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SCHOOL OF BUSINESS, ECONOMICS AND LAW

Micro terminals

- a sustainable solution to urban logistics?

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Research Report

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Abstract

The subject of urban freight distribution has received increasing attention as more people settle in urban areas. Traditionally seen as an essential foundation for the modern society, freight transports have provided urban areas with the necessities needed for its subsistence. Nevertheless, with a growing dependency on fossil fuels and an increasing number of vehicles to distribute goods, questions have recently been raised about its sustainability. In order to meet these challenges, the industry have proposed a number of innovative ways to mitigate the problems. This paper aims to investigate the scope and viability for one of these concepts called a *micro terminal*. Through an exploratory case study this platform has been evaluated against two other methods of urban distribution. Primary data have also been collected from central stakeholders engaged in urban freight distribution in order to explore if this type of initiative is feasible from a planning and business point of view. The findings revealed the concept of a micro terminal performs relatively well compared to other distribution approaches, but that a successful implementation is highly affected by local pre-conditions and the ability of stakeholders agree on measures needed.

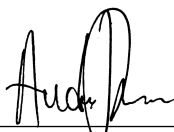
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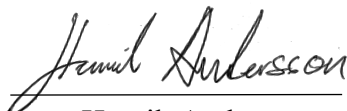
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Andreas Ruus



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Abbreviations

UCC	– Urban Consolidation Center
UFT	– Urban Freight Transport
GHG	– Greenhouse Gases
CO _{2e}	– Carbon Dioxide Equivalent
CO ₂	– Carbon Dioxide
NO _x	– Nitrogen Oxide
O ₃	– Ozone
CO	– Carbon Monoxide
SO ₂	– Sulfur Dioxide
HC _s	– Hydrocarbons
TPTA	– Traffic and Public Transport Authority
dB	– Decibel
HGV	– Heavy Goods Vehicle
LGV	– Light Goods Vehicle
TEU	– Twenty-foot Equivalent Unit

1 Introduction

This chapter will provide the reader with a background and introduce some of the challenges regarding urban freight movement. The introduction will also present the problem formulation as well as the objective, research questions and delimitations.

1.1 The problem of urban freight distribution

Urban freight transport, also known as urban freight distribution, has come of ever growing importance for the development of societies around the world. With an increasing trend of urbanization, more and more people are expected to live and work in cities, and by the year 2030 it is estimated that 60 per cent of the world's population will reside in urban settlements (United Nations, 2017). As these areas grow, so has the importance of transporting goods needed for their subsistence. From this point of view, logistics is often seen as an essential foundation as it provides urban residents with necessities while at the same time enabling businesses to stay competitive in a global market (Anderson, Allen & Browne, 2005).

Nevertheless, despite the importance of logistics, urban goods distribution also generates a number of negative externalities. Often discussed in terms of sustainability, concerns have recently been raised about issues such as increasing air pollution (environmental sustainability); local traffic safety (social sustainability) and a declining urban accessibility (economic sustainability) (McKinnon, 2015). Thus, with the need for transport expected to increase threefold between 2000 and 2050, the oncoming challenges have received more attention from the public and calls for finding new solutions are becoming more stringent (UN-Habitat, 2013). In this regard, traditional ways of goods distribution will have to change (Boudoin, Morel & Gardat, 2014). However, considering the many stakeholders in an urban environment, and the different interests that come with it, finding a new approach is not always an easy task. Thus, as politicians have an urge to reduce the negative impacts of traffic and lower the effects transportation, an increased competition among businesses and change in consumption patterns has at the same time brought about a demand for more intense logistics operations (Taniguchi, Thompson, Yamada & Van Duin, 2001).

Hence, with urban goods distribution being considered as a nuisance by some, but a necessity to others, finding a solution that is appealing to a majority is considered to be essential (Lindholm, 2012). Creating a paradox were urban freight movements in many ways have become a necessary evil, the industry has recently tried to find solutions for harnessing the positive attributes while at the same time mitigating the negative consequences. None the less, while many initiatives have been proposed and tested, an optimal solution is still to be found and the search for better distribution schemes are therefore yet to be explored (Boudoin et al., 2014).

1.2 Problem formulation and research gap

In terms of urban freight transport, one of the main focuses have been on the idea of consolidation (Verlinde, Macharis & Witlox, 2012). With increasing city densities, much of the inner-city transportation is today bundled, and consolidation efforts have therefore been considered an effective way of achieving high quality logistics while at the same time mitigating much of the negative effects of motorized goods. Research has at the same time shown that many platforms, especially urban consolidation centers (UCC), tend to have a short lifespan (Verlinde et al., 2012). It is argued that the additional cost of transshipment often prevents initiatives to be cost effective and that many freight receivers withdraw as they do not see the extra value, especially when they are expected to pay for the service. This have in many cases led to a situation where new initiatives are dependent on government subsidies despite a reported positive impact on emissions, congestion and the local environment (Browne, Allen & Leonardi, 2005; Zunder & Ibanez 2004.)

As outlined above, the challenge of finding new sustainable solutions does therefore not only concern the question of finding a better concept but is also a question of cooperation between important stakeholders. It is so highlighted that the difficulty of engaging various stakeholders in the urban freight transport system is one of the main reasons to the slow development and high risk of failure (Lindholm, 2012). At the same time, it is also stressed that initiatives have to be accepted by stakeholders and that voluntary engagement often lead to more benefits compared to forceful regulation (Holguín-Veras & Sánchez-Díaz, 2015).

Nevertheless, the idea of consolidating goods is still valuable from a logistics perspective. Today, suppliers, carriers and retailers already strive to consolidate freight as much as possible due to efficiencies, and consolidation techniques is therefore an established norm within the industry. In this light, it is necessary to increase the knowledge and continue to evaluate other, efficient and cost-effective consolidation concepts (Verlinde et al., 2012). Recently, a new method of distribution described as “micro terminals” have been suggested. Essentially being referred to as storage units of consolidated goods placed in urban areas, this approach is believed to address much of the increasing demand for urban logistical services, while doing so in an environmentally friendly and economical way. However, being a rather new concept, few studies have actually evaluated its viability, creating a research gap, and this study will therefore take a comprehensive look at how this concept can be compared with other methods of urban freight distribution.

1.3 Objectives and research questions

The objective of this study is to gain a better knowledge and understanding about the scope and greater use of micro terminals. By providing insights into the concept and the various stakeholders concerned, the aim is to explore if this platform is feasible from a planning and business point of view, and if it can provide for a more sustainable solution to urban freight distribution.

To address the objective, the following research questions were formulated:

- How does a micro terminal compare to other approaches of urban distribution?
- From a stakeholder perspective, how viable is a micro terminal of serving city centers in a sustainable way?

In order to answer the research questions a real case will be examined based on a pilot study conducted by DB Schenker. The distribution services to freight receivers in the central business district of Gothenburg will therefore be studied and information from various stakeholders collected.

1.4 Delimitations

This study is reviewing the viability of implementing a micro terminal approach as a more sustainable solution to urban logistics. As discussed in the problem formulation, this concept has received limited attention by previous researchers creating a research gap worth to investigate further. Studying literature for the evaluation of earlier logistical platforms, the core of this study has been limited to the same subjects, ergo the; economic, social/environmental and stakeholder elements of urban freight movements. With an inconsistency in the literature regarding the definition of a micro terminal, this study has also been built upon a single case study. Through an invitation by DB Schenker to expand on their micro terminal pilot project in Gothenburg, conducted during the fall of 2016 and spring 2017, this study has therefore studied the same distribution techniques being direct delivery and a micro terminal approach. Adding to this, a contrasting example of a UCC was also included to further examine the viability of a micro terminal. In this study the UCC takes the shape of the local initiative *Stadsleveransen*. Why this platform was used is due to the recognition it has received in the literature for being a best practice to solve urban distribution challenges. Thus, by investigating these three delivery approaches any other methods have therefore been disregarded.

Within the studied case there are also many stakeholders. However, due to the short time frame and in order to provide academic depth, some stakeholders have not been included. Instead, looking at previous studies, a focus was put on actors considered most influential within urban logistics. Moreover, this study is of an interpretative and exploratory nature. In this sense, the aim is not to generate new theory, but rather to make general inferences into an area with limited research, hoping to contribute with better insights.

2 Literature review

The literature review will present an overview of previous research deemed necessary to understand the topic at hand. Comprised of six parts, this chapter will discuss; The transport system, Network theory, Urban freight and the environment, The evaluation of urban logistics platforms, Stakeholders and interests, and Urban logistics platforms.

This review consists of findings from the field of urban logistics and sustainability. In order to find applicable literature keywords were used to enable comparisons of relevant literature with the intended research questions. The words applied in this study were therefore: *Urban logistics, Consolidation, Sustainability and Micro terminals*. Studying the initial findings and making further explorations of sources thus enabled an identification of the principal research and scholars considered suitable for this study.

2.1 The transport system

The transport system is characterized by movements in time and space. People and goods are moved from one location to another while a certain amount of time pass. Illustrated by Wandel, Ruijgrok and Nemoto (1992) the transportation system can be divided into three levels which provide a clear overview of an otherwise complicated structure for the movement of goods, see Figure 2.1. Here, the top level is representing the material flow. At this level, input goods are located in one point which then have to be moved to another location for production, and yet another for final consumption. This flow of materials creates a demand for freight movements which leads to the second level of the illustration where the goods have to be allocated on different types of carriers and routes, also called the transportation network. The third level of the system is representing the infrastructure which also create the physical boundary and set the rules for where and how the goods can be transported. For freight operations this infrastructure consists of waterways, roads, railways, airports and terminals (Trafikanalys, 2016).

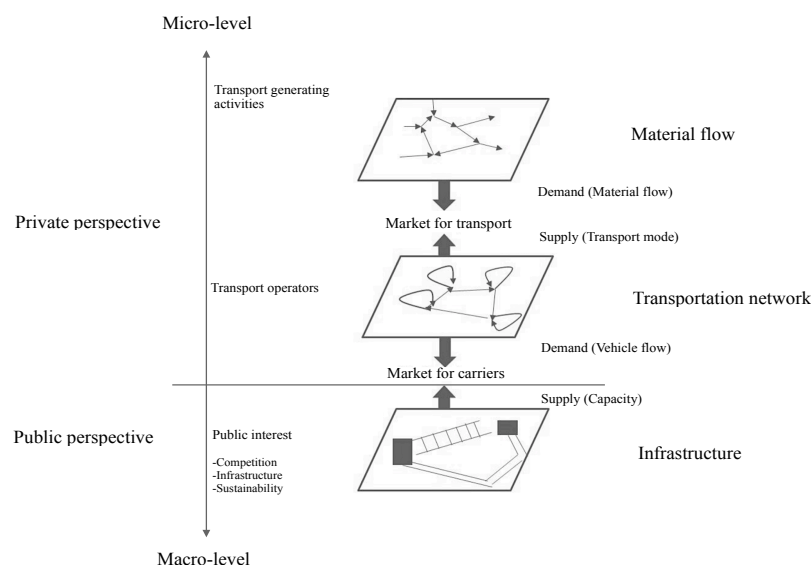


Figure 2.1 Levels of the transport system (Trafikanalys, 2016; Wandel et al. 1992).

How well a transport system work is furthermore dependent on its efficiency. This can be measured by looking at the market for freight carriers and the need for transport. Hence, on the transport market, supply and demand is matched through the need created by the material flow and the supply of carriers for movements, i.e. the number of trucks, trains, aircrafts and boats (Trafikanalys, 2016). The market of freight carriers is in turn dependent on the capacity of the infrastructure and it is therefore generally considered that the level of efficiency in a transport system is dependent on both private and public actors (Trafikanalys, 2016). Creating complicated logistical chains ranging from initial inputs to final consumption, the transportation system consists of many parts making it a complex system to understand.

Urban freight transport

Urban freight transport (UFT), also known as urban freight distribution, concerns a wide range of activities ensuring an adequate service level for a variety of supply chains in an urban context. In a simplified manner urban freight transport could be explained as the activity making sure that goods needed in an area are transported to the right location, at the right time (Lindholm, 2012). However, in terms of definition, the idea of UFT is a rather floating concept. The literature often uses variations of the same term, such as; “city logistics”, “urban goods movement” and “urban distribution”, essentially referring to the same thing. Hicks (1977, p. 101.) provided one of the earlier definitions of this type of transport as; “...all journeys into, out of, and within a designated urban area by road vehicles specifically engaged in pick-up or delivery of goods (whether the vehicle be empty or not), with the exception of shopping trips”. This definition has then been debated over the years and different scholars have provided a multitude of variations. To date one of the more inclusive definitions have been provided by (Lindholm, 2012, p. 6) who define UFT as;

“[...] all movements of goods (as distinct from people) in to, out from, through or within the urban area made by light or heavy vehicles, including also service transport and demolition traffic, shopping trips made by private households and waste (reverse logistics).”

According to the author this broad definition aims to include as much of the goods movements as possible (Lindholm, 2012). Nevertheless, for the outline of this study the focus is on the last leg movement and distribution of goods in an urban area.

Urban areas

Urban areas can further be defined as; “Areas that have urban (i.e. built-up) land of 20 or more hectares that are less than 200 meters apart and linked to form a continuous built-up area.” (UN-Habitat, 2009). However, in order to provide a more convenient definition, this study has considered an interpretation presented by the European Commission. With this framework urban areas can be defined and categorized in the following manner;

- **“Metropolises”** - Considered to be the very largest urban areas with over 3 million inhabitants these areas have a central core and a large proximity from which residents’ commute by railway or bus networks, e.g. London, Paris, Madrid and Berlin.
- **“Other Large Urban Zones”** – These areas have more than 500,000 inhabitants but are smaller than the “metropolises” mentioned above. Being major locations of retail and tourism examples of these are presented as; Gothenburg, Bremen, Krakow and Utrecht.
- **“Smaller Heritage Urban Areas”** – These are areas with less than 500,000 inhabitants but are significant in that they have sensitive environments or are of importance in terms of heritage. Examples presented in this category is Ljubljana and Parma.
- **“Other Smaller Urban Areas”** – Are considered to be all other urban areas which are considered to be smaller in terms of geographic area and population.

(MDS Transmodal, 2012)

2.2 Network theory

On its most basic level, the classical way to distribute goods is by direct delivery, also known as point-to-point. This is when goods are moved from point A to point B translating in to a system offering speed and an easy setup. However, the inherent nature of point-to-point deliveries require an ability to reach high fill rates in order to be efficient (Lumsden, 2006). Thus, when facing volumes less than truckload managers often find themselves in situations having to make decisions on whether to send trucks that are poorly utilized or to wait until the volume of freight is sufficient to make a profit. Consequently, the drawback of direct deliveries is that market demands are hard to match, where on the one side, shipments can be made precisely but poorly utilized, or sent less frequent leading to a lower service level, on the other. The latter is especially relevant considering the increasing demand for just-in-time-deliveries (Lumsden, 2006).

Addressing inefficiencies above, the hub and spoke distribution paradigm was introduced as an alternative way for transport optimization. Easily described, this system is based on the premise that flows are organized around a series of spokes, connecting outlying points to a central hub, see Figure 2.2. In a logistical setting, these systems can be designed in a variety of ways depending on their purpose and utilization. Nevertheless, the fundamental principle is to reduce the number of direct connections (O’Kelly & Miller, 1994). Thus, by introducing hubs in the logistical chain less transport relations are needed enabling more goods to flow in each channel. This is made possible by fact that hubs can both store and consolidate shipments, as well as allowing goods to travel in both directions at the same time. The hub and spoke system can also combine routes to reach the final destination as well as offering return logistics back to the producers (Lumsden, 2006). Hence, leading to higher fill rates for individual shipments it is therefore considered that hub and spoke systems, over all, can offer a higher efficiency and

service level compared to direct deliveries. This especially true when larger systems are introduced and connected to other hub and spoke systems creating a network able to offer even higher levels of consolidation and frequencies of deliveries (Lumsden, 2006).

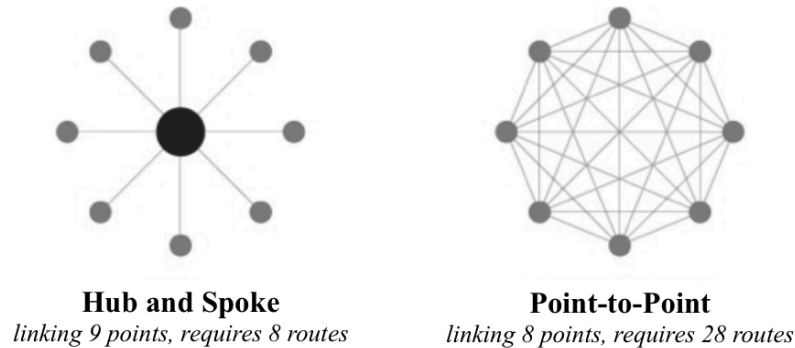


Figure 2.2: Hub and spoke and point-to-point networks (Heathrow, 2018).

At the same time, it should be noted that this system also has some drawbacks. In this sense it is generally considered that goods have to spend a longer time in transit compared with direct delivery. It is also believed that the goods need extra handling and management, creating a trade-off between higher efficiency in reducing the number of transport relations, consolidation and time (Lumsden, 2006). Nevertheless, despite adding the additional handling and transshipment, which by some are seen as a “sworn enemy” of logistics, it is still considered that a hub and spoke system is able to provide a better efficiency overall (Boudoin et al, 2014).

Network theory in city logistics

Previously, most research in logistics have not addressed urban logistics challenges, however since the new millennium more effort and focus have been committed to this area (Boudoin et al., 2014). In city logistics, there is a necessity to reach high fill rates as costs can be spread out over larger volumes of goods. Also, issues of emissions and congestion is more severe in urban settings and have a larger impact on the quality of life. At the same time, high frequencies of transports are demanded by customers due to changed purchase behaviors which again create a tradeoff between service levels and fill rates as explained earlier (Boudoin et al., 2014; Taniguchi et al., 2001). According to literature, theories extending the hub and spoke network have therefore evolved as they are seen to provide new solutions to many of these issues.

