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Contextual factors for omni-channel warehousing: An empirical study in China

Master Thesis

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Abstract

Introduction: In recent years omni-channel retailing has been accepted and used by both physical and e-commerce retailers. In omni-channel retailing different channels are integrated. An effective and efficient distribution system is becoming more crucial. The core of the distribution system is warehousing that affects lead time and logistics cost. The main challenge is to handle large store replenishment and small web orders in an integrated warehouse. The Chinese market is one of the largest growing retail markets with a large number of small and medium-sized retailers. The market is fragmented and changed rapidly.

Therefore, we have much interest in omni-channel warehousing in Chinese retailing and want to have a deep understanding about the experience in Chinese omni-channel retailing and compare with Swedish retailing.

Purpose: The purpose of the thesis is to explore how Chinese retailers have adapted their warehouse operations and design to omni-channel logistics and find related retailers' experience, important contextual factors and challenges.

Methodology: For the purpose of this study, the work consists of a literature review for theory development and a multiple case study for the empirics. The literature review is the basis of building a conceptual framework, including omni-channel retailing, warehousing operation and current findings in omni-channel warehousing. There are four companies from four industry sectors in China being investigated. Empirical data are collected through face-to-face and phone interviews. The analysis is both conducted within case and cross case.

Findings: The retailers' experiences are divided into three perspectives: automation and network, integration and separation, and picking strategies. In Chinese omni-channel retailing there is a trend to using higher automation in warehouse operations and using online fulfillment center in the distribution system. Picking strategies are chosen according to the companies' own features. Then the important contextual factors in the three perspectives are analyzed and found. The main challenges in Chinese omni-channel retailing are illustrated in three areas: logistics performance, the distribution system and warehouse operations. The differences between Chinese omni-channel retailing and Swedish omni-channel retailing are also found with comparing our findings with Swedish cases. Finally, the suggestions for future research in relevant topics are given based on our findings.

Contribution: This thesis has been a complete elaboration between the two authors. Each author has been involved in every part of the process and contributed equally.

Keywords: Omni-channel, Warehouse operations and design, Chinese market, E-commerce, Contextual factors

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Finally, we would like to take this opportunity to thank our family and friends that help us contact the companies and give us constant encouragement and support.

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Abbreviations

WMS = Warehouse Management System
SKUs = Stock Keeping Units
ERP = Enterprise Resource Planning
AS/RS = Automated Storage and Retrieval Systems
AGVs = Automated Guided Vehicles
FIFO = First-In-First-Out
LIFO = Last-In-First-Out
OFC = Online Fulfillment Center
DC = Distribution Center

1. Introduction

This chapter first introduces the general background of omni-channel retailing in the Chinese market. Then there is a detailed explanation of how the authors formulate the research questions, the purpose of the research, and the three research questions. The end of this chapter explains the focus and limitations and gives the reader the structure of the remaining report.

1.1 Background

Omni-channel retailing was introduced only a couple of years ago but it has been accepted and used by both physical and e-commerce retailers (Shaohua, et al., 2018). In omni-channels, different channels are integrated where customers can buy from one channel, then collect from another and return from a third (Kembro et al., 2018). According to Hübner et al. (2016), the warehousing solution of the omni-channel has integrated inventory for flexible, demand-driven allocation and provide cross-channel picking processes in one common zone. The omni-channel leads to a more effective and efficient distribution system and it is becoming more and more important. For example, for bricks-and-mortar retailers, they have noticed the importance of omni-channel. As online shopping has increased rapidly, the entry of bricks-and-mortar retailers into e-commerce is ongoing, but their problems with integration become a barrier. Therefore, the omni-channel strategy has been adopted to integrate their bricks-and-mortar channel and e-commerce channel (Herhausen et al., 2015). In omni-channel retailing, it is found that the capability of integration has a significant positive impact on companies' performance (Shaohua et al., 2018).

The importance of the distribution system is increasing, because omni-channel retailing develops rapidly (Daugherty et al., 2019). Warehousing is the core of the distribution system and plays an important role in meeting shorter lead time and lower logistics cost (Faber et al., 2013), but to handle the fulfillment of large store replenishment and small web orders in an integrated warehouse is a major challenge in omni-channel retailing (Hübner et al., 2015).

The Chinese market is much different from a developed market for example the American market. The characteristics of the Chinese market make it a hot topic. Firstly, the Chinese market is one of the largest growing retail markets (Fung Business Intelligence Centre, 2014). According to the PRC National Bureau of Statistics[1], the total retail sales of consumer goods in 2018 is 380.987 billion yuan[2]. Secondly, the Chinese market is highly fragmented and composed of a large number of small and medium-sized retailers defined by different demographic, economic and cultural characteristics (Hedley, 2017). Thirdly, the e-commerce companies changed the local market structure rapidly in the past several years (Fung Business Intelligence Centre, 2014). Although, there are differences of population, economic development

[1] An agency directly under the State Council of the People's Republic of China charged with the collection and publication of statistics related to the economy, population and society of the People's Republic of China at the national and local levels. Visit at: http://data.stats.gov.cn/english/index.htm
[2] 380.987 billion yuan is around 50.46 billion Euro or 535.32 billion SEK

and culture characteristics of different kinds of market. These does not limit the rapid development of e-commerce (Ye et al., 2018). The transaction value of China's online retail market increased 32.2% to reach 7.18 trillion yuan in 2017. This rapid growth is because of China's large population of internet users and the early adoption of mobile shopping by Chinese consumers (Fung Business Intelligence, 2018).

1.2 Problem formulation

Omni-channel logistics has received increasing attention since 2014. Figure 1.1 shows the growth of the number of researches in "omni-channel logistics" and researches in "omni-channel logistics" and "warehouse"[3]. During the year 2014 to 2018, there are in total 57 articles, but when using both keywords "omni-channel logistics" and "warehouse", there are only 9 in the same time period.

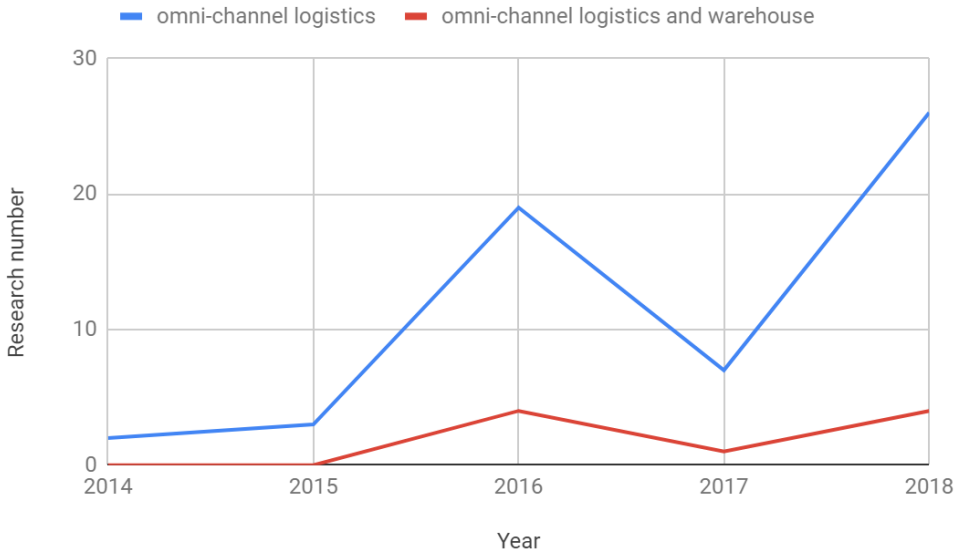


Figure 1. 1 Research number of keywords "omni-channel logistics" and keywords "omni-channel logistics" and "warehouse" in EBSCOhost for each year

According to the research of Kembro et al. (2018), there is a lack of research focused on omni-channel logistics with warehouse operations and design. Besides, there are limited studies focusing on the implementation of omni-channel for developing countries such as China (Ye et al., 2018). Thus, this thesis investigates the implementation of practices of transforming warehouse operation and design to omni-channel logistics in Chinese retailers.

[3] The results retrieved from EBSCOhost for the keyword "omni-channel logistics" and the keyword "omni-channel logistics" and "warehouse", and filtered with only peer-reviewed academic journals.

1.3 Purpose

The purpose of the thesis is to explore how Chinese retailers have adapted their warehouse operations and design to omni-channel logistics and find related retailers' experience, important contextual factors, and challenges.

1.4 Research questions

RQ1: What are retailers' experiences from transforming warehouse operations and design to omni-channel logistics in the Chinese market?

The retailers' experience will be explored from five aspects: automation, network structure, integration/separation (picking process and storage zones) and picking strategies.

RQ2: What are the contextual factors perceived important for implementing omni-channel warehousing in the Chinese market?

The retailers' experience will be explored from five aspects: automation, network structure, integration/separation (picking process and storage zones) and picking strategies.

RQ3: What are the challenges for implementing potential solutions in omni-channel warehousing?

The challenges in omni-channel warehousing will be explored and discovered from three dimensions: logistics performance, distribution system and warehouse operations.

1.5 Focus and delimitations

The research will include various implementation and challenges of omni-channel warehousing specialized in operations and design of Chinese enterprises. The selections of the enterprises will include companies that use both online and offline channels in China, but the selections are limited based on the reasons such as time, location and co-operating personnel access. This thesis is about Chinese market, but the authors currently study in Sweden, there is a limitation on research time and location. Besides, due to companies' regulation, it is hard to connect to many staff in a company as well as request for interviews. The research will focus on the implementation of omni-channel logistics but not involve in any technical architecture of that.

1.6 Structure of the thesis

In the following chapter, chapter 2 will present a literature review of related theory, including omni-channel retailing, general warehouse operation and design, and current findings of omni-channel warehousing. Then in chapter 3, the methodology of this thesis will be elaborated in terms of the methods of how the authors conduct this case research studies. In chapter 4, the empirical data will be described according to single case companies, while chapter 5 analysis

more in-depth cross cases. Finally, chapter 6 will discuss the findings and will propose our conclusions of omni-channel warehousing in the Chinese market.

2. Theoretical framework

This chapter presents our theoretical framework related to omni-channel warehousing. The characteristics of omni-channel retailing will be introduced firstly. Then the theory about general warehousing operations and design will be presented. The end of this chapter will introduce the current findings in omni-channel warehousing.

The structure of this chapter is shown as follow Figure 2.1. The characteristics of omni-channel retailing focus on its differences from multi-channel retailing and its drivers and barriers. The general warehouse illustrates in two parts including operations and design. The warehouse operations address the knowledge of inbound and outbound flows, while warehouse design explains the elements such as layout, equipment, automation solution, labors, and Warehouse Management System (WMS). Then the authors generate omni-channel retailing and general warehouse together into omni-channel warehousing and draw the current findings of it, such as automation and network structure, integration and separation, picking strategies, challenges, and strategic logistics goals.

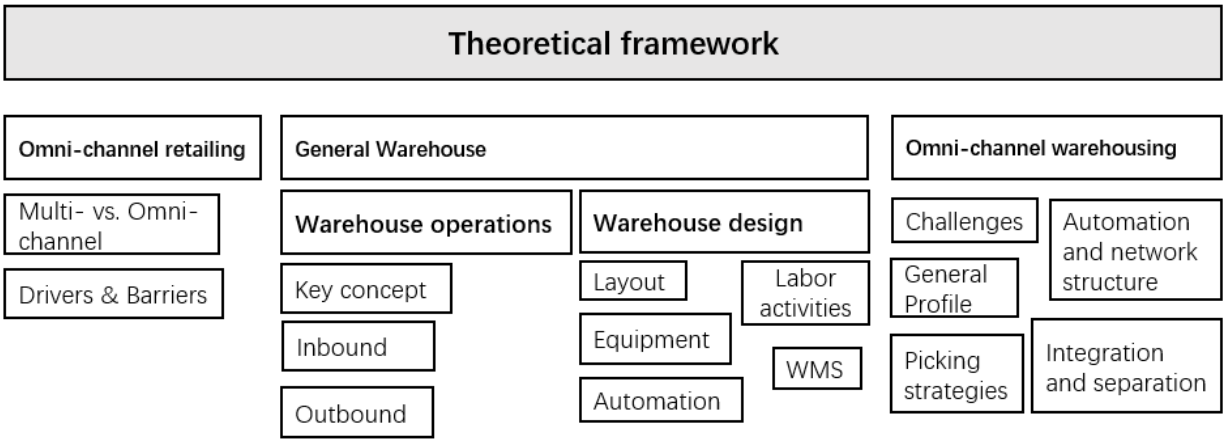


Figure 2. 1 The theoretical framework of this thesis.

2.1 Omni-channel retailing

2.1.1 Multi- vs. Omni- channel retailing

In the last twenty years, e-commerce sales have been growing fast in many markets. Based on this development, traditional companies adopted the multi-channel strategy and included online sales into their business model. Retailers also transferred their business model from a single channel to multiple channels (Marchet et al, 2018). It could hence meet the challenges from the pure e-commerce development (Melacini et al., 2018).

The multi-channel models usually consist of independent channels developed by retailers (Wilding, 2013). The multi-channels initially worked separately, which led to fragmented supply

chains. Therefore, it is hard for retailers to provide a high-quality consumer experience (Melacini et al., 2018). In order to offer a consistent and good consumer experience, omni-channel retailing was introduced. Omni-channel retailing is developed to solve the issue in multi-channel by coordinating processes from all channels to offer consumers seamless and reliable service (Wilding, 2013).

Omni-channel retailing is defined as connecting customers and fulfilling orders using different channels. There are three main flows between customers and retailers that are information, product and funds (Chopra, 2018). Distance orders could be handled through the stores and in-store orders could be used for home delivery (Hübner et al., 2016).

Wilding (2013) developed a framework of three dimensions to define omni-channel retailing. The three dimensions are customer value-add journey, type of channel and agents. One example for the customer value-add journey is the location of the channels. Type of channel stands for the different transformation way for the information and product. Agents include the responsible for each channel (Wilding, 2013). The fulfillment process in omni-channel could be implemented by three ways that are information exchange, joint operations and cross-channel inventories (Hübner, 2016).

In order to define omni-channel in deep, Verhoef in 2015 compared multi-channel and omni-channel retailing. The differences are shown in Table 2.1.

Table 2. 1 Comparison between MC and OC *(source: Verhoef et al., 2015, p.176)*

	Multi-channel retailing (MC)	Omni-channel retailing (OC)
Focus	Interactive channels only	Interactive and mass-communication channels
Integration	Separate channels with no overlap	Integrated channels providing seamless retail experiences
Management	By channel, with channel objectives (i.e. sales per channel, experience per channel)	Across all channels, with cross-channel objectives (i.e. total sales over channels, overall retail customer experience)
Data	Not integrated and not shared across channels	Integrated and shared across all channels

Melacini et al. (2018) propose three dimensions that identify the differences between multi-channel and omni-channel: distribution network design, inventory and capacity management, and delivery planning and executing (Table 2.2). They argue that the main difference between omni-channel retailing and multi-channel retailing is that omni-channel retailing integrate picking, assortment and inventory.

Table 2. 2 Comparison between MC and OC based on three dimensions
(source: Melacini et al., 2018, p.408)

	Multi-channel retailing (MC)	Omni-channel retailing (OC)
Distribution network design		
Distribution system	Inventory location, picking location	Inventory aggregation, picking integration
Logistics facilities	Design of e-fulfilment centre (automation degree, layout), design of return centre	Traditional warehouse restructuring, role of store, store restructuring
Inventory and capacity management		
Assortment planning	Assortment overlapping	Assortment integration
Replenishment policy	Definition of stock level for online channel, integration of returns	Aggregation of stock levels, integration of control policies, inventory visibility, channels priorities
Delivery planning and execution		
Delivery service	Types of home delivery, velocity, time slot, price differentiation	Alternative delivery modes (Click&Collect, Click&Drive)
Shipment policy	Routing for home delivery	Joint delivery

Common features of a well-integrated omni-channel strategy should include highly integrated promotions, cross-channel product consistency, an integrated information sharing systems (Berman and Thelen, 2004). Pricing and inventory data should also be shared. It is allowed to pick up items purchased online from stores (Berman and Thelen, 2004). Leveraging the complementary advantages of online and offline shopping channels to the supply chain could increase the cost effectiveness of omni-channel supply chain and the responsive to customer needs (Chopra, 2018).

Mena et al. (2016) argue that there are seven dimensions regarding operations and design to identify omni-channel and explain how integration is implemented:

Inventory: OC manage integrated inventory in one warehouse solution.
Picking: Phase method are used in cross-channel picking.
Assortment: The number of Stock Keeping Units (SKUs) online is not limited.
Delivery: The delivery options are expanded through process integration.
Return: The return of goods is not coupled to the channel that it was bought from.
Organization: It uses a single integrated logistics with cross-channel coordination.
IT systems: It is based on a joint cross-channel real-time Enterprise Resource Planning (ERP) system.

In omni-channel retailing, customers and retailers could exchange product and information in different ways. Product fulfillment could be executed by customer pick-up and home delivery. There are also two information exchange methods that are face to face, in stores and shopping online. Therefore, Bell et al (2014) argue there are four alternatives for how omni-channel retailing could be categorized based on the different methods (Figure 2.2).

Figure 2. 2 The four alternatives for omni-channel retailing regarding information and product *(source: Bell et al., 2014, p.47)*

2.1.2 Omni-channel retailing drivers & barriers

There are various drivers and enablers for omni-channel retailing. The drivers include internet accessibility, well-designed distribution centers and logistics network, channel visibility, product digitization and cross-channel integration (Wilding, 2013).

Chopra in 2018 introduced four conceptions that could improve omni-channel retailing: customer preferences, experiential technologies, production technologies and transportation technologies. Convenience and instant gratification are two key dimensions of customer preference. While convenience refers to the customer's willingness to reduce environmental impact and related costs. Instant gratification is the time that customer will wait for a product (Chopra, 2018).

The development of mobile technology innovation such as smartphones could improve omni-channel retailing to get more consumers through offline and online channels. There are also some developing technologies that could develop a user-friendly shopping experience such as QR-bar code, online-payment system, social media application and big-data analytics (Ye et al., 2018). Ye et al. (2018) introduced some drivers that could improve omni-channel retailing such as enhancing customer service and market share. Ye divided these drivers into marketing related, supply chain related and organization management related (Table 2.3).

Table 2. 3 The summary of the drivers for omni-channel *(source: Ye et al., 2018, p.662)*

	Marketing related	**Supply chain related**	**Organization management related**
Drivers	Enhance customer service	Enhance supply chain efficiency and reduce operational cost	Improve business competitiveness
	Expand market share	Enhance supply chain traceability and scalability	Infuse business innovation
	Enhance product features		
	Enhance product promotion		

Some barriers exist in omni-channel retailing but the number of relevant research is limited. Some barriers are introduced by Ye et al. in 2018 that are shown in Table 2.4.

Table 2. 4 The summary of the barriers for omni-channel *(source: Ye et al., 2018, p.664)*

	Marketing related	**Supply chain related**	**Organization management related**
Barriers	Inability to differentiate product assortment between offline and online channel	Inability to develop a unified information system across different channels	Loss of competitive edge
	Lack of consistency in managing product lines and prices between offline and online channel	Inability to leverage an integrated supply chain process across different channels	Loss of shared vision and leadership

2.2 Warehouse operations

2.2.1 Key concepts of warehouse operations

Warehousing is defined as the points in a supply chain where product pauses with sorting, reorganizing and repackaging (Bartholdi and Hackman, 2010). Material flow buffering, products consolidation and value adding processes are the main functions of warehousing (Gu et al., 2007).

Warehousing operations could be divided to two processes that are inbound and outbound flows. The inbound process mainly includes receiving and put-away, while the outbound process consists of picking, packing and shipping. Return is also one process in warehousing (Bartholdi and Hackman, 2010). In term of warehousing design, there are six main parts being physical layout, storage equipment, handling equipment, automation solutions, information systems and labor activities (Kembro et al., 2018).

In the following chapter, warehousing operations and design will be introduced and explained in detail according to the framework (Figure 2.3) adapted from Kembro et al. (2018).

