CHALMERS
UNIVERSITY OF TECHNOLOGY

Defining the concept of city hub in urban consolidation schemes

A case study in the city of Gothenburg

Master's thesis in Supply Chain Management

Angel Reyna López
Daniel Serrano Cáceres

DEPARTMENT OF TECHNOLOGY MANAGEMENT AND ECONOMICS
DIVISON OF SERVICE MANAGEMENT AND LOGISTICS

CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2020
www.chalmers.se
Report No. E2020:070

REPORT NO. E 2020:070

Defining the concept of city hub in urban consolidation schemes

A case study in the city of Gothenburg

Angel Reyna López
Daniel Serrano Cáceres

Department of Technology Management and Economics
Division of Service Management and Logistics
CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2020

Defining the concept of city hub in urban consolidation schemes
Angel Reyna López
Daniel Serrano Cáceres

Supervisor:
Sönke Behrends, Ph.D.
Project Manager, IVL

Examiner:
Iván Sanchez-Diaz, Associate Professor
Department of Technology Management and Economics

Report no. E2020:070
Department of Technology Management and Economics
Chalmers University of Technology
SE-412 96 Gothenburg
Sweden
Telephone + 46 (0)31-772 1000

Gothenburg, Sweden 2020

Defining the concept of city hub in urban consolidation schemes

Angel Reyna López
Daniel Serrano Cáceres

Department of Technology Management and Economics
Chalmers University of Technology

SUMMARY
Poor inner-city environment which is reflected in the levels of noise, contamination and traffic is a rising issue due to the need for goods movement to grocery stores, restaurants, retail shops, amongst others. Different strategies have been used to tackle such phenomena within city logistics, where Urban Consolidation Centers have emerged as a possible solution. However, UCC struggles to find financial viability, causing the closure from various schemes.
This project studied the different functions, activities, resources and value-added services needed at urban consolidation terminals, to also provide a suggestion to an ongoing project which aims to establish a fully operational city hub in the city of Gothenburg. This Urban consolidation scheme is visualized as a collaborative transport system where actors that perform the last-mile delivery in cargo bikes to the city center of Gothenburg are established. However, the terminal is currently not fully operational. The results of this master thesis showed that urban consolidation schemes could have different levels of complexity, although most initiatives start off with basic operations in which manual systems are used and limited value-added services are provided. However, as the initiatives become financially viable, their resources and provided value added services increase in complexity, achieving higher levels of efficiency and expanding the value-offer to the receivers.

Keywords: Urban Consolidation Centre, warehousing, distribution center, logistic terminal, city logistics, urban logistics, city hub.

Acknowledgments

This Master thesis was performed during the spring of 2020 at the division of Service Management and Logistics at Chalmers University of Technology in Gothenburg. This Master thesis was performed within the master program Supply Chain Management.

We would like to thank everyone who has contributed to the completion of this project, including all the different representatives from companies who in spite of COVID-19, agreed to have interviews and study visits. We would also like to give special thanks to both our supervisors. Firstly, to Sönke Behrends, our supervisor at IVL. We are truly grateful for the opportunity you gave us to perform this master thesis. Your immense support throughout this project, knowledge and willingness to help were a source of motivation and clearly indispensable for the results. We hope that you find our thesis useful. Secondly, to Iván Sánchez, our supervisor from Chalmers. Your guidance, support and feedback throughout this project has been vital for the outcome of this project.

Angel Reyna López and Daniel Serrano Cáceres
Gothenburg, June 2020

LIST OF ABBREVIATIONS

4PL Fourth-Party Logistics
AGV Automated Guided Vehicles
AS/RS Automated Storage / Retrieval Systems
B2B Business-to-Business
B2C Business-to-Customer
BSS Binnenstadservice
CFS Container Freight Station
CFTS Cooperative Freight Transport Systems
CL City Logistics
CNG Compressed Natural Gas
CO2 Carbon dioxide
COVID-19 Coronavirus disease 2019
CP Cityporto Padova
DHL Dalsey, Hillblom and Lynn
FTL Full Truck Load
FV Freight Village
GBP British pound sterling
GLC Göteborgs Lastbilcentral
HR/DAY Hours per day
ICD Inland Container Depots
IP Inland Port
IT Information Technology
IVL IVL Svenska Miljöinstitutet
Kg Kilogram
KM Kilometer
LSP Logistics Service Provider
LTL Less than a Truck Load
MCC Meadowhall Consolidation Centre
NGO Non-governmental organisation
NOx Nitrogen oxide
RFID Radio Frequency Identification
SKU Stock Keeping Unit
SME Small and medium-sized businesses
SMOOTh SysteM-Of-Systems for sustainable urban gOods Transports
SQM Square meters
TGL The Green Link
TNT Thomas Nationwide Transport
UCC Urban Consolidation Centre
UCS Urban Consolidation Scheme
UK United Kingdom
XL Extra Large
XXL Extra-extra Large

Table of Contents

1. Introduction

This chapter introduces firstly the background to this thesis, which provides a basic overview about the need of the distribution of goods and its challenges. Thereafter, the problem is presented. Lastly, the aim and research questions for this project will be stated, together with limitations for this project.

1.1 Background

The movement of goods plays a key role in every day's life and economy, where most industries and economic activities from grocery stores, restaurants, retail shops, amongst others rely heavily in the distribution of goods (Barone & Roach, 2016). The need for goods distribution has been increasing at an alarming rate due to globalization (Thompson & Taniguchi, 2015), and as a result, a significant amount of jobs is generated, although, challenges such as traffic congestion, CO2 emissions and noise need to be diminished (Barone & Roach, 2016). Additionally, retailers who are located in high density areas might have low levels of in-store storage due to retail space charged at a premium, which creates the need for more frequent deliveries (Rodrigue, 2017). However, these deliveries need to occur and unfortunately, there are limited alternatives than road for completing them. Some trends such as better engine designs as well as the phase out of leaded fuel have helped decrease air pollution and noise (Rodrigue, 2017), although it does not provide a solution for congestion rates and the unreliability of deliveries. This creates a disruption in the transportation system, which causes delays and uncertainties that add to the cost of transportation (Thompson & Taniguchi, 2015). Also, with the growth of e-commerce, a higher rate of returns has also been experienced as well as consumers' desire for fast delivery times (Rodrigue, 2017), which increases even more the pressure for the supply chains.

Different solutions for the better moving of goods have been addressed previously by Barone & Roach (2016). For instance, with the aim of making cities more liveable and to address the challenges of trucks finding access to their final destination to unload their goods, strategies such as increasing the amount of truck parking and loading areas, introducing pedestrian and friendly means of deliveries i.e. roads for bicycles and the construction of Urban Consolidation Centres, could represent an opportunity to minimize some of the issues previously mentioned. Other strategies aim towards configuring the buildings to handle freight. For example, by redesigning loading docks and urban buildings to accommodate both modern trucks and delivery volumes or implementing off-hours deliveries. Some strategies could be focused towards policy making, e.g. considering low emission zones in dense urban centres or promoting a transition to alternatively fuelled vehicles. Lastly, strategies can be focused towards creating behavioural and technological shifts, for instance, by educating receivers about the benefits of consolidation, so that shippers can combine deliveries on behalf of the receivers. According to Barone & Roach (2016), these strategies aim to mitigate the impact of goods movement, which "will not and cannot disappear", since people need goods to maintain their lifestyles.

1.2 Problem

Fragmented Urban freight is leading to a poor inner-city environment which can be perceived in current environmental and traffic issues. However, Urban Consolidation Centres (UCC) are regarded as a means within city logistics that allows freight distribution to take place in urban areas, while still alleviating concerns with greenhouse gas emissions, noise and congestion. Browne et al. (2005) define UCC as "a facility that is situated in relatively close proximity to the urban area that serves a city centre, an entire town or a specific site (for example a shopping centre), from which deliveries are pooled in this area". The concept of UCC has been studied since the seventies (van Rooijen et al., 2010), implemented in different countries, yet they struggle to operate on a commercial basis. Several studies have been performed, aiming to understand the reasons why UCC initiatives fail. For instance, Nordtømme et al., (2015) argue that the main causes are the mismatch between the needs of the receivers and the carriers, as well as the terminal cost when fully operational. Allen et al., (2012) describes the lack of public funding as one of the main causes. Authors such as Lagorio et al., (2016a) confirmed some of the previous findings and described three different scenarios why Urban Consolidation centres fail, i.e., the total cost of ownership of the terminal, the lack of stakeholder participation and the lack of public funds.

Currently, there is no clear scope of the functions and services that UCC needs to provide, neither a clear facility design. Björklund & Johannson (2018) identified the lack of consideration to the activities happening in the UCC, indicating that the literature only addresses superficially this area. Browne et al. (2005) affirm that Urban Consolidation Centres can provide different value-adding activities as a complement to the basic services of storage and transhipment, arguing that some of the activities that could take place at the terminal are pre-retail activities, waste and return handling, amongst others. Allen et al., (2012) argue that UCC projects should keep the initial cost low and develop different added services over time. This, aiming to lower the risk of not being competitive compared with the services previously offered by other carriers or being too dependent on the public funds.

Lastly, the literature does not provide a clear overview of how an Urban Consolidation centre should physically look like. Although considering the basic services provided by UCC (storing & transhipment), the layout could resemble how warehouses and cross-docking terminals are designed.

1.3 Aim

The aim of this project is to define the functions and principle design of city hubs in collaborative transport systems.

1.4 Research questions

The project aims to answer the four following research questions:

RQ1: What terminal functions are required at city hubs?
RQ2: What value-adding services can be provided at city hubs?
RQ3: What resources are needed to provide the city hub functions and value-adding services?
RQ4: What are the principle design elements of city hubs?

1.4 Scope and limitations

This thesis takes a case study approach which is part of an ongoing project in the city of Gothenburg called SMOOTh. This project has been initiated as an initiative which aims to develop solutions to reduce traffic congestion and overcome environmental challenges in the city center of Gothenburg (AB Volvo, 2019). In order to avoid the inefficiencies of urban deliveries, the project is developing a complementary solution to an Urban Consolidation Centre, currently located in the suburbs of Gothenburg (GLC). This solution is the development of a City Hub located in Nordstan Shopping Centre, which will serve as an Urban Consolidation Centre whose main purpose is to avoid the need for good deliveries in the City Centre. This thesis is focused only on the case study in the city center of Gothenburg, the Urban Consolidation Centre located in the suburbs of Gothenburg (GLC), which feeds the city hub in Nordstan was not studied, however, it was used as a source of relevant data.

Qualitative data was gathered from interviews to stakeholders of SMOOTh, as well as site visits to comparable schemes to the City Hub in Nordstan within the city of Gothenburg. However, performing interviews with receivers (store owners) was considered out of the scope due to time limitations and to the focus of this thesis on the logistics operators in the city hub in Nordstan. Furthermore, the number of interviews with relevant actors within urban logistics and to the SMOOTh project was constrained due to limitations regarding COVID-19, which lead also to relying more on secondary than primary data.

Finally, the scope of the project does not include any implementation, which means that it will provide only inspiration to the stakeholders of SMOOTh project for future implementation.

2. Literature review

This chapter presents a literature review on the researched topic. In the beginning, an introduction to the terms of Urban Logistics & City logistics is presented, which sets the ground for this project. Thereafter, the concept of collaborative logistics is introduced. A definition of the concept of "terminal" will follow, together with the different terminal processes and terminal functions. Hereafter, a typology of the different terminals by Higgins et al., (2012) is presented, including a literature review on each of the terminal types. In this section, only the most representative terminals to the topic under investigation were profoundly developed. Following, the concept of Urban Consolidation Centre (UCC) is introduced, which will be complemented by an introduction on successful UCC cases established at different locations. Finally, a synthesis of the literature review is presented.

2.1 Urban Logistics & City Logistics

As a result of the continuous increase of population living in urban zones, different concerns arise, such as safety, pollution as well as different logistic challenges. The freight transport challenges become one of the main focus for urban logistics because of the incremental demand driven by the development of e-commerce and the synchrony and harmony of the different flow of goods (Lagorio et al., 2016b). Urban logistics research is still in development, which is aligned with the continuous transformation of habits such as the increase in demand for e-commerce and the increase focus on sustainable logistics solutions. The concept of urban logistics is often used interchangeable with city logistics (CL), which aim to find alternatives to reduce the negative impacts of logistics in the cities, by improving the deliveries of goods (Lagorio et al., 2016b).

Thompson & Taniguchi (2015) defined the concept of city logistics as "the process for totally optimizing the logistics and transport activities by private companies with the support of advanced information systems in urban areas considering the traffic environment, the traffic congestion, the traffic safety and the energy savings within the framework of a market economy". This concept is an integrated approach of those aspects with the contribution of different disciplines such as transport planning, systems engineering, economics, social science, information engineering and land use planning (Thompson & Taniguchi, 2015).

A seamless and continuous flow of goods is required in operative urban logistics systems. This need for goods flow is achieved with low traffic congestion within the cities (Thompson & Taniguchi, 2015). At the same time, the reliability of urban freight transport is a requirement in operative urban logistics systems where connectivity and time travels are the main tasks to be achieved. The negative impact of freight transport in the cities, including the noise, air pollution, and vehicle vibration, have to be diminished or preferably eliminated (Thompson & Taniguchi, 2015). This is part of the sustainable goals of the urban logistics systems since they look for efficient vehicles that would diminish the carbon footprint of the transport of goods.

The main stakeholders that are involved in the city logistics approach are the shippers, the freight carriers, administrators and residents (Thompson & Taniguchi, 2015). Some authors consider a fifth stakeholder classified as "others" in which, for example, the NGOs and property owners are included (Katsela & Pålsson, 2020). The main objective of the shipper is to deliver goods in the most efficient and low-cost way possible, offering a high service level (Katsela & Pålsson, 2020). The freight carrier´s main interest is to have as much operation as possible with cost-efficient deliveries (Katsela & Pålsson, 2020). The government and the city administrators are looking for minimal environmental impact of the urban freight operations in regards to city logistics performance (Katsela & Pålsson, 2020). Additionally, the administrator's interests belong to the promotion of economic activity and the attractiveness of the city. The city residents seek safety and a healthy environment, where they can prosper and take care of their families.

The stakeholders involved in the city logistics do not always have a positive or negative influence of the success of the logistics operations since they do not have the same motives to participate in city logistics initiatives (Katsela & Pålsson, 2020). However, the involved stakeholders have to collaborate to meet common goals. High diversity and heterogeneity of needs and objectives can create communication barriers between the stakeholders in both the public and private sector (Katsela & Pålsson, 2020). Conflicts amongst stakeholders can be generated due to the scarcity of space to operate freight transports and warehouses. The density of the city is another point of conflict between stakeholders due to the impossibility to generate efficient strategies in highly dense zones of the metropolis (Katsela & Pålsson, 2020).

An important aspect of urban logistics is the last mile delivery. The last mile logistics concept looks for enhancing reliability, cost efficiency, effective resource planning and sustainable solutions (de Souza et al., 2013). As a result of that, the service level and the contractual commitment between the different involved stakeholders are competitively affected by each other. For those reasons, the collaborative logistics plays an important role for completing business objectives and customers' demands.

2.1.1 Collaborative logistics

Relationships in logistics are not only the ones between shipper and the goods receiver. The relations happen in the common triad setup, which is composed by the relationships between shipper-carrier and receiver-carrier are rarely been covered (Gammelgaard et al., 2006). Larson & Gammelgaard (2001) defined the logistics triad as the cooperative three-way relationship between the buyer, the supplier and the logistics service provider who give support for storing and moving the goods between the buyer and the supplier. Stefansson & Russell (2008) mentioned three key players in collaborative logistics management; the transportation carriers, logistics service providers and the logistics service intermediaries. Even though the outsourcing of transport and logistics services contribute with more efficient management of information and transportation of goods, the flow of materials and information becomes more complex and a potential bottleneck (Stefansson & Russell, 2008).

Due to global markets, it is required high level of logistics coordination with focus on connecting and integrating dispersed resources to obtain competitiveness in the market (Wang et al., 2019). Therefore, it becomes highly complex to identify relevant information about which organizations' resources are available as well as other essential data to execute collaborative logistics processes (Stefansson & Russell, 2008). In global enterprise networks, superior companies such as Apple, Dell, Samsung, amongst others, are able to manage their whole supply chain (Li et al., 2015). At the same time, their partner companies share their information with these enterprises. The members of this network share their suppliers and customers with other companies. But the information sharing mostly happens with their direct suppliers and customers. It is hard to carry out the next levels of supplier and customer relationships (Li et al., 2015). Therefore, the process and data fragmentation become the main challenge in the supply chain for those companies.

In order to solve urban logistics challenges, cooperative freight transport systems (CFTS) play an important role. Thompson & Taniguchi (2015) defined CFTS as the system that several entities cooperatively operate all or just part of the transport elements. Information and communication technologies are often implemented in this system. The implementation of a cooperative freight transport system can lead to the reduction of the total transport used and the increase of utilization of them (Thompson & Taniguchi, 2015). CFTS not only collects and delivers goods from a terminal but also it is used for flow of information. Restrictions of delivery times, problems related to not meeting customer needs and different limitations coming from specific material handling specifications, are the different challenges presented with the collaborative logistic systems implementation (Yamada et al., 1999).

2.2 Logistic terminal concept

The term "logistics" has several definitions. Bowersox et al. (1986) defined it as a science of the flow of materials that guarantees the logical and assures the progression of storage and streams of supplies. This progress is performed through the manufacturing plant and the supply chain that ends with the final customer (Bowersox et.al., 1986). Johannessen & Solem (2002) defined logistics as the interplay of modelling, organization, coordination, management and control activities that start from the sourcing of the materials through the manufacturing processes which ends with the end customer. Palšaitis (2004) referred to logistics as the control of resource flows within the supply chain. Also, Palšaitis (2004) added that logistics include the management of the transportation and storage areas.

Likewise, there have been numerous terms for logistic centers. In Europe, the main terms of referring to a logistic center can be arranged by countries. For instance, in the United Kingdom, where they are referred to as “Freight Villages” (Meidute, 2005). In Italy, the common concept for terminals is “Interporto”, in Germany are known as "Güterverkehrszentrum”, in France as “Plateforme Logistique” and in Denmark as “Transport Centre” (Meidute, 2005). During the past decade, terms referring to logistic terminals were developed. Freight village, inland port, dry port, inland terminal, freight hub and freight gateway are some examples (Higgins et. al., 2012). These concepts are defined with a wide variety of scales and roles; referring concepts from the simple terminals with specific functions to complex terminals where business relationships and legal entities are included within the logistic zones (Higgins et. al., 2012). Tsamboulas & Kapros (2003) defined a logistic center as an integrator of various transport modes that enables intermodal transport. This definition was also seen in Konings (1996) where he mentioned that the organizations of logistic centers are interrelated with the intermodal transport chain structure. Konings (1996) also stated that logistics centers are part of an integrated transport system where the shipper develops and operates terminals and rail/barge/maritime transport segments.

A logistic center can also be seen as a terminal. Jean-Paul Rodrigue (2020) defined a terminal as “any location where freight and passengers either originate, terminate, or are handled in the transportation process”. This excludes the transportation of individual trips like pedestrian and private vehicular travels. Terminals become the central and intermediate locations that enable the transportation of passengers and freight (Rodrigue, 2020). According to Rodrigue (2020), the size of a terminal comes along with the importance of their operations. The large terminals like the airports and seaports are considered as gateways and hubs (Rodrigue, 2020). Both concepts are known as the locations where the movement of passengers and freight converge. However, hubs are the terminals where there are several inbound and outbound connections of the same transport mode (Rodrigue, 2020). The gateways are considered as the central locations where the connections imply a shift between modes.

2.3 Terminal processes

Terminals are an important element for all the supply chains because of the contribution they have with handling material processes. The material handling processes relate to the movement of goods from the production plant to customer facilities (Kłodawski et al., 2017a). A terminal such as a warehouse requires processes that can be defined as a set of actions associated with receiving, storage, picking and shipping of products or goods in a suitable adapted place, under particular organizational and technological conditions (Kłodawski et al., 2017a).

The warehouse processes can obtain many different forms, including multiple sub-components. The functions and tasks of the logistics facility determine the selection and the different connections of the warehouse process elements (Kłodawski et al., 2017a). Production, distribution or even cross-docking terminals perform a wide variety of transformations. The elements of the terminal processes are set in a relevant and useful sequence of actions performed and finished through given goals and objectives. Table 1 provides the most common sub-processes and activities included in a logistic terminal or warehouse.

Table 1. Processes and activities at a terminal (Kłodawski et al., 2017a)

Sub-process	**Activity**	**Transformation**
Receiving	Unloading	place
	Cargo identification and control	time
	Buffering	time
Put-away	Transport to storage area	place
	Placing unit loads in storage loation	place
Storage	-	time
Replenishment	Transport to order picking area	place
	Transformation of unit loads to form offered in order picking	form
	Replenishment to pick locations	place
	Placing remaining unit loads in storage location	place
	Placing in selected location empty bins (pallets)	place
Order picking	Replenishment to pick locations	place
	Preparing items for picking	form
	Picking items	place
	Sorting, packing, preparing picked unit loads for transport	form
	Transport of prepared unit loads to selected place in order picking area	place
	Transport of prepared unit loads to buffer	place
Co-packing	Transport of unit loads to co-packing stations	palce
	Preparing items for co-packing	form
	Creation new SKU (e.g. Promotional SKU sets, combined SKU)	form
	Packaging, labelling, tagging, foiling, etc.	form
	Transport of prepared unit loads to selected place of buffer	place
Consolidation, deconsolidation, sortation	-	form (quantity)
Shipping	Buffering	time
	Cargo identification and control	time
	Loading	place
Material return policy, utilization	Cargo identification and control	time
	Buffering	time
	Loading	place
Crossdocking	Transport from input buffer to output buffer	place

The first task to be performed at a terminal is the receiving process. This process is carried out on products delivered to the terminal and the basic elements of such processes are unloading, identification, control and buffering (Kłodawski et al., 2017b). Figure 1 exemplifies the process of receiving material in a terminal. Thereafter, the put-away process is executed in which received materials are transferred to the storage areas into a particular location. The elements of this process are the preformation, repackaging, labelling and safety (Kłodawski et al., 2017b). These elements apply as long as they were not done during the receiving process. The put-away process is often associated with the storage task which is identified when the materials units are assigned into a particular location in the storage area (Kłodawski et al., 2017b). Figure 2 shows the putting-away phase by exemplifying it with a flow diagram.

