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City Logistics Optimization: Gothenburg Inner City Freight Delivery

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ABSTRACT

As number of freight vehicles and the volume handled steadily increase and negative effects of transport are being recognized, sustainable transport attracts more attention from both the researchers and transport stakeholders. Since conflicts of interest among stakeholders are not avoidable, it is important to seek for and keep the balance.

This research conducts a qualitative method to discuss the optimization possibilities of the city logistics of non-chain stores in central Gothenburg, Sweden by focusing on two stakeholders: The administrators and the freight operators. Based on some of the best practices in urban logistics in other major cities in Europe, this paper tries to suggest new methods for the area in Gothenburg.

To understand the subject better, relevant information is collected by the authors from different people involved in city logistics. After getting a clear idea, literature on the subject has been scanned to find the relevant theories.

Based on the dynamics of the city, ideas which are not suitable and which could be suitable are discussed from the perspective of the three pillars of sustainability.

Keywords: Gothenburg, Göteborg, city logistics, innovation, sustainability, non-chain stores

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ABBREVIATIONS

ERP	Enterprise Resource Planning
EEV	Environmentally Friendly Vehicle
FCC	Freight Consolidation Center
FQP	Freight Quality Partnership
FTL	Full Truckload
GPRS	General Packet Radio Service
GPS	Global Positioning System
Innerstad	Gothenburg inner city area
ITS	Intelligent Transport Systems
LCV	Light Commercial Vehicles
LEZ	Low Emission Zone / Environmental Zone
LTL	Less Than Truckload
PPP	Public - Private Partnership
RFID	Radio-frequency Identification
SCB	Swedish Statistics (Statistika Centralbyrån)
UCC	Urban Consolidation Center
ULS	Urban Logistics Space
VAS	Value Added Service

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1. Introduction

Urbanization; which means immigration from rural areas to cities, increases the city populations year by year. As Antrop (2004) stated, *"urbanization is one of the fundamental characteristics of the European civilization"*. Today nearly 75% of European residents are living in urban areas. Expectations are, by 2020, 80% of European citizens will be living in urban areas (Uhel, 2008).