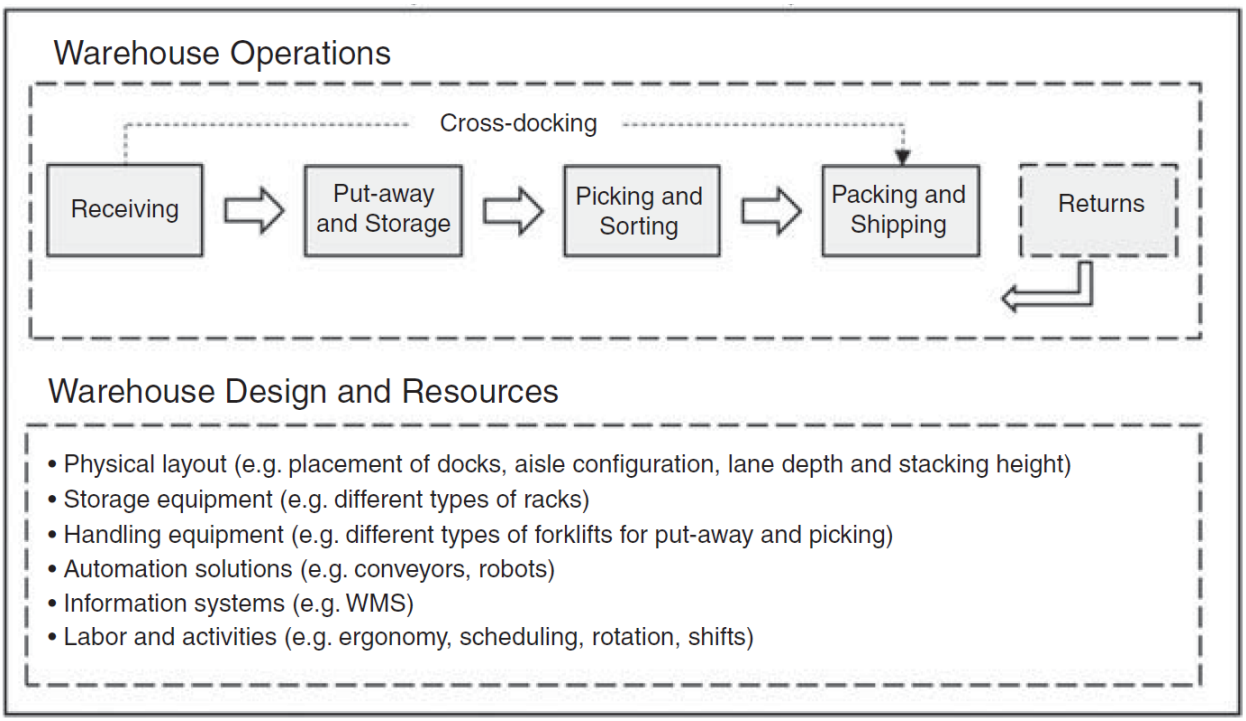


Figure 2. 3 Framework of warehousing operations and design *(source: Kembro et al.,2018)*

2.2.2 Receiving

Receiving is the first process in the warehouse operations that the arriving goods and items will encounter as an advance notification (Bartholdi and Hackman, 2010). The receiving process includes some activities such as unloading the products from the different transportation modes,

updating the inventory record and ensuring the arrival goods with right quantity and quality (de Koster et al., 2007). An assignment policy is usually used in the receiving process to allocate the trucks to docks and wait for transportation to the next process which is put-away (Rouwenhorst et al., 2000). Furthermore, in order to get ready for put-away it may be needed to break out mixed pallets into separate cartons or to palletize cartons (Bartholdi and Hackman, 2010).

2.2.3 Put-away and storage

The put-away process is the transfer of arrival goods to storage locations. This process may also include repackaging and physical movements (de Koster et al., 2007). The first step of put-away is determining the appropriate storage location. It is significant because the location of the products largely determines the time and cost for retrieving customer orders (Bartholdi and Hackman, 2010). Warehouse storage usually use forward-reserve allocation and department allocation. The allocation of goods could be done with a warehouse management system. The allocation depends on the storage assignment policies and the withdrawal principle such as First-In-First-Out (FIFO) or Last-In-First-Out (LIFO) (Gu et al., 2007).

2.2.4 Picking and sorting

Order picking is the process to retrieve goods from storage to a customer request. It is the most labor-intensive process in warehouses that often takes as much as 55% of the total warehouse operating expense (Bartholdi and Hackman, 2010). Therefore, the order picking process is considered as the highest priority area for improvements (de Koster et al., 2007). In more detail, travelling takes the most time and cost of the picking which is around half of the expense (Bartholdi and Hackman, 2010). De Koster in 2007 introduced the detail processes in picking: clustering and scheduling the customer orders, assigning stock on locations to order lines, releasing orders to the floor, picking the articles from storage locations and the disposal of the picked articles. The four common picking methods are single, batch, zone and wave picking. The selection of methods depends on the characteristics of the goods, such as demand, physical characteristics of items, unit loads, etc. For example, the product has large demand but small order size would prefer batch picking. Then the same batch items could be stored in the nearby location (Hassan, 2002).

2.2.5 Packing and shipping

In the packing and shipping process, orders are packed and shipped (Gu et al., 2007). The first step is to sort and merge the different order lines for the customers. Packing is labor-intensive because each order must be handled. Therefore the packing process is convenient to check whether the customer order is accurate or not. Order accuracy is not only a key measure of service to the customers, but the most businesses compete as well. Also, inaccurate orders will generate returns that are expensive to handle (Bartholdi and Hackman, 2010).

In the shipping process, the orders are checked and loaded in trucks, trains or any other carrier (Rouwenhorst et al., 2000). Shipping usually handles larger units than picking, because the

goods are into fewer containers in this process. It is very important to work hard to fill each container because staging freight will create more work (Bartholdi and Hackman, 2010).

2.2.6 Returns

The warehouses also need to handle returns which run around 5% in retail and 25-30% in e-commerce, therefore return is a major function in the warehouses supporting e-commerce (Bartholdi and Hackman, 2010). Most of the warehouses have the return stock. The volume of return stock varies in different warehouses. It is very important to eliminate any processing error to reduce the return stock. In order to provide the high quality of customer service, return stock should be re-shipped to clients and customers as soon as possible. Also all the items should be packed and shipped under good conditions. This will reduce the cost and time and also increase the service level from the warehouses (Ho et al, 2018).

2.3 Warehouse design

2.3.1 Physical layout

The layout plays an important role in the success of the warehouses. The most suitable warehouse layout depends on the conditions and characteristics (Hassan, 2002). It is not easy to select the best layout because there are many different factors that could influence warehouse operations such as placement of docks, aisle configuration, lane depth and stacking height (Bartholdi and Hackman, 2010).

There are two main dock locations that are called as flow-through configuration and U-shaped configuration (Huertas et al., 2007). In U shaped configuration (Figure 2.4), receiving and shipping are on the same side of the warehouse, so there are some very convenient locations and a few inconvenient locations. In the flow-through configuration, the positions of receiving and shipping are on the opposite sides of the warehouse. All goods flows are from one side to the other. Therefore, the convenience of all the storage locations in one aisle are the same. (Bartholdi and Hackman, 2010).

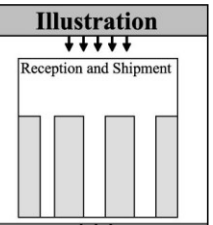
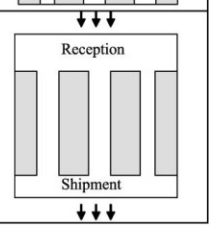
Name	Features	Illustration
U shaped (*cross-docking*)	▪ Docks for reception and shipment located on the same side. ▪ Makes more convenient positions even better, and the less convenient ones, worst. ▪ Appropriate for warehouses with a strong ABC classification. ▪ Allows a flexible use of docks and equipment (forklift).	
Flow-Through	▪ Docks for reception and shipment located on opposite sides. ▪ Makes many positions be equally convenient, and very few good positions be very convenient. ▪ Appropriate for handling high volume. ▪ Appropriate for long and narrow buildings. ▪ Reduces congestion and risk of error in picking.	

Figure 2. 4 Docks location configurations in warehouses *(source: Huertas et al., 2007, p.260)*

It is also very important to determine the number of aisles, their locations, orientation, length and width in designing a warehouse layout (Hassan, 2002). In order to reduce travel between storage and receiving or shipping, the aisles are usually parallel with the material flow. There are two main aisles layout called dual cycle and fishbone layout. In dual cycle layout, the operator could move directly to the next task. In fishbone layout, there could be more direct travel between storage and receiving/shipping location (Bartholdi and Hackman, 2010). The two aisles layout are shown in Figure 2.5 and Figure 2.6.

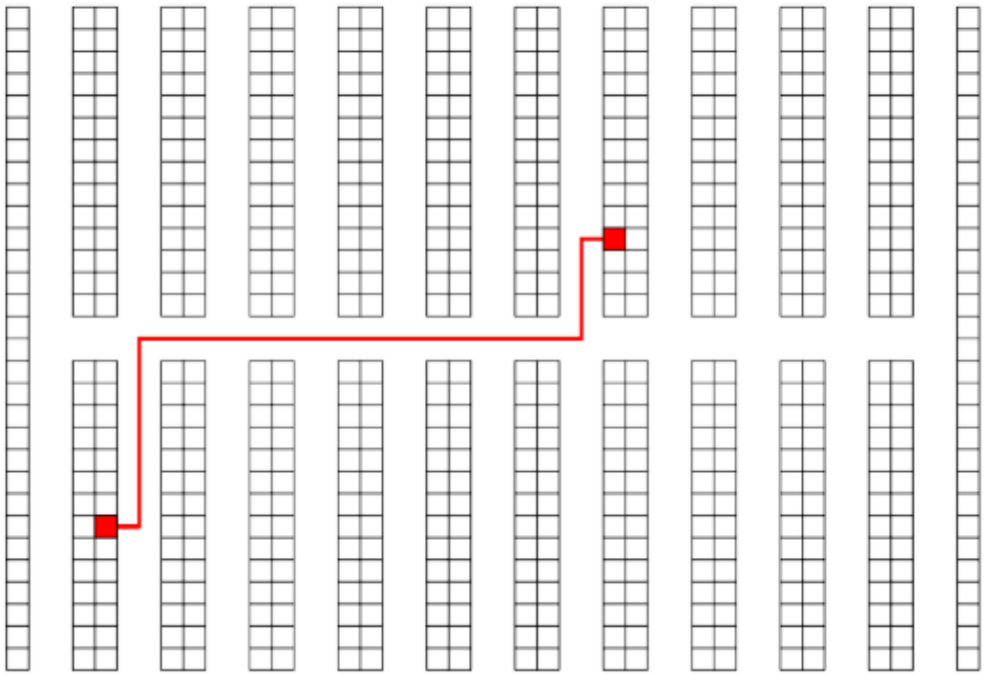


Figure 2. 5 The configuration of dual cycle layout *(source: Bartholdi and Hackman, 2010, p.56)*

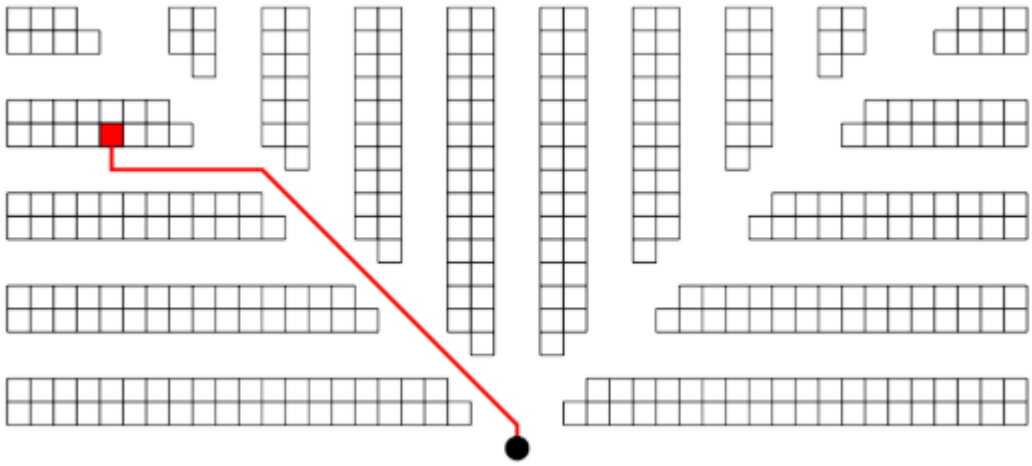


Figure 2. 6 The configuration of the fishbone layout *(source: Bartholdi and Hackman, 2010, p.56)*

Pallets stacked high could increase the utilization of the each storage location. Heavy or fragile goods are not able to be stacked high, so installing pallet racks could resolve this problem and avoid the waste. The stack height should be the configuration with the highest value after comparing different solutions (Bartholdi and Hackman, 2010).

Additional pallets could be stored in a same aisle by using lanes. The lanes of aisles could increase the utilization of space by creating more storage positions. However, the lanes could occur double handling, so there is a trade-off to decide the number of lanes of each aisle (Bartholdi and Hackman, 2010).

2.3.2 Storage and handling equipment

Many storage and handling equipment are designed to increase the space utilization and decrease the labor costs (Bartholdi and Hackman, 2010). There are different types of racks and forklifts used in warehouse operations for put-away and picking (Rouwenhorst et al., 2000).

In storage equipment, there are five main types of racks (Bartholdi and Hackman, 2010):

- Selective rack or single-deep rack: storing pallets one deep
- Double-deep rack: two single-deep racks
- Push-back rack: an extension of double deep rack
- Drive-In or drive-through rack: allowing lift trucks to drive within the rack frame
- Pallet flow rack: deep lane rack and lines with rollers

There are also some types of lift trucks that could be used for put-away and picking (Bartholdi and Hackman, 2010):

- Counterbalance lift truck: the most versatile type of lift truck
- Reach and double-reach lift truck: equipped with a reach mechanism allowing forks to extend
- Turret Truck: with a turret that could turn 90 degrees
- Stacker crane within an Automated storage and retrieval systems (AS/RS): designed to load up to 100 feet high for AS/RS

2.3.3 Automation solutions

Automation is commonly used in large warehouses. The automation solutions such as conveyor, sortation, and automated storage and retrieval systems (AS/RS), are being used in most large warehouses (Baker & Halim, 2007).

Conveyors is commonly used as an automation solution. There are some characteristics of conveyors (Bartholdi and Hackman, 2010):

- The storage locations close to conveyors are also closed to shipping area.
- Conveyors should run as fast as possible.
- Conveyable product should be stored far from shipping area.

Automated storage and retrieval systems (AS/RS) and automated guided vehicles (AGVs) are also designed and used to produce movement and storage without any operators. As a summary, automation solutions could increase service level and reduce the labor cost (Baker & Halim, 2007).

2.3.4 Warehouse management system

Warehouse Management System is a software that companies use to control material from the time it enters a warehouse until it leaves and can create a solid foundation for enterprises to operate (Chen et al., 2017). Physical dimensions and SKU characteristics should be reviewed by the WMS to assess optimal storage policy (Murray, 2018). Faber et al. (2002) argue that the more complex, i.e. order line per day and SKUs, a warehouse is, the higher the need for tailor made and complex WMS solutions (Table 2.5). In summary, the Warehouse Management System is a database of SKUs and stock system. The managers could use WMS to manage both the inventory of goods and the inventory of storage locations (Bartholdi and Hackman, 2010).

Table 2. 5 Comparing warehouse characteristics *(source: Faber et al., 2002).*

W/H characteristics	**Type of WMS**	**Functionalities**	**Flow focus**
Few SKUs and order lines	Basic WMS	Stock and location control.	Operationalize flows.
	Advanced WMS	Plan resources, activities and synchronize flows.	Analyses flows.
Many SKUs and order lines (~10 000)	Complex WMS	Specific and exact location information and tracking. Strategizes storage and replenishment.	Optimizes flows.

More than managing the warehouse, the integration with transport management systems is essential to provide “seamless logistics visibility”, which arguably increase the logistics performance (Napolitano, 2012).

2.3.5 Labor and activities

Labor takes around 50% of warehouse operation costs, so it is very important to plan labor to increase the labor efficiency (Bartholdi and Hackman, 2010).

Labor planning consists of three components that are forecasting labor requirements, predicting future labor supply and coordinating demand differences. The labor requirements sometime fluctuate. Therefore, there are four mechanisms that could be used to deal with fluctuation: the

types of contracts, flexible planning with fixed contracts, job rotation and workload balancing (De Leeuw and Wiers, 2015).

Kim, T. Y. in 2018 introduced a flow diagram (Figure 2.7) combining data, models and activities to create a data-driven labor planning. De Leeuw and Wiers (2015) present four strategies that could be used in labor planning flexible contracts, flexible planning, job rotation and workload balancing.

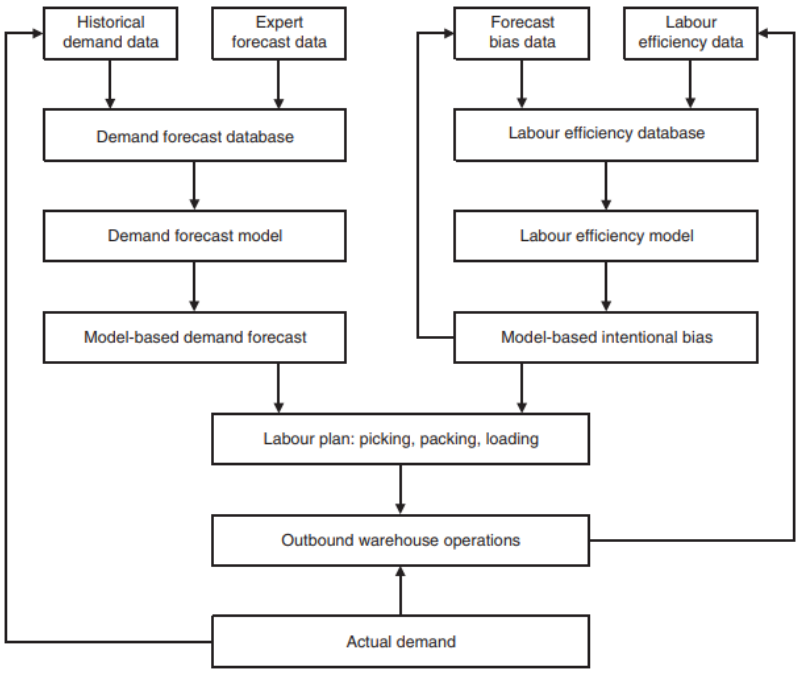


Figure 2. 7 Flow diagram of warehouse data, models, activities, and management *(source: Kim T. Y, 2018, p.94)*

2.4 Omni-channel warehousing

Kembro et al. (2018) proposed that warehousing is essential to omni-channel logistics, however, the available literature of omni-channel warehousing is limited. One of the research gaps is to investigate the warehousing configurations in a different context when companies adapting omni-channel. The term “configuration” represents the combination of operations, design aspects, and resources in a warehouse. There are some researches that already find the effect of contextual factors on configuration elements. For instance, web customers usually require shorter lead times from order to delivery, and thus warehouse needs faster throughput times to fulfill the requirement (Marchet et al., 2018). The order size also differs from store orders and web orders, which may require integration for time- and cost- efficient warehousing operations (Kembro et al., 2018). In another context, reducing warehousing costs become popular among retailers because of serious competition (Hübner et al., 2016). There is an increasing complexity when transforming to omni-channel, which needs a proper design of the distribution network for higher accessibility and lower cost (Kembro et al., 2018). These effects in a way become

challenges to companies in their omni-channel logistics. Kembro and Norrman (2019) identified four major challenges of omni-channel warehouse's configuration, including larger assortment, limited warehouse space, time and cost pressure, large quantity but different shipment.

Norrman and Kembro (2019) then analyze five main dimensions of omni-channel warehousing of six Swedish companies： (1) type of network and handling hubs and (2) degree of automation; the decision to integrate or separate (3) storage zones and (4) picking processes; and (5) the choice of picking method. They then connect the configuration practices with contextual factors.

2.4.1 Degree of automation and type of network structure

Companies that adopt automation solutions normally aim to handle materials more efficient and effective in their warehouse. In omni-channel logistics, there is a trend to integrate various systems across the omni-channel for real-time order and inventory control. Because of the increasing amount of web orders, sorting is extremely important for handling a large number of orders with various orderliness. Standardized packaging is essential in automation, where the use of same packages make it easier to handle and store products (Kembro and Norrman, 2019).

Norrman and Kembro (2019) first analyze the influence of network structure and automation (Figure 2.8). The Figure illustrates the current and future status of the companies regarding their situation of network structure for web orders and the degree of automation. It shows that all cases have a trend of increasing automation. In all cases, the automation is mostly used for the small and more standardized product. Regarding the operation process, storage, picking, sorting, and packing is often automated while receiving and return are manually handled. For the network structure, their studied cases had the trend to increase the drop shipment or more handling nodes closer to customers.

The relative contextual factors are then analyzed for their effect on automation and network structure. For automation, *Turnover, Goods size, Workforce shortage and cost* were found most important[4]. Their observation proposes that the degree of automation depends mainly on (horizontal arrows in Figure 2.8) the *turnover, number of transactions, suitability of products (small size), degree of standardized packaging for automation, level of master data possible to capture,* and *demand variability*. *Labor costs and availability* relative to investment cost, and *national legislation for automation* (e.g. ergonomic aspects) might be important but as all cases were in the same context (Norrman and Kembro, 2019) they could not find differences.

[4] The square boxes below an arrow represent the perceived current points of different companies related to one contextual factor.