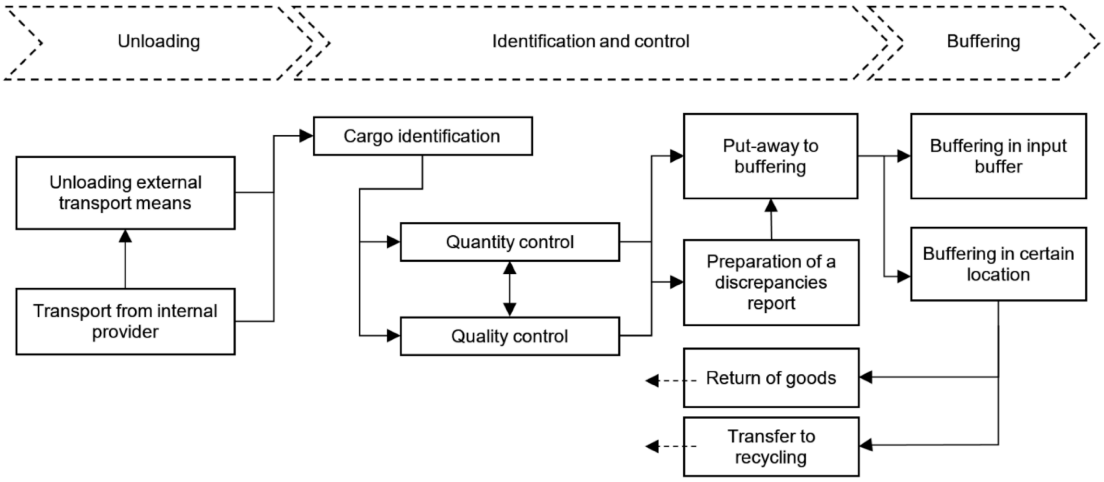

Figure 1. Material reception diagram in a terminal (Kłodawski et al., 2017b)

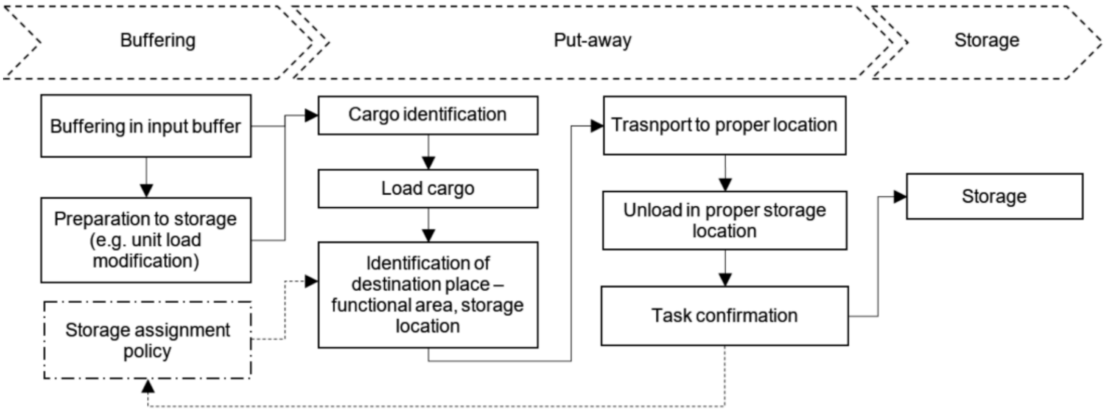

Figure 2. Putting away process diagram in a terminal (Kłodawski et al., 2017b)

The replenishment warehouse operation is defined as the process responsible for supplying the picking area with the correct quantity of a particular stock keeping unit (SKU) (Kłodawski et al., 2017b). The replenishment task can be divided with two possible scenarios; where the units are replenished from the storage area and where the products are replenished from an input buffer (Kłodawski et al., 2017b). With the figure 3, the replenishment process can be illustrated with a flow diagram which shows the key elements of it. The retrieval process is defined as the sequence of tasks to move or transfer the unit products from storage areas to consolidation areas in order to prepare them for shipping (Kłodawski et al., 2017b). The value-adding activities performed in this process can be co-packing, consolidation, sorting, assembling, labelling or configuring products. Figure 4 is a representation of a flow diagram of the retrieval process at a terminal.

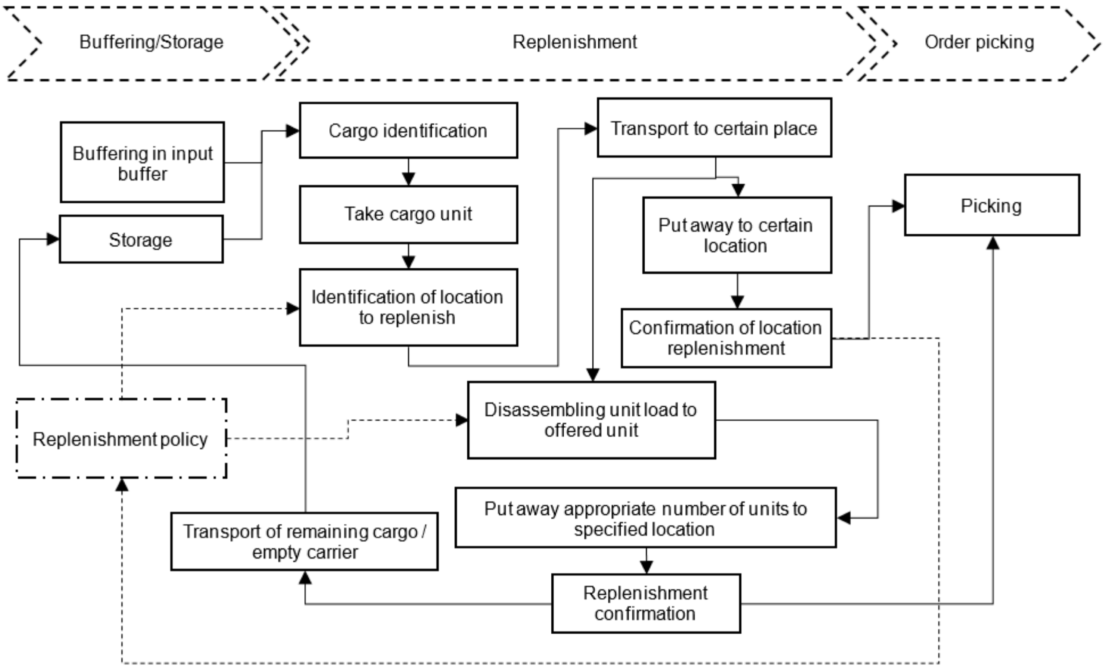

Figure 3. Replenishment phase in a terminal. (Kłodawski et al., 2017b)

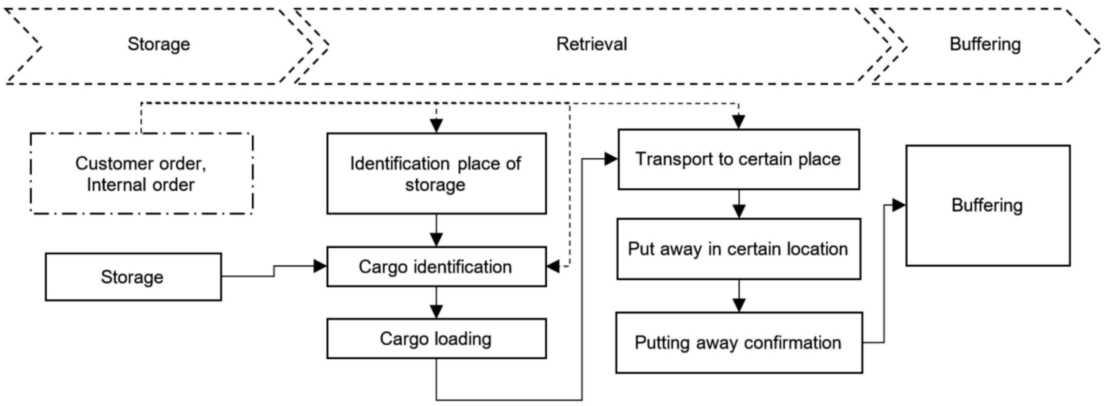

Figure 4. Replenishment phase in a terminal. (Kłodawski et al., 2017b)

2.4 Terminal functions

The ideal transportation of goods is executed when the products contained in one unit from the supplier to the customer, a door-to-door transport (Lumsden, 2007). This ideal transportation of goods not often is seen in reality. Even if the transportation is executed with standardized unit loads, difficulties arise because the size of the consignment is seldom adapted to the consequent transport modes; neither the volumes nor weights (Lumsden, 2007). Direct transports could, therefore, cause a low utilization of different transportation modes and then to higher ongoing costs.

In furtherance of diminishing difficulties with the usage of direct transports, transportation of goods is performed through different terminals (Lumsden, 2007). Weigmans et al. (1998) identified five linking characteristics between terminals. The first one is related to the mainport terminals which link is made through deep-sea, rail, truck and barge global connections. The second one is the International European terminals with the same type of links as the first one but with most continental focus. The third one is referred to as the national terminals which operate with domestic connections. The fourth corresponds to the regional terminals that operate principally with regional distribution centers. The fifth one relates to the local terminals which have simple connections with one transportation mode; deep-sea, rail, truck or barge. Low-cost solution services are offered at the lowest levels but with a reduced logistic network (Gogas et. al., 2017). Urban economies' evolution comes with higher demands whose customers' needs to challenge new supply solutions. There are different functions that can be performed in a logistic terminal.

2.4.1 Consolidation

Consolidation is the most common function performed in logistic terminals (Lumsden, 2007). Consolidation can be considered as the process of combining multiple products from different locations and times, into single-vehicle loads (González-Ramírez et.al., 2009). The main advantage of using consolidation terminals is the reduction of transportation charges, very common in rail, motor carrier and air freight transport systems (González-Ramírez et.al., 2009). Hall (1987) classified consolidation in three variants. The first one as the *inventory consolidation* which is the simplest one. It involves only the storage products that are needed in the production line at different times and transporting them in the same load (Hall, 1987). The *vehicle consolidation* is the one that includes the loading and delivery of products at different origins and destinations. The last classification is the *terminal consolidation* which is a spatial location where the products are sorted, loaded in new transport vehicles, and delivering them into different destinations (Hall, 1987). The optimal mix of the three combination types comes along with the trade-offs between the consolidation benefits and disadvantages (González-Ramírez et.al., 2009). Due to direct deliveries from the supplier rarely adapt to the loading capacity of transportation modes, goods are collected and sent to a terminal where the means of transportation are adapted to smaller units. At the terminal, the goods are transported to the receiver's after consolidation and possibly unification has happened (Lumsden, 2007).

2.4.2 Transhipment

According to the Cambridge Dictionary (2020), the transshipment process refers to the activity of transferring goods from one ship or vehicle to another one. The *transhipment* process will carry on additional operational costs to the chain for handling and storage of goods (Mattfeld, 2006). However, there are several reasons to benefit the supply chain. One of them can happen when the products or goods are needed to be dispatched at the port. Then, immediate storage is required to provide a safety margin for reliable loading and further shipment in direction to the final destination (Mattfeld, 2006). The second reason that provides Mattfeld (2006), happens when the goods to be shipped do not fully load the parcel, then it is needed to transship goods to get efficient transport systems. The third one corresponds to the different services provided by the receiving hub like the break-bulk of goods. When there is needed a manipulation of the parcels to mix goods, the transhipment is needed to be performed (Mattfeld, 2006). The final reason given by Mattfeld (2006) happens when there is a need to coordinate stochastics in the supply and demand of the goods. Commonly, in the supply chains, the goods are temporarily stored at the terminals to provide a particular slack before they are dispatched to their final destination point (Mattfeld, 2006).

2.4.3 Coordination

Having different transport modes, usually arriving at terminals, requires efficient *coordination* in their arrival and departure times (Lumsden, 2007). Also, the coordination of the capacities of the means of transportation to avoid problems such as a delay in the terminal and allocating a small mean of transportation to large cargo or vice versa (Lumsden, 2007). At seaport terminals, requirements of modal splits are demanded by customers (Veenstra et al., 2012). This operation requires the coordination of several processes. Material handling process has to be efficient and link with other processes (Veenstra et al., 2012). The performance of the handling operations can be affected by the lack of coordination of the arrival of barges or any shipment at the sea pot (Veenstra et al., 2012). Legal coordination of the terminal concerns the transportation leg between the seaport terminal and the inland terminal (Veenstra et al., 2012). One of the crucial roles at the coordination terminal is the right information of the arriving goods (Veenstra et al., 2012). Schedule coordination at terminals had been employed in the field of freight transfers (Chen et al., 2016). Lack of coordination can be presented between seaports and equivalent terminals (Van Der Horst & De Langen, 2008). At a cross-dock terminal, the coordinated inbound and outbound minimize the total freight completion time (Boysen et al., 2010). Also, in a cross-docking system, coordinated schedules of inbound and outbound of trucks minimize the total transportation process time (Wang & Regan, 2008). Not only the schedule coordination is needed inside the terminal, but also it is needed through the entire freight network (Chen et al., 2016). Delay probability through the supply chain can happen due to climate change and weather impacts within the transportation systems. When a disruption or delay appears, subsequent schedules become far from optimal performance and it is needed to re-coordinate the operations at terminals to complete the transportation of goods (Chen et al., 2016).

2.4.4 Sorting

There are different reasons when the flow of the products can be stopped. For that reason, it is convenient to implement value-adding operations outside the manufacturing process (Lumsden, 2007). *Sorting* is a value-adding operation where the goods are arranged or categorized according to diverse criteria. With the development of the business-to-consumer form due to the growth of the internet usage, many supply chains are committed to offering deliveries with a next-day lead time, or even the same day, to their customers (Yaman et al., 2012). This compromise generates increased stress on terminal processes and the necessity of having a fast and efficient retrieval of

SKU´s (stock-keeping units) from their shelves (Boysen et al., 2018). This retrieval of products can be related to the order picking process within terminals´ operations. The order picking process can be defined as the process of retrieving products from a storage point or even buffer areas, in response to a customer order (de Koster et al., 2007). Given that the most common goal of order-picking processes is to maximize the service level through efficient management of resource constraints of labour, machines and capital (de Koster et al., 2007).

A critical link between the service level and the order picking is the time since the receipt of the customer order and the availability of the products ready to be shipped to the customer. De Koster et al. (2007) proposed two alternatives to the single order picking process, in order to accelerate the retrieval of goods processed at terminals. The first one is the *zoning* alternative where the order picking area is divided into zones. Instead of the normal procedure of the single picking process where the order picker processes each customer order in a unique tour; each order picker is assigned to pick a part of the order in his assigned zone. With this type of set, the picking process is parallelized, and the user travel distances and times are reduced.

2.4.5 Kitting

The delivery is needed to be re-sorted when products share the same destination. This happens when those destinations in common are brought together with a re-sorting process. To avoid the duplication of processes, the products are gathered into one unit at the terminal and then delivered into one unit (Lumsden, 2007). Certain resources like forklifts can fail when it is pretended to achieve efficiency benefits. As a result of that, different alternative transport systems are standing out in logistics industries. These alternatives, in regard to the material flow, come with automated transport systems or further structure inside the terminal such as line deliveries by train and conveyor technology (Cottyn et al., 2008). Flexibility at terminal operations remains as one of the main goals for achieving operational efficiency, and with the development of lean concepts, it is not only part of the cost-efficiency of the transport system. With alternative transport systems and the implementation of the kitting process, different forms of waste can be eliminated (Cottyn et al., 2008). One of them is the over dimensioning of the transport task because of the uncertainty about their cycle time. Waiting waste can be reduced with automated alternative transport systems rather than forklifts since the transport system becomes vulnerable with the human factor since it can be affected with social disruptions. Finally, the waste caused by safety issues can be reduced by implementing kitting automated solutions since it mostly eliminates the constant threat to the workers and the potential serious material and infrastructure damage (Cottyn et al., 2008).

Kitting can be seen as a common alternative for continuous supply when delivering products or goods in the delivery area at the terminal (Caputo et al., 2015). To achieve a successful kitting process, no products inventories are kept at the workstations since all the products are sorted to one kit unit or contains in order to deliver the products to one common destination. The kits can be prepared in a stockroom before the delivery plan schedule. This can let the operators, if the transport system is not fully automated, to prepare more kits before the next transport deliver the goods to the customer (Caputo et al., 2015).

2.4.6 Sequencing

There has been an increased need for sorting the products in a sequence according to the customer´s detailed demand (Lumsden, 2007). According to Moeller (2011), the order picking process can be defined as the process of retrieving products from the terminal in response to specific customer order. Half of the total costs of terminal operations come from the order picking processes since this process comes by complex and intense labour from operators (Moeller, 2011). At the moment when the customer orders are assigned to picking orders or batches, a batch sequencing regulates the order in which batches are set up, released and processed at the picking line. Also, this sequence determines the allocation of the picker or the operator regarding time requirements and reduces inefficiencies with the delivery of goods (Cano et al., 2018).

2.4.7 Commercialisation

Most of the time the goods or products need to be delivered from the terminal to the immediate sale like in a shop. In contemplation of accomplishing this request, the goods must be prepared in diverse ways in order that they can be received by the customer at the shop commercialization (Lumsden, 2007). Another usage for this terminal function is implemented in e-commerce terminals. Ecommerce can be defined as the sale or purchase of goods or services that are processed through a computer network which offers tools designed to place and receive orders (Żuchowski, 2016). Therefore, e-commerce differentiates from traditional mail-ordering with global availability of the internet; payments do not necessarily have to be made through the internet as well. Through e-commerce, commercialization function in the terminal can relieve labour work since the order is transmitted directly to the supplier (Żuchowski, 2016). At the same time, e-commerce terminal is much more complex since it has to process a large variety of products with variable and high demand, and tight fulfilment time (Kong et al., 2020). Nowadays, more commercial terminal functioning is used in the retail market. Terminals can function as sales support through mail-order catalogues, automotive wholesalers, or even pharmaceutical wholesalers insofar as warehouses mainly are prepared to process electronic orders (Żuchowski, 2016).

2.4.8 Storing

Product´s flow can stop, and diverse operations are executed in the terminal. Therefore, storing goods becomes part of the product's flow (Lumsden, 2007). This function at terminals improves other terminal processes' efficiency because of the available time dimension. Mid-supply-chain logistic warehouses have an important role in balancing the time differences between manufacturer, supply and customer (Ogasawara et al., 2019). Lumsden (2007) stated that storing of goods have different time extensions. During the change of transport mode, the goods normally have to stop for a short period of time. This happens in order to enable a certain amount of freedom for the arrival and departure processes. Warehouse layout, storage assignment, order batching and routing are elements that determined the time taken for picking (Ogasawara et al., 2019). In order to achieve efficient usage of space and reduce time waste for the picking process, the terminal layout has to be maximized and minimized the travel time (Larson et al., 1997).

Terminal operations are normally executed through three storage policies; randomized storage, dedicated storage or class-based storage (Larson et al., 1997). Randomized storage happens when the products are allocated in an available storage location at the time of the storage process. The dedicated storage policy enables to assign the products to a prearranged storage location depending on the product's throughput and storing requisites (Larson et al., 1997).

In order to fulfil new customer demands requisites and new commercial and distribution channels, organizations need to invest in their terminals. New technologies like augmented reality, advanced robotics and smart wearables, are key elements to ensure the competitiveness of the company in the current market (Kong et al., 2020).

2.5 Terminal typology

A standardized terminology of the logistics center and terminals is non-existent. This inconsistency or diversity with the definition of a logistics center is related to the high dynamic of the logistics sector but also with the immaturity of the research and investigations of the topic (Wagener, 2017). Researchers of the logistics field have been making little effort to build a unified logistics center definition (Rimienė & Grundey, 2007). The research on logistics centers has been experiencing a lack of certainty and consensus among different authors (Higgins et. al., 2012). Higgins et al., (2012) elaborated an extensive and comprehensive study of logistics centers from different authors. These authors proposed a standardized typology and hierarchy of logistics centers in order to help the logistics area to evolve and become a more coherent and integrative field of study (Higgins et. al., 2012).

Higgins et al., (2012) included in their article the logistics center hierarchy developed by Notteboom and Rodrigue J-P (2009). The hierarchy is shown in figure 5, which was developed after covering all types of logistics centers. The first level comprehends terminals which represent the smallest scope from Intermodal logistic centers (Higgins et. al., 2012). These terminals on this level are commonly nearby a major gateway. The second level refers to the inland terminals and freight distribution center whose complexity functionality covers a vast market area (Higgins et. al., 2012). The third level comprehends terminals with the largest scope at international mainport terminals (Higgins et. al., 2012). The third level includes the world-class gateways terminals with the main function of serving as an interface between regional and international transportation systems (Higgins et. al., 2012).

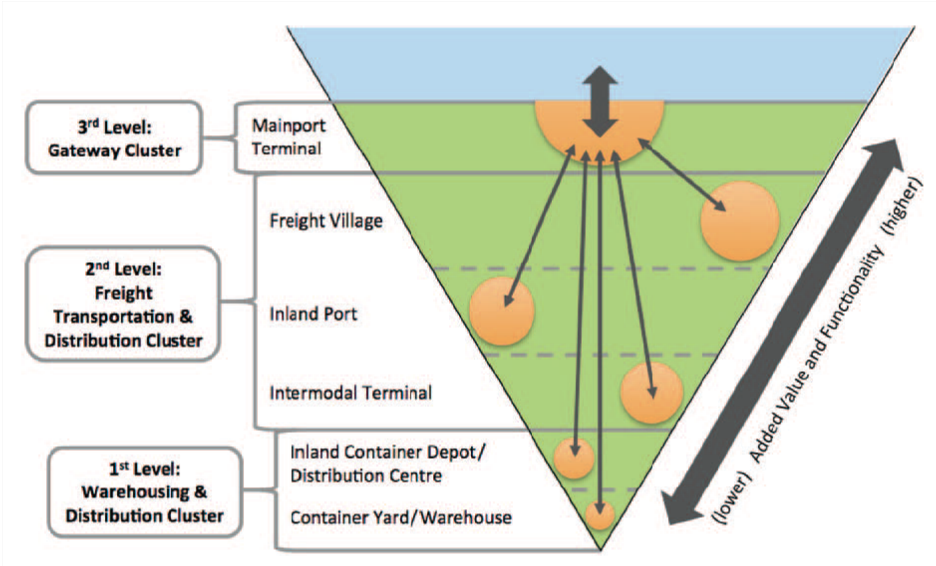

Figure 5. Hierarchy of logistics terminals (Higgins et al., 2012)

2.5.1 First level

WAREHOUSES AND DISTRIBUTION CENTERS

According to Higgins et al., (2012), warehouses usually act as a place for inventory and storage. The purpose of this type of terminal is to provide retail stores and individuals the value of time and place (Taylor, 2014). Usually, manufactures produce in large lot sizes which means that the delivery dates of small receivers cannot be met. This allows the warehouse to act as a bridging actor that allows both parties to operate based on their own requirements (Taylor, 2014). One example of a warehouse with storing facilities is at figure 6. On the other hand, single large warehouses or a cluster of warehouses are usually known as distribution centers and differ from warehouses on their focus, which is the movement of goods rather than storage (Higgins et al., 2012). This type of terminal provides basic functions such as warehousing, shipping, receiving and cross-docking (Higgins et al., 2012). Some of these facilities are designed to increase the efficiency of urban freight logistics, where shipments from different companies can be consolidated for further delivery in fewer or smaller vehicles (Higgins et al., 2012).