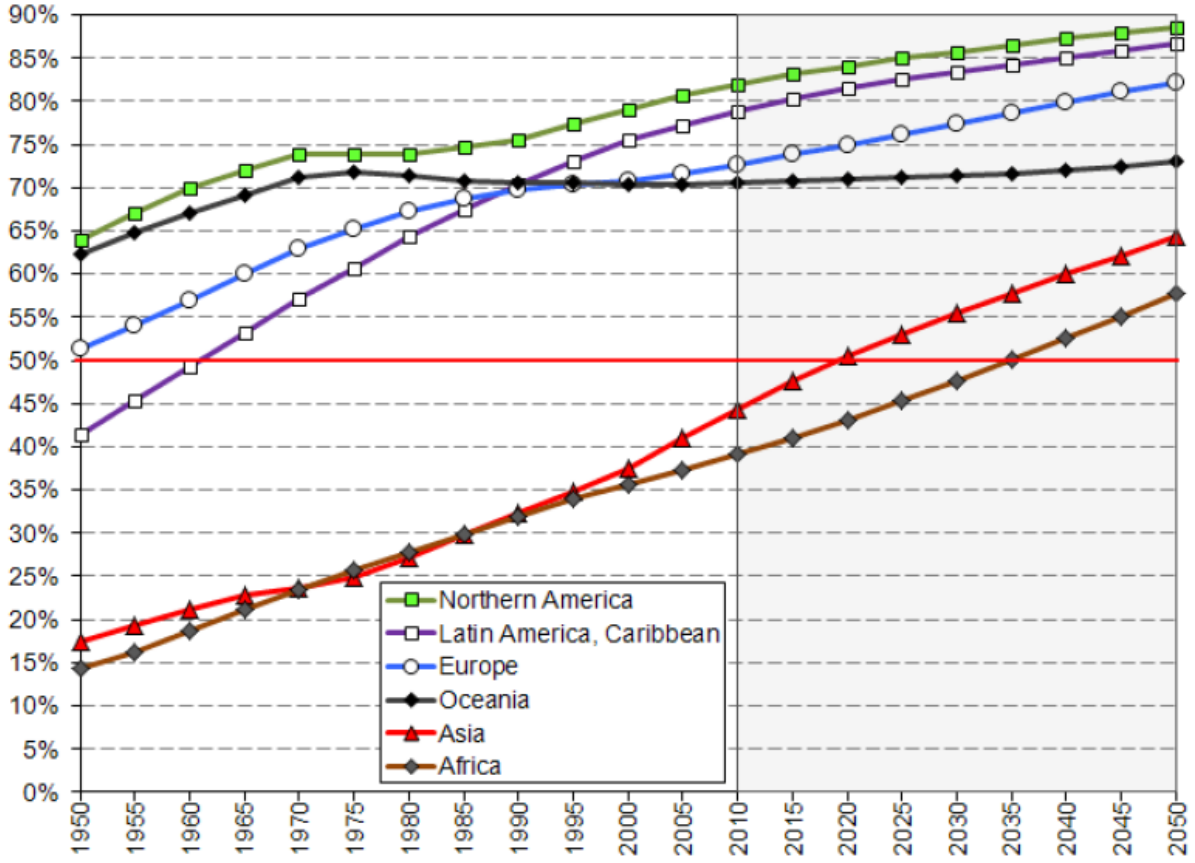

Figure 1 World Urbanization Projection

Source: United Nations

The process of urbanization is intimately related to the development of new transport modes, especially for road and rail transport which increase the mobility and accessibility of the masses (Antrop, 2004). Since 1980s, the high speed train and new railroad network (the first high speed train was invented in France) accelerate the development of urbanization (Ibid). Besides, to fulfill the urban citizens' needs, transportation of products is necessary in today's globalized world; given that most of the products are not consumed at the point of production. Hence a new concept emerged: City logistics, also known as urban logistics, which can be simply described by the transportation process of goods and services to, from, and within a city. Densely populated cities have their own problems in terms of environment, congestion, safety, and energy consumption in common (Taniguchi & Thompson, 2008).

As many major cities do, Gothenburg suffers the aforementioned common problems when it

comes to city logistics. There is a conflict of interest between the local government and city freight operators; two of many stakeholders in city logistics. The government is trying to decrease the congestion by new implementations such as road taxing, and to increase the public transportation usage. These two stakeholders have apart organizational cultures as Taniguchi & Thompson (2008) [Innovations in City Logistics, Chapter 1] describes: Governments are trying to develop policies to minimize the negative effects and to make the city a more livable place; and on the other hand city freight operators try to minimize their costs. Unfortunately, policies and cost reductions are mostly poles apart. Therefore, it is important to find a balance between the stakeholders while optimizing the transport.

This paper consists of five main parts: **(1)** it starts with giving general information about city logistics by reviewing existing literature. **(2)** Then, the methodology followed to write the paper is explained. **(3)** Third, background information will be given in order to give a complete picture to the readers. **(4)** Fourth, urban logistics practices around the world will be summarized to see example measures taken to solve city logistics related problems. **(5)** Lastly, there will be a discussion related to common measures taken in urban logistics, and new suggestions will be made for the selected area of Gothenburg.

1.1. Problem Description and Motivation

As a city which can be considered successful in transportation, Gothenburg is a good case to explore what can be done for further logistics. Unlike London and other big cities with serious congestion and delay problems, in Gothenburg we can suggest new methods from the perspective of sustainability. Gothenburg also represents a number of cities in Europe of similar size and population density (European Commission, 2014b), so conclusions in this thesis can be applicable to others.

There is one fact about trade and freight transportation, that is, the transportation volume is increasing steadily from every aspect together with the increase of population and development of domestic trade. According to Swedish Traffic Analysis, the number of registered lorries has an annual increase of 2.5% in the last 8 years in Sweden (Figure 17). Traffic volume of heavy trucks has also increased during the recent years (Figure 18). All these increases will lead to a larger traffic flows which cause safety problems and negative environmental impact. Hence there is a need to make progress in freight transportation.

Though much research have been done in the area regarding optimization and innovation of transportation, most of the researchers suggested models to improve public traffic instead of freight operations (e.g. Anderson, Allen, & Browne, 2005; Quak, 2008). This can be explained partly because information about public traffic is easier to access. Another direction the researchers follow is the methodology in transportation which is purely theoretical and has no connection to the reality (e.g. Ambrosini & Routhier, 2004; Jacobson, 1988). Little research (e.g. Taniguchi, Thompson, Yamada, Duin, & Van Duin, 2001) have involved both the theory and the reality to explore the possibility and accessibility of new technical application in freight operation, and this is why this paper will do a research about city logistics optimization in a selected packed area.