Traditionally the most common way of distributing goods in the city has been by a single-tier distribution system. This system only has one level of consolidation-distribution activities which means that there is a direct shipping route from the distribution center to the customer, see Figure 2.3. It has many similarities with point-to-point shipments meaning that less handling is needed and that transit times are lower (Crainic, Errico, Rei & Ricciardi 2012). At the same time, by utilizing a single-tier system the flexibility of the transportation also becomes dependent on the vehicles used which means that goods optimization is harder to achieve. The single-tier approach works well in smaller cities and rural areas where restrictions are few and

congestion is low, however it has over time become less suitable for serving growing urban areas and dense inner cities (Crainic et al., 2012).

An alternative way of serving urban areas is instead through a two-tier system, also known as a two-echelon system. This approach is based on the idea to extend the distribution network with an extra hub located closer to the final destination. Here, trucks are loaded at a distribution terminal and goods are then moved to strategically located hubs, where it is transshipped onto vehicles better suited for inner city transport, see Figure 2.3. Basically, an extension of the hub and spoke network, the two-tier system is believed to resolve many of the issues with fill rates and congestion, however one of the central problems is the added financial cost due to extra handling and land space use (Crainic et al., 2012).

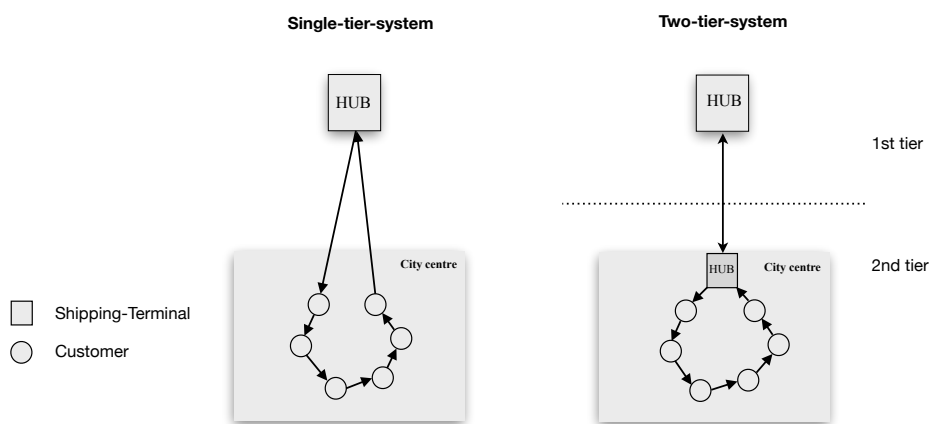


Figure 2.3: Single- and two-tier logistical solutions for urban distribution (Source: Authors).

2.3 Urban freight and the environment

According to scholars one of the central challenges of urban logistics is how to enable efficient goods transports while at the same time mitigating the social and environmental impacts (McKinnon, 2015). From a societal point of view freight transport plays an essential role in the development of urban spaces. At the same time the movement of goods also have a number of negative effects such as air pollution, noise and accidents (Piecyk, Cullinane & Edwards, 2015). With climate change being considered one of the most serious environmental challenges it is estimated that roughly 8 per cent of global CO₂ emissions relate to freight transport (Ribeiro, 2007). Adding to this, complementary facilities such as warehousing and goods handling is also estimated to increase this number by 2-3 per cent in total (Piecyk et al., 2015). Thus, being a sector consuming energy at a relatively fast pace compared to other parts of society, it is estimated that freight transports alone will account for roughly 15-30 per cent of total CO₂ emissions by 2050. This, despite an estimated 33-50 per cent improvement in energy efficiency during the same period (Piecyk et al., 2015).

Studying the environmental effects of urban logistics, it is important to distinguish between several concepts. A distinction is often made between *first- and second order* environmental impacts (Piecyk et al., 2015). First order impacts refer to effects directly associated with freight

transport, such as movements, material handling and warehousing. Second-order impacts, on the other hand, refers to effects that indirectly arise from these movements, e.g. the need for extra infrastructure. In this study a focus is placed on the first order impacts. A discretion is also made between *global, regional and local* effects. Thus, in a global context an emphasis is often placed on greenhouse gases (GHG), while particulate matter is of concern at both a regional and local level (Piecnyk et al., 2015). Discussing the environmental challenges from a local point of view, the literature further identifies five areas of particular concern which are presented below.

Road congestion - Although passenger vehicles take a central role for congestion levels in urban areas, freight vehicle movements are considered to have a significant impact on congestion levels. Typically representing 8-15% of total traffic flow, the congestion from freight vehicles is especially problematic in an urban area considering the many non-uniform start and stop motions. Thus, parking outside designated parking spaces to make collection or deliveries often reduce road capacity and are therefore seen to contribute to the overall problem of congestion (MDS Transmodal, 2012).

Greenhouse gas (GHG) emissions – Emissions from freight transport largely depend on the fuel used. Nevertheless, diesel remains the main fuel and therefore UFT is a significant generator of GHG contributing to global warming. However, GHG are often considered to be less of a concern from the local perspective since climate change often is a matter of national policy with effects perceived in the long term (Piecnyk et al., 2015).

Air quality - If GHG is somewhat discarded from a local point of view, the air quality is on the other hand of real concern. Here, Piecnyk et al. (2015) have identified several pollutants, Nitrogen oxides (NO_x), Hydrocarbons (HC_s), Ozone (O₃), Particulates, Carbon monoxide (CO) and Sulfur dioxide (SO₂) which are especially harmful in an urban setting and believed to cause respiratory and cardiovascular problems. Thus, with most freight engines emitting high levels of particulate matter and nitrogen oxides, the air quality has become a serious problem in many cities (Piecnyk et al., 2015).

Noise pollution – Traffic is one of the main causes of environmental disturbance at a local level and noise generated by freight vehicles is especially regarded as a nuisance by residents. Generated from three sources: propulsion noise; tire/road- contact noise; and aerodynamic noise, some immediate effects of this pollution can be loss of sleep, communication difficulties and an impaired cognitive functioning (Piecnyk et al., 2015). In the EU it is for instance estimated that approximately 20 per cent of the population (100 million) is exposed to noise levels over 55 decibels (dB), making it the second most harmful environmental stressor (European Environment Agency, 2018).

Intimidation and safety - Many city authorities consider urban freight vehicles and especially heavy goods vehicles (HGVs) to be intimidating for pedestrians and cyclists. This is considered to be due to their sheer size but also since accidents involving freight vehicles come with a higher risk of being fatal. This despite the fact that accidents involving freight vehicles are

fewer in terms of distance traveled compared to cars (MDS Transmodal, 2012). However, in light of recent terrorist attacks where perpetrators have used vehicle-ramming as a mean of committing atrocities, freight vehicles have also become a new security threat to urban environments (Transport Security Administration, 2017).

Measuring emissions

In order to meet the environmental challenges, it is universally recognized that emissions have to be measured. However, in practice this process is complex and there is no agreed method of how measurements should be conducted. Instead several different methods have been used all yielding slightly different results depending on how emissions are defined and what factors are accounted for (Piecyk et al., 2015).

One established method is to measure tailpipe emissions. Considered to be one of the narrower approaches of emission measurements, since it ignores all upstream sources of pollution, this method focuses on measuring the exhaust pollutants from vehicles. Suitable for studying specific modes of transport, this measurement can be done in two different ways, top-down or bottom-up (McKinnon & Piecyk, 2009). In the top-down approach total fuel consumption is measured by transport mode and translated macro-level emission figures. In contrast, the bottom-up approach involves surveying operators, enquiring distances traveled, and fuel consumed, then added together and converted into emission values. In terms of measuring emissions for road freight, the latter approach is deemed more accurate (Piecyk et al., 2015).

There are today several databases that have compiled data showing the environmental impact of different transport modes (Piecyk et al., 2015). For this study data have been drawn from the Swedish Transport Administration. In Table 2.1 atmospheric tailpipe pollutants from urban road transport are summarized. Connecting to the previous discussion on air quality the table highlights a wide variation in levels of emissions between different types of vehicles and sources of fuel.

Table 2.1: Average emission factors for freight transports in urban environments

	CO g/km	CO ₂ kg/km	HC g/km	NO _x g/km	PM g/km	SO ₂ g/km
LGV Petrol	6,47	0,20	0,96	0,37	0,0030	0,0005
LGV Diesel	0,31	0,15	0,04	0,59	0,0258	0,0003
HGV	1,15	0,51	0,11	3,68	0,05	0,0009
HGV + Trailer	1,6	0,83	0,08	4,17	0,0579	0,0014

LGV = Light Goods Vehicle HGV = Heavy Goods Vehicle

(Source: Trafikverket, 2017)

2.4 Evaluation of urban logistics platforms

Although urban logistics have been fundamental to the economic development and social well-being for hundreds of years, it is only over the past half century that the topic has come to be recognized as a key determinant of business performance and a major field of academic study (McKinnon, 2015). For those managing logistics, the dominant paradigm during this period has been commercial. Thus, in many cases the prime objective has been to arrange logistics in a matter that maximize profits. With this objective, companies have only calculated on economic costs incurred directly (*internal costs*), and largely ignored any wider consideration for environmental and social aspects (*external costs*) (McKinnon, 2015).

Recently, however, the imbalance between internal and external costs have gained momentum. Today negative impacts are therefore recognized, and many acknowledge that social costs caused by emissions and congestion is rarely reflected in the price charged by freight operators. Thus, despite obvious benefits generated by urban freight, the imbalance between social costs and benefits is not considered sustainable (MDS Transmodal, 2012). Against this background, increasing public and government concerns have created a mounting pressure on logistics companies to reduce their environmental impacts. Consequently, over the 15-20 years a greater priority has been given to environmental issues of urban freight, both by the academic community and the private sector. Leading to a tightening of noise and pollution standards, much of the freight-related externalities have been reduced and a great amount of freight-generating activities have migrated to out-of-town locations (Dablanc & Rakotonarivo, 2010).

Nevertheless, expanding economies, as well as changing patterns of trade have increased the demand for urban freight and changed much of the services provided to commercial and residential locations. Therefore, despite relative improvements in efficiency, the logistics industry still faces massive challenges. At the same time the literature argues that the focus will have to be greater than just cutting carbon emissions if urban logistics should be sustainable in the long run (McKinnon, 2015). According to this view, even if there is a potential to cut environmental costs by a significant margin, sustainability includes more than just the environmental dimension. Drawn upon the Brundtland Commission report of 1988, Keeble, (1988) and refined by Elkington's (1998) "the triple-bottom line", a sustainable development is thus largely considered to be a three-way reconciliation between environmental, economic and social objectives – and something that always have to be balanced (McKinnon, 2015).

Thus, considering the changed focus described above, numerous projects and innovation have therefore been carried out to improve urban logistics movements. With an aim to reduce motorized traffic, and thereby negative externalities, the innovation has mainly focused on new organization structures and concepts such as consolidation centers, the use of new fuels and regulation. At the same time, a central question in these efforts have been on how to measure the efficiency of each individual project (Patier & Browne, 2010).

According to several scholars there has been an inconsistency in the methodologies applied, which in turn have complicated much of the understanding and knowledge transfer. In short this means that units and measurements have had a tendency to differ from one implementation

to another, and despite over 100 logistics experiments carried out in European cities (BESTUFS, 2008), it has been hard to make comparative assessments. Still, the evaluation of logistical platforms is highly important considering that market actors want to run profitable businesses while local authorities and the public sector would like to see the negative externalities being reduced (Browne et al., 2011). It is also stressed that applying a solid evaluation methodology could provide experiments and innovations with a sign of approval, which over time would make sure that public funding is assigned to the most appropriate initiatives and projects (Patier & Browne, 2010).

For this study several papers on evaluation methods have therefore been studied, see for instance; Ambrosini and Routhier (2004); Balm, Browne, Leonardi and Quak (2014); Patier and Browne (2010); Patier and Routhier (2009). While it can be concluded that many of them point towards similar factors to be considered, they all provide specific characteristics and guidelines which can be more or less advantageous depending on the approach. In order to overcome these differences, Allen et al. (2014), have presented a typology of information worth considering when evaluating logistics in an urban environment. According to this, researchers have to collect information related to;

- **The shipment itself:** the nature and quality of the goods (measured in weight, volume and/or surface), the package and the related data to origin and/or destination.
- **The pick-up and delivery operation:** tools and equipment, operations for consolidation-deconsolidation, time data (such as date, hour frequency) and parking conditions.
- **The mode of transports:** vehicle characteristics (capacity, type and special equipment) and data on journeys (travel time, travel path, number of stops and duration).
- **External elements:** the transport network (characteristics, congestion, incidents etc.) and exogenous elements such as weather conditions.

Thus, taking this typology in to consideration and by evaluating the different methods studied, the table below presents the main variables found suitable for this study, see Table 2.2.

Table 2.2: Variables used in this study

Economic Variables	Social/Environmental Variables
<ul style="list-style-type: none"> • Operational costs • Travelled distance • Distribution time • Delivery capacity • Service time • Need of infrastructure 	<ul style="list-style-type: none"> • Emission rates • Congestion rates • Noise rates • Safety

(Source: Authors)

2.5 Stakeholders and interests

The responsibility for creating a sustainable urban environment involve many different stakeholders. According to Boudoin et al. (2014), local governments, logistics companies and business owners all have a stake in how shipments are made and can therefore influence the development. In this sense, governments can take action through policy, logistics operators can improve the coordination of shipments, and business owners can enhance the reception of goods. Nevertheless, with a multitude of stakeholders, each representing its own interests, this also means an increased complexity when it comes to finding optimal solutions (Lindholm, 2012).

Composed of two segments; the literature makes a distinction between those not directly involved in freight transport movements, such as; city authorities, residents, property owners, tourists and visitors on one side (*the public sector*), and the supply chain actors on the other (*the private sector*). The latter can in turn be categorized according to; the supply of goods (shippers or producer), the transport of goods (freight carriers) and the demand for goods (Freight receivers) (Gonzalez-Feliu & Morana, 2011). Clearly presented by Binsbergen and Visser (2001) in Figure 2.4, the model illustrates the different stakeholders and their main interests. Representing either the private or public sphere the next section will summarize the most important objectives and challenges on each side.

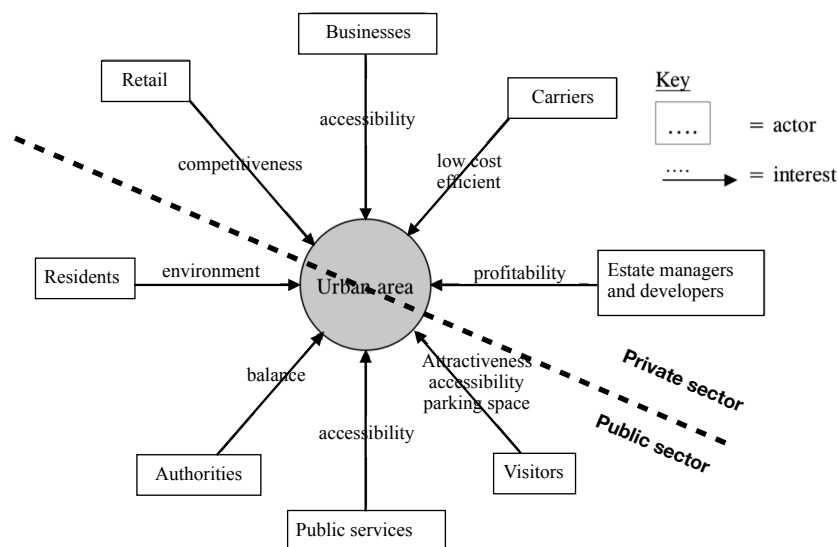


Figure 2.4: Stakeholders in urban goods distribution (Binsbergen & Visser, 2001). Sectors added by Authors.

The public sector

From a public/city perspective the main objective of urban freight movements is to provide residents and visitors with accessibility and services of high quality. This means that city officials have the responsibility to form an infrastructure that respond to the needs of the constituents who live and work in these areas (Lindholm, 2012). However, considering that members of the public do not necessarily have the same interests and priorities this is not always an easy task. Thus, constrained between providing efficient transports, a clean environment and economic growth, the possible organizational schemes are many (Lindholm, 2012). Adding to the complexity, transport planning is also overlooked by many cities. In this sense, local governments often have a transportation plan, a transit plan and a bike master plan, but freight is something that is generally overlooked (MDS Transmodal, 2012).

Thus, when conflicts inevitably arise public authorities frequently intervene trying to balance the interests of both sides and examples of interventions can therefore include;

- Measures to restrict access for vehicles that do not meet weight and emission standards in city centers. While improving the air quality and health of citizens, this also means that transport operators have to modernize their vehicle fleets in order to meet new requirements.
- Imposing time restrictions with limitations on night time deliveries to reduce noise, forcing operators to make deliveries during the day when there is a higher risk of traffic congestion.

However, while these policies may solve one problem they often create another. Thus, with a limit on weight carriers might have to deploy a greater number of smaller vehicles which in the end could lead to even higher emissions (MDS Transmodal, 2012).

