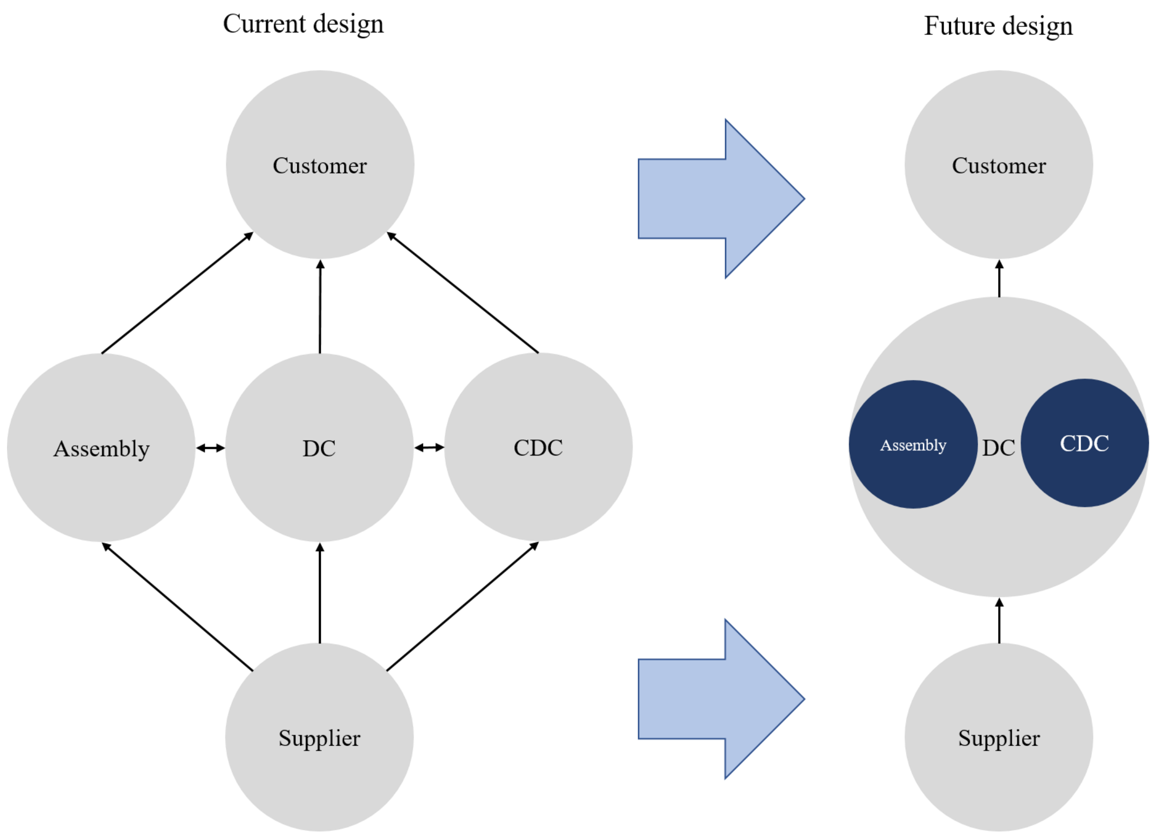


Figure 41: Hybrid approach with multiple functions integrated to the DC.

Utilising the stores for last mile distribution, is as earlier discussed in 6.3.2, not always an optimal solution due to the higher fixed costs. However, to support the increasing customer demands of lead time, it may be necessary to achieve same day shipments to large cities, which then can be provided by the stores. IKEA's stores differentiate from many other companies' stores since they are quite big, and already have an extensive storage capacity. At the same time, the stores are often just outside of the cities which slightly reduces the fixed costs while maintaining a good position for fast deliveries. The other solution to this is to set up LSCs, which then, would provide the possibility for fast last mile distribution. Moreover, it could work as an assembly point close to the customers, which means that fill rates could be higher for a bigger portion of the transportation. The LSC is an easy way to reach cities that are not within range of the bigger stores but could become expensive and unnecessary if there already are stores in proximity to the cities.

6.5.3. Balancing inventory, lead time and customer experience

Before introducing two suggestions to solutions, two perspectives will be further elaborated upon. The first perspective is proximity to the customer. Considering Figure 42 below, the closer to the centre point, the further away from the customer IKEA is.