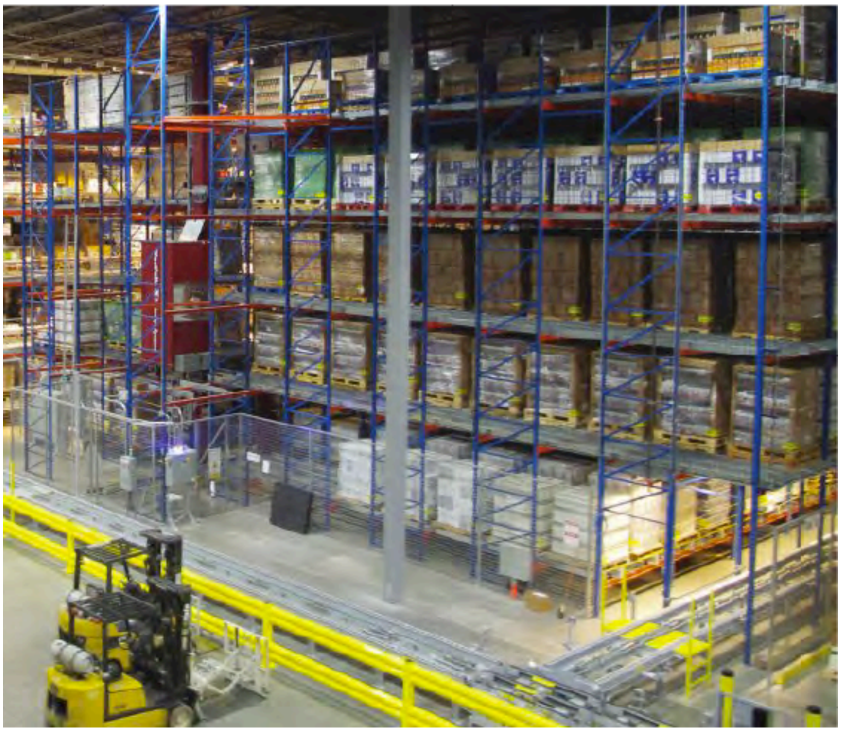

Figure 6. Warehouse (Lewis, 2016)

Warehouses provide additional services that are not usually part of their main provided services. For instance, labelling products for retail stores or repackaging returned products. When returning products, they need to be inspected, repackaged and most likely to return to storage locations. (Taylor, 2014). Distribution centers can also offer value-added services, i.e., order picking, returns processing, information management and labelling (Higgins et al., 2012).

Farahani et al., (2011), states three resources needed at warehouses. Firstly, the equipment, which comprises material handling devices, racks, conveyors, hardware and software. Secondly, people and thirdly, space. The needed equipment will vary depending on the level of automation at the warehouse which could vary from manual, automated or automatic systems (Farahani et al., 2011). For instance, with *manual systems* or *picker-to-product systems*, order pickers use vehicles to pick items and could also include a take-away conveyor for picking products. *Automated systems* or product-to-picker systems could include Automated Storage/Retrieval Systems (AS/RS) which involve machines that can perform the storage and retrieval of pallets or containers or order-picking of small items. It could also involve a *carousel*, which rotates storage positions that deliver the requested item to the order-picker. *Automatic systems* or *picker-less systems* use robots or automatic dispensers, which replace the order-pickers (van den Berg, 1999). Human errors are unavoidable even if the company have many years of experience (Lewis, 2016). Those errors are related to when products are not delivered on time, wrong destination, wrong products, wrong customers and/or damaged products. Therefore, companies are investing in reducing the probability of human error by simplifying the picking process and improving the order fulfilment rate in warehouses and distribution centers. With the integration of automated systems such as AS/RS, the storage capacity can be increased from 30% to 50% and at the same time, decreasing the overall footprint of the warehouse by 50% (Lewis, 2016). Warehouses located in cities can have space limitations so that AS/RS systems allow more efficient usage of available space. Figure 7 shows how an AS/RS system is used in a warehouse where a robotic storage and retrieval system allows to retrieve a pallet from a deep storage zone.

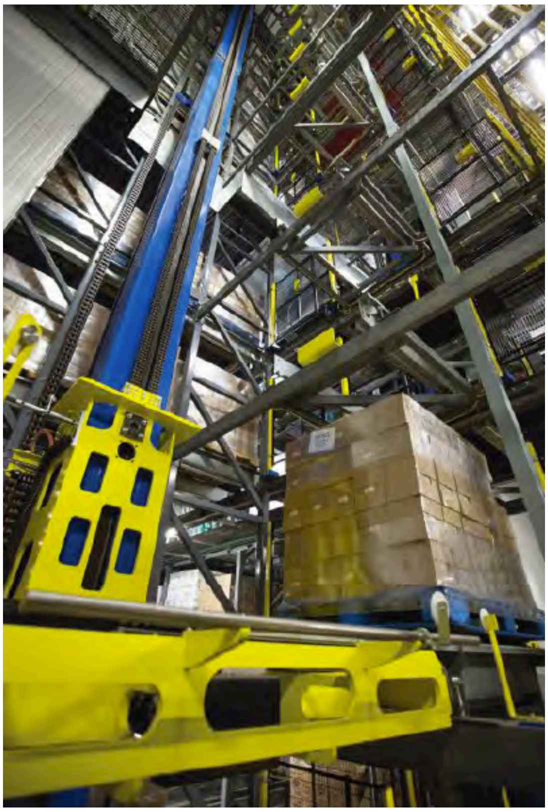

Figure 7. Distribution center (Lewis, 2016)

Having the equipment to transfer the unit loads within a terminal will require a different type of truck i.e. forklifts to handle pallets or straddle carriers to handle larger unit loads as trailers or containers (Lumsden, 2007). The most common forklift used in a warehouse is the counterbalanced or sit-down truck which is located in the rear of the vehicle (Rogers, 2011). This weight counterbalances the weight of the load that ensures the avoidance of tipping forward of the forklift. Choosing the right forklift for a warehouse or distribution center operation is one of the most important factors when customers are looking for increasing the efficiency of resources and lowering operating costs (Rogers, 2011). Fixed transportation could also be used to minimize the need for staff within the terminal i.e. conveyor belts or AGV [Automated guided vehicles] (Lumsden, 2007).

Slow-moving products are usually stored in the bin shelving area, though some products with small required inventory could also be stored in the area (Taylor, 2014). Since slow-moving products often have a small number of requests per order, having a cart with multiple compartments makes it appropriate for picking this type of product.

Fast-moving products are stored in carton flow racks. Picking small orders happen similarly to picking up in the bin-shelving area with the use of a cart with compartments. The pallet rack area has the aspect of a storage area, where products are stored in different levels, the first one acting as carton pick area and the levels above as product reserve. A pallet jack is needed for picking items for small orders. The pallet floor storage serves as an area to store pallets that can be stacked in pallets which do not need to be stored in racks (Taylor, 2014).

Taylor (2014) argues that warehouse layout planning differs from factory layouts in four different aspects. Firstly, half of the needed space for storage in warehouses accounts for more than half of the total available space. Secondly, the surrounding roads and topography determine the location of the docks, which means that there are only a few ways to arrange the layout of the terminal. Thirdly, moving goods between departments is considerably less costly than the cost of processing within departments, which reduces the importance of assigning a place for departments. Fourth, storing resources can be set up in different ways without affecting the equipment or operating efficiency, unlike manufacturing equipment.

In figure 8, Taylor (2014) provides an overview of the different functions within a warehouse, from receiving at the docks the goods until shipping. Figure 9 provides the flow diagram within the warehouse (Taylor, 2014). The bold narrows represent main flows and the dashed narrows the occasional flows. When determining the location, Taylor (2014) states that constructing a flow diagram could prove valuable, since it shows the different flows, which should not cross. According to Taylor (2014), when designing the layout, it can have the same characteristics as the flow diagram to avoid product flows crossing as shown in figure 10.

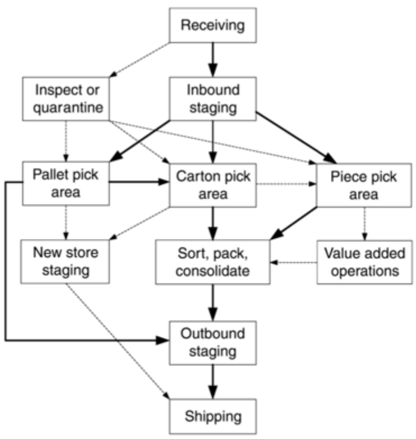

Figure 8. Operations within a warehouse (Taylor, 2014)

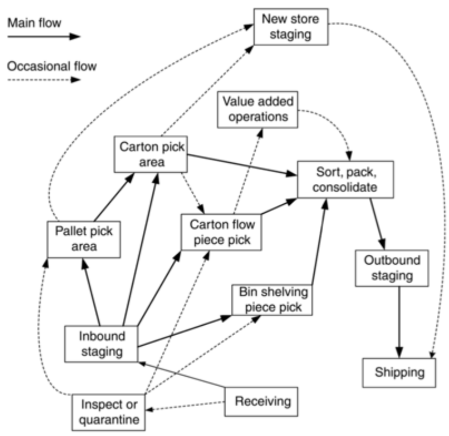

Figure 9. Flow diagram of operations (Taylor, 2014)

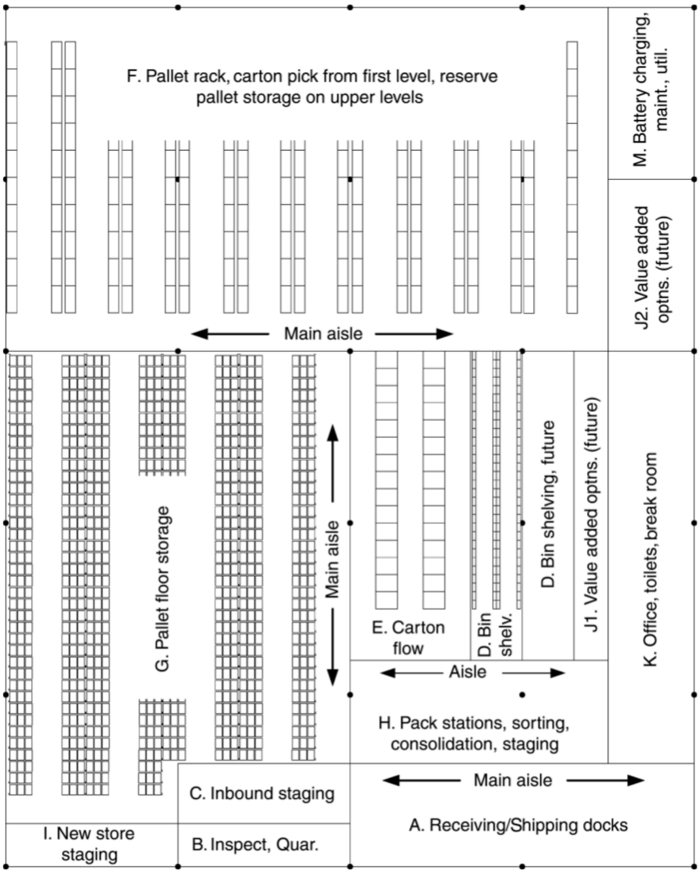

Figure 10. Layout according to operations flow (Taylor, 2014)

The most visible areas from the layout in figure 10 suggested by Taylor (2014) are the pallet floor storage and the pallet rack area, where products can be put into pallets, and fast-moving products are stored respectively. Taylor (2014) suggests that toilets and break rooms are better located near the docks so that visiting drivers can easily access them. Forklifts charging rooms and maintenance areas are located in the top right corner to avoid the room to be in the way of product flow (Taylor, 2014). The area to the left of the office, where the piece pick areas are located, are better designed vertically to easily allow the output from those areas to the pack stations and shipping docks (Taylor, 2014).

INLAND CONTAINER DEPOT

Inland container depots (ICD) are container terminals located inland which offer handling, temporary storage and customs clearance of containers and cargo (UNESCAP, 2009). According to Mittal et al., (2013), container depots are often located close to marine terminals, however, due to the high cost of lands close to seaports, container depots have been moved inland. These facilities have some of the functions besides shipment transfer, such as storage, breakbulk cargo handling and value-added services such as customs clearance and inspection. (Higgins et al., 2012)

CONTAINER YARD

This terminal is dedicated to the storing, cleaning and repairing of containers. These facilities are located close to seaports, which enables empty import containers to be ready to deliver export cargo. (UNESCAP, 2009).

There are various forms of automation in container yards, ranging from semi-automation of unloading equipment to completely automated with the use of quay cranes (UNESCAP, 2009; Kim & Günther, 2007). Software and IT tools are vital resources for real-time decision making, as well as for fast access to information on each individual container (Kim & Günther, 2007).

The layout of this type of terminal is a factor that determines the productivity of the container handling activities (Kim et al., 2008). For that reason, the layout type, the outline of the yard as well as the number of aisles need to be accounted for (Kim et al., 2008). The layout of the terminal often includes some areas for hazardous goods containers, empty and non-standardized size containers (Kim & Günther, 2007).

2.5.2 Second level

INTERMODAL TERMINAL

Intermodal transport is considered the best option to reduce the unsustainable growth of transportation by road (Reis & Macário, 2019). Intermodal terminals allow the transport of goods in one and the same unit load or vehicle using various transport modes, without transhipment of goods when changing the transport mode (ECMT, 2001). These terminals handle large freight flows and hold infrastructure for the transhipment of goods between rail, road and barge to the end destination (Higgins et al., 2012). They also enable not only temporary storage and buffering of goods, but also consolidation and distribution among long-distance and regional transport (Wagener, 2017).

The principal role of an intermodal terminal is to provide space and equipment for loading and unloading of vehicles, creating a smooth transfer between transport modes (Taylor, 2008). This type of terminal can incorporate similar value-added logistics services to freight villages, however, some can act as a terminal dedicated to the basic service of transhipment (Higgins et al., 2012). According to Protic (2019), value-added services typically offered at Intermodal terminals include stuffing and stripping, packing, assembling and picking. Track and trace (Reis & Macário, 2019) are also some of the provided services.

Intermodal terminals require appropriate equipment for transhipment of intermodal transport units, as well as information systems to allow adequate flow in the transport system (Woxenius, 1998). The information systems should enable the supervision of the different operations throughout the intermodal transportation network (Agamez-Arias et al., 2017). The technology to enable transhipment at the terminal must contribute to a quick, flexible and safe loading unit transfer between transport modes

(Woxenius, 1998). In the case of container port terminals, gantry-cranes which allow moving the container to a preferred area, quay-cranes that facilitate the load and unload of containers to vessels, as well as container yards for stacking loaded and empty containers are main required resources (Taylor, 2008). When performing transhipment at intermodal terminals, Woxenius (1998) argues that the space at the terminal has to be very simple and possibly of a flat surface.

INLAND PORT

Inland ports (IP) refer to an inland extension of a seaport, which is connected by a rail shuttle or barge link for sea transportation (Higgins et al., 2012). Dry ports and inland terminals serviced by barges are examples of inland ports (Rodrige et al., 2010). These terminals have functions at the transport, supply chain and at the hinterland level (Rodrige et al., 2010). At the transport level, the IP acts as a *satellite terminal*, which refers to a facility located in close proximity to a port, where functions of low added-value are located, e.g., as a container depot. As a *load* center which enables access from a port to a consumption market, and as a Transmodal *center*, where the IP links with freight systems through the same mode (rail to rail) or different transport mode (rail to truck). From a supply chain standpoint, the IP has functions such as *consolidation/deconsolidation* of cargo; *transloading,* for adaptation to specific domestic regulatory inland constraints e.g., size of the container. For *postponement,* by acting as a buffer for last-minute freight routing considerations and for *light transformations,* such as packaging, labelling or customization depending on the market characteristics. The third tier refers to the function of empty repositioning from retailers and manufacturers. Retailers, which create an unbalanced flow since outbound flows are not generated, and manufacturers, which are more balanced flows since inputs are transformed into outputs.

Serafino et al. (2013) categorized services that are provided in dry ports into basic, intermediate and specialized services. *Basic services* comprise container repair and refurbishment, container cleaning and maintenance and in-bond warehousing. *Intermediate services* refer to specialized warehousing e.g., refrigerated or high-security. *Specialized service* which covers freight forwarding, 4PL management and commercial services. Gantry cranes for handling of barges, forklift trucks and the stacking area are the main resource needed at inland ports (Notteboom & Rodrigue, 2009)

According to TTR (2010), consolidation centers and dryports to operate at the same place in spite of being different concepts. One of the main differences is that consolidation centers are not subject to customs clearance due to only serving domestic freight markets, while dry ports process container traffic which is subject to customs clearance TTR (2010). Dryports usually include a container freight station (CFS), where consignments are assembled or separated, which according to TTR (2010) represents an opportunity to combine dryports and consolidation centers. Figure 11 presents a layout for a dryport without a consolidation area, while figure 12 presents the layout of a dry port with a consolidation area.

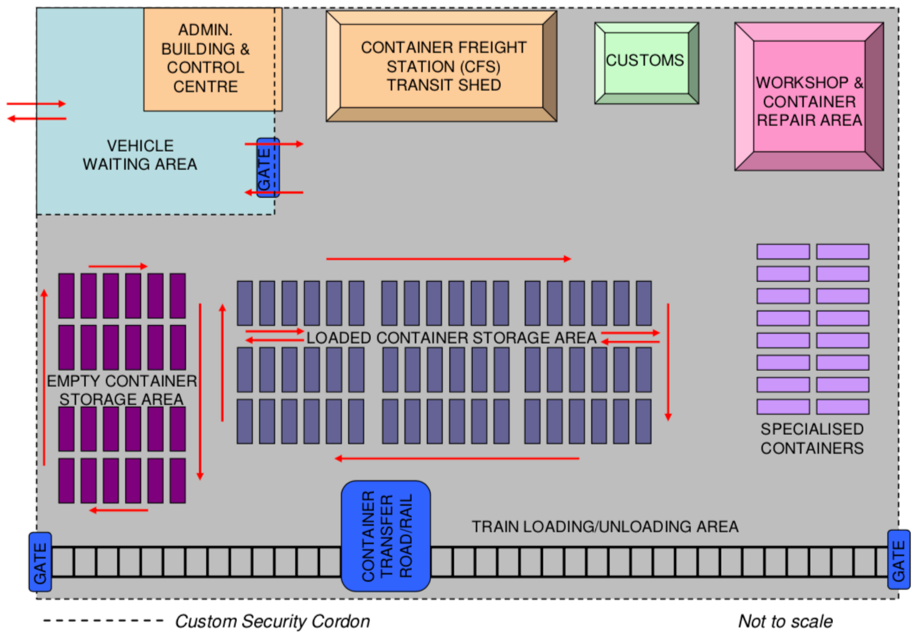

Figure 11. Dryport Layout (TTR, 2010)

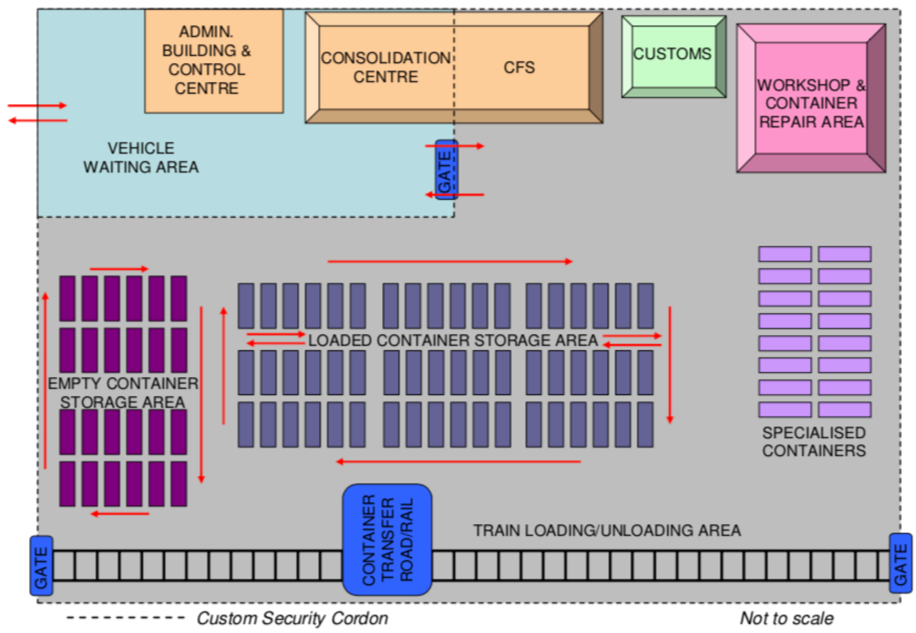

Figure 12. Dryport layout with a consolidation center (TTR, 2010)

In a dry port with a consolidation center, lorries would deliver their cargo and thereafter it would be placed in the consolidation area, where the cargo will be aggregated and stored before being loaded to delivery vehicles (TTR, 2010).

FREIGHT VILLAGE

Freight Village (FV) refers to the industrial logistics site where intermodal, logistics infrastructure, distribution and support services are offered to facilitate the flow of products (Higgins et al., 2012). The European Commission defines a Freight Village as the geographical group of independent companies trading with freight transport services including at least one terminal along with technical and administrative services for the infrastructure itself (Higgins & Ferguson, 2011).

FV performs an important position within the regional consolidation and distribution cargo (Wagener, 2017). An essential aspect to be considered in a Freight Village according to Higgins et.al. (2012), is the connection between transportation vehicles and transportation infrastructure. This aspect enables a quick and responsive transportation system (Higgins et al., 2012). For instance, Freight Villages should be based near urban areas with a high number of industrial districts and large populations (Wagener, 2017). FV are normally settled on the outskirts of the city and it can combine long-distance intermodal transport with regional storage and distribution of goods (Wagener, 2017).

The main functions of FV are to provide services such as warehousing, consolidation activities, customs procedures, maintenance workshops, banking, insurance, offices, amongst others (Tsamboulas & Dimitropoulos, 1999). According to BESTUFS (2007), the distinctive features that are linked to the FV are the transport-related activities such as transport, forwarding, warehousing, additional logistic services and telecommunication. Another characteristic according to BESTUFS (2007), is that FV has a minimum of two links between two transport modes but it is not necessarily located within the same area as the complex. Freight Villages functions as a settlement of different economically independent companies and facilitates the synergies between them (BESTUFS, 2007).

FV are expected to contribute the conversion of freight transport to other modes, facilitating the reduction or even the avoidance of transport processes within urban areas (BESTUFS, 2007). Resource sharing is a distinctive characteristic of Freight Villages since the logistic companies located on-site need to share access to facilities, equipment and services offered in the Freight Village (Higgins et al., 2012). The common services and resources shared by logistic firms are the intermodal infrastructure, customs services, maintenance area and amenities such as cafeterias, restaurants and childcare in some cases (Higgins et al., 2012).

2.5.2 Third level

XXL TERMINALS - XL TERMINALS - LOGISTIC NODES - GATEWAYS

The third level consists of the major internationals mainport terminals such as gateways, logistics nodes, seaports, air cargo port and bulk terminal (Higgins et al., 2012). These terminals produce a large number of activities within the facility and its surrounding and its main function is to act as a node where large volumes of freight are split into smaller shipments, which are still large enough to fill completely a train, barge or ship (Higgins et al., 2012). These terminals provide large areas for storage and a whole variety of value-added activities, including many of the features of the logistic centers located below in the hierarchy (Higgins et al., 2012). These terminals have a vast area for the storage of goods and have heavy-duty infrastructure and technology (Higgins et al., 2012).