The literature also identifies an inherent conflict between residents, visitors and consumers. Accordingly, a majority of city-dwellers regard road freight as a nuisance due to the traffic congestion, noise and environmental pollution. At the same time the same group often want goods to be available in shops, in their near proximity or delivered to them directly. Creating a paradox, the behavior and expectation of the public sector is therefore considered by many scholars to be incompatible with much of the overarching sustainability goals (Boudoin et al., 2014)

Complicating matters further is also the fact that residents, who vote in local elections, are users of personal passenger transport. Operating within the same infrastructure this means that freight carriers will have less political influence and that freight is more likely to be regulated compared to passenger traffic. Thus, with policy implementations having a tendency to affect stakeholders unevenly regulation is often a difficult matter. However, given the potential conflict between stakeholder groups in an urban environment, the public sector is still considered to have an important role to promote sustainable solutions while at the same time minimizing economic costs and impacts on behalf of all stakeholder groups (Boudoin et al., 2014)

The private sector

Even if the private sector confronts the same challenges as its public counterpart, the outlook on urban issues is quite different. In this sense, the financial objective is primary and a fundamental factor in understanding the strategies and choices made (Boudoin et al., 2014). Pressured by increased global competition and changing realities, for many businesses the rigidity of supply chains has become closely associated with their survival. With small margins to spare this also means that receivers often are very price sensitive and have little desire to spend more money on logistical services. Emphasized by already compressed prices, it is also argued that every dysfunction leading to increased costs or lowered delivery quality have a risk to weaken incentives for businesses to stay located in urban areas (Boudoin et al., 2014). For the freight carriers this means that the competitiveness is closely linked to the skill in offering efficient services. As a response many freight carriers have created innovative solutions to keeping costs down. However, as described earlier, these solutions have often implied large external costs and the industry have been accused to piggy back on the expense of society (McKinnon, 2015).

Nevertheless, with an increased concern among the public and private sector, social prerequisites cannot be ignored. Therefore, much of the private sector finds itself in a similar situation to the public where tradeoffs have to be made and stakes considered. With hardening legislation imposed by authorities, the industry has over the years responded with many innovative solutions such as cleaner vehicles and more efficient logistics platforms (McKinnon, 2015). Many have also responded to an increasing market demand and integrated environmental criteria's in their offers as customers become more and more conscious. Hence, being a question of competitive advantage on the one, hand and responding to market demands on the other, it is concluded that the private sector does indeed work towards to innovate their businesses in terms of sustainability and efficiency (Boudoin et al., 2014).

At the same time, many scholars also stress that much of the sustainability work is closely related to marketing efforts and that the initiatives provoke a question of actual intent. Nevertheless, with the majority of logistics decisions being taken on a commercial basis the literature still agree for the need to reconcile conflicts between commercial stakeholders and the wider sustainability objectives pushed by city officials on behalf of constituents (Lindholm, 2012).

2.6 Urban logistics platforms

According to literature much of the challenges regarding urban logistics can be summarized in the “small order problem” introduced by Jackson (1985). This problem contends that one of the central issues of city freight is that it is often dispersed over small consignments, in poorly utilized vehicles, destined for a multitude of locations. Leading to high economic and environmental costs, numerous of projects have over the years tried to find alternative ways of delivering goods. One of the most popular ideas has been to set up consolidation centers in and around urban areas where inbound loads could be disaggregated, and outbound loads aggregated (McKinnon, 2015). While the possible solutions are many, see Leonardi, Browne,

Allen, Bohne and Ruesch (2014), this section will explore the most prevalent ideas and also explore the concept of a micro terminal.

Urban consolidation centers

Urban Consolidation Centers (UCC) have become a widespread solution in city logistics, often introduced by local authorities to reduce the social and environmental impacts of freight distribution. In a broad sense, these centers can be described as logistical facilities located in close proximity to city centers offering a space where different freight carriers can transship and consolidate goods for final delivery. While several value-adding services can be applied in these locations, the main objective is to make sure that shipments entering an urban area have high fill rates reducing the total number of vehicles in service (Browne, Allen, Sweet & Woodburn, 2005).

In a practical sense these centers are seen to operate in a way where long haul-, or inter-city, vehicles from a number of transport operators transship through the same facility. Docking at a UCC, cargo destined for a variety of customers in an urban area are thus unloaded, sorted and consolidated into full loads for a last mile distribution. By using this technique, it is often argued that large freight carriers will be able to transfer much of their loads, reaching a higher efficiency, leading to a variety of social and environmental benefits (Browne et al., 2005).

Nevertheless, some of the issues related to this kind of solution is the high cost of operation and handling. In this light, the expected increase in efficiency is believed to be counteracted as planning and cooperation becomes more complex requiring more resources (Rodrigue, 2016). This is furthermore why the funding for UCCs in many cases are subsidized by local governments and in cases where the funding has ceased the operation of the UCC have proven to be unviable (Rodrigue, 2016).

Logistical hotels

In order to reduce the issues of not being able to bear the costs of facilities the concept of “logistical hotels” have recently emerged (Morana, 2014). This type of solution is based on the idea to build multi-purpose, multi-story facilities in urban settings welcoming various types of activities, such as shops, offices and restaurants. While the main function is articulated around logistics and distribution, it is believed that the issue of spatial cost can be mitigated as more goods can be handled in the same amount of area and with overhead costs being spread out over more stakeholders. Another potential benefit of this type of solution is also the possibility to blend in with the urban environment without being regarded as nuisance to residents (Morana, 2014). In terms of function, buildings like these can be designed in various ways connected to several different modes of transportation. As pilot projects like Sogaris have shown, logistical hotels can also offer several different logistical solutions at the same time including storage, consolidation and transshipment (Dablanc, 2016) Yet, while being a seemingly complete solution to much of the urban freight movements, this is also one of the most complex. In this sense the high initial investments needed is highlighted by the literature, as well as the difficulty to locate suitable premises in an urban setting (Morana, 2014).

Urban logistics boxes

Urban logistics boxes, also known as pack stations, is another form of solution for the transshipment of goods in an urban environment (Morana, 2014). Taking the shape of a several small boxes installed in one unit, or a full booth, this type of platform serves both businesses and private customers. With this system, consignments are shipped throughout an urban area to pre-established locations where boxes have been installed. Thus, if an order is placed by a customer the delivery of goods will be made directly to the nearest booth from which the item can be collected. Usually this procedure is completed in three stages, first by delivering the goods to the location, then notifying the customer with a code to unlock the box, and lastly, the final pick up (DHL, 2018).

According to literature the advantage of a system like this is again the notion of consolidated shipments, where dispersed consignments can be condensed to one location, in one shipment. The system also stands out that the interface between the carrier and the customer is without any human presence. Moreover, another advantage is the control of time whereby deliveries can be made 24 hours a day, seven days a week, which is an aspect considered to be of growing importance in an urban setting (Quak, Balm & Posthumus, 2014). Looking at disadvantages this system, urban logistics boxes are very limited in terms of the total freight capacity and the size of individual consignments. Therefore, even if this system could serve urban areas, it is at present considered to be more suitable for private customers than business deliveries. Another relevant issue is the perception of service since the end-customer is expected to pick up consignments and therefore contribute to the delivery chain. Finally, the last challenge relates to costs with the need to invest in physical boxes and expenditures on administration (Quak et al, 2014)

Multi-use lanes

With cities becoming more urbanized another method for handling freight has been through the introduction of multi-use lanes. With this type of initiative, the idea is to enable a more efficient use of traffic-lanes in city centers by limiting the access of the public for the benefit of freight distribution (Leonardi et al., 2014) By providing space for loading and unloading activities when most needed, and then allowing the space to be used for other vehicle activities during the rest of the day, it is believed that the infrastructure can be used in a more efficient way. Compared to many other logistical solutions this system therefore stands out in that it lacks the element of consolidation, instead the main focus lays on how to use existing infrastructure in a more efficient way (Alvarez & De la Calle, 2011).

A well cited example of the multi-use lanes is provided in the case of Bilbao, Spain. Here, one lane in six different boulevards have been refitted for a multi-purpose use. By installing light signals in the road and through clear messages on street signs, the flow of traffic is controlled so that the area is reserved for goods traffic everyday between 08:00 and 12:00. Apart from these hours the lanes also allow normal traffic movements between 12:00 – 21:00 and offer free car parking between 21:00 and 08:00 (Alvarez & De la Calle, 2011).

According to studies on conducted on this solution there are many potential benefits such as optimized travel distances and a reduction in congestion due to less parking violations. Other mentioned attributes are increases in residential satisfaction, with more free parking space and an extension of parking space in peak hours (Alvarez & De la Calle, 2011). At the same time this solution has two major drawbacks. The first is that it is relying heavily on the existing infrastructure, meaning that the space for reserving a multi-use lane already have to exist. Ergo, streets must have two or more lanes in the same direction. The second is that this solution still will bring heavy trucks in to urban areas and might even encourage this practice further. Therefore, with most legislation trying to limit the access of HGVs in urban areas, this solution could lead to conflicting narratives if implemented wrong (Alvarez & De la Calle, 2011).

Micro terminals

A recently developed method of improving city logistics, and the focus of this study, is the micro terminal. Studying the literature however, it becomes apparent that the concept means different things to different people, and that there seems to be no well-established definition. In addition, the idea of shape and design also seems to be under formation meaning that there has been a variation between specific active schemes and proposals, both over time and between countries (Janjevic & Ndiaye, 2014). Thus, making a classification difficult, the micro terminal concept can instead be seen as a range of applications put on a spectrum on how to best approach similar challenges forming terms such as:

- Micro Depots
- Urban Depots
- City Terminals
- Mobile Depots
- Local Freight Stations
- Urban Logistics Spaces

For the purpose of this study, studying the DB Schenker pilot project, a micro terminal is best described as a concept consisting of small logistical terminals located in the heart of an urban area within a close proximity to receivers. This small terminal offer transshipment of goods and storage for a short period of time, essentially a day, as well as allowing goods to be dropped off and be picked up by another carrier at a different time. The facility is furthermore a small unmanned storage area that is possible to lock and secure and could be either a permanent facility or a movable storage unit (Janjevic & Ndiaye, 2014). In the context of city logistics, where delivery trucks in many cases are banned in city centers at defined hours, this platform could therefore allow city centers to receive goods without contribution to congestion at peak hours. As micro terminals are meant to be located as close to the receivers as possible, the last mile delivery will be reduced to a minimum enabling a more efficient distribution. At the same time, being similar to a UCC, this solution would also need a space to operate and there is still uncertainty regarding the design meaning that there could potentially be more drawbacks. (Janjevic & Ndiaye, 2014).

The closest definition found to the description above is provided by Cranic, Ricciardi and Storchi (2004). In this work they present ideas of using *satellites* which are described as zones within urban areas offering transshipment. With his solution the consolidation is made in the outskirts of an urban area, transported to the zones in the city center and then transshipped by

other vehicles best suited for the city. Micro terminals could be seen as a similar way of conducting the operation but offer the ability to separate the transshipment in time as the micro terminal would offer short term storage. Here the consolidation is also taking place upstream in the logistical chain keeping the handling of goods to its minimum (Crainic et al., 2004). The micro terminal is solely used as a transshipment terminal with limited storage possibilities, but able to hold an adequate amount of goods. The terminals are also able to perform reverse flow of logistical operations moving dry clean garbage or consignments out from the city (Crainic et al., 2004). Considering this description, the central characteristics of a micro terminal can therefore be summarized as;

Characteristics of a micro terminal

- Located close to receivers in a dense urban area
- Container or storage area
- Unmanned (operated by drivers)
- A permanent facility or a movable storage unit
- Used for close proximity distribution and collection
- Short-term storage

Furthermore, despite the apparent ambiguity surrounding the definition of a micro terminal, several projects around Europe can provide valuable insights. Many cities have recently started to implement trails with micro terminal like concepts. In Germany for instance, cities like Hamburg, Nuremberg and Munich have established sustainability programs examining the idea, see Figure 2.5 and 2.6. However, most of these projects are still in an early phase and seem to only focus on few aspects without regards to the greater environment (Civitas, 2017). Therefore, in line with the purpose of this study, more research is needed to establish the viability of this platform.



Figure 2.5: Example of a mobile micro terminal in Germany (Bogdanski, 2017)



Figure 2.6: Example of a mobile micro terminal in the Netherlands (Straightsol, 2018)

3 Context of the study

This chapter will present the context in which this study has been performed. It will introduce the geographical setting, challenges and previous measures. It will also present the case study model and the identified stakeholders.

3.1 Gothenburg and its transportation strategy

Gothenburg is Sweden's second largest city and the fifth largest in the Nordic region. Situated on the west coast it has approximately 564 000 inhabitants, making it a "large urban zone" according to the European Commission, and is a city that is experiencing a rapid growth. With an anticipated population growth of 23.8% between 2018-2035 the city is expected to add around 134 000 new inhabitants and 80 000 jobs (City of Gothenburg, 2014). Leading to an increased demand of goods to be transported in and out, but also within the city, this growth is putting an increasing pressure on the existing transport system as it causes social and environmental challenges. Responding to these concerns the City of Gothenburg has therefore designed a transport strategy which was adopted in 2014. This strategy is intended to be used when the city is planning for, or implementing, new infrastructure projects and aims to mitigate the negative impacts from transport while enabling a better life for citizens and businesses within and around Gothenburg (City of Gothenburg, 2014). Based on three main objectives the strategy focuses on travel, urban space and the transportation of goods.

- **Travel** – how to create an easily accessible regional center where it is easy to reach key places and functions irrespective of the mode of transport and other conditions.
- **Urban space** – how to contribute to more attractive city environments where people want to live, work, shop, study and meet.
- **Transport of goods** – how to contribute to consolidating Gothenburg's position as the logistics center of Scandinavia, where both new and existing industries can develop and create job opportunities without encroaching on quality of life, sustainability and accessibility.

(City of Gothenburg, 2014, pp. 5).

In terms of goods transportation, the strategy further specifies a subset of three priorities specifically aimed at making Gothenburg a leader in efficient and climate-smart handling of goods, see Exhibit 3.1. Focusing on collaboration with several institutions the city therefore stresses the importance of an increased capacity utilization and clear route directions for goods traffic (City of Gothenburg, 2014). The three priorities for goods transportation are presented below. This study will focus on the first priority aiming to ensure "good accessibility for goods transport in Gothenburg while at the same time reducing negative local environmental effects".

GOOD TRANSPORTATION STRATEGY

We will work in collaboration with other bodies to make Gothenburg a world leader in efficient, climate-smart handling of goods. This will be achieved by:

Ensuring good accessibility for goods transport in Gothenburg while at the same time reducing negative local environmental effects

Increased rail network capacity and prioritization of freight traffic on designated routes not only improves accessibility for goods but also allows effective measures to be implemented to reduce the effects of noise, emissions and barriers. Optimizing the choice of transport and the use of combined transport increase efficiency and reduce climate impact.

Collaborating regionally in the establishment of logistics centers and transport-intensive operations

By including goods transport in the urban planning process and applying a regional perspective to the establishment of transport-intensive operations, industry, retailing and logistics can be developed and conflicts between goals can be avoided.

Stimulating innovation in collaboration with academic institutions and businesses

An innovation platform for the city creates clarity and coordination in relation to other parties. Networks and other platforms for dialogue with businesses and public activities generate the conditions required for joint solutions and more rapid implementation. Networks are needed at both the strategic and operative levels.

Exhibit 3.1: Summary of the Goods Transport Strategy in Gothenburg (City of Gothenburg, 2014, pp. 7).

Furthermore, in order to reach these objectives, the city has also stipulated four implementation principles. Applying to all three main objectives these principles consist of;

Implementation principles

- Begin with investments that facilitate travel within, through or around the inner city.
- Ensure that accessibility is maintained while the close-knit city is being realized.
- Support innovation and the introduction of new solutions and allow Gothenburg to be a testing ground.
- Make use of the potential in a meaningful dialogue with businesses and inhabitants.

(City of Gothenburg, 2014, pp. 5).

As this study is exploring the viability of a new platform this study will mainly be concerned with the third principle to; “support innovation and the introduction of new solutions and allow Gothenburg to be a testing ground.”

Freight related initiatives in Gothenburg

In Gothenburg there have already been several initiatives related to the transportation strategy above. One example is Godsnätverket (in English, “*The freight network*”). Established in 2006, this network was created as a forum where different stakeholders can meet to discuss important questions related to freight transport. Considered a unique organization, the freight network is a meeting point for a wide range of professionals informing each other on upcoming projects, new policy implementations and occurring issues. With meetings approximately three times a year the network is not only seen as a discussion forum, but as platform aiming to reach practical solutions. Seen by many as a successful establishment this forum is believed to encourage dialogue between different stakeholders and bridge much of the divergence between the public and private sector (City of Gothenburg, 2018a).

Stadsleveransen (in English, “*The city delivery*”) is another initiative aimed at reducing the social and environmental impacts of freight movements. Essentially an UCC as described earlier, this project was initiated by the Traffic and Public Transport Authority (TPTA) in 2011 and aims to create a safer and more attractive city through the redirection of goods flows. Through the establishment of a collective consolidation center outside the city, deliveries from larger carriers such as DHL have been enabled to be consolidated and distributed to the central business district by electrical vehicles (Innerstaden, 2018).