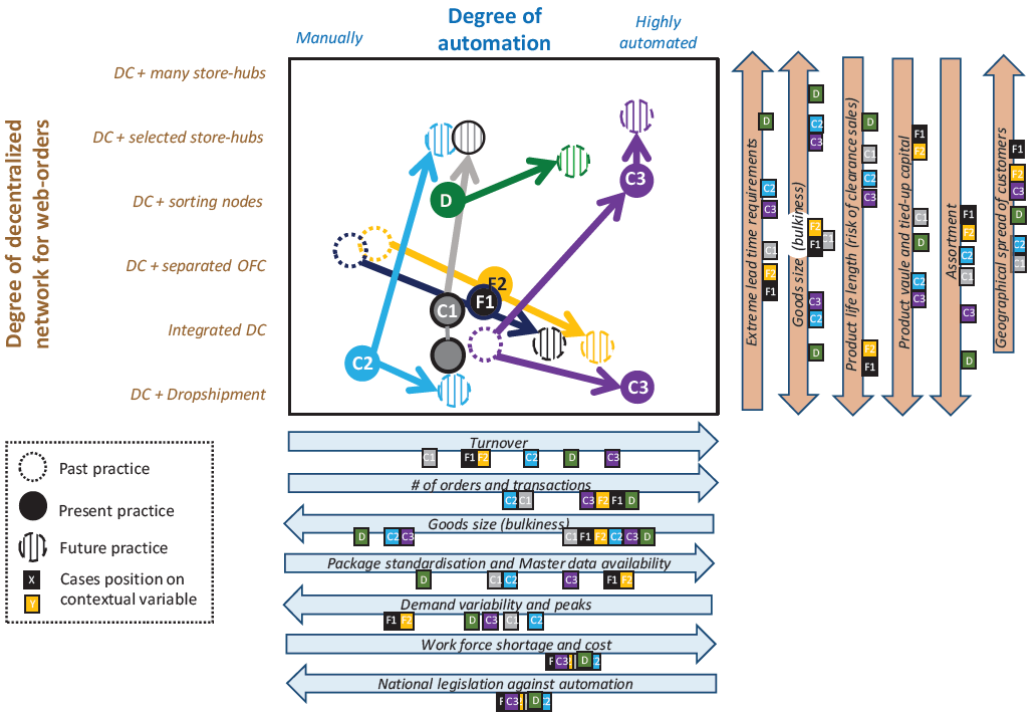


Figure 2. 8 Analysis of contextual factors that influence network structure and automation, respectively *(source: Norrman and Kembro, 2019)*

Grocery retailing logistics are sometimes argued to be different from some other sectors, such as fashion and consumer electronics (Eriksson et al., 2019). Some characteristics are that grocery products normally have low margins but a large category. Besides, some products may have requirements in temperature or perishable. These requirements may lead to different strategies in warehousing operations and design, such as picking and delivery. In addition, grocery sector has different order characteristics such as large amount of orders and small total volume per order. Thus, there is a trend toward establishing Online Fulfillment Center (OFC) separate from traditional Distribution Center (DC), because of the increasing different requirement come from demand patterns, order structure and customer expectations (Eriksson et al., 2019).

According to Eriksson et al. (2019), there are nine identified contextual factors influence the configuration of OFC operation (figure 2.9). To illustrate, customer, product and order characteristic, order volume are the external contextual factors. Besides, shipping route optimization and picking strategies also influence the internal OFC of a grocery retailer.

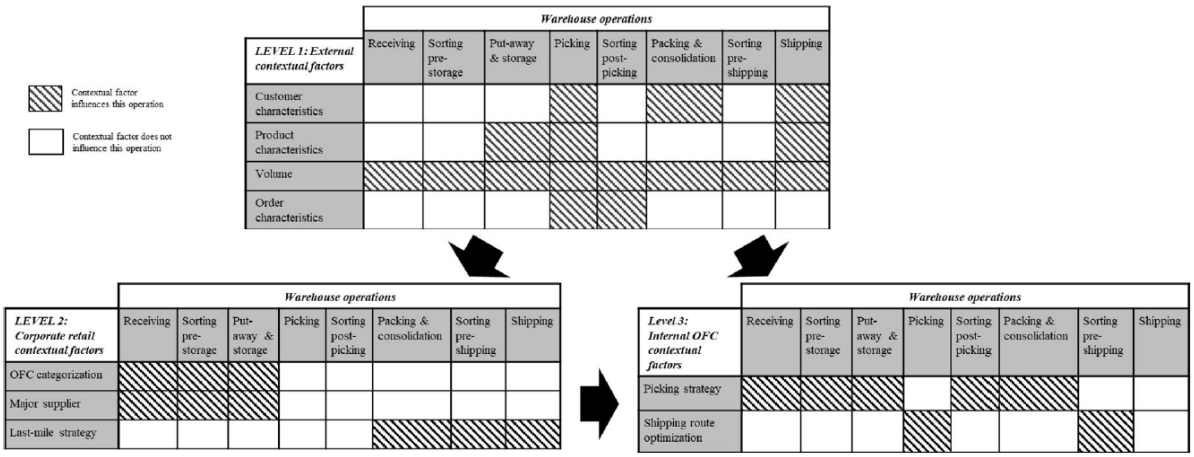


Figure 2. 9 Contextual factors influencing the configuration of OFC operations *(source: Eriksson et al., 2019)*

2.4.2 Integration and separation

Lack of space is an increasing issue in omni-channel warehousing because of the characteristic of web orders such as increasing order numbers, larger product range, and uncertain demand fluctuation. To solve this problem, integrating storage for store replenishment and web orders is one choice. However, the integration of storage may also influence the choice of picking method. In the study of Norrman and Kembro (2019), the studied cases have the trend of becoming more integrated from separated in storage zones and picking zones (Figure 2.10 shows this trend of F1, F2 and D).

According to their analysis, the contextual factors that drive toward more integrated zones are *lead-time requirements, assortment and product value*. Integrated storage can reduce distances and processes to fulfill the short lead time requirement. Besides, it also requires less stock and can cut tied-up capital. The integrating picking processes correlates with *similarity of SKU- and order characteristics, the capability of automated sorting and WMS systems, and higher degree of click-and-collect* (Kembro et al., 2019).

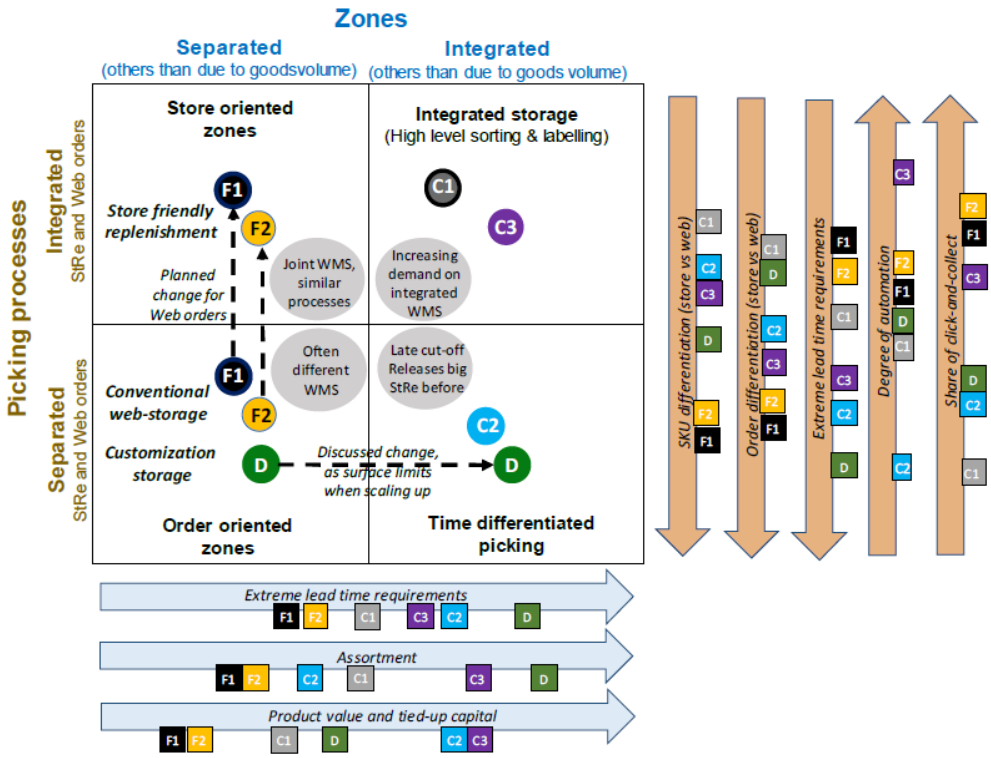


Figure 2. 10 Example of context analysis: Alternatives for separating or integrating picking processes *(source: Norrman and Kembro, 2019)*

2.4.3 Picking strategies

To fulfill the demands of rapid flows and lead time requirements, picking strategies become extremely important. It is critical that a good picking process could avoid bottleneck and enable more efficient flows. In the study of Norrman and Kembro (2019), the picking strategy of web orders is mostly batch picking. The store replenishment orders use either batch picking or single order picking depending on the goods size and the number of stores. Normally, the picker can pick fewer items and orders at the same time for the larger goods size. The product with large size or the orders with a large volume of products to larger stores prefer single order picking. In some of the studied cases, companies extract goods, when there are accumulated demand of an item (100-300) from both store and web orders the picker would pick them simultaneously. Then these products would be sorted. Thus, there are a large amount of same one-order-line orders and sorting and packing are postponed in the warehouse, but without creating a bottleneck.

Figure 2.11 tells the case findings that the choice of picking method is driven by multiple contextual factors including *lead-time requirements, goods size and differentiation,* variation in *order characteristics* as well as *the degree of automation* (Norrman and Kembro, 2019).

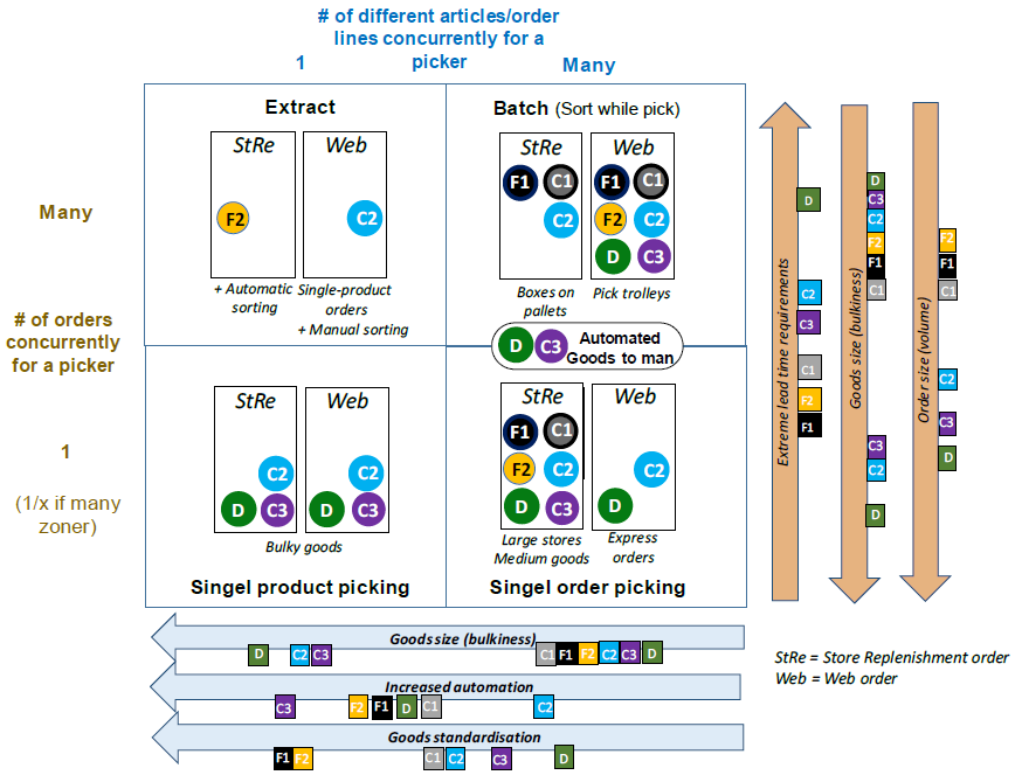


Figure 2. 11 Example of context analysis: Contextual factors that influence picking methods *(source: Norrman and Kembro, 2019)*

2.4.4 General Profile

According to several contextual factors, Norrman and Kembro (2019) also conclude four general profiles of the six case companies and transform them into a visual mapping (Figure 2.12), which could tell which contextual factors are more important to a kind of retailer, and how are they different from each other. For example, product value is the most important factor to the yellow retailer profile, driving them to reducing tied-up capital. However, for blue and black retailer profiles with limited product value, other strategic logistics goals are more important. The omni-channel retailers have four directions in logistics goals (Figure 2.12), including *shorten lead times, increase flexibility, simplifying the complexity of material handling, reduce tied-up capital* and *economies of scale.* The retailers that focus on shorten lead times have fast flows in warehouse operation, where they shorten the internal lead times as much as possible. Second, the retailers that want to increase flexibility configure warehouse vary their capacity with demand fluctuations. Third, the retailers with large numbers of orders and transactions aim at simplifying the complexity of material handling for example by separation and standardization. Fourth, the retailers with high value products and wide assortment range focus on reducing tied-up capital by integrating storage or increasing the use of drop shipment. Fifth, the retailers focus on economy of scale invest a lot in automation to receive a certain level of turnover and number of transactions.

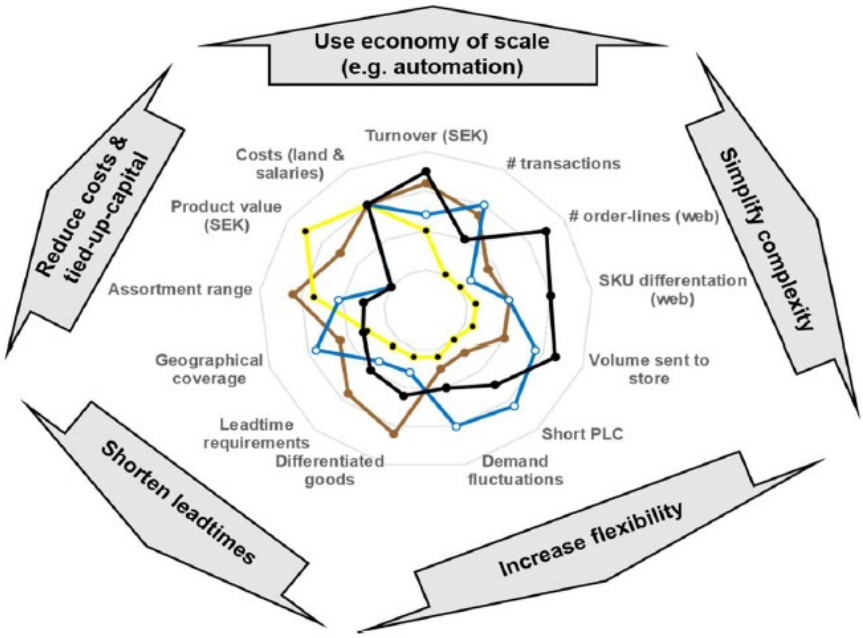


Figure 2. 12 Illustrative retailer profiles and strategic logistics goals for different profiles *(source: Norrman and Kembro, 2019)*

2.5 Summary

Omni-channel retail is defined as connecting customers and fulfilling orders using different channels (Chopra, 2018). A well-integrated omni-channel retailing should have some common features such as highly integrated promotions, cross-channel product consistency, and an integrated information sharing system (Berman and Thelen, 2004).

Warehousing is defined as a point in the supply chain that could provide the functions including logistics buffering, product integration and value-added processes (Gu et al., 2007). There are two main processes in the warehousing operations that are inbound and outbound processes. The warehousing inbound process mainly includes receiving, receiving and outbound processes, including picking, packing and shipping. Return is also an important process in warehousing operations, even though it is not included in inbound and outbound processes (Bartholdi and Hackman, 2010).

The layout also plays an important role in the warehouse. The layout should be designed based on the conditions and product characteristics (Hassan, 2002). Handling equipment is designed and widely used to increase operating efficiency and space utilization (Bartholdi and Hackman, 2010). In order to control materials from entering the warehouse until it leaves and monitor the condition of the warehouse, WMS is used most companies' warehouses (Chen et al., 2017).

Omni-channel warehousing is finding challenging in larger assortment, limited warehouse space, time and cost pressure, large quantity but different shipment. There are several

contextual factors which influence different configuration elements, such as automation, storage and picking. The development in omni-channel warehousing in grocery sector investigated seems sometimes different from other sectors (Eriksson *et al., 2019;* Norrman and Kembro, 2019; Kembro et al., 2018). With the findings of nine identified contextual factors that influence the configuration of OFC operation. With differences in contextual factors, different retailers have different logistics goals such as shorten lead times, reduce tied-up capital, and increase flexibility (Norrman and Kembro, 2019).

The investigation model (Figure 3.5) adopts a similar framework to the theoretical part, especially the cross-case analysis regarding the part of findings of omni-channel warehousing.

3. Methodology

This chapter discussed how the research is undertaken, including the understanding of research philosophy, selection of research approaches and strategies, and elements of research design. Besides the specific process of doing case study is discussed in details, such as research design, data collection method, data analysis tools and testing quality of research.

3.1 Introduction

Data collection techniques and analysis procedures are important to a research method. What is needed to think about, for example, includes designing a questionnaire, conducting an interview etc. However, according to the research onion model by Saunders et al. (2009), before carrying out these steps, which is called the center of the onion, the outside layers should be understood as well (Figure 3.1). The structure of research includes philosophies, approaches, strategies, choices, time horizons, techniques and procedures. In this study, the used theories will be discussed by each layer in the following chapters.

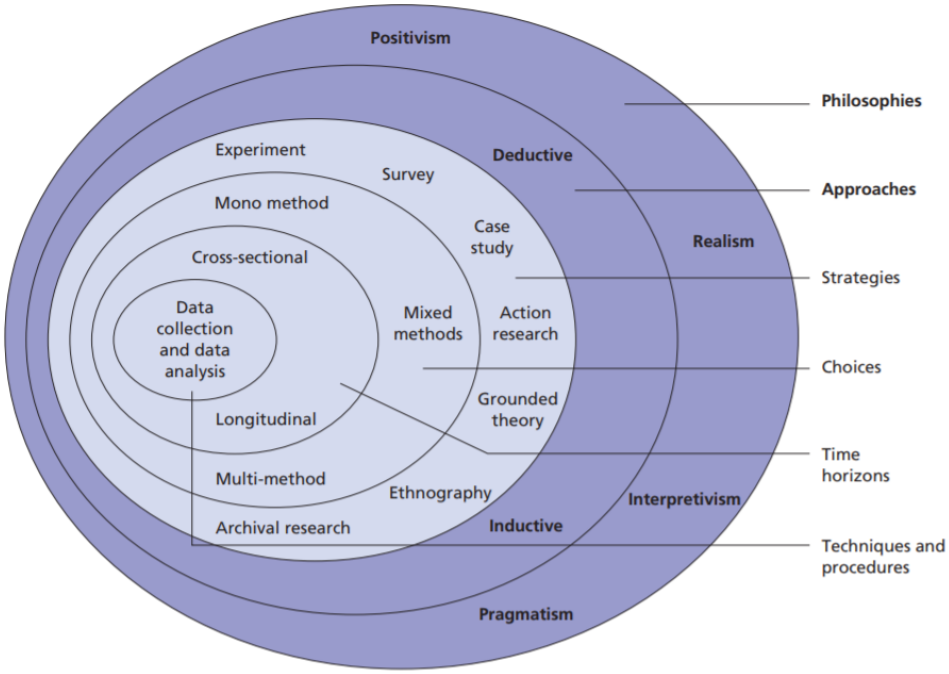


Figure 3. 1 The research "onion" *(source: Saunders et al., 2009, p.139)*

3.2 Research philosophy in logistics

Research philosophy refers to the development and the nature of knowledge. It contains assumptions about the way people view the world and provides the foundation of choosing the right research strategy to understand what to do and what to investigate in research. Positivism, realism, interpretivism, pragmatism are four major research philosophies in management research concluded by Saunders et al. (2009). Practical situations may influence the adopted

philosophy, but the main element may be the view of the relationship between knowledge and its development. A better understanding of the philosophical position helps to understand how to approach the study field. Then the question of philosophy become a question of qualitative or quantitative. The below Table 3.1 shows the suggested data collection method by different philosophies by Saunders et al. (2009).