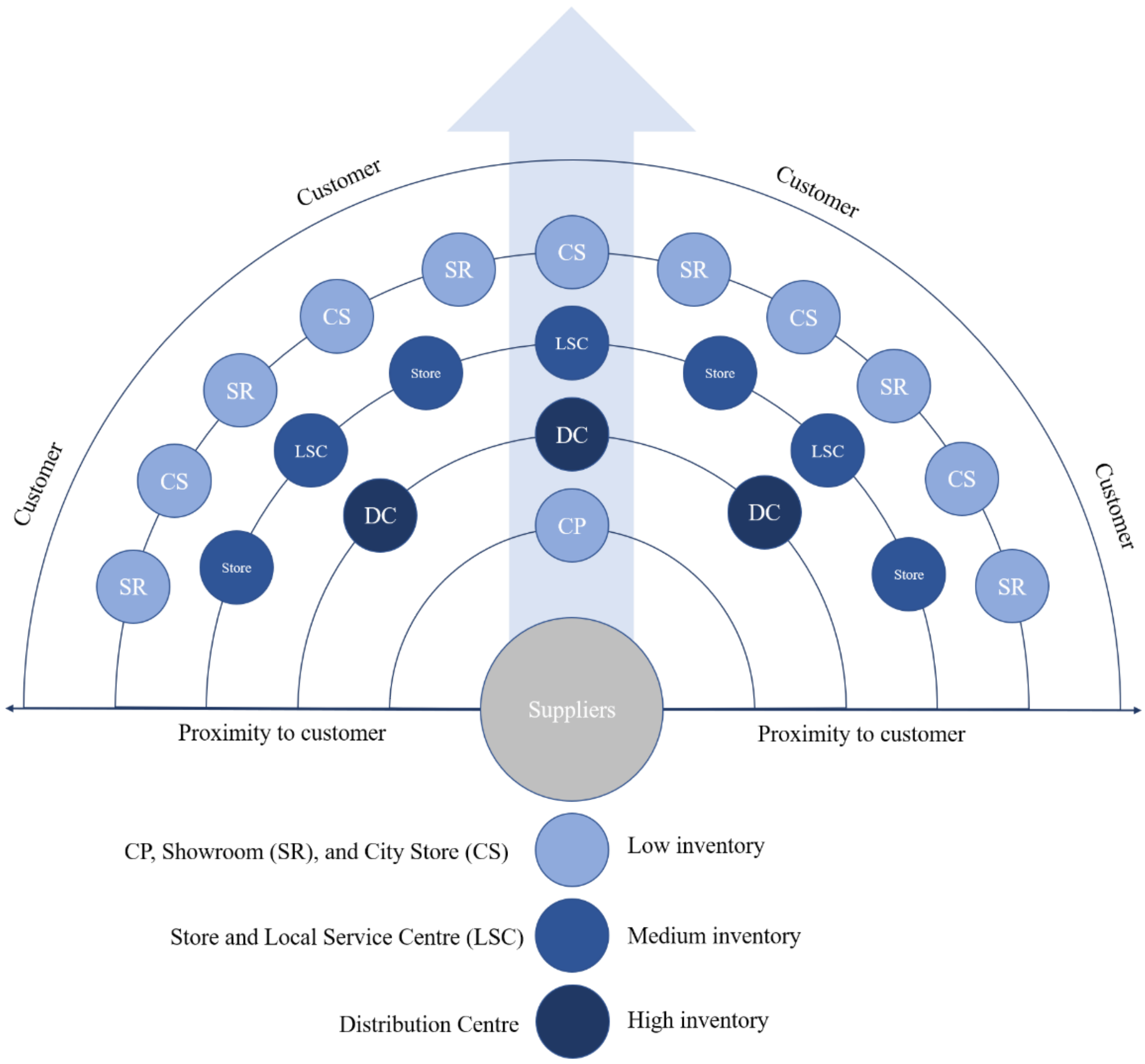


Figure 42: Distribution nodes and sales channels proximity to the customer and inventory levels

City stores and showrooms have the biggest physical customer base since they are placed in proximity to a lot of people, but these also have the smallest inventories. To support the large customer base, which often have higher requirements than the more segregated customers, fast distribution is required from a smaller circle (LSC, Store, or DC). Which in return has higher inventories. This way, it is possible to have close contact points to the customers without increasing the holding cost due to high inventories. Beyond these connections, internet shopping integrates all the nodes through required storage, distribution, and collection points that should be synchronised throughout the omni-channel network. From the current standard, LSC might be redundant, but will in the future play a larger role in a well-coordinated distribution network.

Figure 43 elaborates further on how appropriate a distribution route is for a certain node, ties the inventory levels, lead times, and customers together. Distribution is displayed in five layers (Supplier, CP, DC, CDC, store, and LSC) with decreasing lead time to customers.