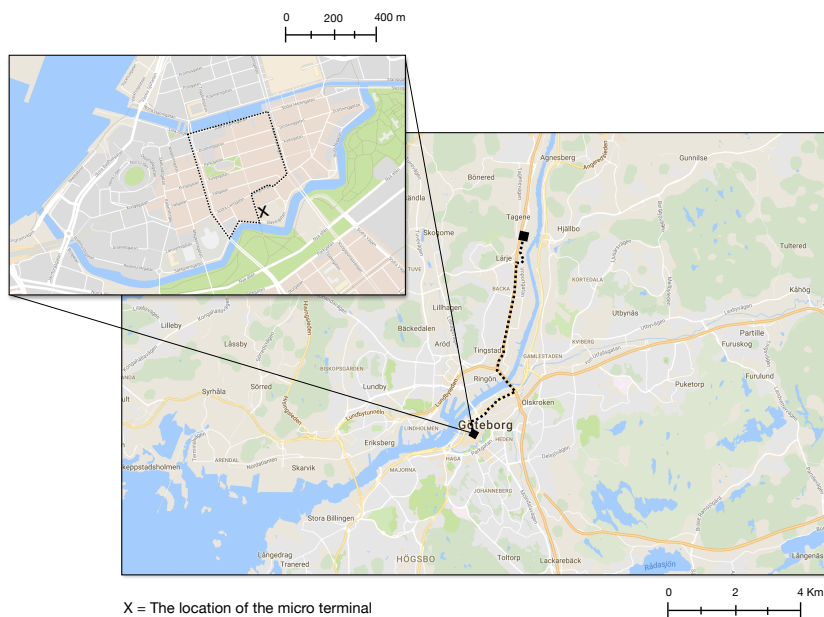
In 2016, the logistics stakeholders in Gothenburg were also informed by the TPTA that the city intended to impose time access restrictions used in many other European cities. Similar to Stadsleveransen and other initiatives, the intent of these restrictions has to reduce the amount of heavy traffic circling in the city center and to create a more attractive inner-city environment. Initially tested during a six-month trial period between January - June 2017 these restrictions got extended, meaning that vehicles heavier than 3,5 tones today only are allowed in the central parts of Gothenburg, between Västra- and Östra hamngatan, within the set time frame (05:00 – 11:00). Causing a lot of concern among freight operators, both freight receivers and carriers have consequently been invited to discuss the changes and express their thoughts. Evaluating the effects of this policy the idea is to see how freight carriers, freight receivers and residents all have been affected by the changes. Although this policy is still under evaluation, city officials have expressed a will to expand the program if the results come back positive (City of Gothenburg, 2018b).

3.3 The DB Schenker pilot project

The DB Schenker project can be seen as one of the outcomes related to the weight restrictions mentioned above. Discussing the new legislation in 2016, the City of Gothenburg approached local carriers and asked how they would handle increased weight restrictions and shortened delivery times in the city. As a response, DB Schenker proposed the idea of a micro terminal which was believed to mitigate much of the problems associated with urban deliveries. In short, the idea was to consolidate large consignments outside the city (Bäckebo) and then deliver one or more large truckloads to the urban area in the format of a 20-foot container (TEU). For overview of the delivery route, see Figure 3.1. Thus, taking the shape of a small terminal,

deliveries would then be made by foot in the city center where space is confined but demand is very high. In this sense DB Schenker wanted to investigate new ways of serving a city centers that would meet the requirements of the public and improve the environment (DB Schenker, 2018).

Assigned with a location for the terminal at Kungspportstorget, the project started in November 2016 and continued through September 2017. Serving the central shopping precinct, the company redirected all deliveries usually made by delivery vans and trucks through the terminal. Depicted by Figures 3.1 and 3.2 below, a terminal was placed close to the shopping district, disguised in a wooden structure. From this point a coworker would then distribute consignments throughout the area assisted by a custom-made and electrified hand truck (DB Schenker, 2018).



X = The location of the micro terminal

Figure 3.1: Map of delivery route from Bäckebol and the local shopping precinct (Google Maps, 2018)



Figure 3.2: DB Schenker's micro terminal at Kungspportstorget in Gothenburg (DB Schenker, 2018)

Focusing on combating inefficiency problems outlined earlier the preliminary results came back positive. According to the final report, substantial environmental benefits could be achieved through this concept. Thus, presenting a new innovative approach to city logistics this new initiative therefore challenged the direct delivery modes already used by Schenker and many other freight carriers, but also the UCC concept (Stadsleveransen) which already had been implemented by the city (DB Schenker, 2018). Nevertheless, evaluating this new approach solely on the basis of environmental gains is according to literature to vague and a much more comprehensive assessment is therefore needed (McKinnon, 2015). In this sense a new platform has to be evaluated from a perspective of many stakeholders and in comparison, to other solutions. In the next, this study will therefore present a case study model for a more comprehensive assessment to the viability of this micro terminal approach.

3.3 The case study model

Built upon DB Schenker’s pilot study, the case model is based on three alternative ways to distribute goods in the central parts of Gothenburg. Depicted in Figure 3.1 the focus is placed on the central shopping precinct, with the delivery route from the logistical terminals in Bäckebo added. The model itself shows three scenarios of how to conduct urban deliveries;

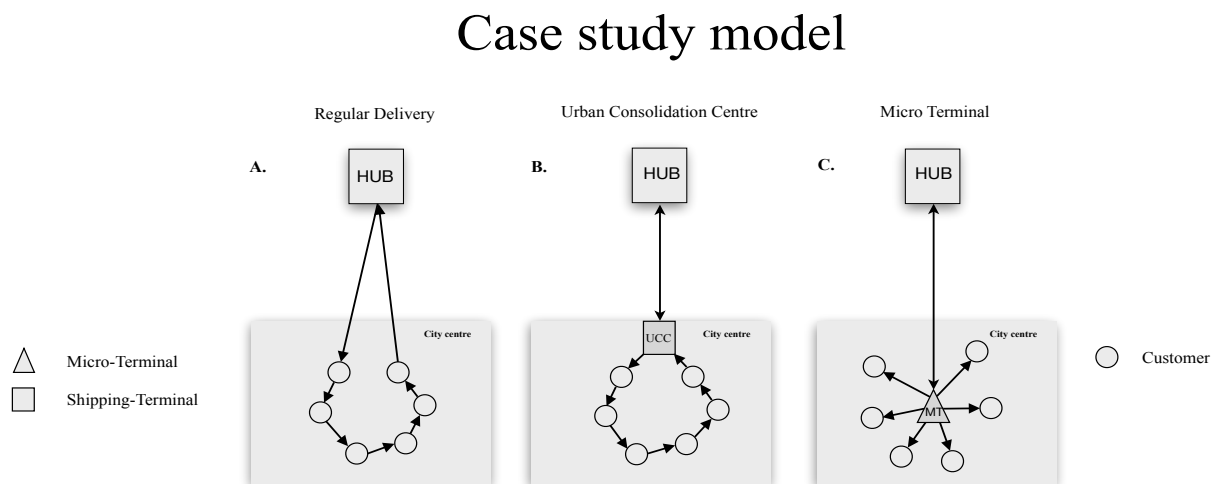


Figure 3.3: Case study model for the implementation of micro terminals in Gothenburg (Source: Authors)

Alternative A, described as *direct delivery*, is today the most common distribution method used by urban freight carriers (Lumsden, 2006). This type of approach is based on round trips that facilitates either distribution or collection services to customers. In this study distribution through this mode means that consignments are loaded in Bäckebo and then transported into the city center between 05:00 and 11:00am. Here, trucks and vans are then moving along the roads and streets distributing goods, often with the assistance of small trollies. The goods can also be transported before and after local time restrictions (05:00-11:00), but then smaller vehicles have to be used weighting less than 3,5 tones, see Figure 3.3.

Alternative B known as an *urban consolidation center* (UCC), is in this study representing the local initiative of Stadsleveransen described earlier. This approach was not originally included in DB Schenker's original pilot study but has been included in this study as a contrasting example. This is because of the recognition UCCs has received in the literature for being a best practice to deal with urban distribution challenges, but also because it is one of the initiatives launched by the City of Gothenburg. Serving the city center by this approach means that freight carriers like DHL delivers consignments via a third party. Distribution through this mode also imply that consignments are loaded on trucks in Bäckebo which are then shipped to a consolidation terminal in Gullbergsvass outside the city center, see Figure 8.1 in the appendix. In this location consignments are then transshipped and loaded on to smaller electrical vehicles, having special permits, covering the final leg and delivery. Reaching the city center these vehicles are also moving along the roads and streets similar to alternative A when distributing goods, see Figure 3.3.

Alternative C is depicting the micro terminal concept used by DB Schenker. In this approach, shipments are consolidated Bäckebo and then delivered in one large load to the city center, see Figure 3.3. From this point the final distribution is then covered on foot with the assistance of an electrified hand truck, see Figure 3.4. In this study the assumption of the micro terminal is principally the same, however taking impression from other initiatives around Europe, it is assumed that the terminal will be flexible, i.e. movable, see Figure 3.5. This means that the terminal will take the shape of a trailer outfitted with an electrified back lift, instead a permanent container. Having this solution would enable the land space to be shared with other functions during vacant hours. Nevertheless, with this solution a large truck would need to deliver the trailer to a parking space at Kungssportstorget in the morning and then pick up the same trailer in the evening. Another assumption is that a special permit also would have to be issued in order for the pick-up to be enabled due to the local time restrictions.



Figure 3.4: Electrified hand truck used in the pilot project (DB Schenker, 2018).



Figure 3.5 Example of a flexible micro terminal used in this case study (Palfinger, 2018).

3.4 Stakeholders in the study

Since the focus of this study is to investigate the viability of a micro terminals, the stakeholders have also been identified by looking at DB Schenker's pilot study. Some stakeholders have not been included due to the short timeframe and in order to provide academic depth. In the following, the different groups will be presented to give the reader a better understanding of the context.

Freight carriers

Freight carriers are considered to be companies who move physical goods between the locations in this study, namely, between the district of Bäckebol and central Gothenburg. There are of course many different carriers that transport similar goods on the same route, however, in this study it has been decided to focus on the carriers with the highest volumes; DB Schenker and DHL. These stakeholders are also most affected by, but also involved in, the development and implementation of new innovation and policy. Stadsleveransen is also included under this category. Not a true freight carrier itself but rather a last mile distribution solution carrying parcels supplied by other operators, it is representing the contrasting example believed to provide valuable insights.

Freight receivers

The freight receivers are represented by different companies who get their deliveries from the freight carriers described above. The common denominator is that they receive deliveries from the different transport approaches bringing more valuable insights being able to contrast the different solutions. As such, a focus is placed on freight receivers in the central shopping precinct.

City officials

Representing the public interest, city officials are important stakeholders for implementing sustainable transport solutions. Embodied through the Traffic and Public Transport Authority (TPTA) these officials are responsible for the maintenance and upkeep of Gothenburg's road, track and tramway network. Providing for smooth communication on behalf of the residents, the managers of the TATA implement and execute strategies which in turn are decided by a local traffic committee formed by political elections. With municipal decisions being based on a transport strategy the opinion of the TPTA is therefore of significant interest (Trafikkontoret, 2018).

4 Methodology

In the methodology chapter, methods used for the study will be described and defended. This chapter will also include the sample and present the philosophy behind the interviews, the quantitative assessment, the processing of data, as well as the interviewees.

4.1 Research philosophy

The foundation of any research lays in the assumptions on which it is built, its research philosophy. In this respect, the concepts forming this study have been based upon the research onion, Figure 4.1, presented by Saunders, Lewis, and Thornhill (2009). The model illustrates important aspects that has to be accounted for before and during a process of conducting a study, however, additional aspects not visible in the model have also been added.

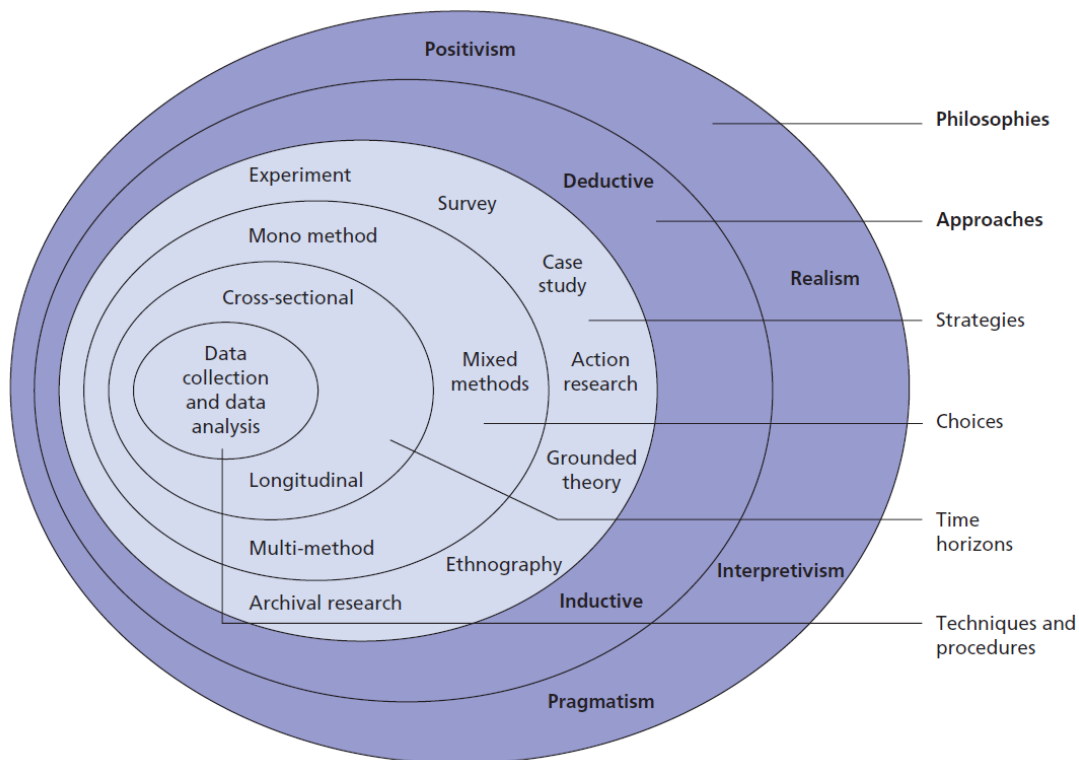


Figure 4.1 Research Onion (Saunders et al., 2009, p. 108)

Conducting the research for this study, an *interpretivist* stance was taken. This philosophy focus on the trait of humans being social actors. It highlights that reality only can be understood through social constructs and that the interpretations of individuals play a significant role. With this view, it is therefore seen inappropriate to approach the research of people in the same way as inanimate objects (Saunders et al., 2009). Thus, considering the complexity of urban logistics in general, and the many stakeholders in particular, this means that an interpretivist position was seen as most suitable. Nevertheless, it has to be acknowledged that this study also consists of minor quantitative elements which could question the use of an interpretivist approach. Albeit, this has not been considered to affect the overall qualitative nature of the study since the quantitative data was collected during in-depth interviews.

According to Saunders et al., (2009) the research philosophy can further be analyzed from an ontological, epistemological and an axiological point of view. Thus, Ontology is concerned with the nature of reality, Epistemology on how knowledge of reality is acquired and Axiology on the role of values in the research made. Using an interpretivist view this study therefore acknowledges that reality is socially constructed, subjective and open to change. That subjective meanings and social phenomena's can be providers of suitable knowledge, and that the research is value bound and therefore not fully objective (Saunders et al., 2009).

Research approach and purpose

For the research approach it was deemed appropriate not to be limited by either deduction or induction, but to apply both. This mix is defined as *abduction* by Alvesson and Sköldböck (2008). With a limited pre-knowledge of city logistics and micro terminals the research started by investigating earlier studies and articles on the subject. This helped build a greater understanding of the topic before the collection of empirical data. The first approach was therefore deductive. At the same time, an inductive approach was also used allowing collected data to influence the research process. By doing this, the literature review was kept open to revision and any additional information added if found suitable. According to Alvesson and Sköldböck (2008), using this abductive approach, moving back and forth between an inductive and deductive approach, will allow a researcher to stay open to new facts and theories. Thus, since our main objective is to contribute to the ongoing research in city logistics, applying an abductive approach was seen most suitable since it enabled adjustments and revisions along the way.

The study conducted is furthermore of an *exploratory* kind. This derives from the purpose of gaining a better understanding and knowledge to the use of micro terminals serving urban areas. To use an exploratory approach is useful when a researcher wants to find out "*what is happening; to seek new insights; to ask questions and to assess phenomena in a new light*" (Robson, 2002, p. 59). It is also useful in trying to clarify the understanding of a problem (Saunders et al., 2009). Thus, since there is little previous literature on the topic of micro terminals it was found appropriate to use an exploratory research model as it could decrease a gap in the field of urban logistics.

Research strategy and choices

According to Saunders et al. (2009), a research strategy is a plan that should provide directions and a systematic structure to any kind of study. Setting up an appropriate strategy, it is also important that the research questions and objectives will be the main drivers. Therefore, in order to answer the research questions for this study a *qualitative case study* strategy was deemed most suitable. A case study is defined as empirical studies of a particular phenomenon within a real-life context using multiple sources of evidence. It is furthermore claimed to be the most appropriate strategy to be used when having an exploratory approach (Saunders et al., 2009). The method is thus considered to have the best ability for answering questions of *how* and *why*, which is also in line with the purpose of this study (Yin, 2009). Hence, the aim is to understand

how a micro terminal compare to other modes of urban distribution, and *how* viable an implementation is from a stakeholder perspective.

Also, considering that this study is done in a business context Mayers (2009, p.76) highlight that “*Case study research in business uses empirical evidence from one or more organizations where an attempt is made to study matter in context. Multiple sources of evidence are used, although most of the evidence comes from interviews and documents*”. Thus, taking the definitions above into account along with the reasons for considering a case study, the empirical findings in the research was generated through interviews with multiple stakeholders involved in the urban distribution of goods in Gothenburg.

Furthermore, in terms of the research choice, which can be either quantitative, qualitative or a combination of both – also referred to multiple method. The study at hand made use of mono method. This can be explained by the scope of the study and its time constraints. Therefore, a qualitative methodology, using a single data collection technique was used (Saunders et al., 2009).

4.2 Data collection

Sampling method and access

In order to collect data, it was decided to follow a non-probability sampling technique. This is due to the qualitative nature of the study and a criterion-based sampling. One of the non-probability sampling methods is the purposive sampling, commonly used when working with a small number of samples such as in case studies (Saunders et al., 2009). In this study suitable interviewees were chosen to meet the objectives and answer the research questions. The primary sampling process was thus initiated through an interview with a contact at DB Schenker. This resulted in a better understanding of the industry, the micro terminal concept, and the logistical challenges in Gothenburg. The interview also provided ideas on whom to contact for further interviews.