1.2. Purpose

The purpose of this paper is to suggest new ideas to improve the inbound delivery system to the shops in a pre-determined dense area of Gothenburg centrum.

1.3. Research Questions

This paper deals with the following research questions:

- What can be done to optimize the freight service to small shops of the area without breaking the existing balance between the stakeholders?
- Demand of city transportation is derived from commercial activities between the citizens and the shop owners. Would any of possible solutions have any effects on either or both of these stakeholders?
- Are solutions from other cities/countries implementable for the area?

1.4. The Area

The selected area is bounded by Södra Hamngatan on the north, Stora Nygatan on the east, Kungstorget on the south, and Kaserntorget on the west, outlined by red lines in Figure 2. The area is important because it is a highly popular shopping area both for the citizens and the tourists, which is responsible for almost the half of the turnover of retailing in the centrum (Kroon, personal communication, 2014). However, the area wasn't built for vehicle traffic, thus pedestrian traffic is under the risk of delivery trucks on its narrow streets and sharp turns. Yet, the area has many small and medium sized shops as well as big chain stores.

Figure 2 Inner city area of Gothenburg

Source: Google Maps

There are two types of streets in the area: Walking streets (Gågator) and living streets (Gångfartsområden). Kungsgatan and Korsgatan are classified as walking streets, where

private cars cannot drive in. The rest of the area is marked as living streets/area, where private cars can drive with a maximum of walking speed and they are required to give way to all pedestrians (Transportstyrelsen, 2013). Main shopping activities are carried through walking streets, which hosts many stores (Innerstaden Göteborg, 2014). These stores have different opening hours depending on their types, which makes transportation challenging.

1.5. Delimitations

In order to be able to focus on research questions listed in Section 1.3, only two main stakeholders (administrators and freight operators) as mentioned above will be described thoroughly. As Quak (2008) states, retailers have few power to change logistics activities or network structure. Freight operators (of any kind) and administrators play the dominant roles when it comes to regulations and innovations of city logistics, so we will focus on these two actors to optimize the selected area. The third stakeholder, the shippers are less relevant to this research. Retailers and citizens are also important to understand the big picture, but instead of being examined thoroughly, they will be mentioned only to explain some parts clearly. Lammgård, Andersson, & Styhre (2013) conducted a survey in Sweden in autumn 2012, investigating how manufactures and wholesaling companies made transport modes decisions. Result shown in Figure 1 implies the dominant role of freight operators as decision makers. Although actual situation of retailing freight delivery may differ, it still has reference value. In fact, research (e.g. Hussain & Sinaga, 2003) about Gothenburg retailing freight delivery in inner city area have seen a similar result but without exact data available.

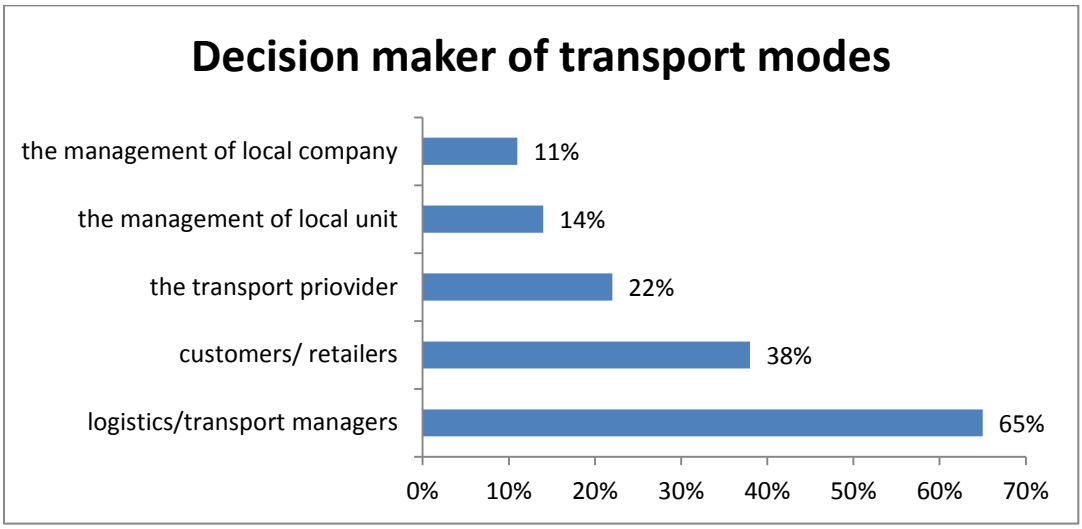

Figure 3 Decision Makers of Transport Modes in Sweden

Note that the total amount is not 100% because in some cases transport modes are decided through negotiations among different parties.