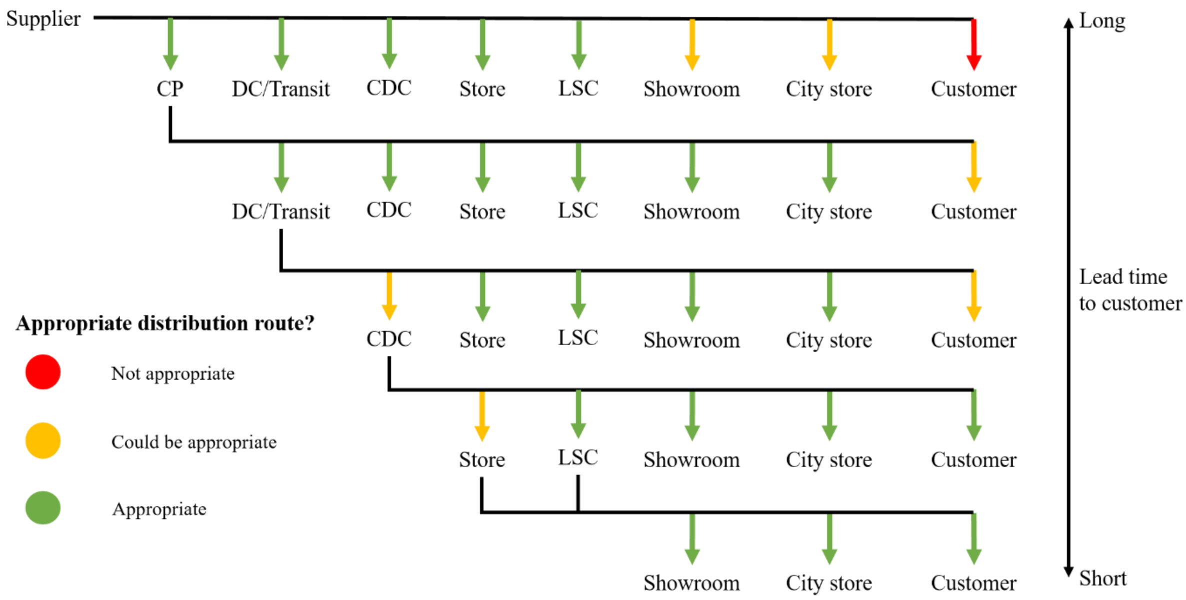


Figure 43: Appropriate distribution routes and links

In the first level, suppliers are suggested to send to CP, DC, CDC, Store, and LSC while showrooms and city store probably not are appropriate, due to their size. Finally, drop shipment to customers is not suggested from the suppliers. Moving down the layers, shipments to smaller concepts and customers become more reliable and possible to distribute. The DC and the CDC have the same possibilities within distribution, but, have implementations that allows them to efficiently target stores or e-commerce. The integration between DC and CDC suggested in 6.5.2 could therefore eliminate a layer, reducing the complexity in the network. Finally, stores and LSCs are suggested to have the same downstream distribution. The LSC provides fast last mile distribution to cities that do not have a store, while cities which already have a store could provide similar functions, due to their inventory levels.

6.5.4. Potential distribution network designs for omni-channel retailing

Based on the discussion and analysis in section 6.2.4 to 6.5.3, two different solutions to improve the network is discussed below. The main difference between the two solutions are the difference in utilisation of the CPs. The focus of the solutions is to utilise integrated nodes to create a united flow of goods that support the different sales channels within the omni-channel concept.

Solution one – CP as a cross-dock

In Figure 44, the first solution to IKEA's distribution network design is mapped. In this solution, CPs acts as a cross-dock.

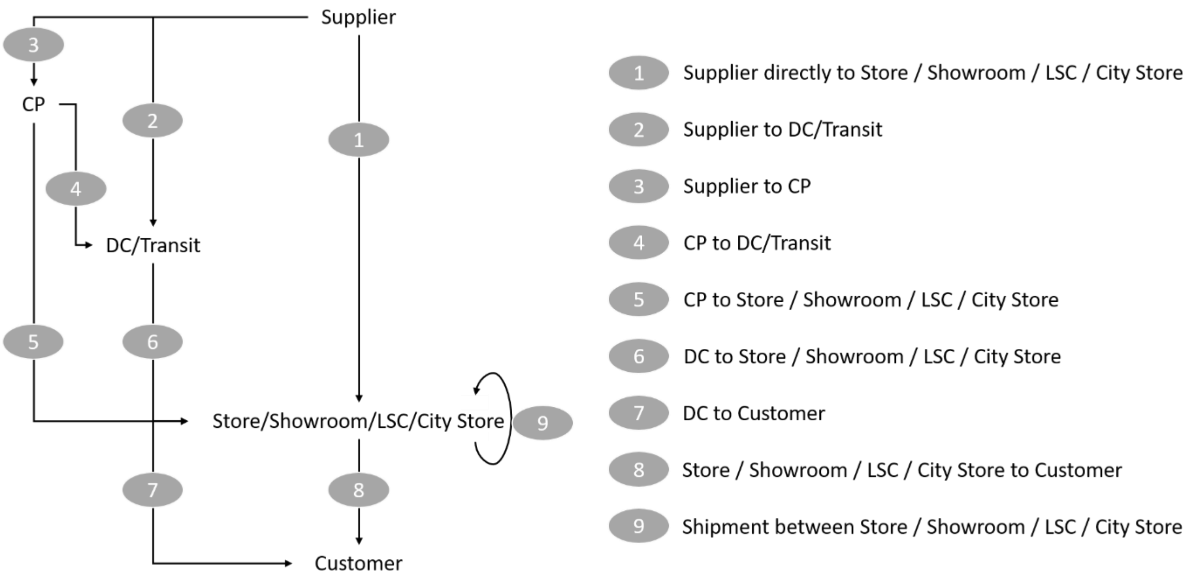


Figure 44: Suggested distribution network with CP acting as a cross-docking

The suppliers can send to all nodes which is in line with IKEA's current standard. Namely, to focus on direct deliveries with FULs. The CP is niched towards cross-docking as suggested by Rodrigue, and do not utilise picking. Therefore, the efficiency and cost should decrease for the CPs while the usage and speed are increased. The DC and the transit point are considered one unit, partially because many of them are in the current state, but also to perform multiple functions, and provide efficient service to all channels. The CDC is also suggested to be integrated directly into the DC for each country, with one strategic CDC (or DC if integrated) for each country. This gives the DC possibility to ship directly to the end customers when orders are received, either through internet, or from the showrooms and city stores. Both CPs and DCs can ship directly to the different sales channels, with only the DC shipping less than pallet loads. All sales channels support pick-up and return of goods. Both the original stores and LSCs have the potential to send directly to the home of customers or to pick up points, as well as, distribute to the smaller concepts. The main purpose for these two warehouses is to achieve quicker lead times that, otherwise, would not be possible through the more centralised DCs. Naturally, this would increase the overall cost of the distribution network, but, should be capable to reduce the inventory levels over time since the big bulk stock will only be at the DCs. Assembly would also be done as a side function, integrated either at the DC, LSC, or store.

Solution two – CP as multifunctional nodes

The second alternative, as presented in Figure 45, is a similar setup but the CPs work as multifunctional nodes.