Table 3. 1 Research philosophies and data collection method *(source: Saunders et al., 2009, p.150)*

	Positivism	**Realism**	**Interpretivism**	**Pragmatism**
Data collection techniques most often used	Highly structured, large samples, measurement, quantitative, but can use qualitative	Methods chosen must fit the subject matter, quantitative or qualitative	Small samples, in-depth investigations, qualitative	Mixed or multiple method designs, quantitative and qualitative

Arbnor and Bjerke (2009) also proposed a methodological framework with three approaches that can be used to better understand the research philosophy in logistics discipline (Gammelgaard, 2003). The three approaches are: (1) the analytical approach, (2) the systems approach, (3) the actors approach. The three approaches have different ideas on reality:

- The analytical approach
  The analytical approach is related to the philosophy of positivism. It is based on the assumption of factive reality, where it requires to discover the invariant elements in the changing environment and variations. The researcher must stay out of the subject and avoid interacting with the subject, so as not to distort the reality that the subject is trying to reveal. The approach to reality is to decompose reality into the smallest possible elements.

- The systems approach:
  The systems approach based on systems theory, where the world is interdependent with its parts, links, goals and feedback and reality is more meaningful than its parts. It is a holistic approach that aims to find practice solutions to the problem.

- The actors approach
  Based on sociological meta-theories, in the actors approach reality is considered as the result of various social construction, which is not objective. The researcher is part of the research reality.

According to three different approaches, their relative theory, method and analysis preference are listed in below Table 3.2, which could be a reference to the appropriate method for the chosen philosophy.

Table 3. 2 The difference of three approaches *(source: Gammelgaard, 2003)*

	Analytical approach	**Systems approach**	**Actors approach**
Theory type	Determining cause-effect relations. Explanation, predictions. Universal, time and value-free laws	Models. Recommendations, normative aspects. Knowledge about concrete systems	Interpretations, understanding. Contextual knowledge
Preferred method	Quantitative (qualitative research only for validation)	Case studies (qualitative and quantitative)	Qualitative
Unit of analysis	Concepts and their relations	Systems: links, feedback mechanisms and boundaries	People – and their interaction
Data analysis	Description, hypothesis testing	Mapping, modeling	Interpretation
Position of the researcher	Outside	Preferably outside	Inside – as part of the process

In this thesis, the systems approach is identified as the main philosophy. The thesis looks at the omni-channel logistics system in warehousing from a holistic perspective. There is more value to a logistics system than its subsystem or actors apart. From the suggested methods for systems approach, the thesis will focus on the links, feedback mechanisms and boundaries of the omni-channel logistics system. And use the method of case study qualitatively.

3.3 Research approach

Deductive and inductive approaches are the two main research approaches. In the deductive approach, researchers often develop theories and or hypotheses and then testing the hypotheses by a designed research strategy. While in the inductive approaches, researchers prefer to collect data first and then build a theory after analyzing the data. Whether to use the deductive approach or the inductive approach depends on the character of the research topic and what the author tend to focus on. Some topics have a large amount of literature that can propose and test the hypothesis, some are a new field that inductive work is well suited. In addition to induction and deduction, there is a third method some research may use, the abduction approach (Peirce et al., 1998). Abduction involves placing a single (often surprising)

case in a general mode of hypothesis that, if true, would explain the case. But new observations or cases should be investigated to support this explanation.

Before designing a proper strategy, it is important to clear the research purpose. It can be classified into three kinds, including exploratory, descriptive and explanatory. A research project may stick on one purpose or have more than one, because the purpose may change over time.

- Exploratory research
  Exploratory research aims 'to find what is happening, especially when it is little known; to seek new insights; to ask questions and to assess phenomena in a new light' (Robson 2002:59). It can be used to generate ideas and hypothesis for future research. There are three main ways of conducting exploratory research, including searching literature, interviewing 'experts' in the subject and conducting focus group interviews. Its greatest advantages are flexibility and adaptability to change.

- Descriptive research
  Descriptive research objects 'to portray an accurate profile of persons, events or situations' (Robson 2002:59). The research can be flexible and/ or fixed. However, it needs a clear knowledge of the situation to gather appropriate information. To distinguish from explanatory research, the description should be the method to the goal but not the goal itself.

- Explanatory research
  The object of explanatory research is 'to explain patterns relating to the phenomenon being researched; to identify relationships between aspects of the phenomenon' (Robson 2002:60). The form of the explanatory research not only includes causation, all kinds of explanation to the problem or situation makes sense.

In this thesis, the field of omni-channel warehousing is quite new. As the introduction part describe, there are only 57 related literatures to generate mature theories or hypotheses. However, the investigation of this thesis is based on the similar research of omni-channel warehousing done in Sweden. Thus, this article aims to be part of an abductive approach. Since it illustrates some findings of omni-channel logistics in Sweden, the authors will seek new insights in China and find out what is happening in warehouse operation and design of the companies' omni-channel logistics. Thus, it is descriptive research because it aims to find the accurate situation of Chinese omni-channel logistics based on the existing findings in Sweden.

3.4 Research strategy and choice

The choice of the research strategy is decided by the research question(s) and objectives, the extent of existing knowledge, the amount of time and other resources that are available, as well as authors' philosophical foundation (Saunders et al., 2009). Yin (2003) also proposed three conditions to be considered when choosing a right strategy: (1) the type of research question posted, (2) the extent of control an investigator has over actual behavioral events, and (3) the

degree of focus on contemporary as opposed to historical events. According to these three aspects, there is a list (Table 3.3) with five main research strategies, showing their differences and similarities.

Table 3. 3 Relevant situations for different research strategies *(source: Yin, 2003, P.5)*

Strategy	**Form of Research Question?**	**Requires Control of Behavioral Events?**	**Focuses on Contemporary Events?**
Experiment	how, why?	Yes	Yes
Survey	who, what, where, how many, how much?	No	Yes
Archival analysis	who, what, where, how many, how much?	No	Yes/No
History	how, why?	No	No
Case study	how, why?	No	Yes

The research choice should be influenced by considerations about data collection techniques and analysis procedures. Qualitative or quantitative is one way to differentiate. Quantitative is predominantly used as a synonym for any data collection technique (such as a questionnaire) or data analysis procedure (such as graphs or statistics) that generates or uses numerical data. In contrast, qualitative is used predominantly as a synonym for any data collection technique (such as an interview) or data analysis procedure (such as categorizing data) that generates or use non-numerical data. Qualitative therefore can refer to data other than words, such as pictures and video clips (Saunders et al., 2009). Thus, according to the research choices framework in Figure 3.2 from Saunders et al. (2009), there is Table 3.4 for each method concept. However, these strategies are not mutually exclusive.

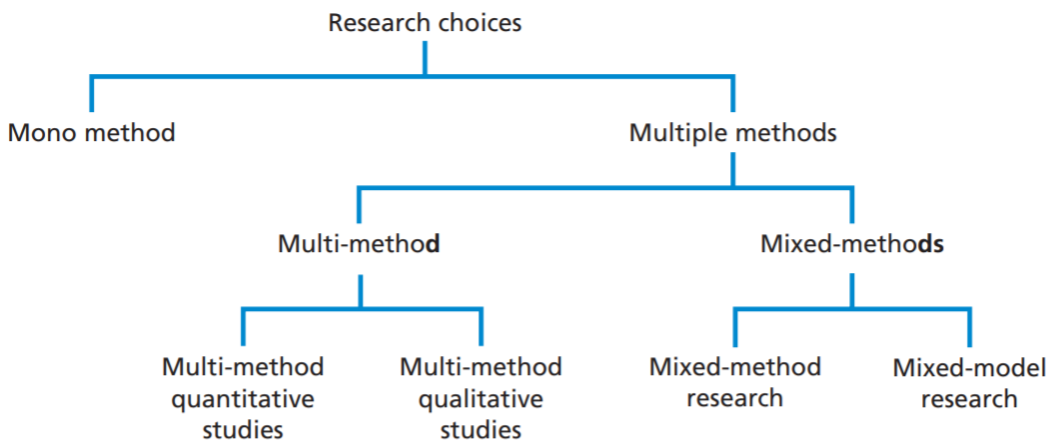


Figure 3. 2 Research choices *(source: Saunders et al., 2009, p. 183)*

Table 3. 4 The concept of each method of research *(source: Saunders et al., 2009)*

	Definition
Mono method	use a single data collection technique and corresponding analysis procedures
Multiple methods	use more than one data collection technique and analysis procedures
Multi-method	Combinations where more than one data collection technique is used with associated analysis techniques, but this is restricted within either a quantitative or qualitative world view
Multi-method quantitative studies	In quantitative view
Multi-method qualitative studies	In qualitative view
Mixed-method	when both quantitative and qualitative data collection techniques and analysis procedures are used in a research design
Mixed-method research	uses quantitative and qualitative data collection techniques and analysis procedures either at the same time (parallel) or one after the other (sequential) but does not combine them
Mixed-model research	combines quantitative and qualitative data collection techniques and analysis procedures as well as combining quantitative and qualitative approaches at other phases of the research such as research question generation.

For this thesis, the research question of “what” is going to be investigated, and to know “how” the system is developed, multiple case studies with interview and observation are conducted.

Qualitative data collection technique is used, for example structured interview. Besides, the analysis procedure is parallel. Thus, this thesis is identified as multi-method qualitative research.

3.5 Research design

According to the above selecting method and the nature of this thesis, the case study is recognized as the main method of this thesis research, although it ended up more in an interview study. To design the case study, which is a difficult part of doing a case study. Referring to the process of case study research by Yin (2003) (Figure 3.3), there are several sub steps in the phase of design which helps to design more rigorous and methodological studies.

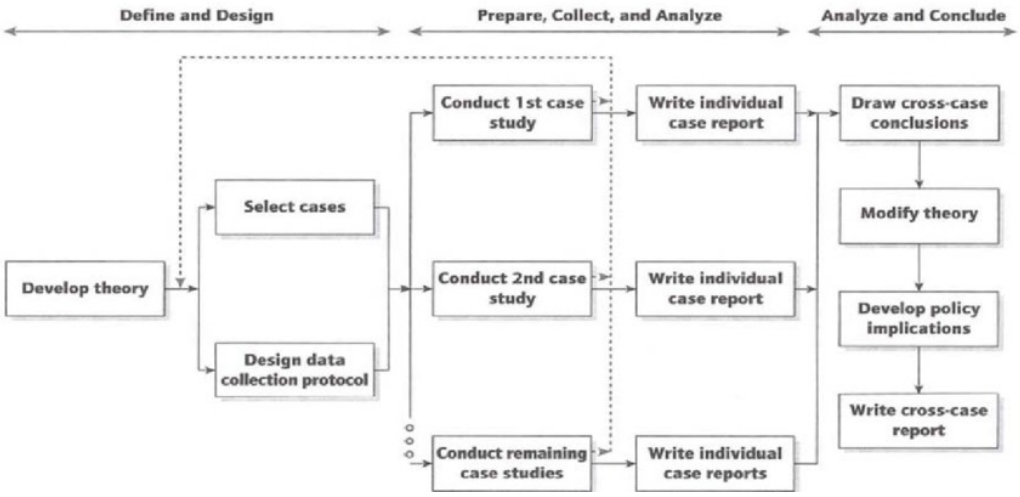


Figure 3. 3 The multi-case study method. *(source: Yin, 2003, p. 50)*

3.5.1 Unit of analysis and time horizon

The unit of analysis related to the fundamental problem of defining what the case is and how the initial research question is defined. It is crucial to tell the case studies of neighborhoods apart from case studies of small groups. If researchers want to compare their findings with previous research, the previous literature could be the reference to define the case and unit of analysis (Yin, 2003).

In this thesis, the primary units of analysis were the *retailers' experience and challenges for warehousing and material handling practices in Chinese omni-channel retailing*. The secondary units of analysis were *the configuration elements warehousing* themselves.

Cross-sectional and longitudinal are two perspectives of time horizon in planning research. Cross-sectional research studies the particular phenomenon at a particular time, while

longitudinal research study change and development. Time horizon to research design is independent of the choice of the research strategy and its method (Saunders et al., 2009). Yin (2003) also emphasize the importance of defining the specific time boundaries at the beginning and end of the case. For this thesis, the time horizon is cross sectional.

3.5.2 Theory development

Before conducting data collection, understanding what is being studied (or theory) is essential. No matter the purpose is to develop a theory or test a theory. The complete research design including the questions, propositions, unit of analysis, logic connecting data to propositions, and criteria for interpreting the findings, embodies the theory of what is being studied. However, theory development is difficult and time-consuming. For exploratory case studies with poor literature knowledge, there are three statements should be preceded: (1) what is to be explored (2) the purpose of the exploration (3) the criteria by which the exploration will be judged successful. Thus, researchers should review the related literature to the study field, discuss with colleagues and professors, and challenge the three statements of the study field. Besides, theory development generalizes the results of the case study (Yin, 2003).

The theoretical framework (Figure 2.1) in this thesis is built mainly by omni-channel theory and warehouse operation and design theory. The contents of the theoretical framework were mainly found in published books, scientific journals, and articles subjected to peer reviews. EBSCOhost was used as a search engine and keywords such as *omni-channel, omni-channel logistics, warehouse operations, warehouse design, etc.* The literature on omni-channel logistics has been around for many years, while the literature on omni-channel logistics in warehouse is a fairly new concept and a buzzword. The authors conducted the literature review for the related theory as above chapters conclude.

3.5.3 Case selection

There are four basic types of case studies in terms of the unit of analysis and case number, as shown in below matrix figure 3.4.

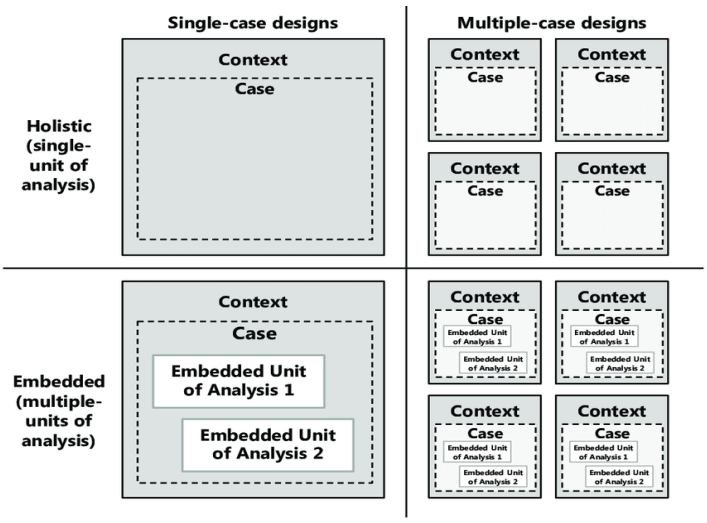


Figure 3. 4 Basic types of designs for case studies *(source: Yin, 2003, p. 40)*

Single- versus multiple-case design

Yin (2003) consider single- and multiple-case studies as different forms of the same methodological framework, which has no broad distinction. There are five rationales for conducting a single-case study: representing the critical case in testing a well-formulated theory; representing an extreme case or a unique case, the representative or typical case; revelatory case; and longitudinal case. However, careful investigation of single-case study is required to avoid the misrepresentation and improving access to collect evidence.

In contrast, multiple-case studies also have pros and cons. Multiple-case studies usually have more compelling evidence and therefore are more robust, while the rationale of single-case studies usually cannot meet the requirements of multiple-case studies. However, multiple-case studies sometimes require extensive resources and time. When deciding whether to choose multiple-case, replication logic but not sampling logic is a major insight. And Yin (2003) suggest multiple-case studies to be preferred for the substantial analytic benefits if both method can achieve the aiming final result.

Holistic versus embedded case studies

Holistic design refers to a case study with only examining of an organization or a program. Embedded case studies, in contrast, are with various samples or cluster techniques. A case study may have more than one unit of analysis, in a single-case study that is when there are subunits. In multiple-case studies, each individual case may be holistic or embedded, which depends on the research questions and the type of the phenomenon being studied. In embedded design, each individual case study may include the collection and analysis of highly quantitative data, including the use of surveys within each case.

In this thesis, with more than one investigated industries and companies, embedded multiple-case studies are identified. A summary of the four cases selected with regards to the established selection criteria is presented in Table 3.5.

Table 3. 5 General information of case company

Case company	Company A	Company B	Company C	Company D
Retail sector	Consumer electronics	Supermarket	Furniture	Maternal and child household products
Sales turnover (in China)	SEK 55.5 billion	SEK 14.3 billion	SEK 20.8 billion	SEK 0.57 billion
Geographical scope	International	China	International	China
# Phys. Stores (in China)	20,000	408	26	398
Part on-line sales	30%	<10%	10%	75%
Interview total duration	2.5 hours	1 hour	2 hours	1 hour
Interview method	By phone	By phone	By phone	In person
Titles of the informants	Logistics manager	Logistics manager	Supply chain specialist	Logistics specialist

3.6 The case study protocol

The case study protocol is a major way of increasing the reliability in any kind of case study research, especially essential for doing multiple-case studies. The only difference of protocol from a survey is that the protocol only collects data from either a single-case study or a single respondent. The protocol contains instrument, procedures and general rules, but is entirely different from an instrument. The funnel model is the most common tool, starting with broad and open-ended questions, and progressing with more specific and detailed questions (Voss et al., 2002). A case study protocol should have following components: an overview of the case study project, field procedures, case study questions, a guide for the case study report (Yin, 2009). In this thesis the protocol certainly follows these procedures. A pilot case study also needs to be conducted, which is a good way to refine your data collection plans. A pilot case study can also help about the content of the data and also the procedures to be followed (Yin, 2009).

In this thesis, the author developed the interview guide first in English and then translate to Chinese for preparing interview (see Appendix 1 & 2). The whole chapter 3 is considered as the part of study protocol so as the interview guide. The interview questions are built with referring to the model by Norrman and Kembro (2019). The pilot test is conducted with a manager in e-

commerce company who is experienced in omni-channel retailing to exam the logic fluency of interview questions.

3.7 Conducting case studies

In case research, there are two common way to collect data: the data from interview, documents provided by companies. As triangulation is essential for collecting data, it is better to use different methods for the same phenomenon (Ellram, 1996). Thus, for this thesis in-depth interviews with prepared interview guide is the main method for data collection.

- Interview
  In order to generate pattern of case studies, there were four interviews of four companies conducted. Because of the limitation of location there was only one face-to-face interview and three phone interviews. And each interview was done by only one author, and another author helped with reviewing the notes. Before all the interview, an interview guide was built with specific questionnaire, and it was sent to the interviewee for preparation. Besides, a pilot test was conducted by one manager in an e-commerce company to increase the research reliability. During the interview, the author followed the line of inquiry and asked actual questions. These are needed manner to decrease the biases (Yin, 2003). Meanwhile, the recorder by Apple phone was used to facilitate the transcribing of the data material during the face-to-face interview and the recording function within Apple phone was used in phone interview. Finally, the google translate will also use to help transcription. After each company report was generate, the report was sent to the interviewee to approval.

- Documents
  The companies also will provide secondary information such as annual reports, introduction powerpoint, etc. for supplement data.

3.8 Analysis of empirical data

When analyzing data, to conclude the learning and precisely express the learnings takes time and effort (Van Maanen, 1987). In order to generate high-quality learnings, there are two suggested steps to do in a case study analysis: within case and cross case (Eisenhardt, 1989).

3.8.1 Within case analysis

In an individual case, vast amount of data is used for the purpose of divide-and-conquer (Eisenhardt, 1989). To be familiar with each single case and its potential unique patterns, is the main reason for within case analysis. The first step is to analyze the pattern of data by constructing an array or display of the data (Voss et al., 2002). For example, a systematic visual display helps to generate effective findings. Then, explanations and causality should be discovered in the array or display.

In this thesis, within case analysis for each company is based on four perspective including general background, supply chain characteristic, distribution system, and warehouse design and operations. Each perspective displays the actual practice of the company.

3.8.2 Cross case analysis

To enhance the generalizability of the analyzed conclusions, cross case patterns is of vital importance. There are many ways of doing cross case analysis, one is conducting an array or a matrix, the same with within case studies. Another is selecting pairs of cases to see similarities and differences. Confirmation from multiple sources can yield more reliable results and increase the internal validity (Voss et al., 2002). It is suggested to use tools like matrices for comparison of groups across dimensions in quantitative studies and use tables in qualitative studies (Wood, 1995).

In this thesis, the cross-case analysis is mainly based on the research questions and using the frameworks from Norrman and Kembro (2019). First, there is a part of basic data comparison, then the retailers' experience and contextual factors are analyzed in three configuration elements. Besides, the challenges and strategic logistics goals are also generated. Finally, there is a comparison between Swedish cases and Chinese cases. The investigation model (Figure 3.5) is built according to how the authors analyze.