2.6 Urban Consolidation Centres

UCC have emerged as a possible solution to lower the emissions generated by last-mile freight transportation (Nordtomme, 2015). However, it is still a new concept for some urban stakeholders (Grandval, 2019), in spite of its first implementation happening in the late seventies (Van Rooijen et al., 2010). BESTUFS (2007) defined UCC as "*all coordinated measures comprising logistic collection and delivery activities of logistic service providers in urban areas that aim at the reduction or prevention of commercial traffic and its negative external effects*". Björklund & Johansson (2018) refer to UCC as systems that comprise both a logistics facility where LSPs leave their goods and outbound deliveries to the different demand nodes. These demand nodes are moderately close to UCCs (Allen et al., 2012) and often require deliveries from the UCC in less than 24 hours, which could otherwise be difficult to achieve if the deliveries take place directly from the suppliers (TTR, 2010). Figure 13 provides an exemplification of the basic functioning of an Urban Consolidation Centre.

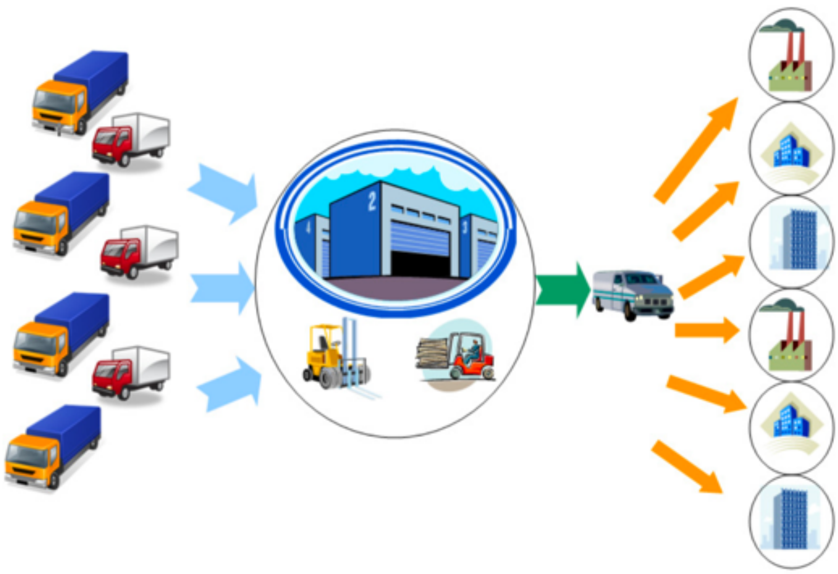

Figure 13. Basic functioning of an Urban Consolidation Centre (TTR, 2010)

Chwesiuk et al. (2008) provides a categorization on UCC based on the type of operation as well as the area which it serves. Firstly, *UCC serving all or a part of an urban area* or *local UCC,* which are facilities that usually supply retail stores but also office products. This type of UCC usually operates in a specific area with features such as narrow streets and historic layouts. Secondly, *UCC serving large sites with a single landlord*, which are normally associated with the supplies for restaurants and cafes. This type of UCC often serves airports, shopping centers and hospitals and in some cases, serves only one large site. The third type, namely *Construction project UCC´s* or *Special UCC project* are used for consolidating construction supplies for building projects. This type of UCC most commonly exists during the time that the building project is being executed.

UCC's main purpose is to avoid having poorly loaded goods vehicles in urban areas, which increases vehicle traffic (Allen et al., 2012; Gogas et al., 2017). Although, the interest in Urban Consolidation is not only for social benefits but also environmental since UCC can reduce the travelled distance, lowering greenhouse emissions and local air pollution (Allen at al., 2012). It also has a key role in the supply chain, as UCCs are nodes in which freight cargo is transshipped from heavy vehicles to smaller and environmentally-friendly vehicles to perform the last mile distribution (Gogas et al., 2017). UCCs, besides providing environmental benefits, should contribute to reducing transportation costs for recipients located in the cities, as well as to better use of the transport fleet (Chwesiuk et al., 2010). A research performed by Lagorio et al., (2016a) on 83 UCC initiatives in Europe, shows that 61% are run by inland freight terminals in which the urban distribution is part of their service pool, though not their main service.

Besides providing the service of consolidating loads from logistics companies subsequent delivery, a variety of other value-added services can be provided by the UCC operator (Browne et al., 2005). However, according to Allen et al., (2012), it is important at pilot stages of Urban Consolidation Schemes, to have simple and straightforward operating methods and provided services. Value-added services could provide the UCC operators with revenue growth, and to users, with an increase in revenue as well as cost reduction (Pålsson, 2014). According to Gammelgaard (2015), the value-adding services have not been properly understood as a result of not recognizing the drivers for the stores using city logistic services; though, value-added services could increase the complexity of the system and consequently, the cost of the UCC operation (Allen et al., 2012). Some value-adding activities can be performed at the UCC facility, for instance, providing a local buffer for the UCC users as a way to reduce the delivery lead time as well as to avoid shortage (Triantafyllou et al., 2014), product quality and quantity check to provide notices of problems with suppliers, pre-retailing activities (i.e. unpacking and labelling) and handling the return of packaging material (Gammelgaard, 2015). Performing inventory and order management could also be a value-added service, keeping track of stock records as well as having control over the replenishing of the stock at the UCC (Gammelgaard, 2015). According to Triantafyllou et al., (2014), other extra services that can also be provided are B2B deliveries, as well as letting the space available to be used for training, where UCC, retailers and drivers could be trained for better performance across the network. Some support services that could also be provided at the receiver's according to Gammelgaard (2015) are the unloading of goods, which could be taken to the receiving area, assisting with the unpacking as well as placing them at the shelves. This could enable the receiver to make use of its time on activities that generate value to the establishment, such as providing customer service to the customers (Gammelgaard, 2015). Table 2 illustrates the different value-added services that can be provided in Urban Consolidation Schemes.

Table 2. Value-added services provided at UCC according to the literature. Source, authors.

Services
Local Buffer
Quality/Quantity Check
Inventory & Order Management
Pre-retailing
Return logistics
Collecting and delivering
Freight pick up
Track & Trace
B2C deliveries
Training areas
Support services at the reciever
E-tailing
Delivery flexibility
Repackaging
Assembling

The location of the UCC will determine the traffic and environmental benefits that can be expected from the project (Allen et al., 2012). That is to say that if the UCC is located far from the delivery zone, vehicles will not have the need to enter the urban zone and the distance which smaller and more environmentally friendly vehicles will need to cover could be maximized. However, smaller vehicles could imply an increase in the number of trips and distance travelled. On the other hand, if the UCC is located too close to the area which intends to serve, it could reduce the distance that environmentally-friendly vehicles cover, lowering the positive environmental impact (Allen et al., 2012). Further environmental impacts that can be perceived from UCC projects are a reduction in both air-borne pollutants noise level and an increase in the load factor (TTR, 2010).

UCC projects could impact positively to small and medium-sized stores which could decrease their storage space to use it for value-adding activities, as well provide the possibility to have a wider delivery time choice, this, since they could also get deliveries on times that conventional vehicles are not allowed by the local authorities (Grandvall et al., 2019). However, large store brands with their own supply chains could possibly mean the need to make adaptations to adopt the UCC, which could be perceived economically risky (Grandvall et al., 2019).

UCC have been implemented in different European cities, the most in initiatives are in the UK and Germany, followed closely by France and Italy (Lagorio et al., 2016a). However, these terminals have not all been successful (Browne et al., 2005). UCCs need to be financially viable without the need of subsidiaries in the medium to long term (Allen et al., 2012). Studies suggest that one of the main reasons for UCC failure is due to the expectations and needs from users and consignees not being considered (Aastrup et al., 2012; Gammelgaard et al., 2015). Also, city logistics might not be appealing to transport operators since not performing the last-mile delivery could mean a reduction in their turnover. Browne et al., (2005) argues that the main reasons are both the high set up and operating costs of the establishment. Some other causes are the shortage of participants for the UCC initiative, as well as the belief from the transportation companies that the municipality aims to create a monopoly in the urban freight transportation (van Duin et al., 2010). Van Rooijen & Quak (2010) concludes that carriers are used to delivering in Urban areas without the use of a UCC, meaning that convincing them with reasons to change the "as is' ' situation could provide a chance to the UCC initiative and increase the participation of transport actors. Lagorio et al., (2016a) reinforces some of the previous findings on their study, concluding that the main reasons for UCC failures are the high cost of ownership, low stakeholder participation and the loss of public funds. Their study concluded that low haulier participation is caused by their fear that the UCC operator lacks the competence to meet their service levels, causing a loss in market competitiveness. Moreover, haulers who transport refrigerated goods are not often part of UCC initiatives since it would mean an increase in management costs for the UCC operator, making it a problem for carriers who serve the hospitality sector (Lagorio et al., 2016a). Other reasons highlighted by Lagorio et al., (2016a) from the carrier's perspective are "*conflict with local government, pre-consolidation already taking place, incompatible IT systems, not being involved in the UCC decision process and having a standardized supply chain*".

Van Rooijen & Quak (2010) mention that UCC results depend on the type of delivery, arguing that a distinction between FTL and LTL deliveries is needed. This, since one FTL delivery for a single store in the city center is more efficient than several smaller vehicles. If FTL deliveries are integrated into UCC operations, it could mean a reduction in efficiency and a rise in the number of vehicles in urban areas.

2.7 UCC cases in Europe

UCC serving all or a part of an urban area

Bristol - Bath UCC - UK

This initiative founded in the UK in 2004 is operated by DHL, who manages all the offerings and operations for retailers in the cities of Bristol and Bath (Grandvall et al., 2019). The terminal delivers every type of product with the exception of perishable goods (Paddeu, 2017) and it counts with two electric vehicles and a space of 500 square meters for operations (Allen et al., 2014). According to Grandvall et al., (2019), DHL offers several value-added services such as delivering the same day or the day after ordering, scheduling of delivery times, storage of goods, return logistics, repackaging services and deliveries outside store opening hours (Grandvall et al., 2019). Other value-added services are peak/seasonal storing and crisis stock management (Duin et al., 2016) and pre-retailing (Zeimpekis et al., 2018). The project was mostly funded by local authorities (60%) and the remaining from invoicing retailers (Grandvall et al., 2019), although when the funding ended, retailers remained with the scheme because of the benefits of using the terminal. By 2016, the terminal served a total of 141 retailers (Duin et al., 2016)

The UCC is primarily used as a cross-dock center and usually holds the stock for retailers if they are experiencing a space shortage at the store (Paddeu, 2017). The initiative has been successful as a result of adding additional retailers over time, as well as from identifying sources of revenue in value-added activities such as pre-retailing services (Allen et al., 2014). By 2014, the average load factor of the 195 vehicles was 74% (Duin et al., 2016), which has resulted in a reduction of 77% in vehicle deliveries to receivers, who also claim to have more time to serve their customers (Allen et al., 2014).

The Green link - France

The Green link (TGL) is a private company which started in 2010 and operates in a simple manner with the use of 50 cargo-bikes and electric vehicles from three small hubs in three districts in the city of Paris (Heitz & Descartes, 2015). An illustration of their operations can be seen in Figure 14 and Figure 15, which show the operations inside TGL´s terminal. The company is a subcontractor to DHL, TNT and Amazon and serves more than 800 customers with sustainable last-mile solutions with zero-emission consolidated deliveries. Logistics operators transport goods to TGL´s logistics hubs, where the shipments are consolidated manually for onward deliveries, avoiding parking restrictions which affect trucks and motorized vehicles (Heitz & Descartes, 2015). The operations at the hub consist of unloading of vehicles, sequencing and loading and only delivers parcels with a total weight of less than 30 Kg (Institute for sustainability, 2015).

Figure 14. TGL operation 1 (Bestfact, 2015a)

Figure 15. TGL operation 2 (Heitz & Descartes, 2015)

TGL makes use of information systems to optimize the flows in real-time, to map the road and cycle-routes considering different factors such as speed, service time, distance, weight and bike lanes (Heitz & Descartes, 2015), which calculates the optimal route for TGL´s drivers (Clausen et al., 2016). TGL also provides the service of delivering home diet meals to the elderly (Changemakers, 2017) and also provides real-time information about the status of the orders to their clients (Uemi, 2017). The company is currently testing temperature-controlled materials to analyze the reduction in temperature, to potentially offer refrigerated deliveries in non-standards refrigerated vehicles (Heitz & Descartes, 2015).

TGL delivered 2500 parcels per day and 600 fresh food meals by 2016 (Changemakers, 2017). The implementation of TGL has reduced the travel distance and has increased the covered area which is by a large extent covered by cargo bikes; also, it has lowered CO_2 emissions by 82% and NOx by 80% (Clausen et al., 2016).

Beaugrenelle - France

Beaugrenelle terminal is located in Paris, built in an abandoned facility, which optimizes the use of space of the Paris metropolitan area (Sakai et al., 2019). This terminal dedicates to the delivery of parcels of less than 30Kg from a French service provided called Chronopost (Heitz & Descartes, 2015). The Scheme started in 2013 and has a surface of 3,027 sqm distributed in 2 levels and is located close to the receivers and is fed from a major hub located further in the south of Paris (Bestfact, 2015b). An area of 462 sqm is dedicated to offices and sanitary/social infrastructure (Citylab, 2017). According to Heitz & Descartes (2015), the initiation of the project was rather complex, where convincing the community residents and the fire department about the construction of the project was the biggest challenge.

Figure 16 illustrates Beaugrenelle terminal, where the parcels arriving are unloaded through a conveyor belt, sorted and then loaded into electric vehicles which perform the last mile delivery (Bestfact, 2014). The terminal serves as a parcel drop and pick up point, which is used by both receivers and shippers (Citylab, 2017). According to Chronopost (2013), the terminal handled 4100 parcels with 10 employees and distributed in 30 vehicle rounds per day.

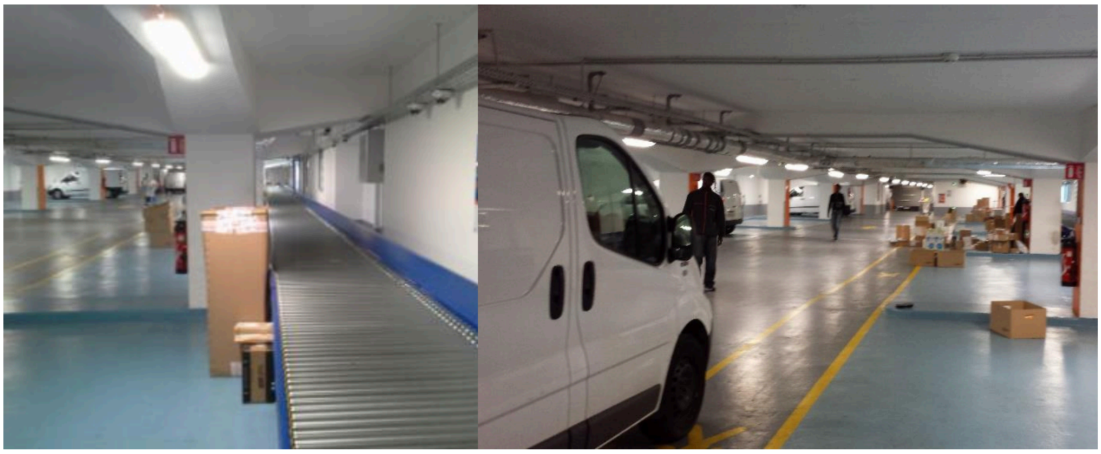

Figure 16. Beaugrenelle terminal. (Heitz, 2015)

La Rochelle - France

This terminal was built in the inner periphery of the city center, which initiated operations in 2001, serving 1300 shops in La Rochelle the city center with the use of electric vehicles (Trentini et al., 2015). The terminal has a space of 750 sqm (Roche-Cerasi, 2012), serves 30% of the total deliveries to the city center (van Duin et al., 2010) and is operated by a private-public transport company (Trentini et al, 2015). The government provides subsidies to the scheme and also encourages all transport companies to drop their goods at the UCC (van Duin et al., 2010).

Besides offering delivery services, La Rochelle UCC performs auxiliary services such as storage for shop owners as well as B2C deliveries (Roche-Cerasi, 2012). The deliveries are performed by nine electric vehicles, some of them equipped with temperature control for perishable deliveries (van Duin et al., 2010). The success of this initiative is due to the early involvement of important stakeholders, which share a sense of urgency to use the terminal (van Duin et al., 2010). The UCC is a cross-docking terminal which makes use of information and communication technologies as the main resources (Trentini et al., 2015).

Oslo UCC

This terminal located in Oslo, opened in 2019 and is mainly used for reloading goods from large to smaller vehicles (Ørving & Eidhammer, 2019). Currently, the Oslo city hub covers an area of 432 sqm, which is used by DB Schenker as the only transport operator. The cargo coming to the terminal has previously been sorted at another terminal from DB Schenker located at Alnabru, in the outskirts of Oslo. These incoming goods to the terminal are reloaded to electric vehicles and electric cargo bikes in the form of pure cross-docking, with no storage overnight (Ørving & Eidhammer, 2019).

Figure 17 illustrates the terminal, which is located close to a motorway, allowing easy access of large vehicles in a safe area where pedestrians and bicyclists do not interfere (Ørving & Eidhammer, 2019).

Figure 17. Oslo city hub terminal (Ørving et al., 2019)

The terminal was built with the use of containers in a very simple layout design, which allows it to relocate easily if it is necessary (Ørving & Eidhammer, 2019). The facility still requires land space for delivery vehicle parking, which is currently limited to only a few numbers of vehicles (Ørving & Eidhammer, 2019).

UCC serving large sites with a single landlord

London Heathrow UCC

The Urban Consolidation Centre at London's Heathrow airport was built on a space of 2,332 sqm, which was funded by financial support from commercial partners as well as contributions from the receivers who use their service (Paddeu, 2017). This scheme was initiated due to the capacity of the road and unloading infrastructure not being expanded accordingly with the retail development at the airport, which caused traffic congestion at loading bays as well as unpredictable delivery times (Allen et al., 2014). The services provided at the terminal are multi-temporal storage and direct delivery of goods to 190 stores 24hr/day (TTR, 2010). The operations at the terminal consist of security checks of the deliveries and dispatching to the retail outlets into roll cages (Allen et al., 2014). By 2002, three tractor units and three box-van trailers with tail-lifts were among the most relevant resources, which also provided the service of refrigerated goods transportation. These vehicles were also used for reverse logistics, in which empty roll cages and packing waste were collected (Allen et al., 2014).

In 2006, a new consolidation center serving the airport was developed, due to the increased demand for a new terminal at the airport. The consolidation center acts as a cross-dock facility, where the staff provides stock shop shelves service, as well as pre-retailing activities such as pricing and ticketing (Allen et al., 2014).

This scheme has enabled time savings of 4,715 GBP annually, as well as fuel savings worth 100 GBP/week per business (TTR, 2010). Vehicles trips have been reduced by 70% which in 2004 resulted in a reduction of 3,100 Kg CO2 emissions per week (TTR, 2010).

Meadowhall Consolidation Centre
Meadowhall Consolidation Centre (MCC) was established in 2003 with the aim to serve the retailers within the Meadowhall shopping Centre at Sheffield (TTR, 2010). The UCC is located close to the shopping mall and can be used voluntarily (Allen et al., 2014). MCC has an area of 3,159 sqm for warehousing, serving 180 retailers to which it provides just-in-time deliveries of an order being placed, where small retailers make the most use of it; however, larger retailers use it on a regular or occasional basis (TTR, 2010). MCC specific objectives are allowing retailers to increase their sales area, to help them maximize sales, to allow retailers focus on dealing with customers and to reduce freight transport and staffing costs to retailers (Clipper Logistics, 2007).

The UCC operates with six employees and two 7,5-ton vehicles that deliver the goods from MCC to the retailers (Clipper Logistics, 2007). Other resources for storing at the UCC are caged areas as well as flexible racking bays for storage (Allen et al., 2014). MCC, besides providing the service of storing, provides pre-retail services such as hanging goods after unpacking, labelling, RFID/security tagging, label printing, returns and space for staff training (Allen et al., 2014).

Construction project UCC

London Construction Consolidation Centre
This consolidation center operated between 2005 and 2007 and served four large construction sites in London (TTR, 2010). The UCC had an available space of 5000 sqm, to where some of the materials, with the exception of aggregates, structural steel, ready concrete, escalators and furniture were assembled and delivered (TTR, 2010). According to Allen et al., (2014), a sixth of the needed deliveries at the construction site were needed on a just-in-time basis. The consolidation Centre had a fleet of six delivery vehicles (Allen et al., 2014), which also had to return back to the UCC with collected materials for recycling, reuse or for collection by a waste operator (TTR, 2010).

The scheme impacted positively the performance on the construction site, where a reduction in time of supplier deliveries and high delivery reliability were achieved (TTR, 2010; Allen et al., 2014). Shortly after the closing of the Construction Consolidation Centre, a 7,500 sqm was built in east London to serve different construction projects in the area of east London (Allen et al., 2014).

2.8 Synthesis of the literature review

The basic processes performed at a terminal are shown with a flow diagram at the figure 18. First, the goods that are handled at the terminal are received and unload from the vehicle that is performing the delivery at the terminal. Then, the goods are manipulated in order to put-away into the terminal facility. The goods are then stored in specific locations where they will wait up to the next process, the retrieval process. Retrieval task is executed when the picking process is performed according to a customer order or a specific order. When the goods are already picked up from the storage within the terminal, they are prepared to execute the final process of the terminal; the shipping. At this final phase, the goods are loaded to the vehicle or delivered to the next carrier which will transport the material to the next terminal or perform the last-mile delivery according to the supply chain strategy.

Figure 18. Basic processes in a terminal. Sources, authors.

At the literature review, there were presented several functions that can be performed inside a terminal. Table 3 summarizes these functions with a brief description on each one.

Table 3. Terminal functions. Sources, authors.

Terminal Functions	**Description**
Consolidation	Combine multiple products from diverse locations into single-vehicle loads.
Transhipment	Activity of transferring goods form one transport mode to another.
Coordination	Since different shipments arrive at the terminal, coordination of inputs and outputs is needed.
Sorting	Goods are arranged or categorized according to diverse criteria.
Kitting	Products are gathered into one unit at the terminal in order to facilitate the delivery process.
Sequencing	Sorting products according to customer's detailed demand requirements.
Commercialization	Products delivered from the terminal to the immediate sale.
Storing	Goods pending to be picked up at the terminal and prepared to be delivered.

As it was presented with the different terminals and UCC studied cases, there are different value-added services that can be provided from a terminal. The table 4 illustrates a list of the different value-added services that can be provided at a terminal, according to the sections 2.5 and 2.7. Those services were compared to the number of UCC cases that offer those value-added services.