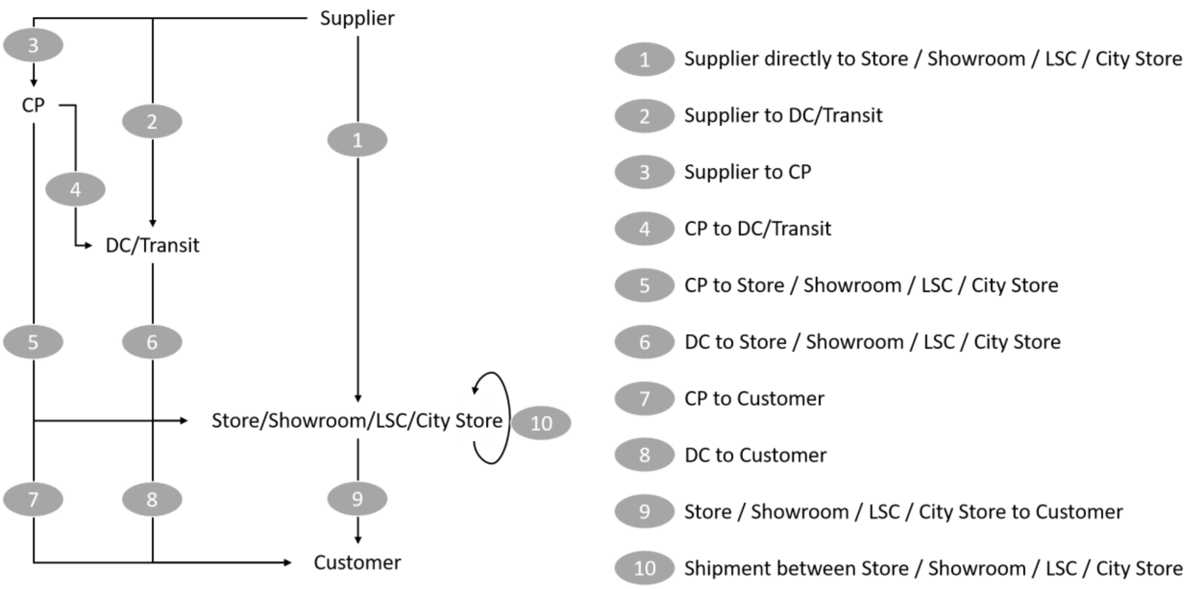


Figure 45: Suggested distribution network with CP acting as multifunctional node

In this solution, the CPs should handle packages, which means, that drop shipments could be performed directly to customers. It would also mean that coordination of goods could be performed closer to the suppliers, reducing the volumes that needs to be shipped to the DCs. Since CPs can ship a combination of full pallets and smaller pallets, the CPs would also be easier to use for the smaller concepts, increasing the usage. However, to introduce picking at the CPs will increase the stock held there. The CPs functions would be similar to the functions of the DCs, but with a less beneficial position. Therefore, the cost would increase for CPs, which potentially could make them obsolete. To avoid this, there might need to be a balance and optimisation of which products that should be available for part pallet shipment to reduce the storage need at the CPs. The main reason for implementing drop shipment at the CP instead of the suppliers is the current contracts with the suppliers. Re-negotiating the contracts is complicated and may not be possible for some suppliers. If there cannot be a united approach for the suppliers, it should be avoided. Except for the mentioned changes, the other functions should be changed as proposed in solution one.

Concluding discussion between the solutions

An alternative is to have a mixture of the two suggested approaches. That is, to utilise some of the CPs for picking while others for cross-docking. This could potentially increase the flexibility of the network, allowing different types of speeds and shipment types while keeping the holding costs down. The CPs could also take the role of the low flow DCs in these scenarios, but may not be beneficial since the DCs are owned by IKEA and are complicated to close. The same balance between inventory and response time is crucial to find at the LSC, since they could become far more in numbers compared to the DCs. Therefore, LSCs present a risk of overstocking goods on a holistic network perspective.

Considering the two solutions, the research shows that the first solution, presented in Figure 44, probably is the easiest and cheapest solution to implement, while still providing the necessary function to support the omni-channel setup. The drop shipment would in most situation not provide quick enough deliveries to satisfy the lead time demands from customers, and the score provided from Table 14 is not sufficient to motivate a change. Increasing the storage capacity at the CPs, which is required to provide picking, may also be a cost that outweigh the benefits. The positive effects of sending directly from the CP to the smaller concepts, may not be big enough to motivate the reduced efficiency towards the bigger flows, due to the solutions becoming more complex. Yet, a mixture of the two concepts could be beneficial on a product level, where different CP implement different concepts to support the omni-channel distribution. However, the research suggests that the focus should be on developing integrated approaches for the DCs and LSCs instead of a heavy focus on the CPs.

7. Conclusions

The purpose of this thesis was to explore how distribution network design is impacted by omni-channel retailing, and how the design should adapt to it. Furthermore, this thesis focuses on the role of CPs today and what role it will have in the future. The CPs were placed within a bigger context of the distribution network design of IKEA. Proposing suggestions for necessary and potential changes that would support omni-channel retailing. The research found that the CPs, in their current state, are sub-optimally used. Therefore, not used to their complete potential. The main reason for this is the lack of support for the delivery solution. Instead, there exist an overwhelmingly focus on direct delivery with FUL within IKEA. Moreover, the distribution network design does not need to change heavily to support upcoming integration of flow of goods and sales channels. However, it should be concentrated, with a higher focus on multi-functionality. Meaning, that the distribution nodes need to be capable of handling the requirements of all sales channels. Distribution to stores, city stores, showrooms, and internet shopping could all be handled by the same node(s).

7.1. Research Question 1: The role of consolidation points

The role of CPs within IKEA is to store and merge goods close to the suppliers before being sent to another node or store in the distribution network. Through merging goods, it is possible to achieve FUL with a combination of goods that otherwise would be shipped LUL in multiple shipments. CP is perceived as a second-hand delivery solution within IKEA, with no clear benefits in terms of cost or transportation time compared to the most prioritised solution, direct deliveries with full loads. Risk of shipments to be stuck at the CP is another disadvantage with the current CP setup. The strategy to choose CPs is based on geographical proximity to supplier as well as predetermining which CP each supplier should consolidate their supply at.