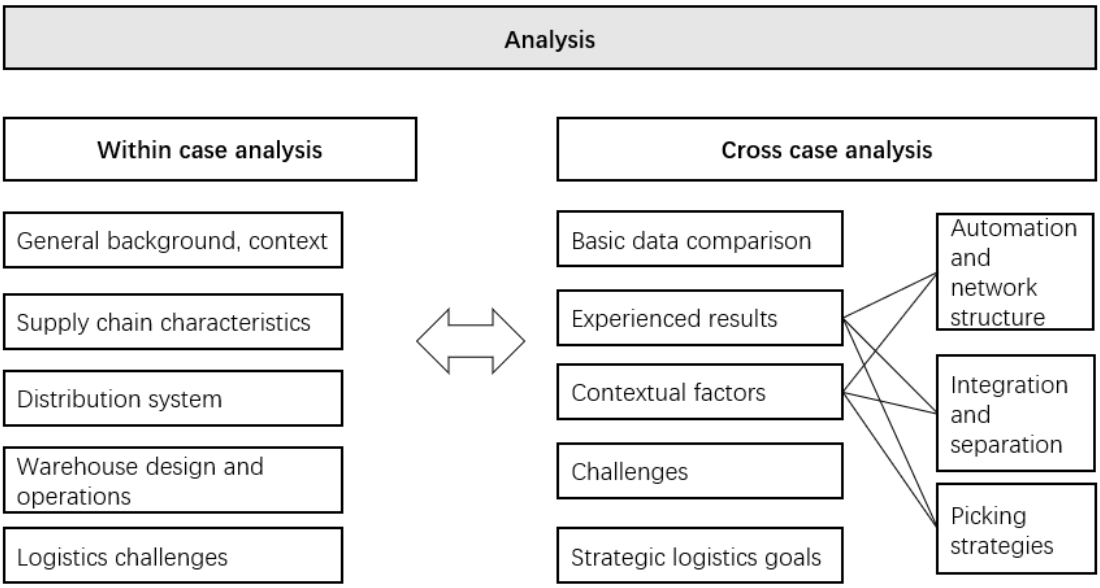


Figure 3. 5 Investigation Model of this thesis

3.9 Research process

The research process of this thesis starts with the preparation of theoretical framework, interview guide and conducting the pilot test (Figure 3.6). Then the empirical data was collected from the target case companies. Each case was analyzed regarding its results, contextual

factors and challenges of omni-channel logistics in warehouse operation and design, based on the theoretical framework. After that, the additional within case analysis was conducted for potential deeper implications, and also the cross-case perspective will be investigated. With analyzed data, there could develop the theory, and finally, the thesis can generalize conclusions or proposition for future research.

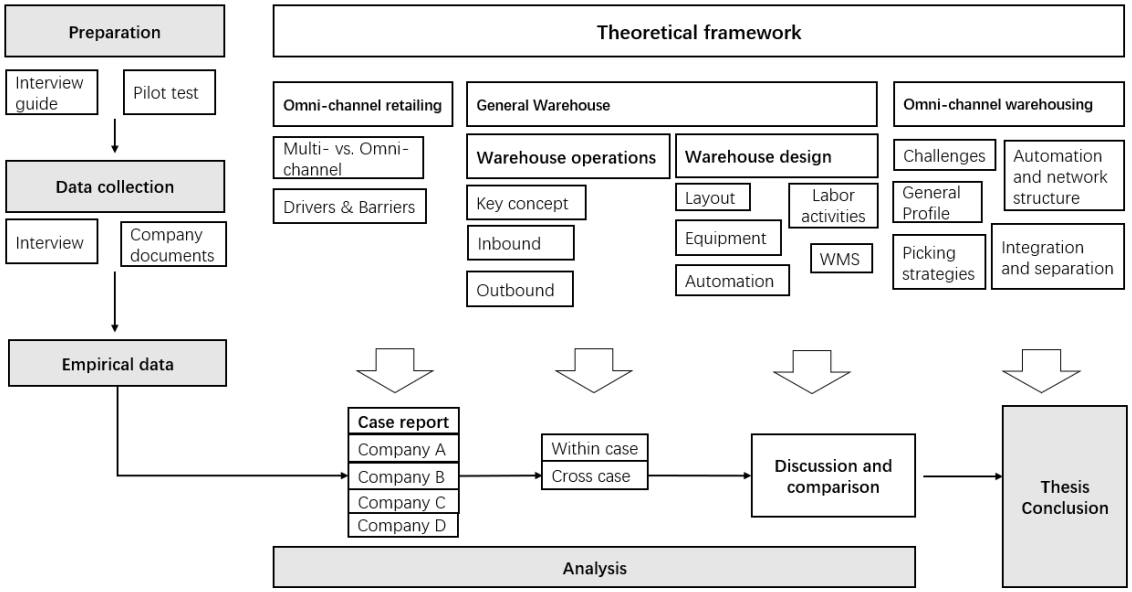


Figure 3. 6 The theoretical framework of the thesis.

3.10 Quality of the research design

The study design should represent a set of logical statements, thus some specific logical tests may be used to determine the quality of the given design. The quality criteria of case research design include external validity, reliability, construct validity and internal validity (Ellram, 1996; Yin, 2003). The following text emphasizes their importance and the way of improvement.

- External validity
  External validity reflects how accurately the results represent the phenomenon studied, establishing generalizability of results. It is the main barrier to doing case studies. The way to address this problem is to replicate case studies and verify patterns (Ellram, 1996; Yin, 2003).

- Reliability
  Reliability demonstrates that whether the replication is possible, the repeatability of the experiment will achieve the same results. The goal of reliability is to minimize the error and biases in a study. There are two important reliability content in the case study: use of a case study protocol, and development of a case study database (Ellram, 1996; Yin, 2003).

- Construct validity
  Construct validity establish correct operation measures for the concept being studied. It is closely related to reliability and normally considered as a part of data collection. To meet the requirement of construct validity, investigators should select the specific types of changes that are to be studied and demonstrate that the selected measures of these changes do indeed reflect the previous requirement. Three ways can be applied: using multiple sources of evidence, establishing a chain of events and having key informants review (Ellram, 1996; Yin, 2003).

- Internal validity
  Concerned in explanatory case studies, the researcher demonstrates that some outcome was caused by an independent variable. And the concern extends to the broader problem of making proper inferences, considering the alternative explanation, use of convergent data and related tactics. The suggested tactics, for instance, are pattern matching, explanation building, addressing rival explanations and using logic models (Ellram, 1996; Yin, 2003).

Table 3.6 is what has done in this thesis to increase the research quality.

Table 3. 6 List of practice to increase research quality

	Have done
External validity	● Conduct multiple cases with four case companies
Reliability	● Build an interview guide with a questionnaire before interviews ● Conduct a pilot test before interviews ● Build a case study database with empirical data
Construct validity	● Using multiple sources of evidence-- interviews and documents ● Having key informants review -- send the summary data to interviewees to review and approval. ● Explained important terms when interview to each interviewee to avoid misunderstanding ● Obtained feedback from peer researchers on case analysis to get feedback and check for validity ● Presented the results for researchers and practitioners familiar with the studied phenomenon to check for validity

4. Empirical data and single case analysis

This chapter describes the collected data from four case companies. For each company, first, its general background is introduced. Then supply chain characteristics, the distribution system and warehouse design and operations are presented.

4.1 Company A

4.1.1 General background of company

Company A is a global leader and technology innovator in consumer electronics, mobile communications and home appliances. It was established in 1981. Company A employs more than 75,000 people in over 80 operations, including 23 R&D centers, 21 manufacturing bases, and more than 80 sales offices around the world. Company A is serving more than 100 million consumers worldwide in around 160 countries.

Company A is comprised of four business divisions -- Multimedia, Communications, Home Appliances and Techne Electronics. It also has two affiliated business areas: Real Estate & Investment and Logistics & Services. The company is one of the world's leading producers of flat panel TVs, DVD players, air conditioners, and GSM and CDMA mobile phones. In 2004, Company A merged with some of the world's most admired and recognized brands and businesses, including the Thomson television business and Alcatel mobile phones. In 2018, its operating income was 39.3 billion yuan[5], of which overseas revenue accounted for 47% and net profit reached 3.23 billion yuan. In 2015, the brand value of Company A had exceeded 71.028 billion yuan, rising from 60th with 690 million yuan in 1995 to the top one TV brand in China today.

4.1.2 Supply chain characteristics

Company A origins from physical stores but is now using omni-channel retailing. There is large difference between their store orders and web orders. The average order lines per store order is around 50, while the average order lines per web order is only 2. In another word, the diversity in store order is very large compared with web order.

The life cycle of the product is relatively low, around one year, and Company A has two new product launches every year. Their two main products are TVs and air-conditioners. For TVs, the number of orders fluctuates little, but for air conditioners the order number fluctuates greatly. In winter and summer, there will be the peaks of air-conditioner orders. In spring and autumn, the number of air-conditioner orders will become low.

Compared to their e-commerce channel, assortment is larger and there are more kinds of product sold in physical stores. The reason is that the consumers have more willingness to buy

[5] 39.3 billion yuan equals to 55.5 billion SEK, 1 yuan = 1.41 SEK

high value products in physical stores because they could have more real feeling. Store orders and web orders use the same package for every products. Web orders do not require a physical venue so web orders have low land costs compared with store orders. Therefore the prices of product from web orders are relatively low.

The land costs and salaries are both very high compared with other companies in the same retail sector. The staff in the company are employed by the company but Company A will hire temporary workers when meeting a peak demand. In the entire logistics system, some processes are handled by in house departments, and others are outsourced to the third-party companies.

4.1.3 Distribution system

The distribution system for web orders is using distribution center and third-party shipping and distribution. Company A is planning to use both distribution center and online fulfillment centers in five years. There are around 7000 physical stores that could be used as material handling nodes. Consumers could use these nodes to return products. For web orders, there is one centrally developed e-commerce solution for all warehouses. The inventories in the different warehouses have joint control, but stocks in stores are managed separately.

Company A meets high requirements for distribution. In general, the lead time for web orders is 3 days. It takes about one day to get ready for delivery. The service level could reach 99%. This is one of the core competitive factors of Company A. For store orders, the physical stores will be replenished once a week. Cost-effective material handling for both store orders and web orders are very important in Company A's distribution system.

4.1.4 Warehouse design and operations

For handling store replenishment and web orders in the warehouse, Company A is using integrated storage zones. The storage zones are allocated according to product types rather than order types. However, the company is using separated picking processes and packaging and shipping areas. There are around 130000 orders handled weekly while is higher than other companies in the same retail sector. The average cost of picking is around 1.5% of the product value. The average picking accuracy percentage is more than 99% (almost 100%).

In picking process, a picker should account for many orders and also many order lines. Automations are used in receiving, put-away, picking and shipping processes. Sorting, packaging and return are handled manually. The company is planning to use more automation in the next five years.

In order to increase operations efficiency, GPS, digital signing and scanning technology are used in the warehousing operations. WMS is also being used offering many functions. KPIs could be developed and evaluated with the WMS used in Company A's warehouse. It could also control the stock and location and make storage and replenishment planning.

4.1.5 Logistics challenges

During the interview, the interviewees answered which logistics performances and dimensions in the distribution system are important challenges in omni-channel retailing by rating. The minimum score is 1 point, and the maximum score is 10 points. The scores are shown in Table 4.1.

From table 4.1, it can be seen that Company A is very concerned about the ability of warehousing operations to reduce lead times, but does not care about the ability to maximize the profitability. The company also hopes that the warehouses could reduce the backlog in nodes and the capital tied and environmental impact, but they prioritize this lower than maximizing delivery service. In the distribution system, delivery service level for web sales is the most important challenge.

Company A also introduced their challenges in warehouse operations. The two main challenges in warehouse operations are packing and handling fluctuation.

Table 4. 1 The rating result of the challenges in Company A

Challenges in logistics performance		**Challenges in distribution system**	
Maximize profitability	2	Delivery service level for store sales	6
Minimize lead time	8	Delivery service level for web sales	8
Minimize environmental impact	4	Cost-effective material handling for store sales	7
Minimize handling costs	6	Cost-effective material handling for web sales	7
Minimize backlog in a node	6	Return management for store sales	6
Minimize capital tied	6	Return management for web sales	7
Maximize delivery service	8		
Capacity levels in different node	5		

4.2 Company B

4.2.1 General background of company

Company B was founded in 1996 by Taiwan Runtai Group. In March 1997, it opened the first large-scale supermarket in Taiwan, China which was completely designed and operated by the

Chinese. The store combines the freshness of the traditional market with the cheap from the department store. The company's comfort and convenience serve customers in a direct way.

Company B opened its first large-scale supermarket in mainland China in July 1998. It is a membership-based large-scale supermarket chain. Kang Cheng Investment (China) Co., Ltd. holds the legal right of the Company B trademark and is the headquarters of Company B in China. Company B's stores in mainland China are invested and owned by Kangcheng Investment (China) Co., Ltd.

Since opening its first large supermarket in Shanghai in 1998, Company B has successfully opened 408 comprehensive large supermarkets in mainland China in March 2019, covering the five regions of East China, North China, Northeast China, Central China and South China. In many cities in 29 provinces, it has more than 100,000 employees and serves more than 4 million customers every day. In 2018, the company's overall turnover reached 101.315 billion yuan[6]. In November 2017, Alibaba Group strategically invested in Company B retail, and officially entered the new retail era.

4.2.2 Supply chain characteristics

Company B originated in supermarket chains and has been using omni-channel retail in the last two years. There is a big difference between their store orders and web orders. Due to the nature of the groceries industry, the number of order lines for each store is very large, and the average order line per web order is relatively small, although still much higher than the web orders of other industries. Compared with other industries, the diversity of web orders and store orders is very large because groceries industry has more types of products.

The products of Company B have long life cycles and some products are almost never replaced. The introduction of new products is highly seasonal, with approximately 5% of the total product category renewed each year. The demand for products fluctuates significantly. During the holidays, the demand for products will increase sharply, which is especially evident in the Chinese New Year, International Labor Day and National Day.

The store sales and e-commerce channels are exactly the same. The reason is that Company B products are mostly cheap products that are familiar to consumers. The intuitive experience of a physical store does not significantly increase the consumer's desire to buy. However, in order to improve the distribution efficiency of web orders, the package size of the online order will be slightly smaller than the package size of the store order. At the same time, in order to increase the purchase amount of consumers in the physical store, Company B occasionally has some discount activities, so the price of the physical store will be slightly lower than the e-commerce price in some events.

In Company B's warehouse operating costs, land and labor costs only account for a very low percentage. The company's employees are normally employed by the company. Due to the low

[6] 101.315 billion yuan equals to 143.078 billion SEK, 1 yuan = 1.41 SEK

technical requirements of the work and the huge population of China, the company can hire a large number of relatively inexpensive operators. During the holidays, when Company B meets peak demand, temporary workers are hired to meet the shortage of people. All of the company's logistics system, including warehouses and distribution, are under the responsibility of the company's in-house departments.

4.2.3 Distribution system

Company B uses a distribution center and many stores as the distribution system. The company plans to use both of a distribution center and online fulfillment centers as the distribution system within five years. About 80% of physical stores can be used as handling nodes for products. Stocks in different warehouses are jointly controlled, but the inventory of the stores is managed separately.

Company B has very high distribution requirements. Typically, the lead time for a web order is 6 hours. It takes about 2 hours to make it ready for delivery. Service level can reach 99%. The extremely short delivery time is one of the core competencies of Company B. For store orders and web orders, cost-effective material handling and good return management are both very important in Company B's distribution system.

4.2.4 Warehouse design and operations

In warehouse operations, Company B uses an integrated storage area, picking process and packing and shipping area. The average picking accuracy percentage is over 99%. There has never been a picking error.

Due to that the number of operators is very large, in a picking process the picker is responsible for picking only one order, but should pick all the different order lines in the order. The company basically does not use any automation equipment. All warehouse operations are handled manually by hand. However, due to the increase in operations, the company plans to automate some warehouse operations, such as receiving and packaging in five years.

In the warehousing operation, the scanning technology is used in large quantities to improve accuracy and work efficiency. Big data analytics technology is used for more clearly demonstrating the operation of the warehouse, forecasting and planning. WMS is also used to control inventory and make replenishment plans.

4.2.5 Logistics challenges

As with the interview with Company A, the interviewees from Company B also answered which logistics performances and dimensions in distribution system are important challenges in omni-channel retailing by rating. The scores are shown in Table 4.2.

It is very important to shorten lead time in Company B warehouse operations. It is also important to reduce environmental pollution and reduce operating costs, although the

importance rate is lower than the shortening delivery time. In distribution system, cost-effective material handling and return management are two main challenges. Company B also introduced their challenges in warehouse operations. There are three main challenges in warehouse operations that are shipping, return and handling fluctuation.

Table 4. 2 The rating result of the challenges in Company B

Challenges in logistics performance		**Challenges in distribution system**	
Maximize profitability	8	Delivery service level for store sales	7
Minimize lead time	9	Delivery service level for web sales	7
Minimize environmental impact	8	Cost-effective material handling for store sales	8
Minimize handling costs	7	Cost-effective material handling for web sales	8
Minimize backlog in a node	7	Return management for store sales	8
Minimize capital tied	8	Return management for web sales	8
Maximize delivery service	7		
Capacity levels in different node	7		

4.3 Company C (China)

4.3.1 General background of company

Company C was founded in Sweden in 1943 and has become the world's largest furniture and household goods company, selling mainly in the sofas, office supplies, bedroom products, kitchen, lighting, textiles, cookware, house storage and children's products. The assortment is about 10,000 products.

Company C has 355 stores in 29 countries/regions, 26 of which are in mainland China (in Beijing, Tianjin, Shanghai, Wuhan, Guangzhou, Chengdu, Shenzhen, Nanjing, Wuxi, Dalian, Shenyang, Jinan, Ningbo, Chongqing, Hangzhou, Xi'an, Harbin, Foshan, Suzhou, Xuzhou, Nantong). Chongqing is the largest standard store Company C has in Asia.

Company C adopts a global procurement model and has established 16 procurement regions around the world, including three in mainland China, namely South China, Central China and North China. Company C's purchases in China have accounted for 18% of the total, ranking first. As of March 31, 2016, Company C had 19 retail outlets in mainland China, and the required storage capacity has expanded from 100,000 cubic meters to over 400,000 cubic

meters. China has become one of Company C's largest procurement markets and one of the most important spaces for business growth, and has a pivotal position in Company C's global strategy.

4.3.2 Supply chain characteristics

Company C (China) originated in physical stores and has used omni-channel retail to provide sales in recent years. There is a big difference between store orders and web orders. The average order line for each store order is relatively large, and the average order line per e-commerce order is also large but smaller than store orders. In other words, the store order is very diverse compared to the online order.

Company C's products are mostly furniture products, and the product life cycle is on average, about 5 years. Company C will have four new product launches each year, in February, April, August and October. The order quantity for all products fluctuates greatly with the demand peak every summer.

E-commerce channels and physical stores sell the same assortment. Consumers can evaluate products through the experience of a physical store and then make purchases through online channels. At the same time, in order to facilitate consumers to purchase, the product price in e-commerce channels and physical stores are exactly the same.

Since Company C's warehouse site is owned by the company and the land cost is relatively low. But the cost of salaries is high, accounting for a high proportion of warehouse operating costs. Employees in the warehouse are both from the company and third-party employees. Due to the high labor cost, Company C could not have a timely response to the peak demand. In many cases, it can only delay the processing of orders and increase the processing time of orders. In the entire logistics system, warehousing operations are handled by in-house departments, and transportation is outsourced to third-party companies.

4.3.3 Distribution system

The distribution system for web orders uses four distribution centers and many store centers. Company C is planning to use the distribution centers and selected store centers within five years. All physical stores can be used as material handling nodes. However, consumers cannot use these nodes to return goods, and they can only return them by purchasing channels. For web orders, there is a centrally developed e-commerce solution for all warehouses. Stocks in different warehouses are jointly controlled, but the inventory of the stores is separated.

Compared with other companies, Company C has no differentiators in delivery requirements, and promises are also very high. Typically, the lead time for web orders is less than 3 days. It takes about around three days to get ready for delivery, which is a relatively long time compared to other companies. Service level can reach 99%. For store orders, the physical store will be replenished once a day. For store orders and web orders, material handling with good return management and cost-effectiveness is very important in Company C's distribution system.

4.3.4 Warehouse design and operations

To handle store replenishment and web orders in the warehouse, Company C uses an integrated storage area to store goods. The area is divided according to the product type, not the order type. At the same time, the company uses an integrated picking process to improve picking efficiency. However, web orders and physical store orders use different packing and shipping areas. Like several previous companies surveyed, the average picking accuracy percentage is over 99%, almost 100%.

During a picking process, the picker only handle one order. The picker is also only responsible for one order line. Automation is used in almost all the warehousing operations, such as receiving, put-away, picking, sorting, packing, shipping and return. The company is very satisfied with the current level of automation, and there is little room and necessity to improve the level of automation. The company plans to maintain this level of automation within five years.

Almost all current warehouse operations techniques are used in Company C's warehousing operations such as scanning, GPS and digital signing. The company also uses both WMS and ERP. ERP is used to consolidate resources and increase the utilization of resources available to the company. WMS is used for all warehouse controls such as control inventory, replenishment plans, and KPIs evaluation.

4.3.5 Logistics challenges

The interviewees from Company C also answered which logistics performances and dimensions in distribution system are important challenges in omni-channel retailing by rating. The scores are shown in Table 4.3.