Table 4. List of value-added services identified in the literature compared to UCC cases. Source, authors.

Value-added services	Number of UCC case offering Value-added services
Local Buffer	5
Return logistics	5
Pre-retetailing	2
B2C deliveries	2
Freight pick up	1
Track & Trace	1
Training areas	1
Delivery flexibility	1
Repackaging	1
Assembly	1
E-tailing	0
Quality/Quantity Check	0
Inventory & Order Management	0
Suport services at the recievers	0

3. Methodology

This chapter presents the methodology for the study. Firstly, the research strategy and approach are presented, followed by a description of the research process. Thereafter, the research methods are described. Lastly, the data analysis method is presented, followed by an evaluation of the validity and reliability of the research.

3.1 Research strategies and approach

The research strategy refers to the general orientation to the conduct of business research, which could be either qualitative or quantitative (Bryman & Bell, 2011). Qualitative research usually highlights words rather than quantification while collecting and analyzing data. On the other hand, quantitative research emphasizes the quantification of data collection and data analysis. (Bryman & Bell, 2011). A qualitative research strategy was used to perform this thesis, which is more suitable than quantitative due to this strategy allowing to fulfill the purpose and the research questions, which seek an understanding of the studied phenomena.

The research approach can be deductive or inductive (Bryman & Bell, 2011). In a deductive approach, the researcher, based on what is known about a certain field, deduces a hypothesis which must be subjected to empirical findings (Bryman & Bell, 2011). Contrarily, an inductive approach aims to contribute with new theory with findings from inferences out of observations (Bryman & Bell, 2011). An approach consisting of a mix of both strategies is known as abductive, which enables the researcher to move back and forth between theory and data to develop or modify current theory (Awuzie & McDermott, 2017). This approach is also seen by some researchers as using intuition to develop new knowledge (Taylor et al., 2002). This approach starts with real-life observation prior to any theoretical framework (Kovács, 2005) with the aim to understand a "new" phenomenon (Alvesson and Sköldberg, 1994). Such an approach was used for this thesis, which was based on empirical studies and literature review for achieving the aim of this thesis project.

Case study research

A case of study relies basically on the existence of a micro-macro link social behavior (Alexander et al., 1987). This could be explained with cases of study used by anthropologists whose main research unit could be a family, ethnic group, village, etc. For the economist, a case of study could be based on the studied firm or a larger conglomeration. For political researchers, the key unit of the case of study could be centered on nations, regions, organizations or elections (Gerring, 2017). Therefore, the investigation of a case of study gains a better understanding by focusing on a key part of the whole. The case concept implies a delimited spatial unit that is observed from a singular point in time or over a stated period of time (Gerring, 2017). Concurrently, it can bring a single observation or multiple observations.

What is a case study?

With the work of Flyvbjerg (2013) the concept of case study was defined as the detailed research of a single example of a class phenomenon. Gerring (2017) described the case study as an exhaustive research of a single case whose main purpose is to reveal information from a larger class of cases i.e. a population (Gerring, 2017). The case study might not be a reliable source of information about a broader class but can be advantageous for preliminary stages of a research or investigation by bringing hypotheses that can be tested in different numbers of cases (Mitchel, 1984). However, a case study must be linked to a hypothesis since case studies cannot be of value in and of themselves (Flybjerg, 2013).

Flyvbjerg (2013) interpreted the conventional wisdom about case-study research and summarized it in five oversimplifications about it. The first one stated that general knowledge has greater value compared to concrete and practical knowledge. The second described that is it not possible to make a sweeping assumption of a unique or individual case since a case study is not able to contribute to scientific development. The third mentioned that the case study is useful for generating and testing hypotheses, nevertheless, case studies are not limited to these research activities only. The fourth one stated that a case study incorporates a bias towards verification since it propense to confirm the researcher´s preconceived notions. The last oversimplification by Flyvbjerg (2013), stated that the general propositions and theories are difficult to summarize and develop on the principles of specific case studies.

Why a case study?

A case study is an essential and plentiful method for specific research tasks in the social sciences and becomes a valuable method compared with other methods within the social science research methodology (Flyvbjerg, 2013). The selection of the case study as a research method is basically conducted by the character of the research question (Swanborn, 2010). Swanborn (2010) presented several factors that case studies are selected as the main conduct to answer the research questions. One of the mentioned conditions stated that case study is selected as a research method when there is the impossibility to isolate or even simulate the studied phenomenon. Also, the uniqueness and design problems were explained as conditions that are presented when case studies are selected as a research method (Swanborn, 2010). Another reason described the case study as part of a complex of strategies that share a common objective. This led the research towards the study of the relationship with the other strategies since they share the same objective.

Case definition

The high circulation within the city centre of Gothenburg does not only contribute to congestion but also generates environmental issues such as air quality, greenhouse gas emissions, noise pollution and safety in the streets. For that reason, SMOOTh has initiated as a project which aims, amongst different other activities, to establish a functional city hub where goods with destination to the city centre will be consolidated and transshipped to cargo bikes. At the city hub, companies such as Best Transport, DHL and Pling take care of the last-mile delivery using electric micro vans and cargo bikes. The city hub, however, is a running initiative that is yet not functioning as desired. The activities to be performed at the terminal are still not fully defined, neither the design nor resources needed to perform the tasks optimally. Currently, a collaborative transport system is inexistent, since the companies that are established at the terminal perform isolated activities in a space which is rented from the landowner.

3.2 Research process

The research process of this thesis has three phases, as seen in Figure 19. *Phase 1* focused on gaining an overall understanding of the field being researched. It consisted of both observations of the city hub in Nordstan as well as a literature study on Urban Consolidation Centers. The visit to the City Hub did not follow any interview with any actor established at the terminal but rather an observation on the available resources, the actors established, as well as the current operations at the terminal.

Phase 2 consisted mainly of data collection. Theoretically, a literature study on terminal theory, focusing on the types of terminals, the functions, services and the layout design elements was performed. This provided the analysis framework. Thereafter, a literature study from successful UCC cases around Europe was performed. Here, the variables of focus were the functions, provided services, resources and the layout design.

Empirically, a visit to an Urban Consolidation terminal established in Gothenburg was performed. The visited terminal was at the terminals from Lindolmsleveransen where the researchers had the opportunity to talk to relevant actors from such scheme. Additionally, data was obtained through a surveys and interviews sent to the different UCC cases.

Phase 3 consisted of both validating the framework through interviews with actors to SMOOTh. Such actors included Pling and GLC. Both the observations and the interviews provided a better understanding of the operations at Urban Consolidation Centers. In this phase, all data was compiled and analyzed, and the project concluded.

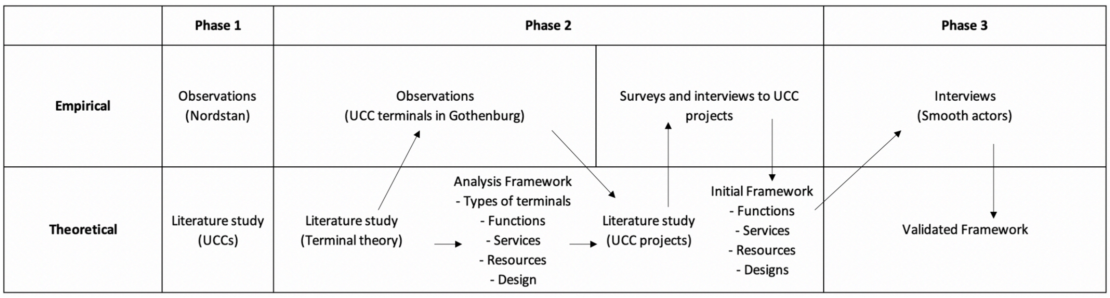

Figure 19. Research process. Source, authors.

3.3 Research methods

The method of conducting the literature and qualitative study will be explained in this section. It includes information in regard to the interview process as well as the relevant literature review for the project.

3.3.1 Literature study

The literature study was divided between phase 1 and phase 2. During phase 1, it focused on collecting general information to understand the field being researched and the problem. Databases from Google Scholar and Chalmers library were used with keywords such as *urban consolidation center*, *UCC*, *urban distribution center, Urban logistics* and *city logistics*.

Relevant literature for Phase 2, which constituted mostly terminal theory and Urban Consolidation cases, was collected with the use of keywords such as *logistic terminals* and *UCC cases*. The literature review started with an introduction to urban logistics and collaborative logistics, which is the ground for this master thesis. Thereafter, the definition of the logistic terminal concept was presented to understand their functionality and role in supply chains. With the aim of determining the different terminal processes, functions, value-added services, resources and design of terminals, the researchers believed that it was necessary to investigate each of those characteristics in the different existing types of terminals. A standardized typology of logistic terminals provided by Higgins et al., (2012) was used to characterize the different types of logistics terminals based on the variables presented earlier in the research process (functions, provided services, resources and layout design). This, since the researchers deemed necessary the use of standardized terminology on logistics terminals due to the high variation of logistic terms available in the literature (Higgins et al., 2012). Additionally, in the literature study on the UCC projects, the researchers performed snowball sampling for the collection of relevant cases, where available literature on UCC cases led to more relevant literature with other UCC cases.

The research questions will partly be answered by the performed literature review. However, such findings will be under scrutiny with the aid of the empirical findings. This way a valid framework on the different functions, value-added services, needed resources and principle design elements of the city hub layout will be established.

3.3.2 Qualitative study

The observations during phase 2 were performed at an UCC scheme within the city of Gothenburg (Lindholmsleveransen). Furthermore, during phase 2, when gathering relevant literature about the Urban Consolidation Cases, the researchers considered necessary to obtain primary to complement the a UCC cases presented in the literature study, as well as to find relevant information about additional UCC schemes. Therefore, a web survey contained in a website link was sent through email to relevant representatives of each UCC initiative presented in the literature, where the respondent had to indicate with an “x” the services that apply to the respective UCC. The questions included in this survey can be found in Appendix A However, the survey was responded to by 3 initiatives. These three initiatives will be presented in the results of the qualitative study, which were complemented by secondary data. Additional UCC cases will be presented, to which the researchers interviewed by Skype.

The interviews with the additional UCC cases in phase 2 as well as from relevant actors from SMOOTh (Pling & GLC) in phase 3, required from interview guides and semi-structured interviews were conducted. The interview questions can be found in Appendix B. Semi-structured interviews according to Brinkmann (2013), allow interviewers to be a knowledge-producing participant rather than only being present with an interview guide. Furthermore, semi-structured interviews allow much more leeway for following up on an angle which the researchers consider important in relation to the research topic (Brinkmann, 2013).

Different Media for qualitative interviewing such as face-to-face, telephone and internet interviews can be used (Brinkmann, 2013). Face-to-face interviews are the richest source of knowledge (Brinkmann, 2013), however, due to constraints generated by the outbreak of COVID-19 and the impact on the companies to be interviewed, video interviews were conducted. Snowball sampling was used to establish the interviewees who were relevant for the study. According to Bryman & Bell (2011), with snowball sampling, the researcher makes initial contact with a small group of people relevant to the topic, who further provide contact with other relevant actors. Sönke Behrends, who is the SMOOTh project manager and also our mentor at IVL, was responsible for identifying and making the initial contact with the interviewees from the SMOOTh project since he knew beforehand the actors who could be a good source of knowledge for the study. Table 5 and 6 present the information of the interviewees from both SMOOTh and complementary Urban Consolidation Schemes. Table 7 provides information in regard to the site visit at Lindholmsleveransen.

Table 5 Interviewees from SMOOTh. Source, authors.

Name	Company	Field of work	Length of the interview
Annika Häggberg	Pling transport	Cooperation and sustainability manager	80 min
Sudo Sulejmanovic	GLC	Business area manager	60 min

Table 6 Interviews with UCC schemes. Source, authors

Name	Company	Field of work	Length of the interview
Christoffer Widegren	Stadsleveransen	Business area manager	20 min
Hans Schurmanns	Proximus	Director logistics operations	45 min

Table 7 Terminal observations in Gothenburg. Source, authors

Name	Company	Field of work	Length of the visit
Mattias Carlberg	Lindholmsleveransen	Business area manager	60 min

3.4 Research quality

To ensure the quality of this research, firstly, a method for data analysis will be presented. Thereafter, an assessment on validity and reliability proposed by Bryman & Bell (2011), based on two criteria namely *trustworthiness* and *authenticity will* be presented.

3.4.1 Data analysis method

Two different methods were used for analyzing the available data. Firstly, the available primary data, by means of the so-called *grounded theory,* which according to Bryman & Bell (2011) is the most used framework for analyzing qualitative data. Secondly, by using *assorted analysis* for analyzing secondary data.

Grounded theory is usually referred to as an iterative method, meaning that the process of collecting data and analysis happen at the same time and often refer back to each other (Bryman & Bell, 2011). Creswell (2013) stated that grounded theory is the qualitative research design in which the analyst develops a general theory or explanation of a process, action, or interaction influenced by different perspectives of a larger number of participants. One of the main important characteristics of the grounded theory method is that it recognizes the role of the researcher in the interpretation of the data (Johnson, 2015). The data emerged from the researcher's compilation and analysis of the qualitative information is at a point equivalent to what the researcher knows systematically about his/her own data (Glaser & Strauss, 2017).

Researchers employ theoretical sampling in order to provide the investigation with conducted comparison by choosing sources with intimate and wide knowledge related to the research questions to inform the research process (Johnson, 2015). These sources are intended to collect future information and are driven through insights that came from previously collected information (Glaser & Strauss, 2017). With the grounded theory, the researchers are intended to minimize the differences between the collected data in order to create similarities, but at the same time, the researchers need to maximize certain differences in order to understand potential boundaries conditions and slight differences in the theoretical data (Johnson, 2015). The process for performing grounded theory is shown in Figure 20.

Steps 1 to 4 were performed following the research strategies and approach presented in section 3.1. When step 4 was reached, the qualitative data was broken into concepts and subsequently classified into categories. These categories were, for instance, services provided by the Urban Consolidation Scheme, currently available resources and challenges of future operations at the terminal. In step 6, the categories were saturated after coding and reviewing the transcripts from each interview and site visit.

The initiation of step 7 began and the researchers generated a series of hypotheses about the relationship between the categories. For example, "the current value-added services provided by the company are a result of the current resources which at the moment are very limited". This hypothesis is a sample of the existent links between the categories "provided services", "resources" and "challenges".

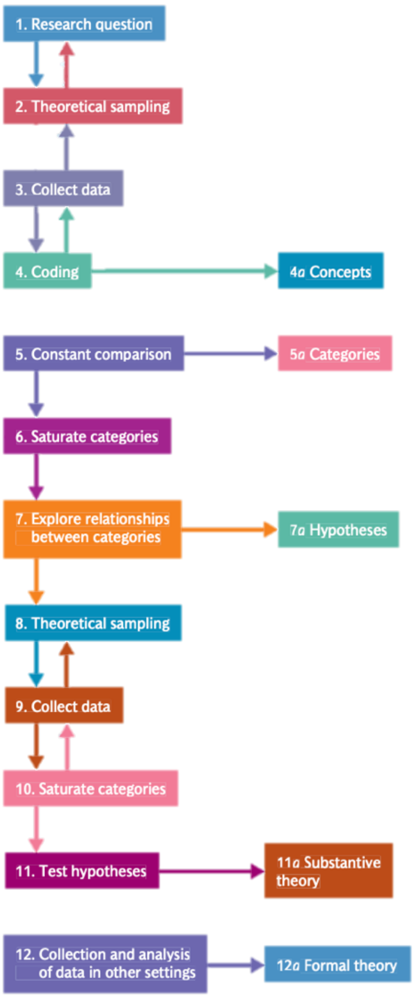

Figure 20 Grounded theory process. (Bryman & Bell, 2011)

The analysis of secondary data was performed by means of the so-called *assorted analysis*. According to Heaton (2004), this variety of secondary data analysis involves the use of various qualitative data and methodologies, in which pre-existing data is combined with primary data. Furthermore, *assorted analysis* can be used to provide new evidence from the diverse sources of data (Heaton, 2004).

3.4.2 Trustworthiness

According to Bryman & Bell (2011), trustworthiness is made up of criteria such as *credibility, transferability, dependability* and *confirmability. Credibility* entails that the research is both performed by the principle of good practice and the findings provided to the studied members to confirm that the researcher has understood the studied field

(Bryman & Bell, 2011). A technique to ensure that this criterion was met is called *respondent validation,* which aims to validate the findings from interviews with the respondent (Bryman & Bell, 2011). This technique was used by the researchers, in which at the end of the interviews and site visits, the researchers confirmed, by emphasizing on information provided by the interviewees, that the conclusions on the interview and site visits were in accordance with the interviewee´s views. *Transferability* refers to the task of researchers of providing thick descriptions of the compelled data (Amin et al., 2020). Bryman & Bell (2011) established that researchers have to provide detailed data of the case of study since it would be possible for others to generate judgements of the studies applicability. *Dependability* entails that the research phases are kept in an accessible manner for "auditing" purposes (Bryman & Bell, 2011). The researchers kept records including interview notes, fieldwork notes and data analysis decisions accessible. Lastly, *Confirmability,* which aims to prove that the researcher has acted in good faith and that personal values or theoretical inclinations to influence the outcome of the research. Since records and notes from site visits were kept accessible, the researchers could ensure that neither personal values or theoretical inclinations influenced the project.

3.4.3 Authenticity

This criterion concerns a broader political impact of research which is measured by *fairness, ontological authenticity, educative authenticity, catalytic authenticity* and *tactical authenticity* (Bryman & Bell, 2011). *Fairness* refers to having a wide representation among different members of a social setting, with the objective of having different viewpoints. *Ontological authenticity* which indicates whether the research allows members to have a better understanding of their social environment. *Educative authenticity* aims to "help the members to appreciate better the perspectives of other members of their social setting". *Catalytic authenticity* which concerns whether the research has acted as a trigger for members to take action to make a change (Bryman & Bell, 2011).

However, this criterion was not considered due to its affinity with a type of research called action research, which differs from the qualitative research performed in this thesis. Action research aims to generate practical outcomes, where the action researcher and a client work together in the diagnosis of a problem and the solution based on such diagnosis (Bryman & Bell, 2011). This type of research also requires involvement with different members of the organization (Bryman & Bell, 2011), which again, does not apply for this thesis project.

4 Empirical findings

This chapter presents the findings from the empirical study. Firstly, findings from the study visits to the City Hub in Nordstan, together with findings from the interview with the Sub-urban hub (GLC) will be presented. Thereafter, findings from a study-visits to an Urban Consolidation Scheme in Gothenburg is presented. Later, primary data from 5 urban consolidation schemes in Europe, complemented by secondary data will be presented. Lastly, a synthesis of the results will be provided.

4.1 Study visits

The terminal in Nordstan– overview

The terminal at Nordstan is currently serving both stores from the shopping mall and stores located in the city centre of Gothenburg. The stores located at the mall get their deliveries from multiple carriers (GLC included) and destinations in an underground area. This area is 1.35km long and it includes several docks where freight vehicles can be loaded and unloaded. Once the vehicles are unloaded, personnel from the receiving company place the goods in a storage/buffer area adjacent to the docks. From here, personnel from the receivers take care of the goods which are subsequently either put in storage or shown at the stores ready for selling.

The goods being delivered to the city centre are transhipped in an area close to the entrance to the underground area. This area is rented by the companies taking care of the last-mile delivery to stores in the city centre (DHL, Pling and Best). Here, vehicles arrive through a single-existing entrance/dock, where goods are transhipped from the vehicle to a cargo bike, as illustrated in Figure 21.

Figure 21 Transshipment at Nordstan City Hub. Source, authors.

The transhipment of containerized goods as shown in figure 21, is performed by DHL, who is currently the only company making use of the terminal for transhipment. Neither Best nor Pling perform this activity at the city hub yet.

Each company (DHL, Pling and Best transport) has its own rented space, where offices have been established. However, Best transport is not established within this area, since the rented space is located in the underground area which currently serves Nordstan shopping mall.

Pling transport

Current state

Pling transport is a non-profit organization that operates bicycles for delivering goods, mostly in the city centre of Gothenburg. The company performs B2B and B2C deliveries, although 90% of them are being sent to other businesses which are mostly from the hospitality industry, including bakeries, restaurants and cafes.

Pling believes that the terminal is well located, although it is currently highly un-used so it is yet unknown whether space is enough to handle future operations. The terminal is currently working as an office and parking for the cargo bikes, however, it is not yet used for transhipment, as previously mentioned. All the deliveries that they perform consist of collecting goods at a customer and delivering it to another customer or location.

Table 8. Value-added services currently offered by Pling. Source, authors.

Services	Service offered (x)
Local Buffer	
Quality/Quantity Check	
Inventory & Order Management	
Pre-retailing	x
Return logistics	x
Collecting and delivering	x
Freight pick up	
Track & Trace	x
B2C deliveries	x
Training areas	
Support services at the reciever	
E-tailing	
Delivery flexibility	x
Repackaging	
Assembling	

The company provides different services to the receivers as shown in Table 8. *Pre-retailing* services performed by the company consist of printing and placing of product labels to the receiver prior delivery. *Return logistics* is a provided service to a low scale, where the unit loads used for the goods transportation are picked up at the receivers once they have been used. Furthermore, the company provides home deliveries and also provides flexibility to the receiver in regard to the desired delivery time, where the bigger the provided time window from the receiver, the less it is charged by Pling.

Collecting and delivering is a service provided by Pling which was not found in the literature, which consist of a service where the company goes to a customer to pick up goods which need to be delivered to the customer's customer.

Pling has its office at the terminal where they have different amenities for employees (such as sofas, coffee machines and toilets) and a space for the parking of cargo-bikes. The available space has concrete pillars and columns which make it hard to manoeuvre the bikes and also reduces the available space. The activities performed at the terminal consist of assigning cargo bikes to deliveries within the city as well as repairing/maintenance of the vehicles. There are no current activities being performed jointly with the other actors at the terminal, however, Pling does the maintenance of the bikes to DHL express and Best. Performing the maintenance to the bikes owned by Best requires Pling's technicians to go to their location to do so. Given Best's location, it results in Pling rather time-consuming to perform such activity.

Future state

Pling sees sharing activities and resources with other actors as not an issue, which could represent more efficiency if a collaborative transport system were to exist. However, some resources such as having a private own-space with facilities such as toilets are seemed rather convenient. Furthermore, it is believed that for a collaborative transport system to work, it is needed that trust amongst the actors exists, as well as the allocation of resources for each company within the system.

The service offering could be extended depending on the customers' requirements; however, it is believed that space at the terminal is the main enabler for expanding the current offer of services.

Sub-urban hub (GLC)

GLC is an urban consolidation centre located in the outskirts of Gothenburg which serves multiple destinations, including Nordstan shopping mall. The terminal provides de service of pure transhipment and warehousing to a wide variety of customers from different industries, which are mostly from the food industry. On top of the previously mentioned services, the terminal offers some value-added services as shown in Table 9.