Moving into the future where the number of city stores, showrooms, and other logistical nodes increases, the current strategy to supply a few stores with major flows is outdated. Instead, the flow to each node will decrease. In this setting, the CP excels since its main function is to consolidate lesser flows of goods. Also, with increasing demand on delivery speed for omni-channel retailers, CPs has the prerequisites to lower lead times in the supply chain through reducing production cycles. However, for CP to function optimally in the future, its role must be redefined, which is an upcoming barrier. It was concluded in this thesis that CPs should move towards being a cross-docking node, rather than supporting picking and break-bulk shipments. An additional barrier is that CPs demand a higher level of coordination and communication on a tactical and operational level. To ease up the second barrier, it was suggested to change the supplier selection process to select fewer suppliers with geographical proximity to each other to reduce the complexity of the distribution network. Moreover, when designing the distribution network, item routes from suppliers should be able to consolidate their shipments at several nearby CPs.

7.2. Research Question 2: Distribution network design

To introduce new sales channels expands and spreads out the customer base, which provides the customer with more choices and flexibility. The analysis in 6.5.2 provides evidence that the number of different fulfilment methods do not need to increase in tandem or correspond to the number of different sales channels. Instead, the fulfilment methods need to be integrated from separate distribution nodes for each channel into nodes that can provide the product with minimum cost at enough speed, service level, and quality, to all sales channels. The integration is further required to align the distribution with the information flow. The alignment should provide support for movement of goods between a sale channel and a customer, and then returned through another channel without unnecessary handling.

In future distribution network designs, there need to be a higher focus on multi-functionality. Multi-functionality implies that solutions are integrated in fewer variants of nodes, to support and align with the omni-channel concept. Logistical nodes need to be closer to the end customer, providing shorter last mile distribution and reaching the customer quicker. Therefore, the DCs and LSCs require internal development, as well as, integration to the omni-channel. The modern store concepts require fast handling and distribution which are provided by either the LSCs or stores. In turn, they rely on the DCs to secure inventory when transport time from direct delivery or CPs is too slow. To be capable of sending shipments through the fewest possible nodes, efficient cross-docking is required at CPs. The focus on transportation cost will need to be reduced with the development of new sales channels and omni-channel. Moving focus towards inventory in the "inventory – transport trade-off" due to the increasing number of small inventory points. The optimisation and placement of inventory will, therefore, become crucial to reduce the holding cost to a higher extent than transportation cost.

7.3. Theoretical and practical contribution

This thesis' theoretical contribution is to show how consolidation points can be used, and how the distribution network can be designed in an omni-channel context. There existed a theoretical gap on how global retailers should utilise shipment consolidation in an omni-channel context, and how to put it in a bigger perspective. Namely, how retailers should design their distribution network to adopt to omni-channel retailing. It was concluded that consolidations, as a logistical node, points has an edge in distribution when IKEA moves from a network with few receivers to a network with many receivers. This is due to its ability of consolidating lesser flows into a single major flow to lower transportation costs. It can also lower the production cycles of the suppliers to reduce lead times, and thus, increase delivery speed. Which is a sought after omni-channel distribution trait. Moreover, this thesis focused on distribution network design in an omni-channel context. It was concluded that IKEA, with a sophisticated distribution network, should move towards more local nodes to increase their customer presence. However, by increasing the number of nodes, fixed cost increases at a high rate. To cope with the increasing costs, the distribution network should consist of multi-functional nodes that can handle different tasks, rather than nodes with single task functionality. The general appeal of shipment consolidation and distribution network design in combination with IKEA being a major actor within the retailing industry may make the findings of the thesis interesting for similar companies within the industry. Currently, there are many retailers which are facing the same transition from brick-and-mortar stores to omni-channel retailing as IKEA.

Thus, the thesis' contribution can work as a framework for shipment consolidation and distribution network design for these companies as well.

8. Future research

This study has focused on the CPs and distribution network from a design and general perspective. The functions of different logistic nodes have been analysed from a view considering the direction costs, stocks, lead times, et cetera, would take due to the changes. Future research would need to, on a deeper level, analyse the total stock and risk of overstocking for integrated approaches. Furthermore, the impact on stock, if the capacity of sending break-bulk were to be moved upstream to the CPs or downstream to the LSC, needs to be further analysed.

The LSC has, in this report, been considered a smaller DC, located between the DC and end customer. As mentioned, there is a risk of getting to much stock within the distribution network if a lot of LSC were to be used, especially if the stock at these nodes would be standardised. Therefore, the LSC needs to have an optimised and well-balanced stock. Future research could, therefore, focus on machine learning processes and methods for predicting where the demand would be. Making it possible to place products at the LSC just in time to meet the demand and avoid unnecessary stock, while still meeting service level requirements.

Further research could also be done within the same area based on multiple companies, for a better comparison of distribution network designs. Companies within different stages of the change process could give insights on good and bad approaches, and, locate trade-offs that will be found through construction of integrated flows. Furthermore, it could provide interesting findings about how changes in the distribution network affects customer attraction and stickiness. In turn, to provide information on payback times, success rates, and required cultural changes for investments in distribution network design.

References

Atamtürk, A. & Savelsbergh, M. W. P., 2005. Integer-Programming Software Systems. *Annals of Operation Research,* 140(1), pp. 57-124.

Aubrey, C. & Judge, D., 2012. Re-imagine retail: Why store innovation is key to a brand's growth in the 'new normal', digitally-connected and transparent world. *Journal of Brand Strategy,* 1(1), pp. 31-39.

Beck, N. & Rygl, D., 2015. Categorization of multiple channel retailing in multi-, cross-, and omni–channel retailing for retailers and retailing.. *Journal of Retailing and Consumer Service,* Volume 27, pp. 170-178.