As a part of the non-probability sampling, convenience sampling was also used to find suitable candidates (Saunders et al., 2009). By studying the local newspaper, magazines, previous studies and other publications, several interviewees were found to be authors or participants in already published articles. To increase the accuracy further, the search engine Google was also used to locate candidates as the study was limited to Gothenburg. This method resulted in five contacts which was then investigated further. However, since the study was dependent on getting access to specific stakeholders and parties involved in all three modes of deliveries, finding the right candidates became harder than expected. Considering this, a search for potential candidates was therefore continued alongside the interview sessions. Through the technique of snowball sampling, a third sampling method was used and at the end of each interview the interviewee was asked if they could provide information to colleagues or business partners having the right profile for the study. According to Saunders et al. (2009), this method is especially useful in cases where a population is hard to identify.

Reflecting on earlier experiences in gathering data it was also known that the method for approaching the potential candidates would have to be thought through. Studying the literature on business research and with advice from other researchers it was found that a dual approach would be the most effective. Reaching out to initial contacts was therefore made through email and a sequent phone call. In the email, information regarding the theme was provided as well as an explanation of the study's relevance. The idea behind the email was further to minimize the feeling of pressure from a spontaneous phone call and thus the risk of declining. In some cases, an email would surely have been enough, however considering the short time line it was felt that a phone call could increase the response rate, cutting through the noise in busy e-mail accounts.

The sample

In Table 4.1 information regarding the samples used for the research is summarized. Here, interviewees are presented by the type of organization, sector, and with regards to their role within the specific organization. The table also include the type of interview, as well as date and length. All of the interviewees and some of the companies will also be presented with an alias. This is due to that confidentiality was guaranteed to all respondents. However, large organizations have been presented with names since they are important to understand the context of the study, something that was also approved by the respondents in these specific cases.

Table 4.1: Breakdown of interviews

Organization	Sector	Alias of the interviewee	Role in the organization	Type of Interview	Date and Length
DB Schenker	Private	FC1	Manager	Face-to-face	20-03-2018 0h 50m
DHL	Private	FC2	Environmental Director	Face-to-face	29-03-2018 1h 10m
National cooperation platform	Public / Private	LE1	Project Manager	Face-to-face	20-03-2018 0h 40m
National cooperation platform	Public / Private	LE2	Project Manager	Face-to-face	27-03-2018 1h 00m
City of Gothenburg	Public	CO1	Project Manager	Face-to-face	27-03-2018 0h 45m
Stadsleveransen	Public	FC3	Managing Director	Face-to-face	28-03-2018 0h 55m

City center store	<i>Private</i>	<i>FR1</i>	<i>Managing Director</i>	<i>Face-to-face</i>	<i>11-04-2018 0h 45m</i>
City center store	<i>Private</i>	<i>FR3</i>	<i>Warehouse Manager</i>	<i>Face-to-face</i>	<i>11-04-2018 0h 30m</i>
City center store	<i>Private</i>	<i>FR4</i>	<i>Owner</i>	<i>Face-to-face</i>	<i>11-04-2018 0h 30m</i>
City center store	<i>Private</i>	<i>FR2</i>	<i>Purchasing Manager</i>	<i>Face-to-face</i>	<i>11-04-2018 0h 30m</i>

Semi-structured face-to-face interviews

Considering the qualitative and exploratory nature of this study, a number of semi-structured interviews were undertaken in order to collect in-depth data. Semi-structured interviews are often used in business research and are based on themes and questions that a researcher wants to uncover. Compared to structured interviews which does not allow one to divert, a semi structured interview is open and allows new ideas to be brought up during an interview depending on what the interviewee says (Stake, 1995; Saunders et al., 2009). In general, it is believed that this method will help a researcher to focus an interview on the topics at hand without being constrained by a certain format (Saunders et al., 2009).

In line with this method, the interviews were carried out starting with a list of prepared questions focusing on urban logistics and different distribution solutions. A lot of effort was put into the design of these questions as the aim was to construct a questionnaire that would be short and easy to understand but that would stimulate contemplation instead of short answers. In general, four topics were covered: (1) Stakeholder profile and background, (2) Challenges of goods logistics in Gothenburg, (3) Different distribution approaches, (4) Solutions in the future. As main objective of these topics was to understand the viability of a micro terminal without being to explicit, the ambition was to motivate the interviewees to talk as freely as possible. Thus, contemplating upon ideas and expanding on questions often led to new insights and a more holistic understanding of the subject.

Furthermore, the idea to use face-to-face interviews seemed to be the most suitable approach for the specific case. In this sense, it was believed that this technique could not only provide us with more in-depth qualitative knowledge, but also a more creative and open discussion which could make the interviewees more willing to open up (Saunders et al., 2009). This later became apparent as it was noticed how differently the interviewees understood the questions asked.

Conducting interviews

Before carrying out any interviews a comprehensive research was conducted on the identified candidates and their relating organizations. This was due to the circumstance that only 30-40

minutes of interview time had been requested. Thus, leading to a challenge of using the time wisely, studying company reports, organizational structures and previous employment was therefore seen to generate valuable information that could be used to conduct more effective interviews. According to Saunders et al. (2009), prior planning before conducting qualitative interviews is of essence in order to prevent poor performance, demonstrate credibility and obtain confidence. In this sense, it is argued that a researcher should have proper knowledge of any company or individual interviewed as it is believed to alleviate hurdles such as the one mentioned above.

It is also stressed that a study can increase its credibility by providing interviewees with relevant information prior to an interview (Saunders et al., 2009). An email containing information about the main topics was therefore sent out in advance to each interviewee. The candidates were in this way given an opportunity to prepare and get back for any needed clarifications. At the same time, it is important to underline that this email did not contain any specific questions as it was believed that explicit questions prior to interviews could risk altering responses to greatly. In terms of scheduling the interviews it was decided to remain flexible with regards to time and place. The rationale behind this decision was a belief that it would be easier to attain more interviews staying flexible, but also that the interviewees would be more open for a meeting in a setting where they could feel comfortable. Hence, in line with Saunders et al., (2009), this strategy was intended to avert any negative influences leading to a lower response rate which can be the case of respondents do not feel at ease.

Once in place, all interviews started with an introduction of the researchers and the study. This was then followed by an explanation of the planned interview whereby the candidates were then asked to present themselves, their background and the role within the specific organization. To emphasize the voluntary engagement, a clarification on how the data would be used and processed was provided, as well as a permission to record the interviews. It was also emphasized that questions considered to be of a sensitive nature were not required to be answered. With regard to Saunders et al. (2009), the first few minutes in an interview are seen as essential as they will decide the level of trust towards the researchers, and therefore also the outcome of the interview. In this way, by providing a clear but relaxed introduction, the ambition was once again to strengthen the trust from candidates.

All interviews were performed in the same way with one author responsible for asking questions, while the other took notes and observed the interviewee. After each interview some time was also taken to reflect on the provided answers and the observations made. Doing this facilitated an opportunity consider any implicit information collected while at the same time drawing patterns among the various interviews contributing to the findings. The interviews were furthermore conducted in Swedish, this is due to the context of the study but also due to the fact that both researchers and the candidates were native Swedes. Thus, arranging the empirical findings, quotes have therefore been translated from Swedish to English in the way considered to be the most accurate.

4.3 Analyzing the empirical data

The process of analyzing the empirical data started with a transcription of all interviews, including both audio-recorded interviews and hand-written notes. This resulted in approximately 60 pages of raw data, which then had to be organized and simplified for a better understanding. Referred to as data reduction, this process is used to remove any information that is not needed for the research (Miles & Huberman, 1994). The data was then organized in line with the interview topics and coded. According to Malhotra, Birks, and Wills, (2012) and Saunders et al., (2009) this is done in order to find patterns and similarities in the answers. As an example, it was found that the question regarding the cause of problems provided a broad range of answers. Therefore, in order to handle the divergence and to find core ideas, answers were color coded identifying reoccurring tendencies. Creating clusters of similarities, the answers were then merged in to the following categories (1) Major challenges of freight distribution in Gothenburg, (2) Local planning of freight distribution, (3) Use of a micro terminal to mitigate problems, (4) Future distribution solutions.

With quantitative data also being provided during the interviews this type information was furthermore sorted out and kept separate. This was done to give the reader a better understanding presenting the empirical findings. Thus, besides the qualitative information described above, quantitative data was therefore also gathered and processed in line with the identified variables for evaluating urban logistics platforms presented in the literature review.

In the empirical section the findings were then written down relating to each of the sub categories and variables. These were revised a number of times, and any recurrent information not adding value to the study was removed. Finally, sorting out the best quotes and description in the end this information was then cross-analyzed and related to the theoretical framework eventually leading to a final conclusion.

Time horizon

There are generally two ways of approaching the time perspective when conducting research. Saunders et al. (2009) define these as cross-sectional and longitudinal studies. A cross-sectional study is useful when there is a time constraint or when researchers want to study a particular phenomenon at a specific in time. A longitudinal study on the other hand can be more useful when researchers want to gathering data for the same subjects, repeatedly, over a longer period of time (Saunders et al., 2009). Taking into consideration that the data collection was conducted during a three-week period, an application of a longitudinal perspective did not seem viable. Another reason for this was also that participants, most likely, would not be able to devote the time needed. With this in mind, an exploratory study based on a cross-sectional approach was therefore constructed.

4.5 Research ethics and trustworthiness

Since this study brought forth information which might be regarded as sensitive by the interviewees, anonymity was provided in order to ensure that respondents would be able to talk freely and honestly about the topics covered. According to Jacobsen (2009), a guarantee of confidentiality is necessary if a study touches upon sensitive information. Thus, after noticing some early hesitation among some of the participants, a decision was taken to apply anonymity to all participants. The consequence of this decision is that only the authors will be able to identify and trace data back to the original sources and that the participants will be anonymous in the final report. Furthermore, this also entails that transcripts and records used for analytical purposes will not be available to the public domain.

In order to test and evaluate the quality of methods chosen in a study, the concept of trustworthiness can be used to define the solidity of the research (Lincoln & Guba, 1984). The concept consists of four segments, each addressing different aspects referring to the quality of research.

Credibility relates to the confidence in the truth of findings (Lincoln & Guba, 1984). The focus of this concept is to establish a match between constructed realities of research participants and the realities represented by researchers (Lincoln & Guba, 1984; Sinkovics, Penz, & Ghauri 2008). According to Lincoln & Guba (1984) one of the best ways to do this is through the method of triangulation whereby a researcher uses multiple sources of data to produce a better understanding of different phenomena. To establish credibility in this study data have been collected from multiple sources (Semi-structured interviews, research literature, corporate documents and government data) which have then been triangulated in the analysis.

Transferability regards the ability to show how findings in a study is applicable to other contexts. Considering this, it is therefore important to provide adequate detail in descriptions ensuring that a reader can evaluate the degree of transferability to different settings (Lincoln & Guba, 1984). To this end, the description of the background and the participating individuals have been described to such an extent as to enable readers to establish the transferability of the findings.

Dependability concerns the consistency and repeatability of findings (Lincoln & Guba, 1984). According to Richards and Morse (2007), a study with high dependability should be able to be conducted again resulting in the same conclusion and should therefore not involve obvious data errors. Conducting an exploratory-, cross-sectional study with semi-structured interviews, it is not possible to guarantee that a repetition would generate the same findings. This is due to the fact that opinions and experiences among the interviewees change over time, and that the researchers' understanding as well as environmental factors could influence the outcome of the interviews. However, providing a detailed description of the background, context and method is believed to alleviate this concern, enabling a possibility to repeat this research under similar conditions.

Confirmability refers to the degree of neutrality of findings, covering to what extent findings are influenced and shaped by respondents and not biased by a researcher’s opinions (Lincoln & Guba, 1984). Acknowledging this, body language during the interviews was therefore kept neutral, enough time was provided to the respondents to answer and the questions was furthermore undertaken not to steer the interviewees to preconceived conclusions.

4.6 Interviewee presentations

Since several different individuals were interviewed for this study the respondents will be presented in groups according to function they have been representing, see Table 4.2. The groups presented correspond to the different stakeholders given in the theoretical framework except for the logistical experts who was added to give additional insight to the subject.

Table 4.2: Respondent groups

Respondent Groups				
Logistical Experts	LE1	LE2		
City officials	CO1			
Freight Carriers	FC1	FC2	FC3	
Freight Receivers	FR1	FR2	FR3	FR4

LE1

The first logistical expert (LE1) has a PhD within city logistics and has been working with the topic for many years. LE1 is currently working for a national cooperation platform aiming to promote collaboration between different stakeholders in the field. This expert has also published several articles and has a broad knowledge of the current logistical situation both in Gothenburg and cities around the world.

LE2

The second logistical expert (LE2) is a project leader at the same national cooperation platform presented above. LE2 is focusing on innovation within urban logistics and is working with projects of digitalization and urban mobility. LE2 also has a background researching the cooperation among logistics stakeholders in an urban setting.

CO1

The city official (CO1) is working for the Traffic and Public Transport Authority (TPTA) in the City of Gothenburg. With a broad knowledge in urban freight transportation, CO1 has been working with many different projects in and around Gothenburg. Previous experience lies within fleet management, parcel delivery and distribution solutions. Currently this person is working with legislative questions as well as questions of technology implementation.

FC1

The first freight carrier (FC1) is representing DB Schenker Sweden. Operating as a contractor to DB Schenker in the district of Gothenburg, this person third generation family business owner managing approximately 200 employees. FC1 is also a part of Godsnätverket and was one of the individuals initiating the micro terminal pilot project in Gothenburg.

FC2

The second freight carrier (FC2) is an environmental manager at DHL Sweden. Employed by the company since the late 1980s, FC2 is today working with environmental management systems, internal and external audits, certifications and development. This individual is also involved in the collaboration between Stadsleveransen and DHL delivering parcels to the Gothenburg city center.

FC3

The third freight carrier (FC 3) is a subcontractor and the owner of the company responsible for operating Stadsleveransen. With a background as a postal worker this individual have a broad knowledge of parcel delivery in a city context. Partly working as a driver on a day to day basis, FC3 therefore have a unique knowledge about different stakeholders ranging from freight receivers to public officials.

FR1

The first freight receiver (FR1) is the logistics coordinator for a large clothes store in Gothenburg. With the business located in the central shopping district this store receives goods several times a day both on pallets, in parcels and small consignments.

FR2

The second freight receiver (FR2) is part owner of a watch dealership located in the city center. The company is a family run business and the respondent also act as a salesclerk. The main goods received by this receiver are parcels and small consignments.

FR3

The third freight receiver (FR3) is the owner of an interior design store located in the city center. The respondent has been operating the business for 15 years and is actively involved in questions regarding inner-city commerce. The goods received is of a fragile nature and delivered on a daily basis.

FR4

The fourth freight receiver (FR4) and last respondent is an owner of a shoe store located in the city center. This store is a family run business provide shoes to the public both through their store, but also by selling online. Regarding the goods situation, they mainly receive goods by parcels, but occasionally on pallets.

5 Empirical results and analysis

In this chapter the quantitative assessment is presented alongside interviews with different stakeholders. Divided into various topics the empirical data will be put forth in a structured manner and each section will then be analyzed through a comparison of the empirical findings and the theoretical framework.

5.1 Assessment of the quantitative findings

This part of the empirical section will present a quantitative assessment for the different distribution approaches presented in the case model. Using variables given in the literature review, data found for each variable will be put forth, grouped and then summarized in Table 5.1 below. Considering the method and the exploratory approach, this assessment should not be seen as a precise measure but rather give insights to the relative performance of the micro terminal in relation to the other alternatives.

Economic variables

Distribution

Calculating volumes, according to FC3 (2018) and CO1 (2018), Stadsleveransen delivers approximately 275 packages a day to the specified area. Each package has an average weight of 10 kilos which equals a freight tonnage estimated to be 2,5-3 tones per day (FC3, 2018). Putting this in relation to the micro terminal, according to DB Schenker, an equivalent volume of goods could be fitted into the micro terminal that was placed at Kungssportstorget (FC1, 2018). In the pilot project the terminal consisted of one 20-foot container (TEU). The volume of this container is also equivalent to one heavy truck regularly used by DB Schenker and DHL to distribute goods. In summation it could therefore be concluded that the volume delivered by Stadsleveransen and the micro terminal is equivalent to one heavy truck fully loaded (FC1, 2018; FC2, 2018; FC3, 2018).

According to Stadsleveransen, the organization uses four electrified vehicles, each consisting of one tractor and two trailers. Delivering on average 275 packages it is estimated that each vehicle is in use 3 hours per day. (FC3, 2018) Thus, multiplying the number of vehicles and the time used leads to a need of 12 working hours per day to deliver the consignments. Dividing the number of packages with the hours needed therefore indicate that Stadsleveransen on average deliver 23 packages per hour (FC3, 2018). Putting this in relation to the other alternatives, DB Schenker estimated that the number of packages distributed by the micro terminal, apart from pallets, was between 40-50 packages a day (FC1, 2018). This was furthermore done for 2 hours leading to an average delivery rate of approximately 22.5 packages per hour. When asked how the micro terminal compared to the direct delivery approach, considering all start and stop motions made by a truck, FC1 (2018) estimated the time needed to be the same. Thus, considering the information provided delivering the same number of packages from the three alternatives was therefore found to be roughly the same.