There are three important challenges in Company C's logistics performance that are minimizing handling costs, minimizing backlog in a node and minimizing capital tied. However, the profitability of warehouse operations is not very general, since the warehouse is more of a functional department than a profitable department. In distribution system, cost-effective material handling and return management are two main challenges that are much more important than delivery service level. Packing and handling fluctuation are two challenges in Company C's warehouse operations.

Table 4. 3 The rating result of the challenges in Company C

Challenges in logistics performance		Challenges in distribution system	
Maximize profitability	4	Delivery service level for store sales	5
Minimize lead time	8	Delivery service level for web sales	5
Minimize environmental impact	7	Cost-effective material handling for store sales	8
Minimize handling costs	9	Cost-effective material handling for web sales	8
Minimize backlog in a node	9	Return management for store sales	8
Minimize capital tied	9	Return management for web sales	8
Maximize delivery service	8		
Capacity levels in different node	2		

4.4 Company D

4.4.1 General background of company

Company D is a well-known mother and baby brand in China. Company D's products are divided into two categories: cotton yarn-based maternal and child household products and infant health care products.

Cotton yarn products mainly include more than 20 kinds of products such as bibs, square towels, children's quilts, bath towels, sleeping bags, climbing clothes and bags. Throughout the design process, the company's designers all hand-drawing, manual proofing.

Baby care products include: diaper series, toddler pants series and dry and wet tissue series. Materials selected by Company D must undergo rigorous safety and performance testing prior to contact with baby skin.

At present, Company D has around 398 physical stores and nearly 60,000 agents, with an annual sales volume of hundreds million SEK, and a sales network covering more than 30 provinces, 208 cities and autonomous regions in mainland China.

4.4.2 Supply chain characteristics

Company D origins from an online store in 2003. It has developed into an omni-channel retailing company with both physical stores and online stores. There are more web orders about 75% of

total orders, than store orders. The order lines of store order are similar to that of web order. Both of them are relatively large.

Company D's products normally have short product life cycle. The new products launches according to the four seasons in China but at a high frequency. April to November are the demand peak seasons, but the fluctuation of demand is not obvious.

Both physical stores and online stores have the same products, with the same package size. There is no difference in price for a same product between the store orders and web orders.

The physical stores are usually located in big mall in the city centers. Thus, the land cost of the physical store is high, as the salaries of staff in stores. The staff are normally hired by the company. If there is shortage of labor at peak seasons, the company will hire temporary workers. The warehouse is operated in house, while the distribution is all outsourced to a third-party logistics company.

4.4.3 Distribution system

The distribution system of Company D for web orders is composed of a distribution center and drop shipments. In the future, they plan to use separated online fulfillment centers and a distribution center. In order to serve the customers, about 10% of the physical stores are used as handling nodes for customers to pick up products when they order online. Therefore, products can also return from different channels. The inventory control is integrated with full visibility.

Store replenishment are handled every day. The required lead time for an order is three days, and the average preparation time needed in a distribution node is one day for an order. However, the service level is 95% which is lower than other companies.

4.4.4 Warehouse design and operations

Company D has separated storage zones for handling store orders and web orders in their warehouses. However, the picking zones are integrated, as well as packing and shipping zones.

In warehouse operations, the picking and sorting are manual. The picker handles one order at the same time but with many items. The picking accuracy are around 98%. The automation system is only used in receiving and put-away. In the future the company wants to increase their degree of automation.

In the integrated WMS used by Company D, there is no different priority between store orders and web order.

4.4.5 Logistics challenges

The challenges in logistics performances and dimensions in distribution system are answered by Company D. The results are shown in Table 4.4.

Minimizing lead time and maximize delivery service are the top considerations for their logistics performance. Delivery service level for web sales is the most important challenge in distribution system. However, they still facing the challenges from packing and handling fluctuation.

Table 4. 4 The rating result of the challenges in Company D

Challenges in logistics performance		**Challenges in distribution system**	
Maximize profitability	5	Delivery service level for store sales	5
Minimize lead time	8	Delivery service level for web sales	9
Minimize environmental impact	3	Cost-effective material handling for store sales	4
Minimize handling costs	7	Cost-effective material handling for web sales	8
Minimize backlog in a node	5	Return management for store sales	8
Minimize capital tied	5	Return management for web sales	8
Maximize delivery service	8		
Capacity levels in different node	4		

5. Cross-case analysis

After describing and analyzing the single cases in three aspects, this chapter presents the cross-case analysis. The cases are investigated in four areas: general data comparison, retailers' experience, contextual factors and challenges about omni-channel retailing. While basic data comparison and challenges are analyzed in different tables. Retailers' experience and contextual factors will be analyzed according to the analytical model introduced by Norrman and Kembro (2018).

5.1 General comparison

5.1.1 Background comparison of four companies

The four companies are from four different industries. Company A, B and C all started from physical stores, compared with D, that origins from online shops, Companies A, B and C have a much larger scale with much higher sales turnover. Company C has the fewest physical stores, less than one-tenth of other companies, but sales turnover of company C is much higher than that of company D because the physical stores of Company C have very large footprint. A store can serve the entire city that it is located in. In general, companies that originated from online stores have much fewer sales than the companies that originated in physical stores. The comparison of these data is shown in Table 5.1.

Table 5. 1 Comparison of background of the four companies

	Company A	**Company B**	**Company C**	**Company D**
Origins	Physical stores	Physical stores	Physical stores	Online shops
Products	Electronic product	Groceries	Furniture and household goods	maternal and child household products
# of stores (in China)	> 1000	408	26	398
Sales turnover (in China)	SEK 55.5 billion	SEK 14.3 billion	SEK 20.8 billion	SEK 0.57 billion

5.1.2 Comparison of the supply chain characteristics

The web sales share of Company D is the highest (75%) because it origins from online shop, while the other companies are less than 30%. Most companies sell the same product categories in different channels except Company A. The reason is that one of the main products of Company A is TVs where consumers need an actual experience before they can assess whether they have willingness to buy. The warehouse employees of Companies A, B and D all

internal staff, while Company C employs some third-party employees in addition to internal positions. The reason is that the skills required for the employees of Company C are higher, so the labor cost is higher. Conversely, employees in Company B needs low skills, so Company B can hire cheap workers in large numbers and use in house department for the whole logistics system. More details of the comparison of the supply chain characteristics of the companies are shown in Table 5.2.

Table 5. 2 Comparison of the supply chains of the four companies

	Company A	**Company B**	**Company C**	**Company D**
Web sales share	30%	10%	10%	75%
Product categories in different channels	More categories in physical stores	Same	Same	Same
Price in different channels	Higher price in physical stores	Lower price in physical stores	Same	Same
Life cycle	Short	Long	Medium	Short
Demand fluctuation	High	Medium	High	Low
Land cost	High	Low	Low	High
Labor cost	High	Low	High	High
Employee positions	Internal staff	Internal staff	Internal staff and third-party	Internal staff
Solutions for labor shortage	Temporary workers	Temporary workers	Delay	Temporary workers
Composition of logistics system	In house department and third party	In house department	In house department and third party	In house department and third party

5.1.3 Comparison of logistics and warehouse operations

The transportation time of these four companies are all less than three days. This is also in line with China's logistics level. The service levels of Company A, B and C all reach 99% except Company D that has the service level of 95%. In general, the lead time requirement is very high in China retailing market.

WMS is used in all four companies and Company C also uses ERP to integrate the management of the logistics system. Company C has the highest degree of automation and use automation in all warehouse operations. Company B does not use any automation in their warehouse operations because the company has low labor cost and could use low cost workers to handle all the operations. All these four companies use scanning in the warehouse operations, Companies A and C also use other technologies such as GPS and digital signing. The commonality of the four companies is that the picking accuracies are all above 99% with high picking accuracy requirements. The details of the comparison of the logistics and warehouse operations are shown in Table 5.3.

Table 5. 3 Comparison of the logistics and warehouse operations

	Company A	**Company B**	**Company C**	**Company D**
Transportation time	3 days	6 hours	3 days	3 days
Time for ready to delivery	1 day	2 hours	3 days	1 day
Service level	99%	99%	99%	95%
Frequency of physical store replenishment	Once a week	Once a day	Once a day	Once a week
Information system	WMS	WMS and Big data analysis	WMS and ERP	WMS
Technologies in operations	GPS, digital signing and scanning	Scanning	GPS, digital signing and scanning	Scanning
Automated operations	Receiving, put-away, picking, shipping	None	Receiving, put-away, picking, sorting, packing, shipping, return	Receiving, put-away
Picking accuracy	>99%	>99%	>99%	>99%

5.2 Retailers' experiences

The analyze RQ1 (What are retailers’ experiences from transforming warehouse operations and design to omni-channel logistics in the Chinese market?), the observed retailers' experience were analyzed in terms of automation and network structure, storage and picking process, and picking strategies.

5.2.1 Automation and network structure

From the automation point of view, the four case companies rated both their current degree and future aim of automation from 1 to 10, which represent from manually to highly automated (Figure 5.1). Company B has currently the most manually warehouse, with no automation at all in the whole warehousing operation process. But it aims to increase a lot in automation in the future. Company C has currently the highest rate of automation, all the operation process from receiving to returns being automated, and thus they would like to stay at this level. Company A and D have a middle rate of automation, and both want to increase their capability of automation. Company D, with the lower degree of automation only has automation solution in receiving and put-away. Company C has more automation in picking and shipping. In general, most companies aim to increase their automation capabilities in the future, as automation can help to increase the efficiency and effectiveness of the warehouse operation. Even for company B, that hire low-cost labor, would like to increase automation in receiving and packaging due to the increase in coming orders that requires more capability in operation.

The authors' defined network structure for web orders, from most decentralized to least decentralized relatively, are:

Distribution center (DC) and many store-hubs: It includes a distribution center and many stores are used to handle web orders.
DC and selected store-hubs: It includes a distribution center and with some stores selected to be the hubs for handling web orders.
DC and sorting nodes: It includes a distribution center, and web orders are not sorted from distribution center until they reach the nodes for sorting to exactly single customers.
DC and separated online fulfillment center (OFC): It includes a distribution center but also a separated center to only fulfill the web orders.
Integrated DC: that the distribution center is integrated for all kinds of orders.
DC and drop shipment: It includes a distribution center, but customer orders are also directly shipped to customers from the manufacturer.

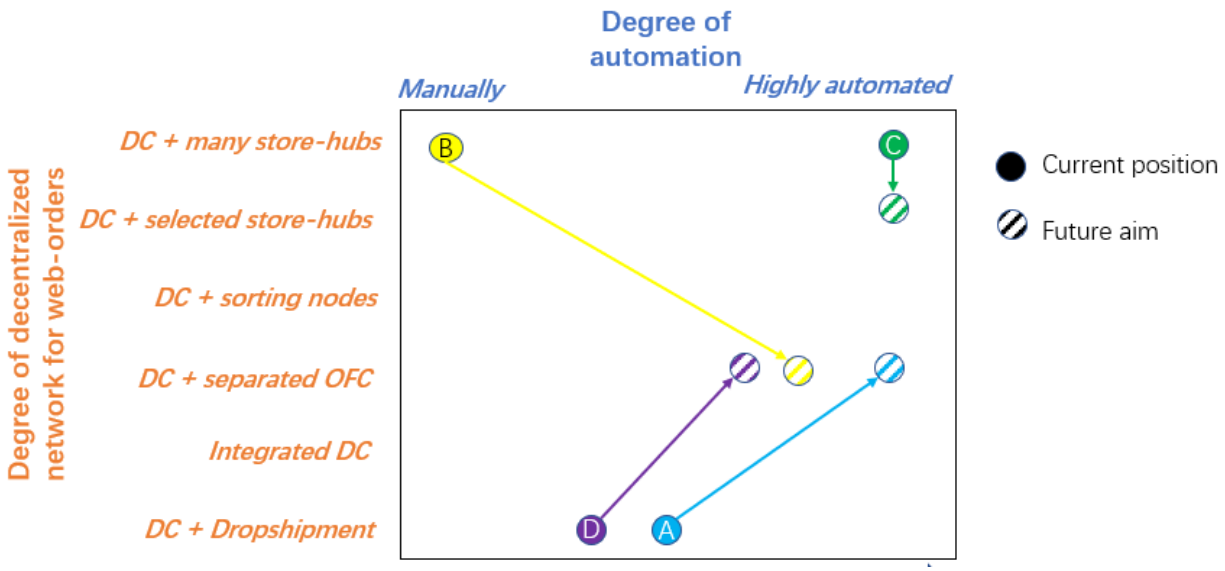


Figure 5. 1 Automation and network structure of case companies

As is shown in Figure 5.1, for web orders, the current distribution network for company B and C is DC + many store hubs, for company A and D is DC + drop shipment. In the future, company C would like to adjust to DC + selected store-hubs. All the other three companies would change into DC + separated OFC. Company C does not have a huge number of physical stores in China, but each store can serve the demand of the whole city where it is located and even other cities. Thus, company C prefers to use many store hubs. All the companies of A, B, D have the trend to invest in separated OFC in the future. The main reason behind this is due to the increasing amount of web orders, which would complicate the operation if store replenishment and web orders are handled together. In particular, grocery company B would benefit from OFC if it separates the store replenishment and web orders, which decreases the complexity due to different order lines, order volume, handling units or lead time requirement. For example, the average orderliness per store order is much larger than that of web orders.

5.2.2 Integration and separation

Regarding storage zones and the picking process for store replenishment and web orders, there are four defined kinds:

Store oriented zones: with separated storage zones for store order and web order, but integrated picking process
Integrated storage: with integrated storage zones and picking process
Order oriented zones: with separated storage zones and picking process
Time differentiated picking: with integrated zones but separated picking process for store order and web order.

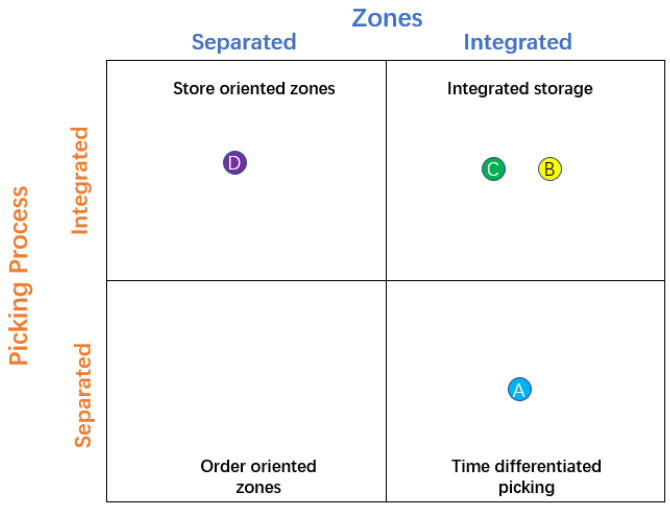


Figure 5. 2 Storage and picking process of case companies

Companies are currently doing different (Figure 5.2). For both storage zones and picking process, most cases companies prefer integration. Company A store all the goods integrated by product type but picking store replenishment orders and web orders separately. As its aim to increase the service in delivery and shorten tied-up capital, storing integrated can shorten the lead time for web orders that the product do not need to be picked in another warehouse and help reduce the tied-up capital that integrated storage reduces the inventory excesses. Company B and C store integratedly and picking both kinds of orders integratedly. However, company C has different areas for packing and shipping. Company D has separated storage zones but picking is integrated.

5.2.3 Picking strategies

Picking strategies are illustrated from two perspectives (figure 5.3). One is the number of different articles or order lines that a picker can handle at the same time. Another is the number of orders that a picker can handle concurrently. Orders are differentiated from store replenishment and web orders. Four kinds of picking strategy are defined in general:

Extract: concurrently with many orders but 1 order line
Batch: concurrently with many order and many order lines
Single product picking: concurrently with only 1 order and 1 order line
Single order picking: concurrently with only 1 order but many order lines

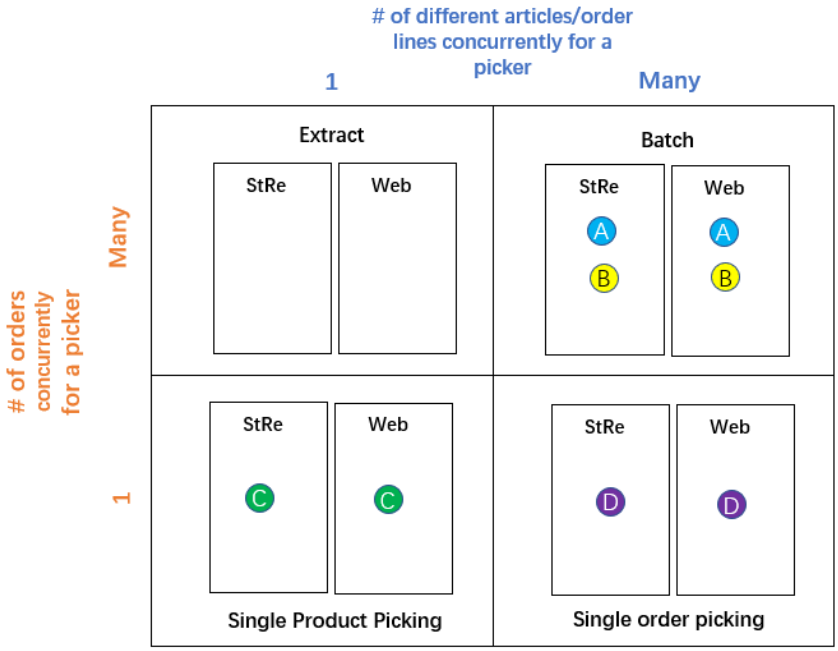


Figure 5. 3 Picking strategy of case companies

All four companies use a similar picking strategy for both kinds of their orders, but the selected strategy differs. Company A and B use the batch picking. Company A has automation in picking, and a picker can pick many orders and many orderliness at the same time, while company B has totally manual in picking. Due to the large volume of orders, it is more efficient to pick much orderliness concurrently. The volume inside order is normally small, thus picking many orders concurrently for a picker is reasonable. Company C uses single product picking with its automation system, and company D uses single order picking because of its small number of orders. All the companies have WMS systems which help planning for storage and replenishment. Planning is important for picking strategy especially because of the short lead time requirement by customers.

5.3 Contextual factors

To answer RQ2 (What are the contextual factors perceived important for implementing omni-channel warehousing in the Chinese market?), contextual factors were analyzed according to the models of Norrman and Kembro(2019). The authors collected some contextual factors that have potential in affecting configuration elements. The contextual factors were analyzed based on the findings of retailers' experience. The contingency analysis is used to propose the contextual factors that the configuration elements depend on.

5.3.1 Automation and network structure

Regarding the decentralized network and the degree of automation, Figure 5.4 shows the impact of each contextual factors to the configuration elements. Each horizontal arrows represent a contextual factor potentially driving the degree of automation (including *sales*

turnover, number of orders and transactions, goods size, package standardization, demand variability, and *workforce shortage and cost*.) The direction of the arrow shows the increasing of the contextual factors itself, while the square with capital letter represents the placement of each company.