Bell, D., Gallino, S. & Moreno, A., 2014. How to win in an Omnichannel World. *MIT Sloan Management Review,* 54(1), pp. 23-29.

Bowersox, D. J., Cooper, M. B. & Closs, D. J., 2007. *Supply Chain Logistics.* 2nd ed. s.l.:McGraw-Hill Irwin.

Brynjolfsson, E., Hu, Y. J. & Rahman, M., 2013. Competing in the age of Omni-channel retailing. *MIT Sloan Management Review,* 54(4), pp. 1-7.

Cabot, A. V. & Erenguc, S. S., 1984. Some branch-and-bound procedures for fixed-cost transportation problems. *Naval Research Logistics Quarterly,* 31(1), pp. 145-154.

Cheong, M., Bhatnagar, R. & Graves, S., 2007. Logistics Network Design with Supplier Consolidation Hubs and Multiple Shipment Options. *Journal of Industrial and Management Optimization,* 3(1), pp. 51-69.

Cheraghi, S. H., Dadashzadeh, M. & Subramanian, M., 2004. Critical Success Factors For Supplier Selection: An Update. *Journal of Applied Business Research,* 20(2), pp. 91-108.

Chopra, S., 2003. Designing the distribution network in a supply chain. *Transportation Research,* Volume 39, pp. 123-140.

Chopra, S., 2016. How omni-channel can be future of retailing. *Decision,* 43(2), pp. 135-144.

Chopra, S. & Meindl, P., 2013. *Supply Chain Management: Strategy, Planning and Operations.* 5th ed. Harlow: Pearson Education Limited.

Clausen, J., 1999. Branch and Bound algorithms - Principles and Examples.. *Computer.*

Coyle, J., Langley Jr., C. J., Novack, R. A. & Gibson, B. J., 2013. *Managing Supply Chains: A Logistics Approach.* 9th ed. s.l.:South-Western Cengage learning.

Davenport, T. H., Barth, P. & Bean, R., 2012. How 'Big Data' is Different. *MIT Sloan Management Review,* 54(1).

de Koster, R. B. M., 2003. Distribution strategies for online retailers. *IEEE Transactions on Engineering Management,* 50(4), pp. 448-457.

Eksioglu, B., Vural, A. V. & Reisman, A., 2009. The vehicle routing problem: A taxonomic review. *Computers & Industrial Engineering,* 57(4), pp. 1472-1483.

Fernie, J. & Sparks, L., 2009. *LOGISTICS &RETAIL MANAGEMENT Emerging issues and new challenges in the retail supply chain.* 3rd ed. London and Philadelphia: Kogan Page.

Haffner, S., Monticelli, A., Mantovani, J. & Romero, R., 2000. Branch and bound algorithm for transmission system expansion planning using a transportation model. *IEE Proceedings - Generation, Transmission and Distribution,* 147(3), pp. 149-156.

Heala, R. & Twycross, A., 2015. Validity and reliability in quantitative studies. *Evidence Based Nursing,* 18(3), pp. 66-67.

Higginson, J. & Bookbinder, J., 1994. Policy recommendations for a shipment-consolidation program. *Journal of Business Logistics,* 15(1), pp. 87-112.

Ho, W., Xu, X. & Dey, P. K., 2009. Multi-criteria decision making approaches for supplier evaluation and selection: A literature review. *Journal of Operations Research,* Volume 202, pp. 16-24.

Hübner, A., Holzapfel, A. & Kuhn, H., 2016. Distribution systems in omni-channel retailing. *Business Research,* Volume 9, pp. 255-296.

Hübner, A., Holzapfel, A. & Kuhn, H., 2016. Operations management in multi-channel retailing: an exploratory study. *Operations Management Research,* 8(Nos 3/4), pp. 84-100.

Ishfaq, R., Defee, C. C. & Gibson, B. J., 2016. Realignment of the physical distribution process in omni-channel fulfillment. *International Journal of Physical Distribution & Logistics Management*, 46(6/7), pp. 543-561.

Kembro, J. H., Norrman, A. & Eriksson, E., 2018. Adapting warehouse operations and design to omni-channel logistics A literature review and research agenda. *Creative Commons Attribution.*

Land, A. H. & Doig, A. G., 1960. An Automatic Method of Solving Discrete Programming Problems. *Econometrica,* 28(3), pp. 497-520.

Lang, G. & Bressolles, G., 2013. Economic Performance and Customer Expectation in e-Fulfillment Systems: A Multi Channel Retailer Perspective. *Supply Chain Forum: An International Journal,* 14(1), pp. 16-26.

Laporte, G., 1992. The Vehicle Routing Problem: An overview of exact and approximate algorithms. *European Journal of Operational Research,* Volume 59, pp. 345-358.

LaSalle, J. L., 2013. *JLL, E-commerce boom triggers transformation in retail logistics.* [Online]
Available at: http://www.jll.eu/emea/en-gb/research/146/e-commerce-boom-triggers-transformation-in-retail-logistics
[Accessed 29 January 2019].

Laudon, K. C. & Guercio Traver, C., 2016. *eCommerce 2016: Business, Technology, Society.* 12 ed. Boston: Pearson.

Leech, N. L. & Onwuegbuzie, A. J., 2009. A typology of mixed methods research designs. *Quality and Quantity,* 43(2), pp. 265-275.

Little, J. D. C., Murty, K. G., Sweeney, D. W. & Karel, C., 1963. An algorithm for the traveling salesman problem. *Operations Research,* 11(6), pp. 972-989.

Lumsden, K., 2007. *Fundamentals of Logistics.* s.l.:Chalmers University of Technology - Department of Technology Management and Economics.