Source: Purchasing of transport services - a survey among major Swedish shippers (Lammgård et al., 2013)

The reasons why the area chosen have been stated above, but readers should notice that not all the retailers in the selected area will be considered as objects. The area includes two big shopping centers; Nordstan and NK. These places already have their delivery locations

underground and do not cause any problems discussed in this paper. Thus, the shopping centers are exempt.

Chain stores which operate their own transport chain are also exempt in this research, since interviews with Trafikkontoret and Svensk Handel prove that chain retailers have their own delivery system which acts quite differently from other small retailers (Magnus Jäderberg, personal communication, 2014) and the operation now is sound without a need to reschedule or cut cost. H&M, ICA, McDonald's, and 7-Eleven can be given as samples for the chain stores which will be excluded from the research.

2. Literature Review

2.1. City Logistics Overview

City logistics with respect to freight delivery basically includes all the freight flows into the city; for example consumer goods, building materials, wastes, mail, and parcel deliveries (Dablanc, 2007). City logistics is defined as "*the process for totally optimizing the logistics and transport activities by private companies in urban areas while considering the traffic environment, the traffic congestion and energy consumption within the framework of market economy*(Ooishi & Taniguchi, 1999, p. 2)". In this paper, the authors will discuss more about the concept "urban freight transportation". OECD (2003, p. 7) defines urban goods transportation as "*the delivery of consumer goods (not only by retail, but also by other sectors such as manufacturing) in city and suburban areas, including the reverse flow of used goods in terms of clean waste*".

Urban freight logistics is important according to many reasons, one of which is that urban freight transport supports citizens' daily life style. It plays an important role in keeping normal commercial activities as well as industrial activities (Anderson et al., 2005). Another reason is that the cost of freight transportation will have an impact on local consumption cost, which will finally be transferred to the residents in the region and influence local economy (Ogden, 1993). In addition, with more attention to environment and sustainability, the impact of urban freight transport on environment attracts more attention than ever before.

There are some common problems about city logistics in modern cities, for example; congestion, environmental impacts, and to minimize the cost and maximize the performance. Thus, objectives of city logistics research are usually related to reduce the cost, increase the efficiency and reduce environmental effects. Research about city logistics usually focuses on the following subjects:

1. Advanced information system for loading and delivery operations. This subject is important to be researched because of high possibility to improve the efficiency for operators. Research has shown a 13.5% increase in the number of trucks and a 10% increase in load factor after applying the GPS system for trucks (Taniguchi et al., 2001).
2. Collaborative transport among private companies. Cooperative freight transport systems can reduce the total travel time and total cost (Köhler, 1997). For now collaborative transport is not widely used because of the competition among different operators. Cities with large population and historical sites intend to use this kind of collaboration. Using collaborative transport can definitely help to improve the load factor, thus creating less energy consumption and cost.
3. Public traffic terminals both in and out the city. To establish a cooperative freight transport system, investments in infrastructure is essential. The public logistic terminals are usually located around the city, and can also serve as a warehouse and/or distribution center.(Chalker, 2011)

4. Limitations, incentives, taxes and other policies by the authority. To solve the problem of congestion and achieve the aim of sustainable development, policies such as congestion tax are widely used to adjust the behavior of freight operators. Initiatives assume that these policies and regulations help produce less environmental impacts.
5. Underground transport and other new transport methods such as using electric vehicles. New transport modes like underground transport and night delivery have been proved to be able to lower the emissions and energy consumption. A research in 1999 (Ooishi & Taniguchi) has shown that using the infrastructure constructed by the city leads to an internal income rate of 10%.

Abovementioned objects are planned by years ahead and implemented carefully, since getting instant results in transportation policies is not possible. Within planning phase, different stakeholders must be considered since each of them are affected differently by the policies.

2.2. Stakeholders

There are four key stakeholders regarding city logistics: Shippers, residents, freight operators and administrators (Taniguchi et al., 2001). Each of the stakeholders has their own targets with respect to city delivery system. Figure 4 shows how these stakeholders are relevant to each other.