Table 9 Services provided at GLC

Services	Service offered (x)
Local Buffer	x
Quality/Quantity Check	x
Inventory & Order Management	
Pre-retailing	
Return logistics	x
Collecting and delivering	x
Freight pick up	
Track & Trace	
B2C deliveries	
Training areas	
Support services at the reciever	x
E-tailing	
Delivery flexibility	x
Repackaging	x
Assembling	
Packaging*	x
Specialized warehousing*	x

* Services provided not identified in the literature

Some of the value-added services are functioning at a very low scale, e.g., return logistics, which is a service provided to only one actor within Nordstan shopping mall, to whom GLC repacks the goods before sending it back to the shipper. GLC, as Pling, also offers the service of collecting and delivering, which often occurs when the customer requires goods to be picked up in a specific location and subsequent delivery to its location. Support services at the receiver consist of helping customers take their goods farther than at the receiving area, usually direct to the shelves or storage racks. Value-added services which were not identified from the literature such as packaging of inbound goods and specialized warehousing (in freezers) are provided by GLC.

GLC does not currently send any goods that need to be transhipped to cargo bikes for last-mile delivery, which means that the sub-urban hub only sends goods to the stores located within Nordstan shopping mall. The goods delivered to Nordstan are transported in 2-5 vehicles per day and will be shipped to Nordstan the same day only if they arrive at GLC before midday. For shipments arriving after midday, their delivery will take place the next day. The receivers at Nordstan have not demanded a specific time for deliveries, which allows GLC to fulfil all orders without delays. However, if a customer in Nordstan requires a special delivery on a specific time, GLC provides such a service.

Lindholmsleveransen

Lindholmsleveransen is an initiative operated by Renova, a company that transports waste and recycled materials. This initiative aims to operate the last-mile delivery of parcels in the area of Lindholmen in Gothenburg. These parcels arrive at the terminal from carriers such as DHL, DB Schenker and Postnord. The terminal also receives mail; however, its last-mile delivery is outsourced to a third party who collects the mail at Lindholmsleveransen terminal.

The current goods delivered by Lindholmsleveransen are often office supplies and food which make up for 50 parcels/day and 2 pallets. At the terminal, two employees receive the goods which after being registered, are stored in shelves and thereafter sorted into bins. These bins are loaded into vehicles and delivered to the receiver. The process flow of such activities is displayed in Figure 22. The service provided by Lindholmsleveransen is unique, since the goods are delivered to the receiver's door, which otherwise are most likely left at the building´s reception. Lindholmsleveransen also provides the service of picking up goods and delivering to another location, although it is a service that is rarely offered to customers.

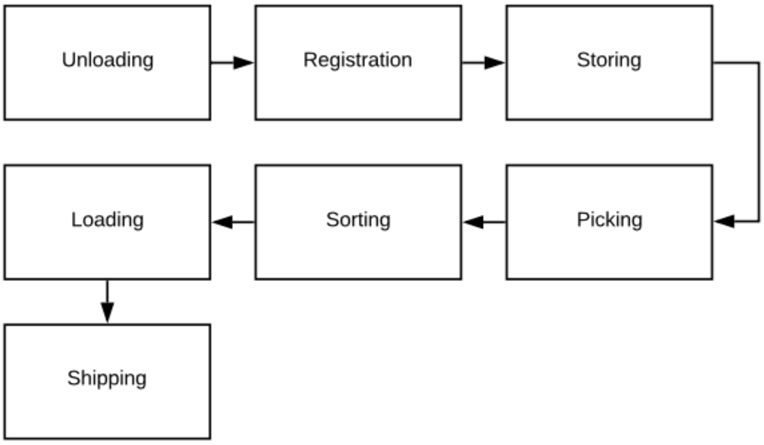

Figure 22 Process flow at Lindholmsleveransen. Source, authors.

4.2 Urban consolidation schemes – cases

This section will present information in regards to 5 other Urban Consolidation Schemes which the researchers managed to collect qualitative data from. The information gathered from Stadsleveransen and Proximus- L'Oréal City Hub - Belgium was gathered through an interview. The primary information on the other three cases was gathered through surveys, which was complemented with secondary data. The findings are described below.

Stadsleveransen

Located in the city of Gothenburg, Sweden. This terminal was set up in 2012 and currently is a subcontractor hauler to Postnord and DHL. The scheme provides deliveries to big and medium sized shops in the city center within 10am and 4pm. During that time, there are no operations being performed at the terminal. Stadsleveransen operation starts at 8am, as goods from DHL and Postnord arrive at their terminal. When goods arrive at their terminal, the goods are sorted into roller cages prior to dispatch. Thereafter, the goods are loosely loaded to the last-mile delivery vehicles. The terminal counts with a space of 500sqm, which includes areas for employees such as showers and a kitchen. A substantial area from the terminal is allocated for parking of 3 electric small vehicles, which they use to perform the deliveries. However, it does have specialized equipment, meaning all activities inside the terminal are performed manually.

Stadsleveransen currently serves 120 receivers, which represent an average of 800 hundred parcels per day. The scheme also adapts the delivery times based on their specific time windows. Besides this service, Stadleveransen also picks up parcels within the city centre, which are taken back to their terminal. Here, companies such as DHL and Postnord collect them.

The biggest challenge faced at the terminal has been reaching financial viability. However, Stadsleveransen believes that will be self-sustainable by June 2020.

Proximus- L'Oréal City Hub

This city hub is an ongoing initiative close to the city centre of Brussels, which aims to reduce the pollution and traffic in the inner city, creating a more viable city. The project started in September 2019 and is run privately by Proximus, a telecommunications & ICT operating in Belgium and L'Oréal, a French personal care company. Both companies use the terminal as a cross-docking facility which tranships their goods to cargo bikes and are subsequently delivered to stores from either Proximus or hairdressers where products from L'Oréal are required. At the facility, the driver from the cargo bike is in charge of the transhipment process.

The scheme aims to increase their volumes and expect a 3PL to take care of the operations at the terminal. However, Proximus & L'Oréal expect different freight forwarders to be established at the terminal as a collaborative transport system, which is currently a challenge due to the unwillingness from the logistics providers for sharing the operations due to current low margins.

Besides transhipment, the scheme also offers the service of collecting flows back to the terminal, as well as flexibility on the deliveries, where a time window of 2 hrs is provided. It is believed that further integration with other value-added services would allow them to reach financial viability, where storage availability and pre-retailing activities are considered the main ones to integrate. Furthermore, when asking about the biggest challenges faced when running their initiative, both the IT integration between stakeholders and reaching financial viability were considered the most crucial.

Binnenstadservice UCC

Located 1,5 km away from the Dutch city of Nijmegen, a city with a historical structure and small streets where independent retail stores are located (Van Rooijen & Quak, 2010). To be part of Binnenstadservice, (BSS), the retailers must change the delivery address from their suppliers to the UCC. The carriers need to deliver the goods to BSS UCC, who bundles the deliveries from multiple suppliers and thereafter delivers them when the retailer desires (Van Rooijen & Quak, 2010). BSS is described as a collective warehouse used by small retailers, offices, cafes and restaurants. This means that BSS focuses mainly on small retailers, avoiding the split of full truckloads deliveries (TRB, 2015). After goods are consolidated, the delivered goods are sent in clean transportation modes such as electric bikes and natural gas trucks (Van Rooijen & Quak, 2010) as shown in Figure 23. However, BSS does only the warehousing; the transportation is outsourced to a carrier that delivers to the end consumer (TRB, 2015), (Duin et al., 2016). Figure 24 illustrates the inner space where most of the activities performed by BSS UCC take place, such as storing (Van Rooijen & Quak, 2010) and labelling (Uemi, 2017). Additionally, BSS provides the services of home deliveries, reverse logistics, e-tailing (Van Rooijen & Quak, 2010; Duin et al., 2016).

Figure 23 Binnestadservice terminal. (Binnestadservice, 2014)

Figure 24 Inner space at Binnenstadservice´s terminal. (Binnenstadservice, 2014)

A research performed by Van Rooijen & Quak, (2010), concluded that BSS initiative became a success, showing a decrease in the number of trucks and number of kilometres driven in the city centre of Nijmegen. Furthermore, it has benefited all actors (public authorities, receivers, shippers, carriers and inhabitants). Receivers from reverse and value-added logistics. Shippers from having a consolidated order which improves their environmental image. Carriers from having a single dropping point and finally, inhabitants, who benefit from a better quality of the public space (TRB, 2015). This achievement has driven the implementation of another UCC in the city of Den Bosch and has propelled BSS to use franchisers to start new consolidation centres in other cities (Van Rooijen & Quak., 2010).

The services identified from BSS in the available secondary data were confirmed as provided services in the survey. However, new information in regards to other provided services was obtained, as can be seen in Table 10.

Table 10 Provided services by BSS. Source, authors.

Value-added service	Binnenstadservice
Local Buffer	x
Return logistics	x
Pre-retetailing	x
B2C deliveries	x
Freight pick up	x
Track & Trace	x
Training areas	
E-tailing	x
Delivery flexibility	x
Repackaging	x
Assembly	
Quality/Quantity Check	x
Inventory & Order Management	x
Suport services at the recievers	
Collecting and delivering*	x
Circular services*	x

(x) Illustrates the provided services by the UCC identified as provided services by the UCC project in the literature
(x) Illustrates the provided services by the UCC which were not identified as provided services by the UCC project in the literature
(*) Additional services provided not identified as a provided UCC service in the literature

BSS, same as with Pling and GLC, also provide the service of Collecting and delivering. Furthermore, a service to which they refer to as "Circular services" is also offered, to which the respondent described as the service of "picking up valuable waste which is brought to companies who can reuse it".

City Logistik - Denmark

Citylogistik is a UCC established in 2013 that supplies goods to the city centre of Copenhagen which received financial support from the authorities to mostly help financing environmentally friendly vehicles (Gammelgaard et al., 2015). This UCC was inspired by Binnenstadservice UCC and its business model consists of generating value to the customers by better resource allocation and better use of the space in shops since the receivers know when and who brings the goods (Gammelgaard, 2015). The initiative focuses on the requirements of customers located in the historical area of Copenhagen´s city centre (Bestfact, 2014c). The retailers served by Citylogistik require that suppliers and transport operators drop their goods in Citylogistik´s UCC, located outside the city centre, from where Citylogistik performs the last-mile delivery in environmentally friendly vans (Bestfact, 2014c). This scheme has contributed successfully to the retailers who don't receive multiple deliveries, to transport companies who deliver to a single location, to shippers who now provide a better service to the clients and to the city, which increased the attractiveness and livability by reducing congestion, noise and pollution (Bestfact, 2014c). To be part of the scheme, retailers need to change the dropping destination of their deliveries to the Citylogistik UCC, although Citylogistik also tries to offer the service directly to transport operators (Bestfact, 2014c).

Besides delivering to the historical city centre of Copenhagen, Citylogistik offers pick up of outbound shipments as well as external warehousing and storage of goods, from where goods can be picked. The company also offers the possibility to track the goods available at Citylogistik's warehouse (Citylogistik, 2019).

The survey sent to CityLogistik was responded to, which allowed to complement the different services offered by the scheme, as can be seen in Table 11.

Table 11 Offered services at City logistik. Source, authors.

City logistik - Denmark	
Services	**Service offered (x)**
Local Buffer	x
Quality/Quantity Check	x
Inventory & Order Management	x
Pre-retailing	x
Return logistics	x
Collecting and delivering	x
Freight pick up	x
Track & Trace	x
B2C deliveries	x
Training areas	
Support services at the reciever	
E-tailing	x
Delivery flexibility	x
Repackaging	x
Assembling	x

(x) Illustrates the provided services by the UCC identified as provided services by the UCC project in the literature
(x) Illustrates the provided services by the UCC which were not identified as provided services by the UCC project in the literature

Cityporto Padova - Italy

This UCC operates in the city of Padua, Italy, with the main aim of reducing the congestion and pollution caused by delivery vans in narrow streets in the city centre. By 2012, the terminal performed more than 100,000 deliveries per year from their customers which are in major proportion couriers, forwarders and SMEs. The terminal is a cross-docking platform of 1549 sqm which is located within a freight village and counts with 11 CNG-powered vans from which 2 are equipped for temperature-controlled goods (Bestfact, 2015a). The operations at the UCC also include warehousing and management of returns (Gonzalez-Feliu & Morana, 2010). Cityporto Padova (CP) has become a successful UCC scheme for factors such as its location within a freight village, being near to logistic platforms and the development of a dedicated IT system (Bestfact, 2015a; Leonardi et al., 2014). The UCC has proved to be attractive for non-perishable goods, due to its compatibility with cross-docking operations. The company now aims to increase their value-offering by including perishable goods transportation into their range of services, an extension of delivery services to non-urban areas, new track and trace system and integration with the rail-road activity at the freight village (Bestfact, 2015).

Some benefits of the operation of CP at different levels were calculated, where it was concluded that the introduction of CP caused a decrease in total travel distance from CP's customers (Bestfact, 2015). CP also decreased the average distance per delivery, which now stands at 1,36 km/delivery, compared to 5,95 km/delivery before the implementation (Bestfact, 2015). The survey sent to Cityporto Padova allowed to complement the offered services by the scheme, as can be seen in table 12.

Table 12 Services offered at Interporto Padova. Source, authors.

Interporto Padova - Italy	
Services	**Service offered (x)**
Local Buffer	x
Quality/Quantity Check	x
Inventory & Order Management	
Pre-retailing	
Return logistics	x
Collecting and delivering	x
Freight pick up	x
Track & Trace	x
B2C deliveries	x
Training areas	
Support services at the reciever	x
E-tailing	
Delivery flexibility	
Repackaging	
Assembling	x

(x) Illustrates the provided services by the UCC identified as provided services by the UCC project in the literature

(x) Illustrates the provided services by the UCC which were not identified as provided services by the UCC project in the literature

Summary of results

The surveys helped complement information from secondary data, which as can be seen in appendix C would have been more limited without primary data. Nonetheless, the table in appendix C presents the provided services not only from the UCC cases in section 2.8 but information in regards to the services provided by actors of SMOOTh such as Pling and GLC. Also, from the interviewed Urban Consolidation Schemes (Stadsleveransen and Proximus- L'Oréal)

5 Analysis

This section provides an analysis of the empirical data in section 4 and the literature review presented in section 2. Even though most of the research questions can be answered with a large extent from the literature review and the empirical data, this section aims to provide a wider understanding of each of the research questions under investigation.

5.1 RQ1: What terminal processes and functions are required at city hubs?

The answer to this question is referred back to section 2.3 and 2.4. It is clear that the different functions that can be performed in a city hub depend on the needs of the customer and the complexity of the city hub itself. Also, that the functions are influenced by the business model, which purpose is to explain the operation of the project and/or organization and generates the value for the different stakeholders involved (Jerman et al., 2019). The result of the value creation for stakeholders in regard to technology management has a strong influence on the functions and processes to be performed in a terminal.

One of the most important processes in a terminal is material handling since it can conduct the most potential improvement with the highest cost impact for the stakeholders (Kłodawski et al., 2017a). Material handling process within a city hub terminal starts with the reception of goods, which according to Kłodawski et al. (2017a), includes the unloading, identification, control and buffering. This is a typical process in terminals and was clearly seen as the most common process at the terminal from the Urban Consolidation Schemes cases as well as the site visits. Additionally, as identified from the different UCC cases in section 2.7 and 4.4, transshipment is the main function present in Urban Consolidation Schemes.

Nonetheless, transshipment is not the only function at terminals as shown in section 2.4. All the different functions help to diminish the difficulties presented with the linkage of logistics terminals (Lumsden,2007). For instance, consolidation is a function that should be considered as a function in a city hub terminal. This function is one of the most common within logistic terminal's operation (Lumsden, 2007), as it allows the terminal to combine different products from different locations and times into single-vehicle loads (González-Ramírez et.al., 2009). According to Hall (2007), the consolidation function can be classified into three variants i.e. inventory consolidation, vehicle consolidation and terminal consolidation. The last two types of consolidation function could be considered in terminals since they use spatial location for receiving the products from different origins and loading them into single-vehicle loads with different destinations (Hall, 1987). This function starts with the reception of different shipments from different origins. Then, the products are sorted and loaded into cargo bike's containers in order to execute the last-mile delivery process throughout the involved project's freight companies. Although the function of consolidation should be considered in the design of city hubs, prior consolidation in unit loads could happen at other terminals before reaching the city hubs (such as a terminal from Schenker consolidating cargo for the city hub in Oslo). Such consolidation avoids the city hub to consolidate cargo in the containers, which means that the main function at a terminal is transhipment to the cargo bikes. However, since the specific case of the terminal in Nordstan wants to address the possibility of sending cargo from the shipper directly to Nordstan without a transhipment in GLC, the terminal at Nordstan needs to consider the function of consolidation.

The sorting and kitting functions correlate with the consolidation process, which happens because these functions have similar activities. Sorting occurs when the goods are retrieved from storage and spread with a logical arrangement based on customer order (De Koster et al., 2007). Kitting process is performed when products need to have extra sorting but share the same destination (Lumsden, 2007). Both functions can be implemented altogether when consolidating to achieve better performance. The function of sequencing can be also implemented integrally with previous functions. Sequencing aids to execute the sorting process aligned with the customer's requests or the convenience of the supply chain performance (Lumsden, 2007). In addition, the service level and value for the stakeholders can be improved as a result of integrating those functions since the terminal's offered services would have better performance.

Implementing a storing function in the city hub's terminal can provide a balanced flow of materials within the supply chain management (Lumsden, 2007). This function would enable the time dimension needed to the city hub when it is required. This function is present in most UCC cases from sections 2.7 and 4.4. However, this function requires available space which could potentially be an inconvenience in terminals where space is a constraint. When referring to the specific case of the city hub in Nordstan, space might not be an issue since there is a possibility to expand the available space if the SMOOTh's project requires it.

Business to customer modes like e-commerce requires the commercialization function to be available at logistic terminals. This function enables the city hub to prepare the goods that will be delivered to the end customer (Lumsden, 2007). The e-commerce market-main difference compared with the traditional market is that the customer orders are received directly at the logistic terminal with the aid of digital platforms, through a computer network (Żuchowski, 2016). This platform provides the customer and supplier with tools designed to place and receive orders more efficient than the traditional mail service. Dealing with e-commerce at Urban Consolidation Schemes is not yet a typical function according to the empirical findings, however, considering the benefits that it could provide when supplying surrounding business and customers with cargo bike deliveries, the commercialization function becomes a key terminal's design element to be implemented.

5.2 RQ2: What value-adding services can be provided at city hubs?

The value-adding services that can be provided at city hubs according to the theoretical framework are several (see table 2 and 4). However, not all terminals that consolidate cargo offer the same variety of value-added services. At sections 2.7 and 4.4, different Urban Consolidation Schemes were studied, where the service of providing storage space/local buffer to the receiver, as well as return logistic services were the most commonly provided services in Urban consolidation Schemes as illustrated in Figure 25.

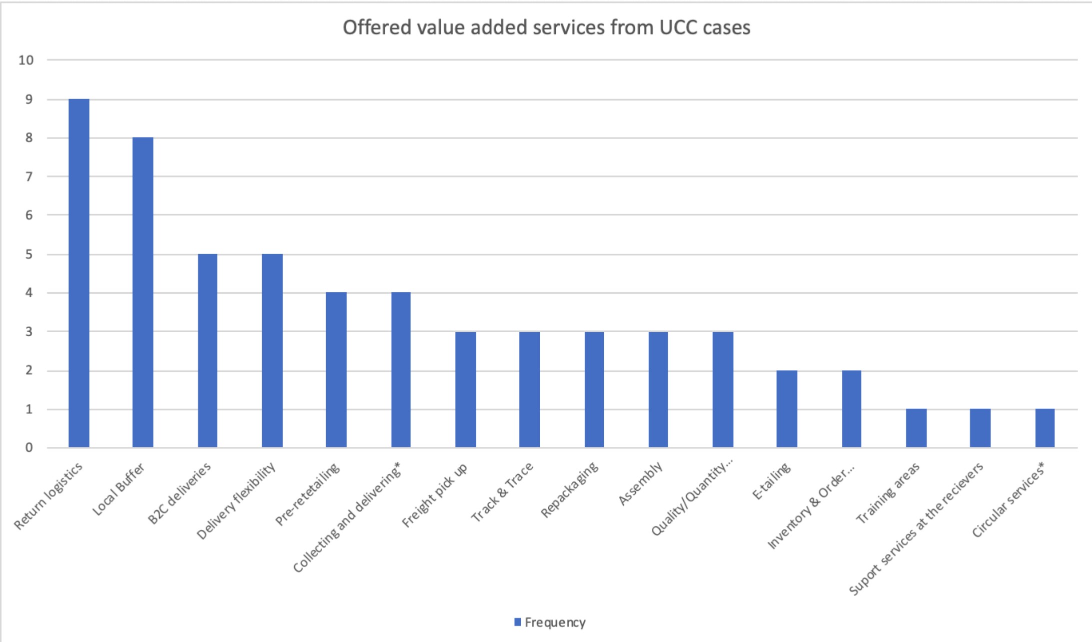

Figure 25 Aggregated times to which value-added services are provided between all UCS cases. Source, authors.

The frequencies on the services shown in Figure 26 were obtained after primary data from interviews and the surveys were collected. This caused the identification from services which were not currently mentioned in the literature. For instance, GLC and Pling provide the service of collecting and delivering, which when added to the surveys sent to the different Urban Consolidation Schemes cases, it turned out that it was also a service provided by each of the three respondent schemes (Binnenstadservice, Cityporto Padova and Citylogistik). Furthermore, identified services in the literature, which were a-priori not part of the service offering from neither of the UCC cases, were selected as offered services from the respondents to the survey. This lack of information in secondary sources indicates to some extent the lack of updated information in regards to provided services at Urban Consolidation Schemes.

The value-added services provided at city hubs as shown from the UCC cases in sections 2.7 and 4.4 are plenty and even though they could be a source of revenue growth to Urban Consolidation operators (Pålsson, 2014), they could increase the complexity of the operation Allen et al., (2012). These two statements were perceived true when performing the literature review of the UCC case studies around Europe, where some schemes operated as a facility for pure transhipment and thus, limited services; whereas others had more functions and allocated space for a different range of services and more complexity. For instance, the city hub which operates pure transhipment in Oslo is only used as a cross-dock terminal with no storage (Ørving & Eidhammer, 2019), as well as the terminal from Proximus & L'Oréal in Belgium. On the other hand, Urban Consolidation Schemes such as Binnenstadservice in Nijmegen provides a wide variety of services but it's a more complex system. The findings from the UCC cases and the empirical study provide evidence that the value-added services provided by Urban Consolidation Schemes will depend strongly on the business model, which vary depending on the complexity of the system.

Addressing the specific case of the City Hub in Nordstan, with the value-added services offered by Pling, it is noticeable the fact that the most common value-added service provided by the different UCC cases, namely *Local Buffer/Storage,* is currently not provided by the company at the City Hub. The available space at the City Hub in Nordstan could potentially be used for a wide variety of value-added services and not offering such service has already been a missed opportunity to Pling (since it has been previously demanded by the receivers). Proximus & L'Oréal city hub which is a comparable scheme to the terminal in Nordstan, is already looking forward to implementing services such as providing a buffer to receivers, as well as implementing pre-retailing activities as a strategy to become self-sustained financially.