Paleka, U. S., Karwan, M. H. & Zionts, S., 1990. A new branch-and-bound algorithm for the fixed-charge transportation problem. *Management Science,* 36(9), pp. 102-1105.

Poirier, C. C. & Reiter, S. E., 1996. Supply Chain Optimization. In: *Supply Chain Optimization - Building the strongest total business network*. San Francisco: Berrett-Koehler Publishers, pp. 1-5.

Rodrigue, J.-P., 2006. Transportation and the Geographical and functional integration of global production. *Growth and change,* 37(4), pp. 510-525.

Rubin, H. J. & Rubin, I. S., 2012. *Qualitative interviewing - The art of hearing data.* 3rd ed. Los Angeles: SAGE.

Sandelowski, M., Voils , C. I. & Barroso, J., 2006. Defining and Designing Mixed Research Synthesis Studies. *Research in the schools,* 13(1), pp. 29-40.

Sharma, M. J., Moon, I. & Bae, H., 2008. Analytic hierarchy process to asses and optimize distribution network. *Applied Mathematics and Computation ,* Volume 202, pp. 256-265.

Skjott-Larsen, T., Schary, P. B., Mikkola, J. H. & Kotzab, H., 2008. *Managing the Global Supply Chain.* 3rd ed. Copenhagen: Liber.

Sparks, L., 1985. The changing structure of distribution in retail companies: an example from the grocery trade. *The Royal Geographical Society,* 11(2), pp. 147-152.

Steele, C. & Hodge, D., 2011. *Background Research Material for Freight Facility Location Selection: A Guide for Public Officials.* [Online] Available at: http://www.trb.org/Publications/Blurbs/165743.aspx [Accessed 6 February 2019].

Talbi, E.-G., 2009. Optimization Methods. In: *Metaheuristics - From Design To Implementation.* New Jersey: John Wiley & Sons Inc., p. 21.

Toth, P. & Vigo, D., 2002. *The Vehicle Routing Problem.* 1st ed. Philadeplhia: Siam.

Tyan, J., Wang, F. & Du, T., 2003. An evaluation of freight consolidation policies in global third party logistics. *The International Journal of Management Science,* Volume 31, pp. 55-62.

Van Weele, A., 2018. *Purchasing and Supply Chain Management.* 7th ed. s.l.:Cengage Learning EMEA.

Verhoef, P. C., Kannan, P. & Inman, J. J., 2015. From Multi-Channel Retailing to Omni-Channel Retailing: Introduction to The Special Issue on Multi-Channel Retailing. *Journal of Retailing,* 91(2), pp. 174-181.

Wollenburg, J., Hübner, A. & Holzapfel, A., 2015. Empirical Studies in Multi-Channel and Omni-Channel Retail Operations and Logistics - An Introduction to Literature.

Voss, C., Tsikriktsis, N. & Frohlich, M., 2002. Case research in operations management. *Journal o Operations & Production Management,* 22(2), pp. 195-219.

Yin, R. K., 2006. Mixed Methods Research: Are the Methods Genuinely Integrated or Merely Parallel?. *Research in the schools,* 13(1), pp. 41-47.

Yin, R. K., 2018. *Case study research and applications.* 6th ed. California: SAGE Publications.

Zohrabi, M., 2013. Mixed Method Research: Instruments, Validity, Reliability and Reporting Findings. *Theory and Practice in Language Studies,* 3(2), pp. 254-262.

Appendix

Interview guide

Introduction

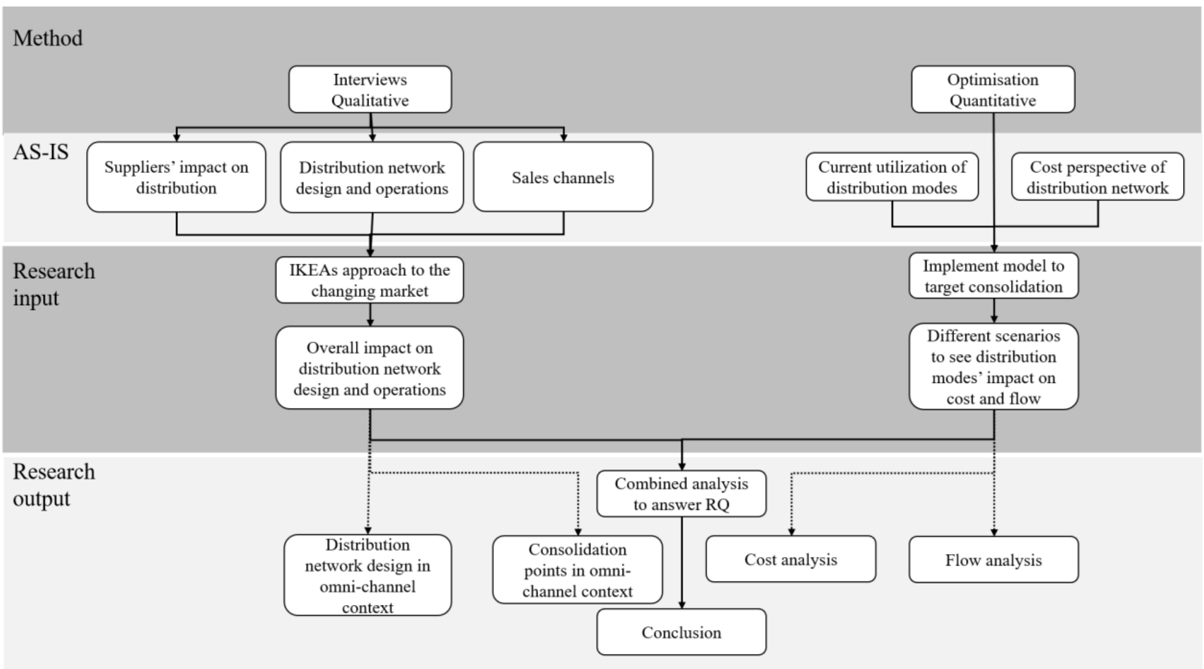
The purpose of this interview guide is to introduce the research questions and reason behind why the interviews are performed. The goals of the interview are also explained. Then the proposed questions are presented.