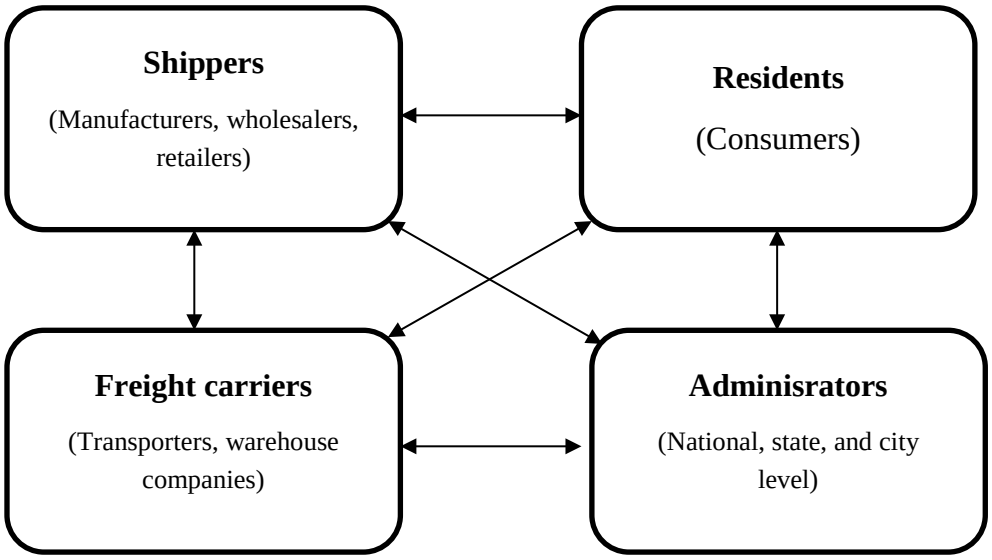

Figure 4 Stakeholders and Their Relationships

Source: Taniguchi et al., 2001

Shippers are usually manufacturers, wholesalers, retailers and so on, who create the demand for city logistics in this case. They can be either the owner or the receiver of the goods. They generally aim at maximizing their service in a way considering cost, accessibility and time for delivery. They tend to receive the goods during a specific time period, which makes it important to consider about the time-window problems. Former research has revealed a large proportion of city delivery with designated arrival times, e.g. 52% of goods in Osaka and Kobe in Japan (Ibid.).

Freight operators are those who take the job of transport. Targets of operators are usually to minimize the cost and maximize the financial performance. With administrators putting more restrictions/charges in urban area, especially city center areas, freight operators pay more attention to the problem which may lower the efficiency, such as congestion.

City residents are people who have activities in the city; including people living, working and shopping there. Their interest is similar to authorities because of their concern about environment and public benefits.

City administers aim at finding a balance between the business satisfaction, and public benefits. They should be responsible to solve the problems such as congestion and road safety. When conflicts between stakeholders can no longer be ignored, city administrators should work to seek for a trade-off. (Schiller, Bruun, & Kenworthy, 2010)

There are some arguments on city logistics and why it can be inefficient. Main reasons of these unsuccessful policies originate from insufficient communication among the stakeholders.

It is also important to know how these stakeholders add value to city logistics. Key actors' influences are listed in Table 1.

Table 1 Influence of key actors

Authorities	**Freight operators**
Good standard of traffic signs; Arrangements for loading and unloading bays; Overnight parking and rest provision; Special lanes for lorries; Real-time traffic information; Review of all restrictions and appropriate deregulation; Supportive strategy and planning decision**.**	Effective vehicles utilization; Driver training to improve efficiency; Best practices in deliveries, noises and urban-friendly vehicles; Decrease in noise and emission.

Source: A guide on how to set up and run FQP (Collings, 2003).

2.3. Arguments on in/Efficiency of City Logistics

Dablanc (2007) argues that city logistics are difficult to organize and modernize. He grouped his arguments under three headings: **(1)** "*Urban goods movements are independent of local urban characteristics*", **(2)** "*Local governments do not know how to organize freight*", and **(3)** "*The provision of urban logistic services is poor and inappropriate to the demand*". He bases these arguments on statistics. For instance, ratios of types of goods delivered in city logistics are constant in every city regardless of the size (Dablanc, 2007, P281). Except the nature of city logistics, the author also complains about local governments and their policy making

strategies in his second argument. By planning regulations "the way they did it 20 years ago", local governments cannot enforce regulations to truck drivers. He emphasizes that most of the regulations have the problem of being too much local and conflicting with neighbor municipalities which causes inefficiency, thus causing the truck drivers to be noncompliant with the regulations. Abiding by the rules can be controlled by strict enforcement and controls, but his argument also includes that most of the local governments cannot create coordination within different branches such as the legislative and the enforcement authorities. He also mentions that the enforcements must not prevent the freedom of trade. Thus, his argument concludes that local governments have a lack of knowledge of solving the crises.