Operational cost

The operational cost between the different alternatives was complicated to estimate. This is due to the very complex nature of the supply chains and the secrecy regarding operational costs from a business point of view. In order to make an assessment for this factor calculations had to be made backwards. Thus, by gathering cost information from Stadsleveransen and then split these over the amount of yearly deliveries, a rough estimate on the delivery cost per package was enabled. This estimate suggested that the average cost to deliver with Stadsleveransen is somewhere around 20 SEK/package, see Appendix 8.2. This number was later confirmed by CO1 (2018) who verified that the calculations for the running costs of Stadsleveransen was close to the actual number. Having confirmed the cost of distribution a double-check was then made to make sure that the estimated cost was accurate. Thus, in an interview with DHL the interviewee was asked to give an appreciation of cost for delivering the same type of packages. The response was that calculations are very hard to make and that delivering with Stadsleveransen is slightly more expensive, but that costs for direct deliveries on average should be somewhere in the region of 20 SEK/package (FC2, 2018). In terms of the cost delivering packages through the micro terminal the same number was also estimated and confirmed by DB Schenker's own reports and through an interview with FC1 (2018).

From the information gathered it could therefore be stated that the cost of delivering with different alternatives seems to be roughly the same. However, according to CO1 (2018), this knowledge does not give much insights unless one look at the underlying financing of operations. Considering this, it was also argued that direct deliveries are the most cost-effective, and that this is due to the fact that the direct deliveries cover its own costs (FC1, 2018; FC2, 2018). Therefore, even if it could be established that the price toward the end consumer is roughly the same among the three alternatives, considering that Stadsleveransen and the micro terminal are dependent on subsidies it was therefore argued that these become inferior from a cost perspective. In this sense Stadsleveransen was seen not only to be dependent on its subsidized facilities to operate, but also on EU grants, vehicles permit and advertising revenues in order to stay in business. Looking at the micro terminal platform, it was seen that this approach would also need permits and a space to operate, however differing from Stadsleveransen DB Schenker covered the costs of the terminal during the pilot project (CO1, 2018; FC1, 2018; FC2, 2018; FC3, 2018; LE1, 2018; LE2, 2018).

Service time

Regarding the service time, it was found that the direct transport approach was believed to be the least flexible arrangement. This is due to restrictions imposed by the city creating a limitation on how and when deliveries can be made with trucks over 3,5 tonnes (CO1, 2018). For the freight operators using a direct delivery approach this means that goods can be delivered between 05:00-11:00. At the same time, it was also noted by FC2 (2018) that deliveries still can be made before and after this time but then with the use of lighter vehicles weighting less than 3,5 tones. According to several respondents the use of lighter vehicles has also been one of the effects resulting from the time restriction and that this is problematic considering that using smaller vans are more expensive and that the intent goes against the advantages of having shipments consolidated (CO1, 2018; FC1, 2018; FC2, 2018). Comparing the direct delivery to

the other approaches Stadsleveransen was found not to be affected by restrictions since the electrical vehicles have a special permit meaning that customers can be served all day (FC3, 2018). In terms of the micro terminal, this platform was also found to be able to serve customers all day considering the delivery by foot (FC1, 2018).

Delivery capacity

In terms of delivery capacity, the direct delivery approach was found to deliver consignments of up to 1000kg (FC1, 2018). According to FC3 (2018) this is made possible since goods is often shipped on pallets. Thus, with a direct delivery approach goods are consolidated on to pallets and then loaded on to a truck with the help of a forklift. Unless a smaller package is taken directly from the pallet, unloading the goods is made possible through the assistance of an electrified lift on the back of the truck and through the use of a manual pallet lift. Discussing the different alternatives, the direct delivery approach and the micro terminal were believed to be very similar. Thus, considering that the micro terminal essentially is a lorry trailer with an electrified back lift this would also enable the handling of pallets weighting up to a 1000kg (FC1, 2018). Deliveries by Stadsleveransen on the other hand was found to be limited and the least flexible. This is due to the logistical chain where packages are delivered to the terminal in Gullbergsvass and then sorted by hand. Since packages are handled manually weight restrictions apply, leading to a weight limit of 25kg (CO1, 2018; FC3, 2018).

Social/Environmental variables

Emissions

Studying the emissions, all three alternatives start from the same point in Bäckebo and serve the same destination. Two of the alternatives (direct delivery and the micro terminal) take the same route in to the city, while deliveries made through Stadsleveransen make a slight detour to the UCC in Gullbergsvass (FC1, 2018; FC2, 2018; FC3, 2018). According to data from DB Schenker one heavy truck moving goods from Bäckebo and distributing it in the city center leads to average emissions equivalent of 16,23kg CO_{2e} per day (FC1, 2018). Putting this in relation to the other alternatives it was found that emissions using a micro terminal lead to an equivalent of 10,6kg CO_{2e}, and Stadsleveransen 8,66kg CO_{2e}. Thus, in percentage terms a micro terminal and Stadsleveransen could therefore have a potential of lowering emissions by 34.7% and 46,7% respectively compared to a direct delivery approach (FC1, 2018). For details on calculations and clarifications, see Appendix 8.2. At the same time, it should be noted that the findings above are measured in terms of distance traveled. According to FC1 (2018) trucks can often be running idle when consignments are delivered meaning that pollutants are not only emitted during transport but also during the final delivery. Accordingly, an exact number of emissions is hard to achieve unless a specific study is conducted suggesting that the divergence in emissions could be even higher (FC1, 2018).

Congestion

From a spatial consideration, it was found that a large truck used for direct delivery takes up the space of 8 x 2,6 m (FC2, 2018). Considering the delivery time this means that the direct delivery takes up an equivalent amount of space 12 hours each day. Comparing the direct delivery to Stadsleveransen this approach is also dependent on rather large vehicles to deliver the same amount of freight. In this sense Stadsleveransen needs four electrical vehicles measuring 10 x 1,25 meters which in total take up twice the space during the same amount of time (FC3, 2018). Putting this in relation to the micro terminal, according to DB Schenker's pilot study, only an electrified hand truck was needed for the distribution (FC1, 2018). However, considering that the terminal is expected to be flexible it would also be dependent on a pick-up and delivery service using a semi-tractor. Nevertheless, since it was stated that the total time needed to pick up and deliver the terminal would be less than 30 minutes, a micro terminal was seen to be the least demanding option in terms of space (FC1, 2018). Investigating the topic further it was also found that several of the interviewees did not see space in the inner city as the problem, but rather the congestion in the streets and on the roads (CO1, 2018; FC1, 2018; FC2, 2018). Keeping this in mind, different conclusions could therefore be reached depending on how one defines the problem. In this sense if overall space was considered to be the problem, then Stadsleveransen was seen as the least suitable option. However, if the respondent instead saw the congestion on roads and streets as the main problem, the opposite was found true considering that Stadsleveransen can utilize alternative routes (bike paths) to move goods. Thus, in conclusion it was found that direct delivery is the least suitable option overall and that the two other alternatives have an individual advantage depending on the problem definition.

Noise

Studying data provided it was found that a large truck generates noise levels between 72-81dB while in motion, and 81-91dB running idle, making direct delivery the noisiest alternative. Comparing this to Stadsleveransen, an electrical vehicle generates noise levels of 69dB while in motion and 0dB running idle (FC1, 2018). Adding to this, trailers connected to the vehicles also produce extra noise going over uneven surfaces making the total number even slightly higher (FC3, 2018). Data for noise levels created by the electrified hand truck was not available and can therefore not be presented, however according to the conclusions from the pilot study conducted by DB Schenker, the overall noise level using the micro terminal was found to be lower considering that goods were distributed by foot (FC1, 2018). Noting that that a precondition for the micro terminal (in this case) is a pick-up and delivery service, it would not be noise free. However, as stated above, with the total time needed being less than 30 minutes the total sound generating activity should be less compared to Stadsleveransen according to FC1 (2018).

Safety

Regarding safety, the direct delivery approach was seen to pose the most risk to individuals. With streets being intended for pedestrian use, having large trucks driving in the same space was not seen suitable. According to LE2 (2018), there are primarily two safety issues. The first being that accidents can occur with trucks having blind-spots and altered driving patterns due

to irregular parking. The second is a threat of terrorist attacks. With the incident in Stockholm, in 2017, where a man hijacked a distribution truck and killed five people, the City of Gothenburg has also expressed concerns about the issues and have started to plan for precautionary measures (CO1, 2018). Thus, looking at the two other alternatives it was believed that Stadsleveransen could be a better option using electrical vehicles which are smaller and have a lower top speed. However, these vehicles are also heavy when fully loaded which could pose a safety threat, even if a minor one (FC3, 2018). Thus, considering that goods is distributed by foot with a micro terminal this alternative was considered to be the safest alternative for pedestrians (FC1, 2018; LE1, 2018; LE2, 2018). Again, the micro terminal has to be delivered to its location by a truck, but this is done on roads for made vehicle traffic. Utilizing a micro terminal also mean that movements with a truck are made in the early morning and late evening when fewer pedestrians are around (FC1; 2018).

Infrastructure

In terms of infrastructure the direct delivery was not seen to need any extra investment since freight operators can use the existing roads, streets and parking facilities (FC1, 2018). Comparing this to the other alternatives, it was stated that Stadsleveransen being a UCC need a physical building in order to operate. In the case of Gothenburg this is takes the form of an old industrial building in Gullbergsvass. According to FC 3 (2018) this space is today rented from the city costing approximately 150 000 SEK/year. However, since the building is expected to be demolished, rent is considered to be under market value and could therefore be seen as a subsidy by the city (CO1, 2018). An equivalent market value for the property is not known but is estimated to be considerably higher (CO1, 2018). Being a temporary facility also raises the question about a future location, nevertheless this was something that according to our findings had not yet been considered (CO1, 2018).

It was also highlighted by (CO1, 2018) that a micro terminal approach also would need additional infrastructure in order to work. In the DB Schenker pilot study, a space at Kungspportstorget was provided by the City of Gothenburg (CO1, 2018). For this the company paid 1500 SEK/month which could also be seen as an indirect subsidy considering the nature of the project being a pilot (FC1, 2018). Calculating on the actual cost of renting the space needed to operate, a more accurate cost for the space is estimated to be around 7500 SEK/month or 90 000 SEK/year, see Appendix 8.3. Implementing a micro terminal would also call for a further development of the electrified hand truck and trailer. In this sense being able to better cross cobblestone streets and tram tracks would according to FC1 (2018), enhance the range and use of the micro terminal.

Table 5.1: Summary of the quantitative assessment

Variables		Direct Delivery	Stadsleveransen (UCC)	Micro Terminal
Economic Variables	Distribution Volume	275 packages/day.	275 packages/day.	275 packages/day.
	Distance	30 km	16 km	19,6 km
	Mode	1 heavy truck	4 electrical convoys	1 micro terminal
	Time to distribute consignments	22.5 packages/hour	23 packages/hour	22.5 packages/hour
	Operational cost Costs to deliver consignments	Covering its own costs.	Needs subsidies and additional side revenues to cover costs.	More expensive than <i>direct delivery</i> , but less dependent on subsidies compared to <i>Stadsleveransen</i> .
	Service time Hours of potential delivery	05:00-11:00 *Can deliver after and before time restrictions with the use of smaller vehicles	All Day	All Day (Exception have to be made for pick-up of the terminal)
Delivery capacity Weight of good	0-1000 kg (pallet)	0-50kg	0-1000 kg (pallet)	
Social/Environmental Variables	Emissions CO _{2e} per day.	16,23kg CO _{2e} / day	8,66kg CO _{2e} / day	10,23kg CO _{2e} / day
	Congestion Size of vehicles	8m x 2,6m	10m x 1,25m	8m x 2,6m
	Number of Vehicles	1	4	1 *Only for delivery and pickup
	Noise Rates In motion	72-81dB	69dB	N/A
	Standing idle	81-91dB	0dB	N/A *Only sound from the electric pallet lift and service vehicle.
	Safety Risk for accidents/terror	Heavy vehicles possible of reaching high speeds.	Use of light slow-moving EVs.	No trucks needed. *Only for delivery and pickup
Infrastructure Conditions	No need of extra infrastructure.	Need of a physical terminal building for transshipment.	Need of space for the Micro Terminal.	

Sources: City of Gothenburg, 2018; DHL, 2018; DB Schenker, 2018; Stadsleveransen, 2018

5.2 Analysis of the performance

Looking at the different approaches, from a quantitative perspective, it is clear that no single alternative is superior to the other in all measured variables, but rather that the different distribution alternatives have individual advantages. In line with the literature an assessment therefore has to acknowledge the relative importance of each variable (McKinnon, 2015). However, considering the many stakeholders in the urban context this can be a challenge since opinions are diverse, as described by Lindholm (2012).

From an economic perspective the results show that a direct delivery approach is the most cost-efficient approach since operations are covering its own costs. Thus, considering variables of distribution, operational cost, service time, and delivery capacity, the direct delivery approach was found to be the most efficient. Furthermore, in line with the literature, the inherent problems of financing a UCC as discussed by Browne et al. (2005) and Rodrigue (2016), was also confirmed. Thus, with Stadsleveransen being dependent on subsidies and alternative revenues it is showing that the extra handling activities needed often tend to drive costs, making it expensive. For the micro terminal on the other hand, the results show that this type of platform could be more cost effective than Stadsleveransen, but still more expensive than the direct delivery. The reasons behind this is most likely the extra handling that is avoided since the micro terminal is prepared in Bäckebol and that the distribution network therefore is more similar to a direct delivery approach. However, being a two-tiered system, this adds extra costs due to the land space use as described by Crainic et al (2012), making it less competitive compared to the direct approach.

At the same time while the direct delivery could be seen to do well in a strict economic sense this is based on a prerequisite that only internal costs are acknowledged (McKinnon, 2015). However, freight operations generate external costs on the environment and the literature therefore stress the importance to recognize these in order to get a complete understanding (MDS Transmodal, 2012). Hence, from an environmental point of view the direct delivery did not do as well. This is due to the use of heavy diesel trucks leading to higher levels of congestion, emissions, noise and risks. Consequently, with Stadsleveransen and the micro terminal not being as dependent on trucks they could therefore be seen to do much better with the latter coming out on top. Accordingly, while initiatives like Stadsleveransen and a micro terminal in strict financial term could be argued to perform less well, including any external costs could at the same time make this question very relative. In this sense, it could be argued that the valuation of the environment is affecting the attractiveness of the different approaches. Ergo, if environmental variables are valued low (it cost little to pollute) then the alternatives to the direct delivery might seem expensive. However, if the cost of pollution gets high the more attractive they become.

In an overall analysis it could therefore be stated that the micro terminal has a stronger operational and economic performance compared to Stadsleveransen, but that an implementation of this solution would cost more compared to direct deliveries considering the current regulation.

5.3 The viability of a micro terminal from a stakeholder perspective

This part of the empirical section will present the qualitative content from the interviews. Here, attitudes and opinions toward the micro terminal and its context will be brought fourth. Guided by the purpose, the responses are furthermore clustered into four sections for an easier understanding.

The major challenges of freight distribution in the Gothenburg

Discussing the challenges of freight distribution in Gothenburg it became clear all of the freight carriers, logistical experts and city officials saw the problem of congestion as a primary issue and that this is the cause of many other problems. In essence it was argued that accessibility had become a deteriorating problem and that this had led to a multitude of problems (FC1, 2018; FC2, 2018; FR2, 2018; FR3, 2018; LE1, 2018; LE 2, 2018). However, depending on the profile of the respondent the problem description tended to differ. In this sense freight receivers complained about an increased challenge of receiving consignments in time and that this in many cases had reduced the ability to stay competitive with out of city locations (FR3, 2018; FR4, 2018). The freight carriers also indirectly confirmed this picture by describing complications of making deliveries in time and that this was due to a longer time spent in traffic (FC1, 2018; FC2, 2018). From the city officials perspective, a focus was instead placed on safety and that increased problems with congestions could affect residents in a negative way (CO1, 2018). At the same time, a more neutral stance was taken by the logistical experts concluding that congestion might be the main problem but that the consequences are more of a social/environmental concern than economic (LE1, 2018).

As the problem of congestion in most interviews was established at an early stage a natural progression became to talk about the cause of the problem. Treating the subject, four topics came to stand out. The first one was that freight volumes have increased. Here, both the logistical experts and the freight carriers painted a picture of more shipments being made but that the infrastructure in many cases had remained the same (FC1, 2018; FC2, 2018; FC3, 2018; LE1, 2018; LE2, 2018). According to one of the respondents this could partly be due to the limited space in the area, but that little had been done in order to meet the challenges. The second topic regarded how the implementation of weight-restrictions had come to shorten the time to operate in the city and that this has contributed to a more limited accessibility (FC1, 2018; FC2, 2018). In this regard both freight receivers and freight carriers expressed a frustration over, what they argued to be, a limited analysis on behalf of the city to the commercial impact of such limitations (FR3, 2018; FR4, 2018; FC2, 2018). Interestingly enough, the city official also seemed to be self-critical stating that a restriction of heavy weight vehicles at a certain hour without any thorough thought could be devastating for any commercial actor involved (CO1, 2018). At the same time this respondent also underlined that the intention of the weight restriction had been just that, to leave a time window possible for the freight carriers to be able to deliver their goods within time, but still push them to find new ways to deliver the goods excluding the truck in order to improve the environment (CO1, 2018).

The third topic highlighted was the problem of personal transports. Accordingly, both logistical experts and freight carriers argued that personal transportation like cars, sharing the same space,

often are in the way of freight transportation and that these are the cause to the real problems (FC1, 2018; LE1, 2018). In this regard one of the freight carrier stated that people only use cars to travel between two points and that they often are grossly underutilized (FC1, 2018). Furthermore, it was also argued that freight transportation has a greater social benefit compared to personal transportation and that it therefore should be more prioritized (LE1, 2018).

The last issue highlighted the shortage of loading-zones in the city center. According to many respondents this had become a problem as the layout of the streets over time have changed (FC1, 2018; FR1, 2018). From the city's perspective this was done intentionally, trying to create a more attractive environment but also recognized that this had led to a situation where delivery-parking more often are made in undesignated spots. Surprisingly, one of the store owners expressed that most stores within the area actually saw the removal of loading zones as problematic meaning that the complication of deliveries outweighed the positive benefits of more pedestrian space (FR3, 2018).