However, Allen et al., (2012) argue that the services provided at city hubs need to be initially simple since reaching financial viability is a challenge in most Urban Consolidation Schemes. This statement suggests that the UCC schemes could initially provide only the services of last-mile delivery and increase the value-added services as the initiative has proved financially viable with no need of subsidiaries.

5.3 RQ3: What resources are needed to provide the city hub functions and value-added services?

The resources needed in a city hub depend on the functions and processes to be performed at the terminal. Back in section 2.5, the different types of logistic terminals were presented with the functions and processes that can be performed within them. These functions and processes require material handling, which, as previously stated, is the process with the biggest contribution to the terminal's operations (Kłodawski et al., 2017a). With a high level of contribution, the mentioned processes and potential value-added services entail a major requirement of resources.

According to Taylor (2014), warehouses and distribution centres' main purpose is to provide retail stores and customers the value of time and place. Therefore, a city hub terminal can relate to the first level of the hierarchy of logistics terminals from the typology from Higgins et al., presented in section 2.5.1. This type of terminals performs basic functions such as warehousing, shipping, receiving, and cross-docking (Higgins et al., 2012). Additionally, these terminals can provide different services such as labelling, repackaging or quality inspections (Taylor, 2014).

These functions and activities provided in these types of terminals require different resources for operations which according to Farahani et al., (2011) are space, equipment and people. However, space according to the study visits and performed interviews is the most important resource, which could be sometimes scarce. For instance, the city hub in Nordstan has limited available space located in the basement of the shopping mall and in the area where the transhipment to the cargo bikes occurs. Consequently, not only the vehicle manoeuvre becomes difficult, but also the allocation of space to potentially perform value-added activities.

According to Farahani et al., (2011), the needed equipment in a terminal depends on the level of automation of the terminal, which could be either with manual or automatic systems. The manual systems, also called the picker-to-product systems, is an approach that could be perceived as the system in most UCC cases, as well as in the site visit to Lindholmsleveransen, where the stored goods are picked up from their storage places and dispatched to their delivery destinations. The Automated systems, also called product-to-picker systems, include automated retrieval of goods (Farahani et al., 2011). Advanced terminals in terms of automatization of warehousing processes could include systems such as Automated Storage / Retrieval Systems (AR/RS) where machines perform the picking tasks. The visited terminals and interviewed schemes only operate through manual systems, where operators perform the receipt and dispatch of goods without automatic processes. It is clear that the equipment needed at a terminal depends on the performed tasks and provided services. Also, forklifts are the most used resources in a terminal where there is no automation or partial automation. However, these industrial trucks are not often used for small items or small picking orders, creating the need for a bin-shelving area and carts with multiple compartments, or as with Stadsleveransen, roller cages where goods can be placed.

Based on a simple operation at the City Hub in Nordstan, it can be said that the currently available resources at the terminal are enough to start off basic operations. It is considered that if the actual function of the city hub is transshipment, there are available resources that enable the execution of this special function, as it already happens with the terminal from Proximus & L'Oréal. However, the transshipment at the terminal in Nordstan with the available resources, does not enable an easy loading of the container to the cargo bike, which could mean a decrease in efficiency for the operations. At the same time, the current available space is a limited resource. However, from the interviews, it could be inferred that the spatial resource can be modified according to the city hub's needs. Also, since the consolidation function is currently being performed at GLC, the resources to execute the process of consolidation are not needed for the moment. This means that if an Urban Consolidation Scheme is operating as a pure transshipment terminal and goods are previously consolidated, the needed space is less, as well as the required resources to perform other functions and activities.

5.4 RQ4: What are the principle design elements of city hubs?

The terminal typology presented by Higgins et al., (2012) in section 2.5 provides partially the answer to this question. The 1st level in the hierarchy of logistic terminals which relate to warehouses and distribution centres are two types of terminals whose functions can relate closely to the functions performed by Urban Consolidation Schemes, and therefore, the layout design also. The functions and activities performed by the different UCC cases in sections 2.7, 4.4 and the empirical studies from GLC and Pling support the suggestion that these terminals perform typical functions and activities from such cluster. However, terminals within the same cluster such as Inland Container depots and Container yards, perform activities from container terminals which are necessary at Urban Consolidation Schemes, if the unit loads handled at the consolidation terminal are containers. These activities mean that Urban Consolidation Schemes which make use of containers e.g., containers for the cargo bikes, could require to allocate a specific space within the terminal for storing empty containers as well as a space to perform the maintenance and repairing. Consequently, a space for maintenance and storing of small containers would be needed just as the container yard, but on a smaller scale.

Taylor (2014) suggests using a flow diagram when determining the layout of the terminal since it can prove useful to avoid product flows crossing. Considering the different activities performed during the site visit to Pling in Nordstan and Lindholmsleveransen, as well as secondary data from the UCC cases, figures 8 and 9 in section 2.5.1 resemble the activities performed on such terminals and could be helpful when designing the layout. However, having in mind that the initial phases of Urban Consolidation Schemes require the operation methods and provided services to be simple and straightforward (Allen et al., 2012), the layout design and space at the terminal should be an enabler.

Terminals which only provide the service of transhipment will have different layout requirements to terminals which perform a wider variety of functions and services. This difference can be seen when comparing the layouts from the initiatives in Oslo (Oslo City Hub) and Nijmegen (Binnenstadservice), where it can be inferred, based on the activities performed at the city hub in Oslo, that the layout was designed to facilitate transhipment from larger to smaller vehicles and since there is no storage, the available space at the terminal is mostly allocated to resources such as docks and conveyor belts, which facilitate the transfer from one vehicle to the other. On the other hand, Binnenstadservice offers a wider scope of services, which is clearly shown by the look of their terminal. Here, the layout requires allocated space for inbound staging, space for storing different types of goods (fast-moving products, slow-moving products, high-value products), allocated space for performing pre-retailing activities such as labelling and tagging, space for sorting, consolidating and packing. Furthermore, it is required for space for amenities such as offices, toilets and break rooms.

Woxenius (1998) states that in a small-scale intermodal transportation system, the surface of the terminal needs to be flat and very simple, which was a characteristic of the UCC cases in which terminal´s images could be found. However, when addressing the specific case of Nordstan City Hub, specifically the area where the last-mile delivery companies are located, it can be inferred that the area was not originally built for a logistics terminal, which makes the area look not as simple. Further, this area has only one dock which could make the terminal inefficient if two vehicles arrive at the same time. The current volumes being handled at the terminal are handled with a single dock, however, based on the expected handled volumes, it could prove to be a bottleneck for future operations. This suggests the need to establish part of the operations of the city hub in the basement of Nordstan shopping mall, where space is less constraint.

Nordstan City Hub is visualized in the near future as a collaborative transport system where actors will share resources and perform activities jointly. This initiative is seen as a viable option for Pling, meaning that the design of the terminal could be focused towards a design that maximizes efficiency by increasing collaboration and resource sharing between the actors within the terminal. However, the terminal from Proximus & L'Oréal is also aiming to create a collaborative transport system, which has been a problem for the freight forwarders who want to either be the only actor operating the terminal, or not being at all due to the low margins.

6. Discussion

This section presents the research discussion. This section aims to describe the implications of the findings with consideration to the literature review. Initially, the specific terminal implications are addressed, and secondly, future research is presented.

6.1 Terminal implications

The city hub in Nordstan is an ongoing project which is yet not functioning as visualized by the stakeholders of SMOOTh. However, the project is in an early stage which needs to reach financial viability by having a system that minimizes the initial costs. This means that the functions, resource investments and provided services should enable cost savings. Space is clearly the most important resource, since it directly impacts the activities performed at the terminal. However, as could be seen in section 2.5.1, equipment is a major resource needed at terminals, which could vary depending on the level of automation. Manual systems could represent an opportunity to save cost to city hubs in the initiation phase, although, at the expense of efficiency. This has been the case for Proximus & L'Oréal which is a comparable case to Nordstan city hub in terms of the time that has been functioning and their objectives.

Reaching financial viability in a terminal which provides only the service of delivering has proved to be possible as could be seen from Stadsleveransen, however, the time horizon for such a scheme to be financially viable was rather long. Furthermore, considering that some urban consolidation schemes fail by means of not understanding the needs from the final users, city hubs require to implement services that can provide the scheme with revenue and thus avoid being dependent for too long on public funds. Different value-adding services that could potentially be provided by urban consolidation schemes have been mentioned throughout the project, as well as the current services provided by one of the companies established at the terminal who is part of SMOOTh (Pling). Considering that the services provided by Pling have not required major investment and most of them do not require space at the terminal, these services could be kept as an offer to receivers. Furthermore, value-added services which would not require any major investment, and which could be provided with the current available resources such as quality/quantity check of inbound goods, freight pick up and support services at the receiver, could be part of the initial city hub provided value-added services. Even though providing receivers with a local buffer where goods can be stored is a typical service provided by urban consolidation schemes, it requires allocated space within the terminal for warehousing operations. This service could increase the complexity of the terminal and the need for specialized equipment, however, the available space at the terminal in Nordstan represents an opportunity to provide such service. This activity could be performed in the basement of the shopping mall, although, it still remains unknown how much space could be allocated for such activity.

In consideration to the possibility to have deliveries from multiple carriers to the city hub, avoiding them to drop the goods at GLC due to their proximity to the city hub, it is believed that in the one hand could generate a positive impact on the environment by reducing the transported distance, however, it could also mean increasing the traffic in the city centre. This could possibly be counterproductive considering SMOOTh´s objective of reducing the number of trucks in the city centre. Although, if the goods being transported by a carrier are FTL, consolidating the cargo at GLC could only add an unnecessary transshipment. If this decision could only be made based on the desired complexity at the terminal in Nordstan, then receiving all goods from a single carrier could be the best option. This way the terminal in Nordstan could focus on operating as a transshipment point, but also potentially as a facility where goods can be stored.

Finally, there are different aspects to be considered in the design of the terminal in Nordstan. As previously mentioned, and based on the needed functions at the terminal, the design could consider the allocation of space to perform consolidation of goods besides space for pure transshipment. Based on the fact that the terminal in Nordstan is visualized as a collaborative transport system, it needs allocated space for common resting areas, showers, bathrooms which could be shared amongst the different actors. The financial resources will determine whether some of these facilities can be provided to the actors individually. Considering the current services provided at the terminal, there is a need for space where value-added activities can be performed. At the moment, the space available for actors such as Pling is just enough to provide some pre-retailing activities, however, the need for space to perform value-added activities will increase as the value-added service offering increases. It is also necessary to allocate space for parking the vehicles as well as space to store containers.

6.2 Future research

Due to COVID-19, information in regard to the other actors established at the terminal in Nordstan, was not gathered. This of course represents a single point of view about the future state of the terminal, increasing the risk for bias. That is why it would be interesting to analyse different points of views from actors who will be part of the collaborative transport system at Nordstan in a future research.

Furthermore, it still remains unknown whether all goods with destination to the city hub in Nordstan should be consolidated at GLC or if some deliveries depending on the characteristics of the load or the location of the shipper should be delivered directly to the terminal in Nordstan. Finding the optimal decision which minimizes the cost and the environmental impact would be beneficial for SMOOTh. At the same time, future research will be needed when the city hub has been fully operational on a wider time frame. This, since the needs from the customer and stakeholders could change, requiring a re-evaluation of functions and value-added services offered.

7. Conclusions

The purpose of this work is to provide an analysis of the different functions and design principles of city hubs in collaborative transport systems. Different concepts of urban logistics and its different challenges related to the city hubs were provided. Despite this, a definition of city hub in the literature was non-existent. The term “City Hub” is yet not an accepted term in the literature, even though it is a term that is already being used for some consolidation schemes in Urban Logistics. However, based on the performed literature review as well as the empirical studies, a city hub could be defined as a terminal within urban logistics which is close to the nodes of demand, that in most cases only perform the service of transhipment, however, providing value-added services could prove necessary to become financially viable.

The term of “City hub” For instance, the terminal in Oslo which provides urban consolidation to the city centre is called “Oslo City Hub”. However, some initiatives which also do Urban Consolidation such as the terminal that provides consolidation to the city centre at Nijmegen in the Netherlands, is referred to as an Urban Consolidation Centre (Binnenstadservice UCC). Furthermore, even though there are not specific definitions within the scientific researches of different concepts such as urban consolidation centre and urban logistics, this work provides several points of views from different research papers. This allows to have a more holistic perspective of the discussed topic. The objective of this work was to understand the different elements that help to design a city hub and offer suggestions regarding the best directions for future implementation of the city hub located at Nordstan shopping centre in the city of Gothenburg, Sweden.

During the development of this research, COVID-19 was a faced situation, which brought difficulties in the empirical study. However, the information gathered from the literature review with the data obtained from surveys, interviews and study visits, enriched the outcome of this thesis which is expected to benefit the city hub in Gothenburg. The literature review covers a general perspective from the urban logistics concept and its challenges, to the urban consolidation cases which brings a more specific perspective of a city hub. Nowadays, the urban logistic concept is in constant evolution which enables us to find actual and recent information about city hubs and urban consolidation centres. However, it also comes with the challenge of finding relevant information since there are limited scientific papers related to the topic.

We believe that this work can generate value to the actors in Nordstan. Further research will be required when the city hub is fully established and the operations of the city hub had started.

8. References

Aastrup, J., Gammelgaard, B., & Prockl, G. (2012). 3PL Services in City Logistics: A User's Perspective. In Proceedings of the 24th Annual Nordic Logics Research Network Conference: NOFOMA 2012 (pp. 2-20). Turku School of Economics and Business Administration.

AB Volvo (2019). The "SMOOTh" research project: Volvo Group. Retrieved Jan 29, 2020, from https://www.volvogroup.com/en-en/news/2019/nov/volvo-reduces-transports-using-a-digitalized-system.html

Alexander, J. C., Giesen, B., Münch, R., Smelser, N. J. (1987). The micro-macro link. Univ of California Press.

Allen, J., Browne, M., Woodburn, A. and Leonardi, J. (2012) "The role of urban consolidation centers in sustainable freight transport". Transport Reviews, 32(4), 473−490.

Allen, J., M. Browne, A. Woodburn, and J. Leonardi. (2014). "A Review of Urban Consolidation Centers in the Supply Chain Based on A Case Study Approach." Supply Chain Forum: International Journal 15 (4): 100–111. doi:10.1080/ 16258312.2014.11517361.

Alvesson, M. and Sko¨ldberg, K. (1994), Tolkning och Reflektion. Vetenskapsfilosofi och Kvalitativ Metod, Studentlitteratur, Lund.

Agamez-Arias, A.-M., & Moyano-Fuentes, J. (2017). Intermodal transport in freight distribution: a literature review. Transport Reviews, 37(6), 782–807. https://doi.org/10.1080/01441647.2017.1297868

Amin, M. E. K., Nørgaard, L. S., Cavaco, A. M., Witry, M. J., Hillman, L., Cernasev, A., & Desselle, S. P. (2020). Establishing trustworthiness and authenticity in qualitative pharmacy research. Research in Social & Administrative Pharmacy : RSAP. https://doi.org/10.1016/j.sapharm.2020.02.005

Awuzie, B., & McDermott, P. (2017). An abductive approach to qualitative built environment research. Qualitative Research Journal (Emerald Group Publishing Limited), 17(4), 356.

Barone, R., & Roach, E. (2016). Why Goods Movement Matters: Strategies for Moving Goods in Metropolitan Areas.

BESTFACT, (2015a). Best practice factory for freight transport [WWW Document]. URL http://www.bestfact.net/wp-content/uploads/2015/09/BESTFACT_D2.3_BP_Handbook_2_v1.0_20150205.pdf

BESTFACT, (2015b). Urban Delivery Centre (UDC) in Beaugrenelle, central Paris, France [WWW Document]. URL http://www.bestfact.net/wp-content/uploads/2016/01/CL1_135_QuickInfo-Beaugrenelle-16Dec2015.pdf.

BESTFACT, (2015c). Urban Delivery Centre (UDC) in Copenhagen, Denmark [WWW Document]. URL http://www.bestfact.net/wp-content/uploads/2016/01/CL1_095_QuickInfo_CityLogistikCopenhagen-16Dec2015.pdf

BESTUFS. (2007). BESTUFS II: Best Practice Update 2007 Part 1. Best Urban Freight Solutions (BESTUFS).

Binnenstadservice (2014) "Franchisenemers." Binnenstadservice RSS, 2014, www.binnenstadservice.nl/franchisenemers/.

Björklund, M., & Johansson, H. (2018). Urban consolidation center – a literature review, categorisation, and a future research agenda. International Journal of Physical Distribution & Logistics Management, 48(8), 745–764. https://doi.org/10.1108/IJPDLM-01-2017-0050

Bowersox, D. J., Closs, D. J., & Helferich, O. K. (1986). Logistical management: a systems integration of physical distribution, manufacturing support, and materials procurement.

Boysen, N., Fliedner, M., & Scholl, A. (2010). Scheduling inbound and outbound trucks at cross docking terminals. OR spectrum, 32(1), 135-161.

Boysen, N., Fedtke, S., & Weidinger, F. (2018). Optimizing automated sorting in warehouses: The minimum order spread sequencing problem. European Journal of Operational Research, 270(1), 386–400. https://doi.org/10.1016/j.ejor.2018.03.026

Browne, M., Sweet, M., Woodburn, A. and Allen, J. (2005), "Urban freight consolidation centers final report", Transport Studies Group, University of Westminster, Vol. 10.

Brinkmann, S. (2013). Qualitative Interviewing : Qualitative Interviewing. Oxford University Press, Incorporated.

Bryman, A., & Bell, E. (2011). Business Research Methods (Third ed.). New York: Oxford University Press Inc.

Cambridge Dictionary. (2020). TRANSSHIPMENT: Meaning in the Cambridge English Dictionary. Retrieved June 03, 2020, from https://dictionary.cambridge.org/dictionary/english/transshipment

Cano, J. A., Correa-Espinal, A. A., & Gómez-Montoya, R. A. (2018). A review of research trends in order batching, sequencing and picker routing problems. Revista Espacios, 39(04).

Caputo, A. C., Pelagagge, P. M., & Salini, P. (2015). A model for kitting operations planning. ASSEMBLY AUTOMATION, 35(1), 69–80. https://doi.org/10.1108/AA-02-2014-020

Chen, C. C., Tsai, Y. H., & Schonfeld, P. (2016). Schedule coordination, delay propagation, and disruption resilience in intermodal logistics networks. Transportation Research Record, 2548(1), 16-23.

Chronopost, 2013. Dossier de presse: Inauguration de l'Espace Logistique Urbain (ELU) de Beaugrenelle (Paris 15ème) [WWW Document]. URL http://docplayer.fr/14106253-Dossier-de-presse-inauguration-de-l-espace-logistique-urbain-elu-de-beaugrenelle-paris-15-eme.html

Chwesiuk, K., Kijewska, K., & Iwan, S. (2010). Urban consolidation centers for medium-size touristic cities in the Westpomeranian Region of Poland. Procedia - Social and Behavioral Sciences, 2(3), 6264–6273. https://doi.org/10.1016/j.sbspro.2010.04.036

Citylab. (2017). Living labs. Citylab-project. doi:http://www.citylab-project.eu/documents/Living_labs_300917.pdf

Citylogistik (2019) "Citylogistik Is a Receiver-Oriented Solution." Citylogistik Danmark A/S, 2019, citylogistik.dk/about-citylogistik/.

Clausen, U., Geiger, C., & Pöting, M. (2016). Hands-on Testing of Last Mile Concepts. Transportation Research Procedia, 14, 1533–1542. https://doi.org/10.1016/j.trpro.2016.05.118

Clipper Logistics, (2007), The ARC at Meadowhall. Available from http://docplayer.net/14922290-Consolidation-centres-logistics-evolved.html

Changemakers, A. (2017). THE GREEN LINK, sustainable city logistics. Retrieved June 02, 2020, from https://www.changemakers.com/discussions/entries/green-link-sustainable-city-logistics

Cottyn, J., Govaert, T., & Van Landeghem, H. (2008). Alternative line delivery strategies support a forklift free transition in a high product variety environment. In 11th International Workshop on Harbor Maritime Multimodal Logistics Modeling and Simulation (HMS 2008) (pp. 55-60). DIPTIM University.

Creswell, J. W. (2013). Qualitative inquiry and research design : choosing among five approaches (3., [updated] ed.). SAGE Publications.

de Koster, R., Le-Duc, T., & Roodbergen, K. J. (2007). Design and control of warehouse order picking: A literature review. European Journal of Operational Research, 182(2), 481–501. https://doi.org/10.1016/j.ejor.2006.07.009

de Souza, R., Goh, M., Lau, H.-C., Ng, W.-S., & Tan, P.-S. (2014). Collaborative Urban Logistics – Synchronizing the Last Mile a Singapore Research Perspective. Procedia - Social and Behavioral Sciences, 125, 422–431. https://doi.org/10.1016/j.sbspro.2014.01.1485

Duin, J. H. R. van, Dam, T. van, Wiegmans, B., & Tavasszy, L. A. (2016). Understanding Financial Viability of Urban Consolidation Centers: Regent Street (London), Bristol/Bath & Nijmegen. Transportation Research Procedia, 16, 61–80. https://doi.org/10.1016/j.trpro.2016.11.008

ECMT (2001), Terminology on Combined Transport (English-French-German-Russian), OECD Publishing, Paris, https://doi.org/10.1787/9789282102114-en-fr.

Farahani, Reza Zanjirani Rezapour, Shabnam Kardar, Laleh. (2011). Logistics Operations and Management - Concepts and Models - 10.2 The Role of Distribution Centers and Warehouses in Logistics. Elsevier. Retrieved from https://app.knovel.com/hotlink/pdf/id:kt00C3ZCP3/logistics-operations/role-distribution-centers

Flyvbjerg, B. (2013). Five Misunderstandings About Case-Study Research. https://doi.org/10.1177/1077800405284363

Gammelgaard, B., van Hoek, R., & Stefansson, G. (2006). Collaborative logistics management and the role of third-party service providers. International journal of physical distribution & logistics management.

Gammelgaard, B. (2015). The emergence of city logistics: the case of Copenhagen's Citylogistik-kbh. International Journal of Physical Distribution & Logistics Management, 4.

Gammelgaard, B., Prockl,G., Holm, P., Schramm,H., Wieland,a., Maalouf, M., Kinra,A., (2015), "The emergence of city logistics: the case of Copenhagen's Citylogistik-kbh", International Journal of Physical Distribution & Logistics Management, Vol. 45 No. 4, pp. 333-351. https://doi.org/10.1108/IJPDLM-12-2014-0291

Gerring, J. (2017). Case study research : principles and practices (Second edition.). Cambridge University Press.

Glaser, B. G., & Strauss, A. L. (2017). Discovery of grounded theory: Strategies for qualitative research. Routledge.