The third and last issue he discusses is about logistic services responding too slow to changes. He gives examples on e-shopping, a relatively new habit that changed the behavior of shoppers. People now not only changed their place of shopping, but also the time of it. An average person can do shopping in a supermarket, in a regular market, and on the internet on the same day. However, in return to this 'volatile' market, he complains that the logistics operators do not react to these changes fast enough. He refers to a survey conducted in Lille and Tours, two large French cities. According to results 15% of retailers were interested in inner city storage space and to start home deliveries for their customers; 8% of retailers were interested in a dedicated delivery area; and more than one third of them wanted a service to pick up pallets and cardboards. The author adds, that most of the requested services not available today. Yet, a pickup service of pallets, cardboards, and other packaging materials will be implemented soon in Gothenburg (Christoffer Widegren, personal communication, March 13th, 2014). On the other hand, Dablanc's paper (2007) lacks some aspects of optimization possibilities. Another academic from Greece, Zeimpekis (2011) argues that city logistics can be inefficient because of externalities that cannot be easily controlled, such as infrastructure, traffic conditions, and clients. However, he proposed a real time fleet management system which has been tested in real life, and found out that service levels can be increased successfully up to 20 percentage points in different case scenarios. Zeimpekis' paper proves that efficiency of city logistics can be increased with the help of technology if implemented smart.

In order to increase the efficiency, a long-term planning is a must. This planning is named as 'transportation master plan' and it includes the future plans of improvements of logistics in an area. Different master plans focus on different scales such as national, geographical, or city.

2.4. How to Design a Master Plan in City Logistics

A master plan for transport is often described as "A plan giving comprehensive [long-term strategy,] guidance or instruction" (the Free Dictionary, 2014). Its aim is to show existing problems of the system and to make new propositions to solve the problems until a pre-determined date. A master plan is not abandoned, but it can be changed to fit the plan to latest developments. Without a master plan, governments shouldn't regulate the transportation since they need long-term consistency to see an effect on some key performance indicators such as environmental quality.

A city may have multiple master plans valid at the same time. Countries may publish master plans which just mention general points to be improved, and cities may create their very own master plans for the specific problems of the city. Macário, Filipe, Reis, & Martins (2008) introduce five types of measures that can be implemented while designing a master plan in urban logistics.

Table 2 Measures implemented to solve urban logistics problems.

Type of Measure	Examples
Legislative and organizational measures	Cooperative logistic systems, encouraging night deliveries, public-private partnerships, intermediate delivery depots.
Access restriction measures	Access restrictions according to vehicle characteristics (weight or volume), conditioning access to pedestrian areas, urban tolls, periodic restrictions.
Territorial management measures	Creation of loading and unloading areas, of load transfers, and mini logistic platforms.
Technological measures	GPS, track and tracing systems, route planning software, intelligent transport systems, adoption of non-polluting vehicles and vehicles adapted to urban characteristics (size and propulsion).
Infrastructural measures	Construction of urban distribution centers, and peripheral storing facilities, use of urban rail for freight (freight trams), underground freight solutions.

Source: Innovations in City Logistics (Macário et al., 2008)

Each of these measures has pros and cons, so they have to be chosen carefully considering the unique dynamics of the city in question. These unique dynamics can be listed as urban characteristics of the city, the requirements of logistics agents, and the characteristics of the products being consumed in the city (Macário et al., 2008). Together, these create a profile of the city and each Master Plan has to be considerately produced. Macário et al. (2008) point out areas which have high commercial density and homogeneity, have possible solutions under some certain conditions with eco-friendly light delivery service as well as cooperating among companies. Master plan includes policies which are intended to improve the overall situation by restricting certain actions and regulating travel rules to change the traffic behavior of the city.