The local planning of urban freight distribution.

According to the logistical experts many of the freight related issues in Gothenburg have historically been overlooked (LE1, 2018; LE2, 2018). Supporting this statement, freight carriers and city official also remarked on how visions produced by the city often illustrate new urban areas with an idyllic perception. In this sense it was believed that a focus all too often have been placed on green spaces, bicycle lanes and coffee shops with little regard to logistical services (FC1, 2018; CO1, 2018) One of the logistical experts stated that goods are not as prioritized as individuals, and that this is nothing specific for Gothenburg but a common tendency in most cities, making new logistical solutions difficult to introduce (LE1, 2018).

As many of the respondents believed that freight issues tend to be far down on the political agenda, it was also underlined that Gothenburg in many cases does relatively well compared to other cities. Thus, many respondents mentioned both *Godsnätväcket* and *Innerstaden* as examples of organizations trying to resolve challenges (CO1, 2018; FC1, 2018; FC2, 2018, FC3, 2018; FR3, 2018; LE1, 2018). However, talking about these initiatives also exposed differences in understanding among the interviewees on how things are handled. Stressed by one of the freight carriers the main problem is the fundamental understanding of the issues at hand. According to this person political initiatives often suffer from little knowledge of the actual problems and that there is a disconnect between the industry and legislators (FC2, 2018). As an example, the time restrictions were lifted. While believing that the intentions were good, representing a large freight carrier, it was also argued that the restrictions were concentrated on the wrong actors (FC2, 2018). Accordingly, it was argued that large carriers already today consolidate much of the consignments and that the new restrictions had led to a less efficient system (FC1, 2018; FC2, 2018). Thus, instead of delivering all goods with fewer large vehicles, an increased number of smaller vans had come to substitute the large trucks leading to more congestion and pollution. Much of the points from both carriers and receivers focused on what they called to be an uneven playing field arguing that tough rules had been imposed on freight deliveries, and essentially trade, but not on other stakeholders such as personal transports (FC1, 2018; FC2, 2018; FR3, 2018)

The city official admitted that freight issues have been neglected and that politicians are mainly focusing on passenger transportation and mobility, but not enough to solve the freight related issues (CO1, 2018). At the same time, it was also stated that recent projects have shed more light on transportation and freight planning. Here, Stadsleveransen was lifted as an example and that new strategies were planned for coming expansions of the city (CO1, 2018). In concluding remarks one of the logistical experts also commented that there is an inherent connection between the attractiveness of a city and its logistical services, and that this is something that will become more important in the future as cities are expanding (LE1, 2018).

The use of a micro terminal to mitigate problems.

Asking the stakeholders if a micro terminal could mitigate problems provided the study with many different viewpoints. Acknowledging a diminishing ability to deliver goods in a traditional way the interviewees saw the concept as an interesting idea commenting on positive attributes, at the same time many questions were also raised, and opinions differed depending on the stakeholder profile. In an overall consideration the interviewees stated that a micro terminal most likely would have a positive impact on the environment. Thus, delivering goods by foot and making deliveries consolidated was seen as a positive attribute (FC1, 2018). However, the city official contemplated that a micro terminal would need space to operate and that this raised questions about how many terminals would be needed, and furthermore how they should be divided among the operators in terms of permissions (CO1, 2018). From a receiver perspective one of the store owners also commented the need for space and questioned how the interference of the micro terminal in the city landscape could affect the attractiveness of an urban area (FR2, 2018).

From a freight carrier perspective one of the first points made when discussing an implementation was the question of the business model. Two of the freight carriers made parallels to Stadsleveransen describing the problems of this approach and the issues of integrating it into existing supply chains - both in a practical sense but also in terms of financing (FC1, 2018; FC2, 2018). Here it was explained that a fundamental difficulty of Stadsleveransen had been the transfer of responsibility to a third party. It was argued that since much of the business models in freight transportation revolves around the ability to keep high service levels, letting go of the last leg of delivery would be a commercial risk (FC1, 2018; FC2, 2018). This point was also confirmed by Stadsleveransen stating that having a separate IT-systems created problems and that this was due to an unwillingness of upstream suppliers to integrate for business reasons (FC3, 2018). Thus, with a micro terminal potentially being fully controlled by the freight carriers this was seen as a positive attribute (FC1, 2018; FC2, 2018). This idea was also supported by one of the logistical experts stating that the major advantage of a micro terminal is that business models would become less complex and that conflicts with other actors therefore could be avoided (LE2, 2018).

While the questions of congestion, the environment and integration had varying emphasis among the respondents, financing was a concern lifted by all. From a freight receiver perspective, the main interest was to understand if a micro terminal would lead to higher

shipping costs (FR1, 2018; FR2, 2018; FR3, 2018). According to one of the store owners, operating in the city center already meant that marginal was slim and that additional costs for freight could not be handled (FR4, 2018). The freight carriers on the other hand provided a more thorough analysis. First of all, they stated that the most efficient way for them was to ship goods through a direct delivery. However, contemplating the alternatives they again referred to Stadsleveransen and increased costs. Thus, pointing towards the need of extra handling and facilities, a worry was expressed over potential costs that could incur following an implementation of a micro terminal (FC1, 2018; FC2, 2018). According to one of the freight carriers utilizing both Stadsleveransen and a directly delivery approach, Stadsleveransen had only added costs and complexity to the system. When asked about why they still participated, the answer was that it was due to experimental reasons and that it looked good from a public perspective (FC2, 2018). Nevertheless, with the freight receivers understanding the business model of a micro terminal, the financial aspect was seen in a more positive light compared to Stadsleveransen (FC1, 2018; FC2, 2018). From a city perspective, the city official explained that the city had given permission to DB Schenker to conduct the pilot study and also that they also were a part of Stadsleveransen. With this in mind, and also considering that the city imposed weight restrictions, it was indicated by the city official that finding alternative solutions had been the primary objective (CO1, 2018) Thus, when asked about the financial aspect of a micro terminal the response was quite unclear.

Another area that was treated concerned practical issues such as the working environment and the exposure to weather conditions. Here, one freight carrier contemplated if there could be issues with having a worker towing goods over cobble stone (FC2, 2018). This was nevertheless seen to be less of a problem when the technical solution of an electrified hand truck was explained. At the same theme both the freight carriers and the receivers saw the ability to ship heavy goods on the micro terminal as a significant advantage compared to Stadsleveransens limitation of 25kg (FC1, 2018; FC2, 2018; FC3, 2018; FR1, 2018; FR2, 2018; FR3, 2018; FR4, 2018). Regarding the exposure to weather conditions this was primary seen as an issue by some of the freight receivers as well, worrying that the goods might become spoiled in the advent of rain (FR3, 2018; FR4, 2018). At the same time, an interesting point was made that much of the goods delivered by a direct approach today in many cases have to be delivered by foot, exposed to the weather, and that this is because of the limited availability of loading zones (FC1, 2018).

In overall remarks it was agreed by several of the respondents that the idea of a micro terminal is interesting. At the same time, it was also expressed by many of the stakeholders that they would need more knowledge of this solution in order to provide more clear judgements (CO1, 2018; FC2, 2018; FR1, 2018; FR2, 2018).

Future distribution solutions.

Having discussed the problems and the potential use of a micro terminal, the stakeholders were asked about how they envisioned the solutions of the future. In this subject the freight receivers showed a limited ability to visualize any concrete ideas, however for the other three parties there was an agreement on two major trends (CO1, 2018; FC1, 2018; FC2, 2018; FC3, 2018; LE1, 2018; LE2, 2018).

The first one referred to the electrification of freight vehicles. Here, all freight carriers talked about the application in the near future and that several of the major truck manufacturers were planning to release fully electrified vehicles (FC1, 2018; FC2, 2018; FC3, 2018). Expanding their thoughts, the freight carriers were enthusiastic about the possibility to overcome much of the problems generated by combustion engines and therefore envisioned new possibilities. One given example was that more quiet vehicles would open for expanded operation hours and that freight would be able to be distributed in areas that are today subjected to noise restrictions (FC1, 2018; FC2, 2018; FC3, 2018).

The second trend concerned the need to restrict cars used for personal transportation in urban areas even further. The city official, the freight experts and the freight carriers all concluded that this would be needed in order to promote a safer and more health environment (CO1, 2018; FC1, 2018; FC2, 2018; FC3, 2018; LE1, 2018; LE2, 2018). According to one of the logistical experts the necessary transportation should still be available, but that city centers in the future only should allow public traffic, walking, bicycling and freight deliveries (LE1, 2018).

Also, despite having diverse thoughts on the cause of problems, solutions and the future, all interviewees furthermore agreed that no single solution will be able to answer all challenges. Instead it was believed that combination of measures is the way forward. Thus, it was stated that most solutions come with a flipside and if there were a grand answer to the problems it would already have been adopted.

5.4 Analysis of the viability.

In the interviews it became clear that the perceived challenges of freight distribution in Gothenburg is similar to many other cities and what is described in the literature. Thus, coinciding with McKinnon (2015), the main issue is how to enable efficient goods transports while at the same time mitigating environmental and social impacts. Even though the interviewees seemed to agree on the challenges of congestion and the environment it is evident that the understanding of problems differ quite substantially. This was also underlined by one of the business owners who stated;

“...Quite often it feels like public officials have many ideas of how to resolve problems but no clue of how it effects businesses and people in reality” – (FR3, 2018)

Thus, confirmed by the research presented by Lindholm (2012), the complexity of having multiple stakeholders is also a problem in Gothenburg. However, even though many of the interviewees complained about a slow political process dealing with freight issues, it was at the same positively emphasized how the city is in the forefront of stakeholder collaboration raising the question of why seemingly deep disagreements could persist. Understanding these differences and how the stakeholders perceived problems also became necessary in order to understand how, and if, the concept of a micro terminal could be viable. Thus, considering that the traffic with small vans had actually increased since the regulation came in place, despite an alternative like Stadsleveransen, it was therefore important to make sure that a new solution would be accepted by all parties. Studying the factors of importance to the stakeholders it became evident that the private sphere, representing the freight carriers and freight receivers, first and fore most emphasized the financial aspects. Meanwhile, alternative solutions and the environments was found to be the primary objective of the city official, representing the public. This fact got especially apparent listening to how the Stakeholders reasoned around the alternatives.

“...We work consistently to lower costs and to increase the efficiency. I’m sorry to say; the idea behind Stadsleveransen is good, but it is not feasible” – (FC1, 2018)

” Transports costs money, but are too cheap to motivate any extra handling [...] therefore it’s about creating incentives and regulation to make sure that these types of solutions are used” – (CO1, 2018)

Thus, corresponding to the discussion by Boudoin et al. (2014) regarding the interests of the public and private sphere it was hence understood that a condition for a successful implementation of a micro terminal would have to be an acceptable financial performance while at the same time providing a better alternative compared to direct deliveries. Discussing the concept of a micro terminal it was therefore interesting to see how closely the arguments of the freight carriers and freight receivers corresponded to the principles of network theory presented by Boudoin et al. (2014) and Lumsden (2006). In this sense, the freight carriers withheld that the most efficient way for them to make deliveries was through a direct approach with few intermediaries. Thus, from a financial consideration the micro terminal was seen as less

effective. However, considering that congestion is a growing problem and that the public concern for the environment probably will make restrictions even tougher, a micro terminal was seen as more favorable having a less complex structure and fewer intermediaries compared to Stadsleveransen. The business model was another aspect talking in favor of the micro terminal. Thus, in line with McKinnon's (2015) discussion on the growing importance of offering efficient services, many of the freight carriers underlined the value of controlling the services offered. One of the freight carriers remarked that the logistics industry simply is in the business of sending freight from point A to point B and that the business proposition lays in how fast and accurate shipments can be done. Therefore, having a collaborative business model like the one provided by Stadsleveransen was therefore seen to hinder competition and put fundamental principle out of place. Something that again would speak in the favor of a micro terminal.

"...to have a truck from Schenker, PostNord and DHL delivering on the same street in an urban area does of course not look good, but this is what competition looks like. Shall we not have competition? If not, then Stadsleveransen is a good alternative" – (FC2, 2018)

As described in the empirical section, the city official also focused less on the financial implication of a micro terminal and more on a diverse range of questions. This is most likely because of the greater consideration that has to be made by officials looking at the challenges from a public perspective. Supported by Lindholm (2012), having to focus on both efficient transports, a clean environment and economic growth, makes finding a solution more complex.

Thus, considering that the city supported the pilot project conducted by DB Schenker and with intention to be a testing ground declared in the goods transportation strategy, the overall impression was that new initiatives are welcomed. At the same time, having this profile it was also recognized that the opinion by the city official might be slightly biased and therefore any reservations towards the micro terminal was of extra importance. In this regard two reservations were made, the first being that an implementation of a micro terminal would mean that allocation of space between the private operators would have to be made. The second being that having private businesses operating their own terminals would lower the collaboration in finding new solutions. Contemplating the first point this could be a challenge considering the multitude of logistics operators in place. From another perspective this could at the same time be resolved through an official bidding process. Regarding collaboration, this is probably also true. However, as mentioned by one of the freight carriers, innovation is also created through competition.

Analyzing the viability of a micro terminal in a longer perspective and the trends discussed, one also has to think about the long run implication for this type of platform. In this sense, the electrification of freight vehicles could potentially be a better alternative in the near future as it will solve many of the problems experienced today. From one point of view this is partly true and therefore it could be argued that an electrification would make the micro terminal concept redundant. At the same time, the belief of the interviewees was that there will be no universal solution, but rather that an electrification will open new possibilities.

“...in urban logistics there are no quick-fixes, had it been, then they would already have been implemented [...] instead a combination of solutions has to be implemented.” – (LE2, 2018)

In this sense, substituting a diesel truck with an electrical alternative will not solve the problems of congestion and a micro terminal could therefore probably fill a function in the future and be a part of a more comprehensive solution.

6 Discussion and conclusion

In this chapter discussion based on the analysis in the previous chapter will be presented. A conclusion will then follow, along with contribution, limitations and further research.

6.1 Discussion

The discussion is considering the chapter 5.2 and 5.4 looking at the different aspects, contrasting them against each other.

The relative performance of the micro terminal

To understand the greater scope for implementing a micro terminal in to an urban context, the results have clearly shown that the situation on Gothenburg in many ways reflect the literature and how problems are described. In this sense much of the concerns about the sustainable development discussed by Piecyk, Cullinane and Edwards (2015), have also been apparent in the chosen case. This means that Gothenburg like many other cities have to find new ways to handle an ever-increasing population and the challenges that come with it. Thus, the looking at the variables to evaluate how well a micro terminal perform compared to other common distribution approaches, it was found to do so relatively well. Nevertheless, as contemplated in the analysis, and by McKinnon (2015), this conclusion is rather dependent on how one approaches the problem. As such, the micro terminal was found to have a smaller environmental impact compared to the direct delivery, but to be more expensive. An evaluation would therefore dependent on how one values the environment in relation to financial costs. At the same time, the results also found that the micro terminal probably would be less expensive compared to Stadsleveransen. Thus, considering that the approaches would handle the same amount of goods further lead to an interesting insight. Simply explained this would imply that a micro terminal in terms of performance could be placed in-between the direct delivery and the UCC approach of Stadsleveransen. Therefore, with the knowledge that Stadsleveransen need financial support, supported by Browne et al's (2005) discussion on UCCs, this would suggest that public funds could be used in a more efficient manner and that a micro terminal is worth to investigate further.

Stakeholder complexity in urban freight distribution

The study also confirmed the research in that finding new logistical solutions involve many different stakeholders, and that this is something that can increase the complexity to find new solutions (Boudoin et al., 2014). Thus, analyzing the viability, or rather the stakeholder perspective, it was found that the stakeholders in the case also had a wide range of opinions and ideas. These thoughts did furthermore not only include the micro terminal concept, but also the cause of problems and the logistical challenges in general. Having categorized the stakeholders in to two groups, some common tendencies could therefore be identified both among the public- and private stakeholders. From the public side these tendencies meant that there was a focus on finding new solutions to mitigate the social/environmental impacts and that the main drive is public pressure. Thus, focusing less on the financial implications from a business perspective,

the tools was furthermore to use regulatory measures to reach the goals. From a literature perspective this trend has been found before, however the literature also emphasize that advancing too hard with regulation measures could have negative effects (Lindholm, 2012). From the private side the tendencies suggested that financial implications are priority number one. Maybe not surprising, the study therefore found a discussion of business models, finance and competition to be high on the agenda. At the same time the study also confirmed that the private sphere did not discard sustainability questions completely. Instead, similar to previous research, McKinnon (2015), the freight carriers expressed many ideas in how to respond to a changing market demand becoming more environmentally conscious.

From these observations it became clear that all stakeholders had ideas on how to improve the current system to become more sustainable, but that the approach to solve the challenges take different ways. Thus, considering the research suggesting that collaboration among stakeholders improve the ability to find new solutions, Lindholm (2012), and the many collaboration platforms in Gothenburg, it was unexpected to find such a persistent disagreement among the stakeholders in the case. Contemplating how these findings could apply to understand the viability of a micro terminal, it was therefore found that only a solution appealing to the majority of stakeholders is a key determinant. In this light, the study found that most of the stakeholders, both private and public, expressed a positive attitude towards a micro terminal concept. From the public side this could probably be explained by the greater enthusiasm in general to get rid of unwanted nuisances and the pressure of officials to find solutions, also discussed by Boudoin et al. (2014). Maybe more interesting was the thoughts conveyed by the private sector. Here it was so found that most of the freight carriers and the receivers viewed any change with some apprehension, but that most saw the necessity of change. Thus, with the majority of the private sector viewing the UCC concept in Gothenburg in a negative way, understanding the business model and financial implication of a micro terminal was therefore seen in favor. Of course, without contrasting approaches such as the direct delivery and Stadsleveransen the outcome of opinion might have been slightly different. However, considering that tighter rules for the environment is advancing in urban areas, being perceived as a more viable solution by all stakeholders therefore speak in the favor of the micro terminal concept.