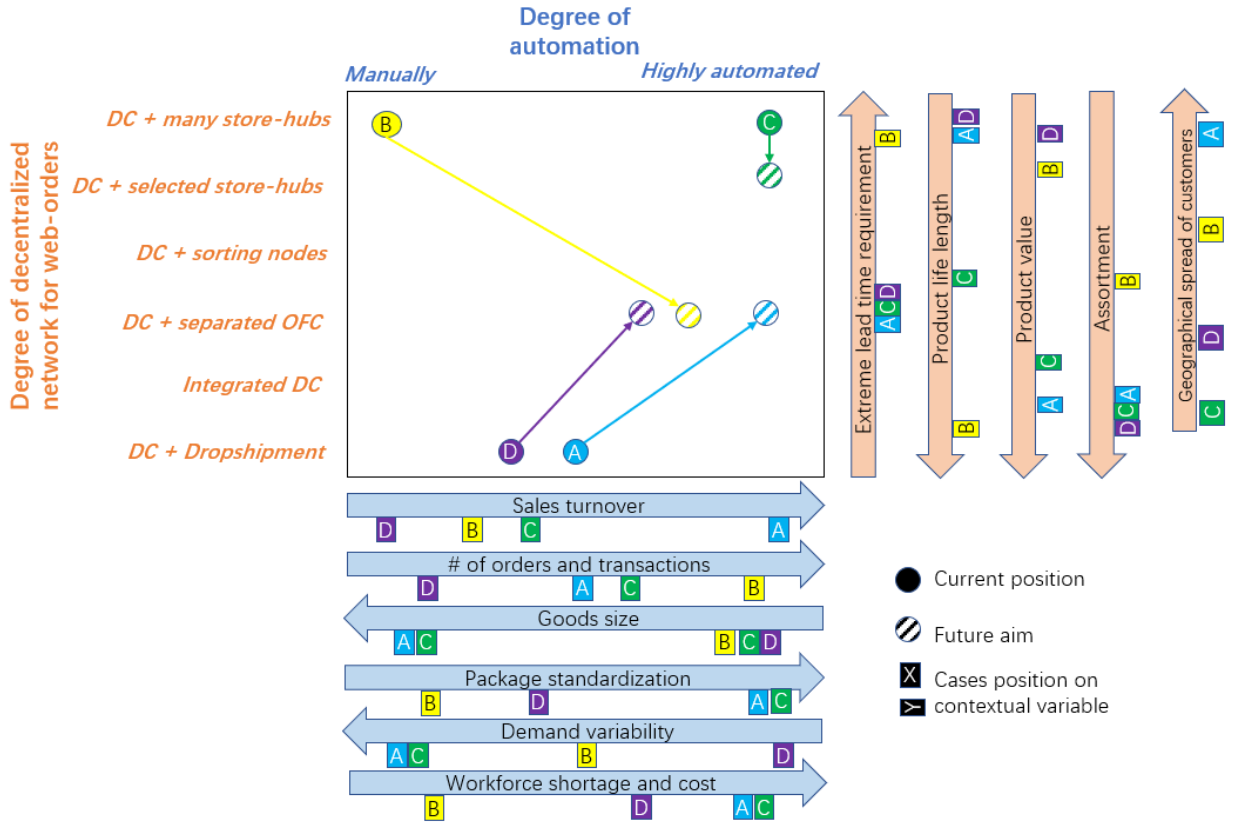


Figure 5. 4 Analysis of contextual factors that influence network structure and automation

From the result, it could be concluded that the *packaging standardization* and the *workforce shortage and cost* is totally in line with the company's automation situation. The main reason behind this is that the more the package are standardized, the easier to automate the operation. If the workforce shortage and cost is relatively low, companies would prefer to choose manually picking or packing rather than invest in automation. *Goods size* similar to *package standardization* also impact the automation a lot, where the larger the goods size the harder to use automatic operation. However, company C is an exception. It is already highly automated, making the goods size no problem for its whole operation. *The number of orders and transactions* are relatively influencing the automation, where larger number causes higher automation. But in this factor, company B, in the grocery sector, is different, and the characteristics of grocery seems to decide its uniqueness. The grocery sector normally has a large number of orders but small volume per order, and the product could be fragile, perishable and sometimes require a certain temperature when storing and delivery. Thus, it is hard to have a highly automated solution. Besides, sales turnover connects with companies' future prospect in automation. The company who earns more has more willingness to use more automation in

the future, as the company could afford higher investment. As for *demand variability*, the author could not conclude its relation with automation in this study.

The vertical arrows show the contextual factors related to the decentralized network, including the *lead time requirement, life cycle, product value, assortment* and *geographical spread of customers*. There is a big difference from company B to other companies (Figure 5.4). In this study, the degree of a decentralized network for web orders is not related to *extreme lead time requirement*, but seems more related to *product value* and *assortment.* Because the lead time requirement by customers are all at a high level and the last-mile distribution in China is well developed for the cheaper labor in delivery. For company A, *product value* and large *assortment* are quite important, but for company C these two factors do not show much relevance. As for *product life length*, the shorter it is the higher degree the company is decentralized. Besides, the larger the *geographical spread of customer* is, the lower it is decentralized. However, it can be identified that company B stands unique from others in terms of all these contextual factors. The grocery sector has a shorter lead time requirement and assortment due to its product characteristic, which has a relatively shorter life cycle.

5.3.2 Integration and separation

The integration of storage zones and picking process is discussed in the following figure 5.5. The contextual factors considered regarding storage zones in horizontal include *extreme lead time requirement, assortment* and *product value*. *Extreme lead time requirement* seems not important in this thesis study. *Assortment* and *product value* which could influence the tied-up capital may have an influence in the decision of integration. Companies with higher product value and assortment such as company A, C, may have the trend to storage integration for decrease safety stock and increase the efficiency by handling product in shorter distance.

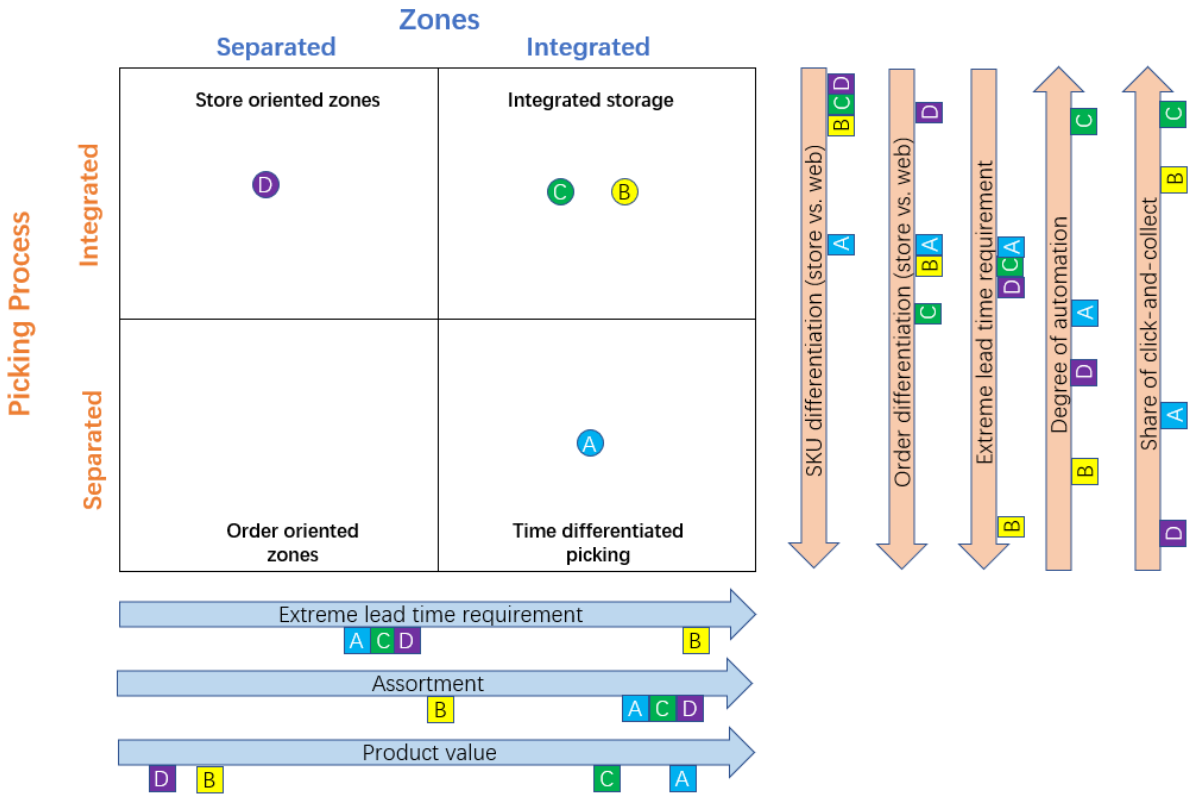


Figure 5. 5 Alternatives for separating or integrating picking processes

The vertical contextual factors of the picking process have *SKU differentiation (store vs. web), order differentiation (store vs. web), extreme lead time requirement, degree of automation*, and *share of click-and-collect*. *SKU differentiation* between store order and web order related to picking process. If there is a larger difference in SKU, it is better to pick separately. However, this does not apply to *order differentiation* between store order and web order. In this study, it might be not important. So as the *extreme lead time requirement*. *Degree of automation* might be important for company A, C that has automation in the picking process, but not important to company B, D that are manual in picking. Share of click-and-collect influence the picking process if there is a larger share of click-and-collect the picking might be more integrated. However, company D differs from the other three companies that have a small share of click-and-collect. Mainly because it is origin from e-commerce, and preferably product would be delivered directly to customers. So, there would not be that much store handling nodes. It does not influence their decision of picking integratedly.

5.3.3 Picking strategy

The picking strategy is analyzed in below Figure 5.6. The horizontal line has the contextual factors related to concurrent orderliness including *goods size, increased automation*, and *goods standardization*. It could tell from the figure that *goods standardization* is totally disconnected with the decision in picking. *Increased automation* differs according to the character of the product and the automation system itself. For example, company C, that is highly automated,

could pick only one orderline concurrently per picker for both big or small size product, while company A partly automated can pick many even for big size products.

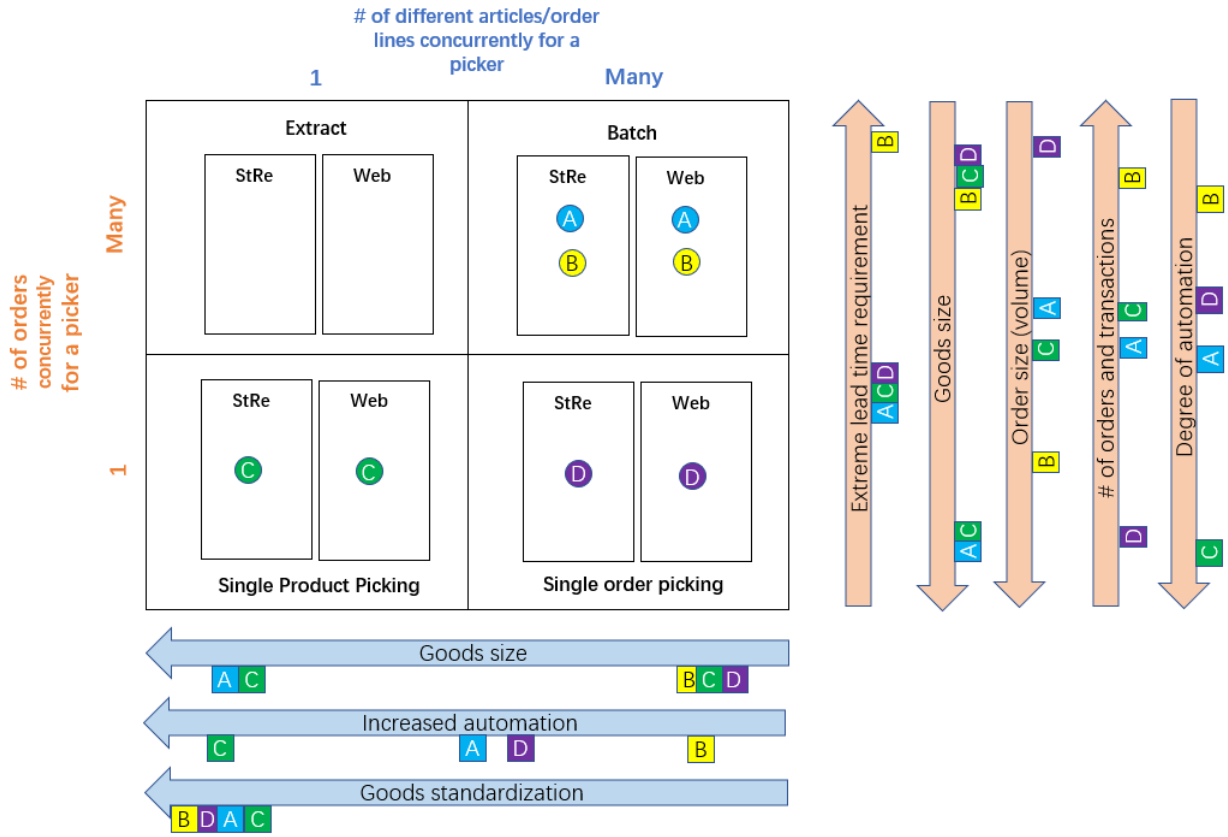


Figure 5. 6 Contextual factors that influence picking methods.

The vertical contextual factors related to concurrent order picked per pickers include *extreme lead time requirement, order size(volume), goods size, number of orders and transactions,* and *degree of automation.* Similar to previous configurations, the *extreme lead time requirement* does not seem to differentiate in this thesis study as all cases are in a similar context. How many orders a picker will pick is not much related to order size in these case, but seems much more related to *number of orders* or the *degree of automation* and difference in *goods size*. For instance, company D has small goods size. In theory, it is better for company D to pick many orders and order lines at the same time for higher efficiency. But they choose single order picking just because of the small number of orders, which sometimes only have one for a long time period in a day. They pick all the order lines concurrently just when an order comes. Company C has another practice, that although it has both large and small goods size, and medium order size. It is because of its high degree of automation that company C decide not to pick small goods by batch. Company B is the one that has small goods size and a large number of orders, besides it is manual in picking, so the batch picking is the most suitable choice.

In general, the choice of picking strategy seems related to *goods size, number of orders* and *degree of automation* in this case study.

5.4 Challenges

To answer RQ3 (What are the challenges for implementing potential solutions in omni-channel warehousing?), the analysis was made from the within-case analysis with additional perspectives.

5.4.1 Challenges in logistics performance

During the data collection phase, interviewees answered which logistics performances are important challenges in omni-channel retailing by rating. The rating result is shown in Table 5.4.

For the aspects of minimizing lead time and maximizing the delivery service, all four companies all gave high scores. Therefore, minimizing lead time and maximizing the delivery service are two important challenges in logistics performance. Company B gave high score to all of investigated dimensions, so groceries industry seems to face more challenges than other industries when using omni-channel retailing.

Table 5. 4 The rating result of the challenges in logistics performance

	Company A	**Company B**	**Company C**	**Company D**	**Average**
Maximize profitability	2	8	4	5	4.75
Minimize lead time	8	9	8	8	8.25
Minimize environmental impact	4	8	7	3	5.5
Minimize handling costs	6	7	9	7	7.25
Minimize backlog in a node	6	7	9	5	6.75
Minimize capital tied	6	8	9	5	7
Maximize delivery service	8	7	8	8	7.75
Capacity levels in different node	5	7	2	4	4.5

5.4.2 Challenges in distribution system

During the data collection phase, interviewees also answered which dimensions in distribution system in omni-channel retailing are important challenges by rating. The rating result is shown in Table 5.5.

Cost-effective material handling for web sales and return management for web sales got the highest score, so these two aspects are important challenges in distribution system. Since in Company D only 25% sales are from physical stores, so they only rate 4 for cost-effective material handling for store sales. However, the other three companies gave high scores in this aspect, so cost-effective material handling for store sales can also be considered an important challenge.

Table 5. 5 The rating result of the challenges in distribution system

	Company A	**Company B**	**Company C**	**Company D**	**Average**
Delivery service level for store sales	6	7	5	5	5.75
Delivery service level for web sales	8	7	5	9	7.25
Cost-effective material handling for store sales	7	8	8	4	6.75
Cost-effective material handling for web sales	7	8	8	8	7.75
Return management for store sales	6	8	8	8	7.5
Return management for web sales	7	8	8	8	7.75

5.4.3 Challenges in warehouse operations

During the data collection phase, interviewees answered an open question about the challenges in warehouse operations in omni-channel retailing. The answers are shown in Table 5.6.

From Table 5.6, it can be seen that handling fluctuation is mentioned in all the companies and packing is mentioned in three companies. As a result, handling fluctuation and packing are two important challenges in warehouse operations in omni-channel retailing.

Table 5. 6 The rating result of the challenges in warehouse operations

	Company A	**Company B**	**Company C**	**Company D**
Challenges in operations	Packing	Shipping	Packing	Packing
	Handling fluctuation	Return	Handling fluctuation	Handling fluctuation
		Handling fluctuation		

5.4.5 Summary

The different challenges in logistics performance, distribution system and warehouse operations are summarized in Table 5.7.

In Chapter 2.1.2, there are some theories about challenges and barriers for omni-channel. In theory, the main challenges and barriers are handling the differences such as different product assortment, managing prices between different channels and integration supply chain processes. There are some new findings about challenges after comparing the practice and the theory. In China, the companies using omni-channel logistics focus more on cost-effective material handling and increasing the delivery service that were not mentioned in the theory.

Table 5. 7 The summarization of the different challenges in using omni-channel retailing

Dimension	**Challenges**
Logistics performance	Minimizing lead time
	Maximizing the delivery service
Distribution system	Cost-effective material handling for web sales
	Return management for web sales
	Cost-effective material handling for store sales
Warehouse operations	Handling fluctuation
	Packing

5.5 Strategic logistics goals

Based on the contextual factors, there is a visual mapping of strategic logistics goals created. The map is shown in Figure 5.7. The logistics strategy goals could be divided into five aspects: Use the economy of scale, simplify complexity, increase flexibility, shorten lead times and reduce cost and tied-up capital. The companies can locate them in the map according to their own profiles.

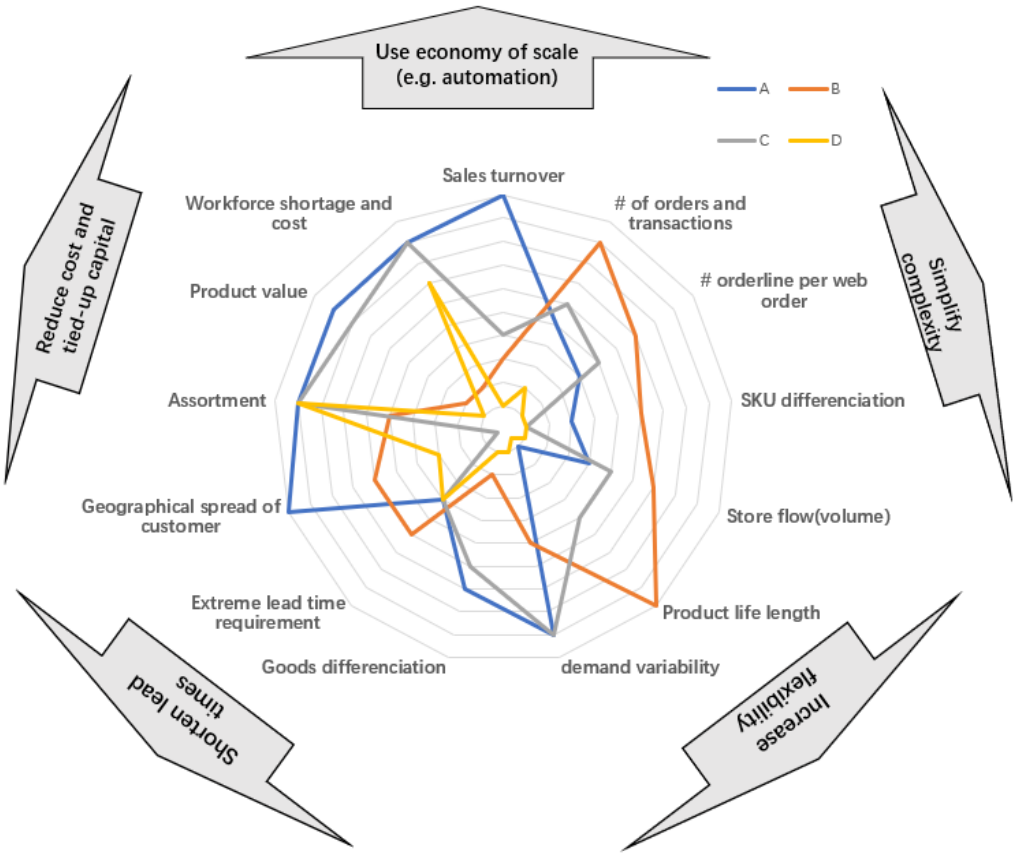


Figure 5. 7 Contextual factors and strategic logistics goals for different profiles

All the companies rate the lead time (8-9, see Table 5.4) as the most import factors, however, due to the already high level of lead time fulfillment. In China, the lead time requirement is quite high (in Chinese cases, from 6 hours to 3 days). However, because of the well development in last-mile delivery in China and cheap labor for staff in express delivery, the fulfillment is relatively high. Thus, the delivery level in China is at a high level. All the companies do not have a trend towards the strategies of shortening lead times.

Company A shows the trend towards the strategy of reducing cost and tied-up capital and using the economy of scale, which is actually in line with their second goal of minimizing tied-up capital and handling cost. Company B trend to focus on using the economy of scale, simplifying complexity and increasing flexibility because they have a long product life cycle, a large number of orders and transactions. Combined with companies' emphasis on the lead time, these results

to the investment in OFC, as Eriksson et al. (2019) discussed the operation solution of the grocery sector. Company C has a large assortment, high product value, high labor cost and large geographical spread of customer, so one of the strategic logistics goals is to reduce cost and tied-up capital. Company C also have high demand variability, so they strategically focus on increasing flexibility as well. Company D seems to be in reducing the cost and tied-up capital and using the economic scale. It has challenges in handling return orders in stores but high labor cost in the store operation. Thus, they could increase automation for the economy of scale and integrate storage to lower tied-up capital and cost.

5.6 Comparison to Swedish cases

There are both difference and similarities between Chinese cases and Swedish cases[7]. The following analysis has four perspectives: results in configuration elements, contextual factors, challenges, and retailer sectors.

In both China and Sweden, different companies have different solutions with regard to different configurations. One similarity is that all the companies in both counties have the trend to invest in higher automation. The same reason is the increasing volume in web orders. But the trend toward the degree of decentralized network is different. Swedish companies would prefer to be either more centralized or more decentralized. While Chinese companies will most likely have separated online fulfillment center in the future.