Grandval, S., Nimtrakool, K., & Grant, D. B. (2019). Factors of adoption governing the emergence of urban consolidation centers. Supply Chain Forum: International Journal, 20(4), 247–265. https://doi.org/10.1080/16258312.2019.1631713

Gogas, M., Adamos, G., & Nathanail, E. (2017). Assessing the performance of intermodal city logistics terminals in Thessaloniki. Transportation Research Procedia, 24, 17–24. https://doi.org/10.1016/j.trpro.2017.05.061

Gonzalez-Feliu J., & Morana J. (2011). Are city logistics solutions sustainable? The Cityporto case. TeMA: Journal of Land Use, Mobility and Environment, (0). https://doi.org/10.6092/1970-9870/496

González-Ramírez Rosa G., Ronald G. Askin, Neale R. Smith, & René Villalobos. (2009). Shipment consolidation by terminals and vehicles. Revista de Matemática: Teoría y Aplicaciones, 1, 178. https://doi.org/10.15517/rmta.v16i1.1426

Hall, R. W. (1987). Comparison of strategies for routing shipments through transportation terminals. Transportation Research, 6, 421.

Heaton, J. (2004). Reworking Qualitative Data (1st ed.). SAGE Publications.

Heitz, A., & Descartes, I. C. (2015). Paris, urban laboratory for urban logistics.

Higgins, C., & Ferguson, M. (2011). An exploration of the freight village concept and its applicability to Ontario. McMaster Institute for Transportation and Logistics.

Higgins, C. D., Ferguson, M., & Kanaroglou, P. S. (2012). Varieties of Logistics Centers Developing Standardized Typology and Hierarchy. TRANSPORTATION RESEARCH RECORD, 2288, 9–18. https://doi.org/10.3141/2288-02

Jerman Andrej, Erenda Ivan, & Bertoncelj Andrej. (2019). The Influence of Critical Factors on Business Model at a Smart Factory: A Case Study. Business Systems Research, 10(1), 42–52. https://doi.org/10.2478/bsrj-2019-0004

Johannessen, S., & Solem, O. (2002). Logistics Organizations: Ideologies, Principles and Practice. International Journal of Logistics Management, 13(1), 31–42. https://doi.org/10.1108/09574090210806342

Johnson, J. S. (2015). Qualitative sales research: an exposition of grounded theory. Journal of Personal Selling & Sales Management, 262–273. https://doi.org/10.1080/08853134.2014.954581

Katsela, K., & Browne, M. (2019). Importance of the Stakeholders' Interaction: Comparative, Longitudinal Study of Two City Logistics Initiatives. Sustainability, 20, 5844.

Katsela, K., & Pålsson, H. (2020). A multi-criteria decision model for stakeholder management in city logistics. Research in Transportation Business & Management.

Kim, K. H., & Günther, H.-O. (2007). Container Terminals and Cargo Systems. [electronic resource] : Design, Operations Management, and Logistics Control Issues (1st ed. 2007.). Springer Berlin Heidelberg.

Kim, K., Park, Y.-M., & Jin, M.-J. (2008). An optimal layout of container yards. OR Spectrum, 30(4), 675.

Kłodawski, M., Jacyna, M., Lewczuk, K., & Wasiak, M. (2017a). The Issues of Selection Warehouse Process Strategies. Procedia Engineering, 187, 451–457. https://doi.org/10.1016/j.proeng.2017.04.399

Kłodawski, M., Lewczuk, K., Jacyna-Gołda, I., & Żak, J. (2017b). Decision making strategies for warehouse operations. Archives of Transport, 41.

Kong, X. T. R., Yang, X., Peng, K. L., & Li, C. Z. (2020). Cyber physical system-enabled synchronization mechanism for pick-and-sort ecommerce order fulfilment. Computers in Industry, 118. https://doi.org/10.1016/j.compind.2020.103220

Konings, J. W. (1996). Integrated centers for the transshipment, storage, collection and distribution of goods: A survey of the possibilities for a high-quality intermodal transport concept. Transport Policy, 3(1–2), 3–11. https://doi.org/10.1016/0967-070X(96)00007-8

Lagorio, A., Pinto, R., & Golini, R. (2016a). Research in urban logistics: a systematic literature review. International Journal of Physical Distribution & Logistics Management.

Lagorio, A., R. Pinto, and R. Golini. (2016b). "Urban Distribution Centers: Doomed to Fail or Optimal Solutions for Last Mile Deliveries." In Proceedings of the 21st Summer School Francesco Turco, Volume 13-15 September 2016, 220–224. Naples

Larson, T. N., March, H., & Kusiak, A. (1997). A heuristic approach to warehouse layout with class-based storage. IIE Transactions, 29(4), 337.

Larson, P. D., & Gammelgaard, B. (2001). Logistics in Denmark: A Survey of the Industry. International Journal of Logistics: Research & Applications, 4(2), 191.

Lewis, C. (2016). 4 trends evolving from the inside. Modern Materials Handling, 71(3), 114–118.

Leonardi, J., Browne, M., Allen, J., Bohne, S., & Ruesch, M. (2014). Best Practice Factory for Freight Transport in Europe: Demonstrating how 'Good' Urban Freight Cases are Improving Business Profit and Public Sectors Benefits. Procedia - Social and Behavioral Sciences, 125, 84–98. https://doi.org/10.1016/j.sbspro.2014.01.1458

Li, Q., Wang, Z., Cao, Z., Du, R., & Luo, H. (2015). Process and data fragmentation-oriented enterprise network integration with collaboration modelling and collaboration agents. ENTERPRISE INFORMATION SYSTEMS, 9(5–6), 468–498. https://doi.org/10.1080/17517575.2013.879742

Lumsden, K. (2007). FUNDAMENTALS OF LOGISTICS. Göteborg, GOT: Chalmers University of Technology.

Mattfeld, D. C. (2006). The Management of Transshipment Terminals. [electronic resource] : Decision Support for Terminal Operations in Finished Vehicle Supply Chains (1st ed. 2006.). Springer US.

Meidute, I. (2005). Comparative analysis of the definitions of logistics centers. Transport, 20(3), 106-110.

Mittal, N., Boile, M., Baveja, A., & Theofanis, S. (2013). Determining optimal inland-empty-container depot locations under stochastic demand. Research in Transportation Economics, 42(1), 50–60. https://doi.org/10.1016/j.retrec.2012.11.007

Mitchell, D. (1984). The Penguin Dictionary of Sociology. Sociology, 18(4), 600.

Moeller, K. (2011). Increasing warehouse order picking performance by sequence optimization. Procedia-Social and Behavioral Sciences, 20, 177-185.

Nordstan. (2019). Nordstan. Retrieved May 21, 2020, from https://nordstan.se/en/

Nordtømme, M. E., Bjerkan, K. Y., & Sund, A. B. (2015). Barriers to urban freight policy implementation: The case of urban consolidation center in Oslo. Transport Policy, 44, 179–186. https://doi.org/10.1016/j.tranpol.2015.08.005

Notteboom, T., & Rodrigue, J. P. (2009). Inland terminals within North American and European supply chains. Transport and communications bulletin for Asia and the Pacific, 78(1), 1-39.

Ogasawara, A., Ishigaki, A., & Yasui, S. (2019). Adaptive Storage Reassignment in Order Picking Systems to Picker Learning and Change of Demand. Procedia Manufacturing, 39, 1623–1632. https://doi.org/10.1016/j.promfg.2020.01.279

Ørving, T., & Eidhammer, O. (2019). Evaluation of Oslo City Hub: the Planning and Establishment of a Depot for Transshipment of Goods (No. 1730/2019).

Paddeu, D. (2017). The Bristol-Bath Urban freight Consolidation Centre from the perspective of its users. Case Studies on Transport Policy, 5(3), 483–491. https://doi.org/10.1016/j.cstp.2017.06.001

Palšaitis, R. (2004). Logistics centers influence on economical development of the region. In Conference Proceedings. Development of Logistics, Transport and Communication Services in the Baltic Sea Region (pp. 21-26).

Pålsson, H. (2014). Diversified service offerings in city logistics-understanding the need for different groups of users. In NOFOMA, 2012. NOFOMA.

Protic, S. M., Voegl, J., Gronalt, M., & Fikar, C. (2019). Analysing the impact of value added services at intermodal inland terminals. International Journal of Logistics Research and Applications. https://doi.org/10.1080/13675567.2019.1657386

Reis, V., & Macário, R. (2019). Intermodal Freight Transportation. Elsevier.

Rimienė, K., & Grundey, D. (2007). Logistics center concept through evolution and definition. Inžinerinė ekonomika, (4), 87-95.

Roche-cerasi (2012). State of the art report. “Urban logistics practice” [WWW Document]. URL https://www.sintef.no/contentassets/067ef756b7644281ad2514bef7955c53/gbo/gbo-l-2.1-state-of-the-art-report--urban-logistics-practices_l.pdf

Rodrigue, J.-P. (2008). The Thruport concept and transmodal rail freight distribution in North America. Journal of Transport Geography, 16(4), 233–246. https://doi.org/10.1016/j.jtrangeo.2007.08.003

Rodrigue, J.-P., Debrie, J., Fremont, A., & Gouvernal, E. (2010). Functions and actors of inland ports: European and North American dynamics. Journal of Transport Geography, 18(4), 519–529. https://doi.org/10.1016/j.jtrangeo.2010.03.008

Rodrigue, J.-P. (2017). City Logistics: Concepts, Policy and Practice. New York, NY: MetroFreight Consortium. Retrieved June 02, 2020, from https://globalcitylogistics.org/.

Rodrigue, J.-P. (2020). The Geography of Transport Systems (FIFTH EDITION). New York: Routledge.

Rogers, L. K. (2011, 08). Lift truck basics. Modern Materials Handling, 66, 39-42. Retrieved from http://proxy.lib.chalmers.se/login?url=https://search-proquest-com.proxy.lib.chalmers.se/docview/903303767?accountid=10041

Sakai et al., (2019). Modelling logistics facility location decisions: an analysis for the Paris region. in the 11th International HHT Scientific Conference : June 8-11, 2017, Dubrovnik, Croatia. (2019). Angiogenesis, 21(1), 527–535

Serafino Luigi, De Villiers Gerard, & Mackay James. (2013). Inland intermodal terminals and freight logistics hubs : transportation engineering. Civil Engineering = Siviele Ingenieurswese, 8, 17.

Stefansson, G., & Russell, D. M. (2008). Supply Chain Interfaces: Defining Attributes and Attribute Values for Collaborative Logistics Management. Journal of Business Logistics, 29(1), 347–359. https://doi.org/10.1002/j.2158-1592.2008.tb00083.x

Swanborn, P. (2010). Case study research: What, why and how?. Sage.

Taylor, S. S., Fisher, D., & Dufresne, R. L. (2002). The Aesthetics of Management Storytelling: A Key to Organizational Learning. Management Learning, 33(3), 313.

Taylor, G. D. (2008). Logistics Engineering Handbook. CRC Press.

Taylor G. Don. (2014). 11.7 Warehouse Functions. In Logistics Engineering Handbook. Taylor & Francis.

Thompson, R. G., & Taniguchi, E. (2015). City Logistics: Mapping The Future. CRC Press.

TRB. Transportation Research Board. (2015). 7.1.1 Case Study: Binnenstadservice. In City Logistics Research - A Transatlantic Perspective, Summary of the First EU-U.S. Transportation Research Symposium. Transportation Research Board.

Trentini, A., Feliu, J. G., & Malhéné, N. (2015). Developing urban logistics spaces: UCC and PLS in South-Western Europe.

Triantafyllou, M, Cherrett, T and Browne, M (2014) Urban Freight Consolidation Centers: A Case Study in the U.K. Retail Sector. Paper 14-5743 presented at Transportation Research Board 93rd Annual Meeting January 12-16, 2014 Washington DC. Presented in Session 714 and will be published in Transportation Research Record.

Tsamboulas, D., & Dimitropoulos, I. (1999). Appraisal of investments in European nodal centers for goods – freight villages: A comparative analysis. Transportation, 26(4), 381.

Tsamboulas, D. A., & Kapros, S. (2003). Freight village evaluation under uncertainty with public and private financing. Transport Policy, 10(2), 141–156. https://doi.org/10.1016/S0967-070X(03)00002-7

TTR. Transport and Travel Research Ltd. (2010). Freight consolidation center study: Main report (Prepared for Department for Transport). Lichfield: Transport and Travel Research Ltd. Retrieved June 20, 2011, from http://www.dft.gov.uk/pgr/freight/research/freightreport/pdf/mainreport.pdf

UEMI. (2017). Last mile urban deliveries with cargo cycles. Berlin: UEMI Secretariat.

UNESCAP. (2009). Review of Developments in Transport in Asia and the Pacific.

van Rooijen, T., & Quak, H. (2010). Local impacts of a new urban consolidation center – the case of Binnenstadservice.nl. Procedia - Social and Behavioral Sciences, 2. https://doi.org/10.1016/j.sbspro.2010.04.011

Van Der Horst, M. R., & De Langen, P. W. (2008). Coordination in hinterland transport chains: a major challenge for the seaport community. Maritime Economics & Logistics, 10(1-2), 108-129.

van den Berg, J. P. (1999). A literature survey on planning and control of warehousing systems. IIE Transactions, 31(8), 751–762. https://doi.org/10.1023/A:1007606228790

van Duin, J. H. R., Quak, H., & Muñuzuri, J. (2010). New challenges for urban consolidation centers: A case study in The Hague. Procedia - Social and Behavioral Sciences, 2(3), 6177–6188. https://doi.org/10.1016/j.sbspro.2010.04.029

Van Rooijen, T., & Quak, H. (2010). Local impacts of a new urban consolidation center – the case of Binnenstadservice.nl. Procedia - Social and Behavioral Sciences, 2. https://doi.org/10.1016/j.sbspro.2010.04.011

Veenstra, A., Zuidwijk, R., & van Asperen, E. (2012). The extended gate concept for container terminals: Expanding the notion of dry ports. Maritime Economics & Logistics, 14(1), 14.

Wagener. (2017). Intermodal Logistics Centers and Freight Corridors – Concepts and Trends. LogForum, 3.

Wang, J. F., & Regan, A. (2008). Real-time trailer scheduling for crossdock operations. Transportation Journal, 5-20.

Wang, Y., Huang, L., & vanden Broucke, S. (2019). An activity theory based approach for ontological modelling of collaborative logistics process dynamics. International Journal of Logistics: Research & Applications, 22(4), 371–392. https://doi.org/10.1080/13675567.2018.1535650

Wiegmans, B. W., Masurel, E., & Nijkamp, P. (1998). Intermodal freight terminals: an analysis of the terminal market. Transportation Planning and Technology, 23(2), 105-128.

Woxenius, J. (1998). Development of Small-Scale Intermodal Freight Transportation in a Systems Context. Chalmers University of Technology.

Yamada, T., Taniguchi, E., Noritake, M., & Horie, A. (1999). Attitudes of companies towards introducing co-operative freight transport systems. In INTERNATIONAL CONFERENCE ON CITY LOGISTICS, 1ST, 1999, CAIRNS, QUEENSLAND, AUSTRALIA.

Yaman, H., Karasan, O. E., & Kara, B. Y. (2012). Release Time Scheduling and Hub Location for Next-Day Delivery. Operations Research, 60(4), 906–917. https://doi.org/10.1287/opre.1120.1065

Zeimpekis, V., Aktaş, E., Bourlakis, M. A., & Minis, I. (2018). Sustainable Freight Transport : Theory, Models, and Case Studies. Springer.

Żuchowski, W. (2016). The Impact of E-Commerce on Warehouse Operations. LogForum, 12(1), 95.

9. Appendices

APPENDIX A

Questions asked to a representative from each of the Urban Consolidation Schemes gathered from secondary data. Replies collected from CityPorto Padova, Binnenstadservice & City Logistik.

Does the UCC offer the service of Buffer/Storage? (Space provided to the receiver at the terminal for the storage of goods)

Does the UCC offer the service of Quality / Quantity check on inbound goods?

Does the UCC offer the service of inventory and order management?

Does the UCC offer the service of Pre-retailing? (Services provided to the receivers such as unpacking, tagging and/or labelling)

Does the UCC offer the service of return logistics?

Does the UCC offer the service of collecting and delivering? (Collection of goods in a given location and subsequent delivery)

Does the UCC offer the service of freight pick-up? (Goods can be collected at the terminal)

Does the UCC offer the service of track and trace?

Does the UCC offer the service of B2C deliveries? (Deliveries to pick-up points or at the end-costumer location)

Does the UCC offer the service of allowing the terminal space to be used for training? (To allow the UCC premises to be a place where retailers and drivers can be trained for better performance across the network)

Does the UCC offer extra services at the location of the receiver? (To help placing goods on the shelves, unpacking, et)

Does the UCC offer the service of E-tailing? (Selling of retail goods on internet)

Does the UCC offer the service of Delivery flexibility? (Un-fixed delivery times)

Does the UCC offer the service of repackaging? (If products being sent back to the shipper)

Does the UCC offer the service of assembling? (Goods-assembly before being delivered)

Does the UCC provide any other services? Which ones?

Do you have any comments?

APPENDIX B

Last mile actors

PLING

Contact: **Annika Hagberg, annika.hagberg@plingtransport.se**
Position: **Cooperation and Sustainability Manager**

General questions

- Can you give us a presentation about your company, yourself and your role?
- What type of goods do you transport and what kind of customers do you serve?
- Where are your customers and receivers located?

Hub-related questions

- What are your thoughts in regards to the city hub in Nordstan? (Space, location …)
- What are your thoughts in regards to the current operations at the terminal?
- How and who delivers the goods to your company at Nordstan City Hub?

Activities

- What activities do you currently perform at the city hub?
- What activities/functions do you believe that could be performed better? Why?
- Do you perform any activities together with other companies established at the terminal? Which ones?
- What activities do you consider can't be performed together with the other companies established at the terminal (DHL, Pling, Best)?
- What do you believe is the most critical activity performed at the terminal?
- Which of these activities could be performed at the city hub? Why/why not?

Local Buffer
Quality/Quantity Check
Pre-retetailing
Return logistics
Inventory & Order Management
Track & Trace
B2B deliveries
B2C deliveries
Training facility
Services at the recievers
E-tailing
Delivery flexibility
Repackaging
Freight pick up
Assembly

Resources

- What do you believe are the most important resources needed at City Hubs?
- Are you currently sharing resources with the other companies? Which resources? How?
- What resources can be difficult to share with the other actors?
- Which resources do you consider that could be shared in order to improve the service level or to reduce costs?

Value-adding activities

- Are there any services being demanded from the receivers that you currently don't offer? Which ones?
- What changes (activities, resources, functions) would be required to provide such services?

Finishing questions

- What has been the biggest challenge of operating at the terminal in Nordstan?
- How do you see the terminal in 5 years from now?

Urban Consolidation Schemes

STADSLEVERANSEN

Contact: **Christoffer Widegren, christoffer.widegren@trafikkontoret.goteborg.se**
Position: **Logistics consultant**

General questions

- Can you give us a presentation about your company, yourself and your role?
- Where are your customers and receivers located?
- What type of goods do you transport and what kind of customers do you serve?
- Do you have any information regarding the number of deliveries, number of parcels delivered, number of trips to the city centre, the number of vehicles?

Activities

- What activities do you currently perform at the terminal of Stadsleveransen?
- What do you believe is the most critical activity performed at the terminal?
- How do you consolidate the goods in the vehicles? (is it by area or) ?

Resources

- What are the different resources available at the terminal (equipment, material handling devices, racks, conveyors, hardware and software)

Value-adding services

- Do you provide any value-added services to your customers?
- What changes (activities, resources, functions) would be required to provide such services?

PROXIMUS

Contact: **Hans Schurmans, hans.schurmans@proximus.com**
Position: **Director Logistics operations and transformation**

General questions

- Can you give us a presentation about your company, yourself and your role?
- Where are your customers and receivers located?
- What type of goods do you transport and what kind of customers do you serve?
- Do you have any information regarding the number of deliveries, number of parcels delivered, number of trips to the city centre, the number of vehicles?

Activities

- What activities do you currently perform at the terminal of Stadsleveransen?
- What do you believe is the most critical activity performed at the terminal?
- How do you consolidate the goods in the vehicles?

Resources

- What are the different resources available at the terminal (equipment, material handling devices, racks, conveyors, hardware and software)

Value-adding services

- Do you provide any value-added services to your customers?
- What changes (activities, resources, functions) would be required to provide such services?

GLC | Göteborgs Lastbilcentral

Contact: **Sudo Sulejmanovic, sudo@glc.se**
Position: **Business Area Manager**

General questions

- Can you give us a presentation about your company, yourself and your role?
- Can you give us a presentation on the functioning and the operations of the UCC? (If it's a warehouse, cross dock facility, DC …) Is it an Urban Consolidation Centre?
- What customers do you serve?

UCC - City Hub related questions

- What services do you provide at GLC? (Storage, pre-retailing, order and inventory management, reverse logistics …) Check the excel file
- When do you get goods to GLC that need to be delivered to Nordstan?
- When do those goods need to be delivered to Nordstan?
- Does it happen that goods arrive too late to GLC and they can't be delivered to Nordstan on time?
- Do you have a certain schedule for the deliveries to Nordstan?
- What are the characteristics of the goods being sent to Nordstan city hub?
- How do you consolidate the goods going to the city hub in Nordstan?
- How do you know what goods need to be sent to Nordstan and when?
- What are the unit loads being used for shipping the goods to the city hub?
- Do you send goods on the same vehicle to the different actors based in Nordstan?
- How often are the consolidated shipments sent to Nordstan?
- Do you provide the receivers with track and trace services?

Finishing questions

- What has been the biggest challenge while serving the city hub at Nordstan?
- How do you see the terminal and your relationship with Nordstan city hub in 5 years from now?

APPENDIX C

Services provided by all logistics schemes studied throughout the project.

Value-added service	Binnenstadservice	Bristol-Bath	City Logistik	Cityporto Padova	The green link	Beaugrenelle	La Rochelle	Stadsleveransen	Oslo City Hub	London Heathrow	Meadowhall	London Construction	Lindholmslveransen	Proximus- L'Oréal
Return logistics	x	x	x	x				x		x	x	x		x
Local Buffer	x	x	x	x			x			x	x	x		
B2C deliveries	x		x	x	x		x							
Delivery flexibility	x	x	x					x						x
Pre-retetailing	x	x	x								x			
Collecting and delivering*	x		x	x									x	
Freight pick up			x	x		x								
Track & Trace			x	x	x									
Repackaging	x	x	x											
Assembly			x	x						x				
Quality/Quantity Check	x		x	x										
E-tailing	x		x											
Inventory & Order Management	x		x											
Training areas											x			
Suport services at the recievers				x										
Circular services*	x													

(x) Illustrates the provided services by the UCC identified as provided services by the UCC project in the literature
(x) Illustrates the provided services by the UCC which were not identified as provided services by the UCC project in the literature
(*) Additional services provided not identified as a provided UCC service in the literature

DEPARTMENT OF TECHNOLOGY MANAGEMENT AND ECONOMICS
DIVISION OF SERVICE MANAGEMENT AND LOGISTICS
CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden
www.chalmers.se

CHALMERS
UNIVERSITY OF TECHNOLOGY