Transferability and future development

Since this case have only studied Gothenburg, it is also important to contemplate if a micro terminal could be transferable to other urban environments and how it could evolve in the future. From this point of it should be acknowledged that both the literature and this study have underlined that local preconditions can have a quite substantial impacts on the transferability of ideas (Lindholm, 2012). It could also be stated that in terms of density, Gothenburg being considered a “large urban zone” (MDS Transmodal, 2012) would have small problems compared to larger cities, and that the testing a micro terminal would be more suitable in a metropolitan area such as London. This would speak against the idea of a universal implementation in urban areas. At the same time, the study found that Gothenburg, and the specified area, in many ways reflect much of the challenges and ideas discussed in the literature.

Thus, considering that these studies also in many cases have been conducted in a broad range of settings around the world would therefore speak for the truth of some transferability.

Looking at the how the micro terminal could evolve in the future it is clear that the concept is in its early stages of development. This was not only confirmed by the literature review but also the interviews where the respondents had different ideas in its design. The example used in this study could furthermore be seen as a hybrid of the solutions presented. In this sense a flexible micro terminal could be argued to take influences from a variety of the urban logistics platforms presented in the literature review. Thus, drawing on the ideas of logistical hotels and urban logistics boxes, discussed by Morana (2014), the micro terminal concept could be seen to represent a middle way. It could also be argued to be rather similar to the function of the multi-use lanes tested in Bilbao Spain, providing for the ability to use urban land space more efficiently, discussed by Leonardi et al. (2014). The wide potential for further development also leads to the last point in this study. The finding that a micro terminal by itself is no grand solution to more sustainable urban logistics. Instead, it was found both by looking at the literature and through the interviews that this solution instead should be seen as a compliment in a more comprehensive effort to make urban freight distribution sustainable.

6.2 Conclusions

The main purpose of this study was to explore the distribution concept of a micro terminal and to understand if it could be a viable method mitigating much of the sustainability problems related to urban freight distribution. The main body of the study was thus structured around two questions aimed at examining *how a micro terminal compare to other approaches of urban distribution* and if the concept *is a viable way of serving city centers from a stakeholder perspective*. A case study based on a DB Schenker pilot project was conducted and in the next section the main findings will be presented.

How does a micro terminal compare to other approaches of urban distribution?

It was found that the micro terminal performs relatively well compared to other distribution approaches, in this case a UCC and direct deliveries. Thus, while not being superior in all aspects it was found to be able to mitigate much of the problems associated with urban distribution. Acknowledging that a micro terminal in fact would be costly compared to the direct delivery it was also established that it has a better environmental performance and would be less dependent on subsidies in relation to Stadsleveransen. Thus, in line with the literature, considering the trend of legislators pushing to internalize environmental costs, a solution like the micro terminal with less environmental implications would over time become more attractive.

From a stakeholder perspective, how viable is a micro terminal of serving city centers in a sustainable way?

Regarding the stakeholder perspective, the study found that the discussion of a micro terminal involves many stakeholders making it highly affected by local pre-conditions and the ability to find a common problem definition. Despite this a majority of the interviewees indicated a positive stance towards the idea of a micro terminal. In this sense, while the private actors

expressed a general skepticism toward any change that would incline a financial implication they also realized that they would have to adapt to a changing environment and new rules. Also, not being content with the current situation they saw any new alternative leading to lower costs and improved operations as a better alternative. From the public perspective a willingness to test new ideas was also found in favor of implementing a new concept. Focusing on the ability to lower any environmental or social constraints would therefore speak in its favor.

Thus, overall the study found that a micro terminal could be viable solution to city logistics and an answer to a more sustainable distribution. It was also found that this solution is likely to be transferable and could be implemented in other cities. Nevertheless, since the concept is under formation more testing would be needed to understand the full implication of the system. Moreover, as the interviewees did not see the micro terminal as a grand solution to the logistical problems faced by cities, a potential implementation of a micro terminal concept is instead suggested to be seen as a compliment in a larger cluster of possible solutions.

6.3 Contributions and limitations

Regarding the contributions and limitations of this study it can be stated that the complexity of the subject provides many more layers suitable for exploration than what can be covered in a master thesis. With that said, it is still believed that his study has bridged some of the research gaps in the field of urban logistics and sustainability. Thus, through conducting an exploratory study the aim has been to provide for a better and more cohesive understanding of the subject from an outside perspective.

In terms of research procedure, the study has been limited with regards to the academic guidelines, time frame and geographical area. Thus, the academic guidelines restricting the total number of pages has therefore limited the number, and length of each interview. That is, considering the qualitative nature of the project, a lesser constraint could have enabled more interviews and provided more insightful evidence. The timeframe of four months also meant that a cross-sectional study was the only reasonable choice. Consequently, it is understood that a short study like this will not be able to give insights to any current trends, something that could have been a case conducting a longitudinal study. Lifted earlier, by conducting a single case study in Gothenburg the findings are also specific to the city. Considering this, the authors do therefore reserve for any geographical differences. However, contrasting the findings with the literature review and the challenges and preconditions mentioned in other urban areas, the findings are still believed to be valuable outside the specific geographical context.

With that being said, it is believed that the interviews have been honest and open-hearted, that the findings are representative of the industry, and that the results therefore can be seen as a contribution to the research.

6.4 Future research

Regarding the future research, several suggestions could be made. With the knowledge that micro terminal and many of the solutions presented in the literature review are dependent on urban space to operate, an interesting area to investigate would be long term city planning. Thus, a study focusing on how the urban areas of tomorrow are planned and how this affect urban logistics would most likely provide valuable insights to the research field.

Another area to investigate is how the electrification of freight vehicles could potentially disrupt, or enhance, the logistics platforms currently used today. Since an introduction of electrified commercial trucks are expected during 2019, an initial study could therefore bring about knowledge not only valuable to the scientific community but also commercial actors within the field.

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8 Appendix

Topic guide for the interviews

Conducting the interviews, the topic guide below was used as a framework to guide the discussions. Using a semi-structured approach, new ideas were allowed to be brought up and evolved by follow-up questions individual to each interview and depending on the context. The original guide was made in Swedish, this is a translation.

Questions for the city official

- General questions
 - Could you introduce yourself and tell about your work?
 - What is the largest challenge with goods logistics in central Gothenburg today?
- The city perspective
 - How does the city plan for freight transportation?
 - Which priorities does the city have? (Environment, green, coziness, companies)
 - What is the thought behind the restrictions of heavy vehicles and is there any limit of the restrictions?
 - What are the solutions of the future?
- Distribution approaches
 - Which possibilities and challenges can you see with the direct deliveries?
 - Which possibilities and challenges can you see with the city delivery (Stadsleveransen)?
 - Which possibilities and challenges can you see with a micro terminal?

Questions for the freight carriers

- General questions
 - Could you introduce yourself and tell about your work?
 - What is the largest challenge with goods logistics in central Gothenburg today?
- The company's perspective
 - What is the most important priorities of your company in question of distribution of goods?
 - How does the city plan for freight transportation?
 - Which solutions do you see in the future?
- Distribution approaches
 - Which possibilities and challenges can you see with the direct deliveries?
 - Which possibilities and challenges can you see with the city delivery (Stadsleveransen)?
 - Which possibilities and challenges can you see with a micro terminal?

Questions for the freight receivers

- General questions
 - Could you introduce yourself and tell about your work?
 - What is the largest challenge with goods logistics in central Gothenburg today?
- Business perspective
 - What do you consider to be problematic with the deliveries today?
 - Which solutions do you see in the future?
- Distribution approaches
 - Did you perceive any differences in DB Schenker's pilot project with the micro terminal solution?

Specific questions relating to the variables

- Distribution
 - What volumes do you distribute in the specified area?
 - What mode do you use for distribution?
 - How long does it take to distribute consignments?
- Operational cost
 - Could you give an estimate of the cost to deliver a parcel to the area?
- Service time
 - What is the operating hours for your delivery approach/approaches?
- Delivery capacity
 - Do you have any weight limits?
- Emissions
 - Could you provide us with data on emissions?
- Congestion
 - What is the size of the vehicles you use?
 - How many vehicles do you use?
- Noise rates
 - Do you know what noise levels your vehicles generate?
- Safety
 - What risks do you see with the different delivery approaches?
- Infrastructure
 - What type of infrastructure does your delivery approach need?

Table 8.1: Detailed description of the quantitative assessment

Variables		Direct Delivery	Stadsleveransen (UCC)	Micro Terminal
Economic Variables	Distribution Volume	275 packages/day.	275 packages/day.	275 packages/day.
	Distance	30km	16km	19,6km
	Mode	1 heavy truck	4 electrical convoys	1 micro terminal
	Time to distribute consignments	22.5 packages/hour	23 packages/hour	22.5 packages/hour
	Operational cost Costs to deliver consignments	Approx. 20 SEK/Package *See next page.	Approx. 20 SEK/Package *See next page.	Approx. 20 SEK/Package *See next page.
	Service time Hours of potential delivery	05:00-11:00 *Can deliver after and before time restrictions with the use of smaller vehicles	All Day	All Day (Exception have to be made for pick-up of the terminal)
	Delivery capacity Weight of good	0-1000 kg (pallet)	0-50kg	0-1000 kg (pallet)
Social/Environmental Variables	Emissions CO _{2e} per day.	*See next page.	*See next page.	*See next page.
	Congestion Size of vehicles	8m x 2,6m	10m x 1,25m	8m x 2,6m
	Number of Vehicles	1	4	1 *Only for delivery and pickup
	Noise Rates In motion	72-81dB	69dB	N/A
	Standing idle	81-91dB	0dB	N/A *Only sound from the electric pallet lift and service vehicle.
	Safety Risk for accidents/terror	Heavy vehicles possible of reaching high speeds.	Use of light slow-moving EVs.	No trucks needed. *Only for delivery and pickup
	Infrastructure Space needed.	Existing space.	Facility*450m ²	Land use*30m ²
	Cost	0kr	150 000 SEK/Year *See next page.	18000 – 90000kr/Year
Additional permits	No.	Yes – For the EVs		

Sources: DHL, 2018; DB Schenker, 2018; City of Gothenburg, 2018; Stadsleveransen, 2018

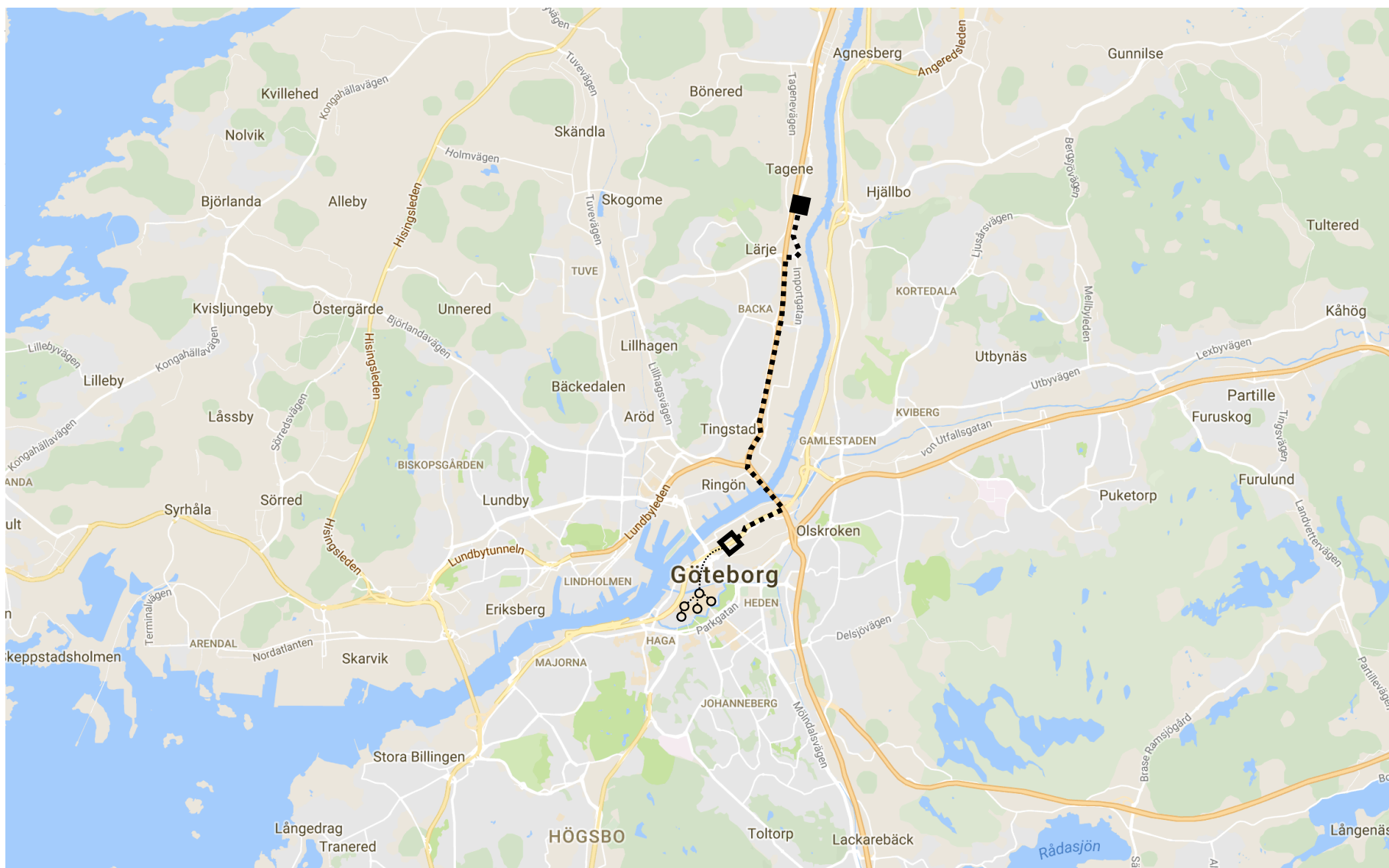
Table 8.2: Detailed description of the quantitative assessment cont.

Variables		Direct Delivery	Stadsleveransen (UCC)	Micro Terminal
Environmental Variables	<p>Emission Emission per mode in relation to direct delivery.</p> <p>*CO_{2e} is called a <i>carbon dioxide equivalent</i> and is a measure that express other greenhouse gas emissions in terms of CO₂ based on their relative global warming potential. It is therefore a summation of total emissions in a common unit.</p>	<p>CO_{2e} 16,23kg</p> <p>Distance 30 km</p> <p>CO_{2e} 541g*30 = 16 230g = 16,23kg CO_{fossil} 524*30 = 15 720g = 15,72kg NO_x 1,707*30 = 51,21g SO₂ 0,001*30 = 0,03g HC 0,015*30 = 0,45g PM 0,024*30 = 0,72g</p>	<p>CO_{2e} 8,66kg</p> <p>Distance 16 km</p> <p>CO_{2e} 541g*16 = 8 656g = 8,66kg CO_{fossil} 524*16 = 8 384g = 8,38kg NO_x 1,707*16 = 27,31g SO₂ 0,001*16 = 0,016g HC 0,015*16 = 0,24g PM 0,024*16 = 0,384g</p>	<p>CO_{2e} 10,6kg</p> <p>Distance 19,6 km</p> <p>CO_{2e} 541g*19,6 = 10 606g = 10,6kg CO_{fossil} 524*19,6 = 10 270g = 10,27kg NO_x 1,707*19,6 = 33,46g SO₂ 0,001*19,6 = 0,0196g HC 0,015*19,6 = 0,294g PM 0,024*19,6 = 0,4704g</p>
	Economic Variables	<p>Cost Operational</p> <p>Approx. 20 SEK/Package</p> <p>Explanation. This number was concluded and confirmed the interview with FC2 (2018) at DHL. According to the interviewee calculations here very hard to make but around 20 SEK/package and delivery should be correct.</p>	<p>Approx. 20 SEK/Package</p> <p>Explanation. Through interviews with FC3 (2018) the following was found;</p> <p>Cost of facility 150 000 SEK/year Vehicle cost 720 000 SEK/year Labor cost 1600 000 SEK/year Total 2400 000 SEK/year</p> <p>Average delivery of packages in total (including deliveries outside the specified area): 500. Number of operational days: 250. Total 500 x 250 = 125 000 Packages/ year</p> <p>2400 000/125 000 = 20SEK (19,76 SEK) /Package</p> <p>This number was also confirmed by CO1 (2018)</p>	<p>Approx. 20 SEK/Package</p> <p>Explanation. This number was concluded and confirmed by DB Schenker's own reports and through an interview with FC1 (2018). According to the interviewee the micro terminal had led to some, but very incremental financial gains compared to the direct delivery.</p>

Table 1.3: Detailed description of the quantitative assessment cont.

Variables		Direct Delivery	Stadsleveransen (UCC)	Micro Terminal
Economic Variables	Infrastructure			
	Cost	No extra cost.	Cost of facility 150 000 SEK/Year Explanation. This number was provided by both FC3 and CO1.	Cost of land use 18000 – 90000kr/Year Explanation. For the space used during the pilot study, DB Schenker paid 1500 SEK/month which equals 18 000 SEK/year. This was however seen as a discount price by CO1 due to the project nature of the pilot. In order to get a more accurate number, an estimate was made based on the parking fees in the same location. The terminal would need two parking spots, each costing 30kr/hour during the day (08:00-18:00). Thus, occupying two spots for 6 hours each day of operation (250 days) gives the following calculation. $30 \times 2 \times 6 \times 250 = 90\,000$ SEK/year.

Figure 8.1: Location of the urban consolidation center in Gullbergsvass



▣ = The urban consolidation center