Table 5.8 shows the influence of different contextual factor in both the Chinese cases and Swedish cases. It could tell that most contextual factors that influence configuration elements in Swedish cases also applies to that in Chinese cases. However, there is one distinct contextual factors, the extreme lead time requirement, which in Chinese case is not important because of the high delivery level in China (as discussed in chapter 5.5). Demand variability is also not important in automation in Chinese cases, while the workforce is considered more important and relevant in the Chinese market, as the lower cost may lead to lower automation, where it for Swedish cases seems less important. Another big difference is in picking strategies, where Chinese companies consider the number of orders more important while Swedish companies seem to be influenced by goods characteristics and order characteristics.

[7] The companies are based on the study cases in Norrman and Kembro (2019)

Table 5. 8 The influence of contextual factors of Chinese cases and Swedish cases

Configuration elements	**Contextual factors**	**Chinese cases**	**Swedish cases**
		○ means included, × means not included	
Automation	Sales turnover	○	○
	Number of orders and transactions	○	○
	Goods size	○	○
	Package standardization	○	○
	Demand variability	×	○
	Workforce shortage and cost	○	×
	National legislation against automation	Not mentioned	×
Network Structure	Extreme lead time requirements	×	○
	Goods size	○	○
	Product life length	○	○
	Product value	○	○
	Assortment	○	○
	Geographical spread of customers	○	○
Storage Zones	Extreme lead time requirements	○	○
	Assortment	○	○
	Product value	○	○
Picking	SKU differentiation (store vs web)	○	○

Processes	Order differentiation (store vs web)	×	○
	Extreme lead time requirements	×	○
	Degree of automation	○	○
	Share of click-and-collect	○	○
Picking strategies	Goods size	○	○
	Goods standardization	×	○
	Degree of automation	○	○
	Extreme lead time requirements	×	○
	Order size (volume)	×	○
	Number of orders and transactions	○	Not mentioned

There is also the comparison of challenges for omni-channel retailing in warehouse operations and design between Chinese cases and Swedish cases. The similarities are that Chinese retailers and Swedish retailers both think that minimizing lead time and getting cost-effective material handling are the main challenges for implementing omni-channel retailing. There are some differences between Chinese cases and Swedish cases. Picking and inventory management are two main challenges in warehouse operations for Swedish retailers, however, Chinese companies think that handling fluctuation and packing are main challenges in warehouse operations.

The results of this thesis show some similar characteristic for similar retailer sectors in the two countries. For example, in the grocery sector cases, in both countries have unique features making them differ from sectors like fashion or consumer electronics. Grocery retailers share the same points in goods characteristics and order characteristics. In consumer electronics, the storage of all cases is going towards integrated. However, for the Chinese electronic case picking is simple, being batch picking that separate store replenishment orders and web orders. In the Swedish cases, there are different picking methods within the companies and between different consumer electronics companies. This may connect to the workforce and the cost of staff. Although Swedish cases share the same context regarding labor cost, in Chinese cases the cost of labor is much lower. This influence the companies' decision of automation, thus it influences their choice of storage and picking strategies.

6. Discussion and conclusion

The final chapter of this thesis answers three research questions in the beginning. The answers could be seen as conclusions based on the previous analysis and discussion. The findings are compared with Swedish cases. The chapter briefly explains the theoretical contribution, the limitation about this thesis and gives the suggestion for the future research direction.

The purpose of the thesis is to explore how Chinese retailers have adapted their warehouse operations and design to omni-channel logistics and find related retailers' experience, important contextual factors, and challenges. As the result, the authors investigated four companies in four different sectors which have already implemented omni-channel logistics in China to explore their experience. By interviews with warehouse and supply chain managers to get important practices about the warehouse operation and design. Then the authors concluded their challenges and analyzed the companies experiences and contextual factors through five dimensions, including: (1) type of network and handling hubs and (2) degree of automation; the decision to integrate or separate (3) storage zones and (4) picking processes; and (5) the choice of picking method. The related findings were mapped through the models. The authors' purpose has been addressed by completely answering the research questions.

6.1 Key findings

The most important findings to this thesis, first is the characteristic of Chinese retailers in their omni-channel warehousing experience that in Chinese market the lead time requirement can be fulfill at a high level, which in some way does not influence that much in managers decisions. Besides, the labor cost and the number of orders is the main consideration regarding the decision of automation. Second, Swedish cases have much similarities in contextual factors. Most perceived important factors in Swedish cases can applied to Chinese cases. However, due to the Chinese market characteristics there are some different influence in some contextual factors. Third, in line with the theory packing and maximizing delivery service are identified as the main challenges in our cases.

6.1.1 RQ1: What are retailers' experiences from transforming warehouse operations and design to omni-channel logistics in the Chinese market?

The retailers' experiences for four companies from four different sectors is divided into three perspectives: automation and network, integration and separation and picking strategies. For all the results, the authors could find the characteristic in the Chinese market. First, due to its low labor cost in distribution, the last-mile delivery is well developed which narrow the influence on lead time requirement from customers. All the customers of these four cases companies require a lead time less than three days, some even less than 6 hours. Because this is the general service level in the Chinese market. Second, the labor cost is a key consideration for a company's decision on automation. Investment in automation may cost much more than just use manpower. But there is still a trend to higher automation because of the increasing order volume. Third, most case companies would like to invest in an online fulfillment center in the future. Fourth, companies have different decisions on integration or separation between store

replenishment order and web orders. Most companies result in integrated decisions are that desire higher delivery services. Fifth, companies choose different picking strategies according to their own features in operation.

In general, the findings are in line with the highlight of previous theory. The decision of integration and separation shows its impact on companies performance especially on delivery services. As Shaohua et al. (2018) indicate, the capability of integration has a significant positive impact on companies' performance. Regarding automation solution, Chinese cases share the same circumstance as Kembro and Norrman (2019) emphasized, to increase effectiveness and efficiency in omni-channel warehouse operation, it is crucial to choose the type of automation and storage system as well as picking approach process. There is one inconclusive result that reducing tied-up capital while moving toward OFC seems contradictory in Chinese cases. In these investigated Chinese cases, the authors considered that the decision of moving into OFC mainly decided by considering the increasing number of orders. The perspective of reducing tied-up capital is seen within a warehouse regarding how to manage inventory. However, it is not surprising to find the grocery store due to its own order characteristics moving to OFC, which verifies the same reasons in the article of Eriksson et al. (2019).

6.1.2 RQ2: What are the contextual factors perceived important for implementing omni-channel warehousing in the Chinese market?

The second research question aims to find the reasons of retailers' experience, in other words exploring the critical contextual factors that influence the omni-channel warehousing. The research results are considered in three configuration elements in warehousing, including 1) automation and network structure, 2) integration and separation, and 3) picking strategies.

For the first configuration elements, the contextual factors that influence companies' status toward automation include *sales turnover, number of orders and transactions, goods size, package standardization,* and *workforce shortage and cost*. The factors that drive the companies to a higher degree of decentralization are *product life length* and *geographical spread of customer. Product value* and *assortment* vary by different companies. *Extreme lead time requirement* might be important in other cases but not in this study.

Secondly, the contextual factors that drive towards higher integration in storage zones between store replenishment and web orders are *assortment* and *product value.* Companies with higher product value and assortment may have a trend to storage integration. The factors driving towards higher integration in the picking process are *SKU differentiation (store vs. web), degree of automation*, and *share of click-and-collect*. *Extreme lead time requirement* and *order differentiation (store vs. web) is not relevant.*

For the third configuration, the contextual factors that influence the picking strategies are *goods size, number of orders* and *degree of automation.* But *goods standardization*, *extreme lead time requirement,* and *order size(volume)* are not relevant in this study.

Warehousing is the core of the distribution system(Faber et al., 2013), as the related contextual factors show that there are many important factors play an important role in meeting shorter lead time and lower logistics cost. There are some unexpected results that shows the difference between Swedish cases and Chinses cases. First is the lead time requirement and labor cost, as previous chapter 5.6 explained in Chinese market the delivery service is well developed. Thus, in our result model this contextual factors considered not that important in decision making in these cases. The number of orders influences a lot in companies' decisions which shows its impartable relation of the rapid development of e-commerce in China, as Ye et al. (2018) illustrated. Due to the characteristics of each company own order number and operation, order number is important in Chinese cases, which differs from Swedish cases that the goods standardization and order size are important.

6.1.3 RQ3: What are the challenges for implementing potential solutions in omni-channel warehousing?

The challenges for implementing omni-channel logistics in warehousing are divided into three perspectives: logistics performance, distribution system and warehouse operations. In logistics performance, the two main challenges for implementing omni-channel logistics are minimizing lead time and maximizing delivery service. Consumers in China have high requirements for delivery time and delivery service.

Related to the distribution system, there are three main challenges which are cost-effective material handling for web sales, return management for web sales, and cost-effective material handling for store sales. Cost-effective material handling is an important challenge in omni-channel retailing in China. It is also one of the ways companies increase their income. With web sales increasing, return management for web sales also became an important challenge.

In warehouse operations, handling fluctuation and packing are two main challenges for implementing omni-channel retailing. Labor shortages and difficulties in company planning led handling fluctuation became an important challenge. Due to order size and different shipping requirements between web orders and store orders, packing is another challenge in warehouse operations for omni-channel retailing in China.

6.1.4 Comparison to Swedish cases

Firstly, regarding different configurations, in both counties, all the companies have the similarity of investing in higher automation. But two countries have a different trend toward the degree of a decentralized network. Secondly, most contextual factors that influence configuration elements in Swedish cases also applies to that in Chinese cases, except some factors like lead time requirement, demand variability in automation, workforce, and the number of orders, due to the different situation in two countries. Thirdly, both counties consider minimizing lead time and getting cost-effective material handling are the main challenges, but handling fluctuation and packing is more challenging in China and picking and inventory management is the challenge of the Swedish cases. Fourth, both countries share the same order and product characteristics of

the grocery sector, but due to the differences in labor cost in two countries, they have a different solution to picking and storage in the electronics sector.

As Ye et al. (2018) indicate, the main challenges in omni-channel retailing are inability to manage different channels and loss of competitive edge. In our findings, packing and maximizing delivery service are the main challenges. These findings are generally in line with the theory. In addition to these, in our findings handling fluctuation and cost-effective handling are the main challenges that are not mentioned in the previous theory.

6.2 Practical and theoretical contribution

6.2.1 Practical contribution

The purpose of the thesis is to explore how Chinese retailers have adapted their warehouse operations and design to omni-channel logistics and find related retailers' experience, important contextual factors, and challenges. This thesis has, based on four cases, generated findings and given an overview of the development of omni-channel warehousing in the Chinese market. These provided retailers' experience with regards to automation, integration, and picking can be referred to for future market investor. Besides, the thesis provides valuable information in contextual factors to support Chinese companies when they want to implement or improve omni-channel warehousing and suggests the related strategic logistics goal to difference companies' profile.

6.2.2 Theoretical contribution

This thesis provides a research database in warehousing operation and design of omni-channel logistics, especially in China, a developed country. It concludes the challenges in omni-channel warehousing in China and discusses the important contextual factors of omni-channel warehousing, particularly in warehouse operations of storing and picking and in warehouse design of automation and distribution network. In addition, these research findings also exam the models provided by Norrman and Kembro (2019) related to configuration elements and contextual factors (Figure 2.8, 2.9-2.12). Thus, the thesis also offers a comparison to the Swedish market regard to the models and cases in Norrman and Kembro (2019), and finding similarities and differences in grocery sector according to Eriksson et al. (2019).

6.3 Limitations

There are three main limitations in this study. First, the number of companies interviewed is only four, creating a limitation for this thesis. The data collected may hence not fully represent the status of omni-channel retailing in China. The four companies came from four different industries so the data collected could not be compared within one industry. The data collected were obtained when the interviewees answered the questions designed before the interviews. Therefore, the important contextual factors found are limited to the scope of our design.

Second, the collected data is qualitative data, and the analysis uses a qualitative analysis method. Interviewees are subject to subjective factors in interviews. For example, the labor cost of a company is lower than that of other companies, but the interviewees believe that the labor cost is very high that looks at the same level as other companies. This may have an impact on the results of the analysis.

Third, this thesis is an exploratory study. There is limited theory in the field. Inadequate academic research also creates a limitation for this thesis. Besides, the research results mainly considered three configuration elements, making the exploration of other configurations limited.

6.4 Future research

Since our analysis is based on only four cases, more findings are needed to prove the conclusion. Firstly, future research in related fields can be based on the three aspects this thesis involved in. Researchers can use one or more of these aspects as a reference and comparison object, and then use multiple case studies to validate our conclusions. Researchers can focus more on a particular retail sector. In this way, the comparison within the industry is carried out to obtain a conclusion for a certain sector. Researchers can use on-site observations, company data reports to obtain more quantitative data to reduce the impact of subjective factors on the analysis.

Secondly, in our findings, there are some differences about contextual factors between Swedish cases and Chinese cases. For example, workforce shortage and cost is an important contextual factor for automation in Chinese cases, but it is not contextual factor in Swedish cases. Researchers could investigate more differences between Swedish cases and Chinese cases and try to find the reason why these differences exist.

Thirdly, there are some challenges in omni-channel retailing introduced in our thesis, but it lacks detailed solutions. Researchers could try to find some experience or potential solutions for dealing with these challenges.

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Appendix

Appendix 1. The interview guide (English)

1. What is the origin of your company?
A. physical store
B. e-commerce
C. entity combined online

2. Degree of decentralized network of web orders
A. DC + many store-hubs
B. DC + selected store-hubs
C. DC + sorting nodes
D. DC + separated Online Fulfillment Centers(OFC)
E. Integrated DC
F. DC + Drop shipments

3. What is the company's target degree of decentralized network of web orders ?
A. DC + many store-hubs
B. DC + selected store-hubs
C. DC + sorting nodes
D. DC + separated On-line Fulfillment Centers(OFC)
E. Integrated DC
F. DC + Drop shipments

4.How do you define the degree of automation of your warehouse (From Manually → highly automated numbered from 1 to 10)

5. What is the target degree of automation of the company's warehouse?

6. For handling store replenishment and web orders in the warehouse, do you use integrate or separate storage zones?/picking zones?/packing and shipping zones?

7. For store replenishment order/web order, how many orders does a picker pick at the same time?

8. For store replenishment order/web order, within a picking does a picker account for a single product or many products?

9. What's the average number of order lines per store order?

10. What's the average number of order lines per online order?

11. What is the difference in packages (size) between store and web?

12. What is the volume and frequency of the store flow (volume) per week?

13. What is the average picking efficiency? # of order per hour

14. What is the assortment range? Large, average or small

15. How long is the product life cycle? How frequent is the introduction of new products in a year?(low, seasonal, high...)

16. How is the demand fluctuations?

17. How is the goods differentiation in terms of weight, volume, price and handling requirements?

18. What is the lead-time requirement?

19. What is the average lead time for delivery?

20. What is the average service level?

21. What is the share of sales through online channels?

22. How many physical stores does the company have?

23. How many cities has the company set up shop?

24. What percentage of the store is used as a product processing node?

25. Do you have a centralized e-commerce solution, or does each store have its own solution?

26. What's the degree of outsourcing in the network(warehouse and DC)
A. In house
B. Outsourced to a 3rd party
C. Mix

27. What are the staff employed by?
A. Normal position employed by the company
B. Normal position employed by the 3/4PL

28. At peak demand how do you deal with labor capacity?

29. How is the cost for land and salaries? (low, high)

30. What's the characteristic of inventory management
A. Joint with full visibility
B. Joint control but stock in store are separate
C. All controlled separately

31. Compared with e-commerce, are the types of goods in brick-and-mortar stores the same?

32. How often are products delivered to physical stores?

33. Which of the following information systems are used in your warehouses?
A. ERP
B. WMS

34. What functions do your information system have?

35. Could return goods be done in different locations?

36. How do you rank these parameters critical to the warehouse operation?(1-10)
A. Maximize profitability
B. Minimize lead time
C. Minimize environmental impact
D. Minimize handling costs
E. Minimize backlog in a node
F. Minimize capital tied
G. Maximize delivery service
H. Capacity levels in different node

37. What technology do you use in your warehouse?

38. How do you rank these parameters ?（1-10）
A. Delivery service level for store sales
B. Delivery service level for online sales
C. Cost-effective material handling for store sales
D. Cost-effective material handling for online sales
E. Return management for store sales
F. Return management for online sales

39. What's the method of your picking and sorting
A. Manual
B. Automatic
C. Semi-automatic

40. What is the average pickup cost? In store/online

41. What is the average picking accuracy? %

42. Which has a higher priority? Online order or Store order

43. Which process do you use automation in?
A. Receiving
B. Put-away
C. Picking
D. Sorting
E. Packing
F. Shipping
G. Return management

44.What are the top three challenges for material handling to omni-channel?
A. Receiving
B. Put-away
C. Picking
D. Sorting
E. Packing
F. Shipping
G. Return management
H. Using stores as material handling nodes
I. Varied order volume

Appendix 2. The interview guide (Chinese) 采访指导（中文）

1.贵公司的起源是什么？

A 实体店

B 电子商务

C 实体在线相结合

2.网络订单配送体系是什么？

A 配送中心+多个商店中心

B 配送中心+选定的商店中心

C 配送中心+分类节点

D 配送中心+分离式在线配送中心（OFC）

E 配送中心+第三方转运配送

3.公司目标的网络订单配送体系是什么？

A 配送中心+多个商店中心

B 配送中心+选定的商店中心

C 配送中心+分类节点

D 配送中心+分离式在线配送中心（OFC）

E 配送中心+第三方转运配送

4.如何定义公司仓库的自动化程度？（从手动→高度自动化，从 1 到 10）

5.公司目标的仓库自动化程度是多少？

6.在处理商店补货和网络订单时，仓库使用集成还是单独的存储区域？

在处理商店补货和网络订单时，仓库使用集成还是分离的拣货流程？

在处理商店补货和网络订单时，仓库使用集成还是分离的包装和装车区域？

7.对于商店补货订单/网络订单，拣货人员同时负责多少订单？

8.对于商店补货订单/网络订单，在单次拣货过程内，拣货人员负责单个产品还是多种产品？

9.每个商店订单的平均产品种类数量是多少？

10.每个在线订单的平均产品种类数量是多少？

11.商店订单和网络订单之间的包装（尺寸）有什么不同？

12.每周商店流量（体积）的数量和频率是多少？

13.每小时平均订单处理数量是多少？

14.同一订单内，产品的多样性如何？（大，平均，小）

15.产品生命周期有多长？一年内推出新产品的频率如何？（低，季节性，高）

16.订单量如何波动？

17.在线和实体零售下，货物在重量，数量，价格和处理要求方面的差异如何？

18.交货时间的要求是多少？

19.配送的平均准备时间是多少？

20.平均客户服务水平是多少？（在协议供货时间内完成的百分比）

21.通过在线渠道销售的份额是多少？

22. 公司现有实体店多少？

23.公司在多少个城市设立了商店？

24.商店用作产品处理节点的百分比是多少？

25.您是否拥有集中的电子商务解决方案，或者每个商店都有自己的解决方案？

26.物流的外包程度是什么（仓库和配送中心）？

A 公司内部负责物流

B 外包给第三方

C 混合

27.受雇的员工是什么？

A 公司的正常职位

B 第三方公司

28.在需求高峰时，公司如何处理劳动力不足？

29.员工工资和场地租金成本分别如何？（低，高）

30.库存管理的特点是什么？

A 联合且全面可见

B 联合控制但存储库存是分开的

C 全部单独控制

31.与电子商务相比，实体商店中的商品种类是否相同？

32. 产品配送实体商店的频率是多少？

33.公司的仓库中使用了如下信息系统？

A 企业资源计划

B 仓库管理系统

34.公司的信息系统有哪些功能？（广泛意义上）

35.消费者是否可以在不同地点退货？

36.您如何对如下仓库运营参数的重要性进行打分？（1-10）

A 最大化盈利能力

B 最大限度地缩短交货时间

C 尽量减少对环境的影响

D 最大限度地降低处理成本

E 最小化节点中的积压

F 最大限度地降低资本

G 最大化送货服务

H 不同节点的容量级别

37.公司在仓库运营中使用了哪些技术？

38.您如何如下参数的重要性进行打分？（1-10）

A 实体销售的送货服务水平

B 在线销售的送货服务水平

C 实体销售的经济有效的物料处理

D 具有成本效益的在线销售物料处理

E 实体销售的退货管理

F 在线销售的退货管理

39.公司的拣货方法是什么？

A 人工

B 自动化

C 半自动

40.平均提货成本是多少？

41.平均拣选准确度是多少？

42.在线订单和实体订单相比，哪个优先级更高？

43.在哪些操作中，使用了自动化处理？

A 接收

B 储存

C 拣货

D 分类

E 包装

F 运输

G 退货管理

44.在如下方面中，您认为全渠道零售面临的挑战有哪几个？

A 接收

B 储存

C 拣货

D 分类

E 包装

F 运输

G 退货管理

H 使用商店作为物料处理节点

I 订单量波动