As a final project at the Faculty of engineering in Lund, students perform a master thesis. In our case we perform a project within the Business Range and Supply department at IKEA. The project is a variant of pre-study focusing on optimisation of a supply chain model, especially considering consolidation points that are used within IKEA distribution network. Through data analytics and supply chain modelling (Supply Chain Guru, DORS) the goal is to find a model that in an effective and repetitive way finds the best consolidation point based on all suppliers and stores within specified areas.

To create an academic approach to the subject, a more general research question is proposed as an extension to the business optimisation. The research question is derived from the consolidation points and distribution network of IKEA in combination with the theory proposing that the retail industry has and is undergoing big changes. Below the research question and purpose of this thesis is presented:

Research question: How should consolidation points be utilised and optimised to support the changing landscape of the market in retail?

The purpose of the thesis is to analyse the utilisation of shipment consolidation within retail distribution and how it changes due to the shifts towards omni-channel retailing in the market.



To achieve this understanding, the authors are interested in performing interviews at IKEA covering multiple roles within the organisation. Through a mix of both presenting similar questions to everyone and specific questions for each role. The authors believe they can get an extensive understanding of IKEAs challenges, future possibilities and the relation between retail as a business and retail distribution. Since IKEA is a world-leading and big furniture company, conclusions should be possible to be drawn from these interviews in combination with the understanding of optimisation that are applicable for the general industry. Naturally, feedback to IKEA and potential gaps will also be presented and elaborated on.

Interview questions

Personal questions

Name?

Position and specific working area?

Previous positions that could be relevant, within or outside of IKEA?

Have you ever used the supply chain guru model or the results of it?

What connections or integration points do you have with distribution?

Distribution network

Distribution modes

IKEA uses direct delivery (DD), distribution centre (DC), consolidation points (MRS), shipment transit (MRR), combined supply (CS), and milk runs as different distribution modes. Could you explain the different modes from your point of view?

What do you see as benefits or potential trade-offs between the different modes? E.g. inventory, fill rate, warehouse cost, cost of lost sales

Can you give any examples where you think it could be beneficial to use a distribution mode although it isn't the cheapest?

Fill rate appears to be an important factor for IKEA, how is this fulfilled and affected by the different modes? Can you name any factors that changes the fill rate requirement? E.g. product, distance, etc.

How do purchasing and transport coordinate to meet the requirements?

What are the differences between your high and low flow, and how does it impact the distribution network?

Expanding on consolidation points, can you specify the process? Are there more or less benefits to consolidation point compared to a transit point for example or how do they more in depth differ? How would you say that these differ from classical cross-docking (explain cross

docking is necessary)? Are there any typical settings were a consolidation point is placed (geographical)?

What are the differences between DC and CDC in, for example, functions performed and parameters for using it? Since CDC is for e-commerce, how is it changed, inventory etc?

Transportation

From what we know, IKEA mainly uses two types of transportation modes, namely truck and boat. What are the decision parameters for choosing one of the transportation modes outside of cost? Examples could be: distance, weight, volume etc.

Intermodal transportation (usage of multiple transport modes within one leg) is, from what we understand used at IKEA. Outside of the transportation benefits, are there any other benefits (cost, functions, value-adding) sought from intermodal transportation? Example could be: shipment consolidation are performed at a harbour when the goods are transferred from boat to truck.

How are products developed to be more optimised for the transportation? For example, what are considered within stowability or other factors that affects the distribution such as density or weight? What connection areas are there between product development and distribution?

The changing landscape of retail and its impact on IKEA

As of now IKEA has two different sales channels, the big stores and website, how are they integrated in relation to information systems, distribution to the sites and returns? What barriers do you see within your area for the integration between the channels?

According to literature, customer service are in general experienced through variables such as Response time, Product variety, Product availability, Customer experience, Order visibility and Returnability. How would you say IKEA works with these areas within the distribution network and sales channels? Are there other areas that you focus on instead?

The retail industry has during the last decade undergone quite big changes within customer behavior and required customer experience. What do you see as the biggest challenges for the retail industry as a whole and IKEA specifically? How has and will IKEA as an organisation have to adapt to cope with the changes and challenges?

How are IKEA planning on expanding through introducing new channels and fulfilment methods (delivery methods)? Examples could be showrooms, drop shipping.

Can you elaborate on the strategy for the development of potential new channels?

What are the tactic for integrating the new and old channels?

Relating back to the distribution network, how do you believe it will need to change to adopt to the new potential channels or challenges given by the customers? Do you believe that new channels should be fully integrated with the old ones to one flow?

If the order sizes become reduced due to less store shopping, how will that impact the distribution network? For example, the size of the flows, both low and high flows and the usage of consolidation points and transit points?

Supply Chain Optimisation (only relevant if used/data from it is used)

As mentioned, we work with optimisation of the supply chain model that is used for IKEAs supply chain. How do you believe that the model impacts your work, or how do you work with the data from the model to improve your work?

Can you name any gaps in the model or data that you would be interested in having?

In what situations is it easier to move away (or work outside) of the data given from the model?

Are there ways to "cheat" the model?

What are the main focus within development of new models in the future?