2.5. Policies Regarding City Logistics

There are many policies which have been mentioned in relevant literatures. It should be noted that although every policy has the potential of improving the situation, they can worsen if not implemented successfully. It is possible that some policies can be perfect for a city, but they can lead to inefficiency in another due to some internal factors such as infrastructure; and external factors such as culture of people living there. Thus; each policy below should be examined with all its benefits and limitations, and must be tailored for the needs of particular city in concern.

2.5.1. Low Emission Zone (LEZ)

One problem caused by freight operations is air pollution. The fact is that heavy goods vehicles and commercial vehicles are the major source of freight emissions in urban areas (H. J. Quak, 2008). Common pollutant emissions include carbon dioxide (CO_2), carbon monoxide (CO), nitrogen oxides (NOx), sulphur oxides (SOx), particulate matter (PM_{10}) and volatile organic compounds (VOCs). Usually the emission of freight operations is measured in CO_2, by different calculation methods. These results are called carbon footprint.

Table 3 Low emission zones in Europe.

City	Start	Finish	Vehicles affected	Diesel	Retrofit
Gothenburg, Helsingborg, Lund, Malmö, Stockholm	01/01/2010	01/10/2015	Over 3.5 T	<6 years, 6-8 must be at least Euro 3	**Y**
Mölndal	01/07/2010	01/10/2015	Over 3.5 T	<6 years, 6-8 must be at least Euro 3	**Y**
Uppsala	01/01/2013	01/10/2015	Over 3.5 T	<6 years, 6-8 must be at least Euro 3	**Y**
Umeå	01/04/2014	01/10/2015	Over 3.5 T	<6 years, 6-8 must be at least Euro 3	**Y**
All of the 8 cities	01/10/2015	01/10/2016	Over 3.5 T	<6 years, 6-8 must be at least Euro 4	**Y**
All of the 8 cities	**01/10/2016**	**--**	**Over 3.5 T**	**Euro 5**	**Y**

Source: www.lowemissionzones.eu

Governments set low emission zones to improve air quality by forcing people to use green vehicles. Low emission zones mean that in selected areas, the most polluting vehicles are banned from entering or charged with a fee. LEZ are also called environmental zones. Vehicles' emission is measured by the Euro emission standards. There is a term "environmentally friendly vehicle" (EEV), referring to "clean" vehicles over 3.5 ton in the category M2 and M3 with the emission standards between Euro 5 and 6. In the EU, few cities used to have this kind of compulsory regulations years ago, but the application is extending. In July 2007, the first environmental zone in the Netherlands was established in Utrecht

(Quak, 2008). Now there are 14 countries and around 140 cities which used or are using the LEZ regulations in Europe (European Commission, 2013). In Sweden seven cities are using LEZ. These cities are Gothenburg, Helsingborg, Lund, Malmö, Mölndal, Stockholm, Umeå, and Uppsala.

The impact of LEZ is remarkable. Berlin has experienced a 24% reduction in emissions of diesel particulates and an 8% decrease of PM_{10} one year after the implementation of LEZ. Other cities have similar results. London has a benefit of £250-670 million (1 pound equals around 11 kronor on average as of 05.05.2014). (European Commission, 2013)

Though low emission zones do help reduce the emission in the city, this method is less useful for organizations or private companies. This is because the effects on private companies rely on two factors: the company's vehicle replacement cycle and "the geographical profile of delivery and collection compared with geographical coverage of LEZ scheme". (Anderson et al., 2005)

2.5.2. Access Restrictions: Weight, Time, Length, Width, etc.

Restrictions are usually used in combination. In vehicles' weight restrictions, only those meeting the requirements of certain gross weight would be allowed to enter the restricted area. Weight restriction is usually used together with time restrictions to ensure no heavy vehicles enter city center in rush hour or daytime. Restricting the weight and time of trucks entering central area are also good method. But these two methods had better be used in large scale, since these methods are too risky for individuals. Otherwise some negative impacts may occur.

Anderson et al. (2005) finds that the companies (freight operators) are affected differently by the weight restrictions according to the vehicles they own. Companies using light vehicles are not affected at all since the restrictions would not apply to them. But those handling delivery and pick up with heavy vehicles would have to change the vehicles they use or retime their delivery, which increase the cost up to 30%. Also, there is a negative impact on total traveling distance and travelling time (increase of up to 50%). Taniguchi & Thompson, (2004) get similar results in Tokyo and prove that weight restrictions can help improve safety. There are also other researchers who get the conclusions that restrictions can increase efficiency (Thompson & Hassall, 2006), improve life quality (Groothedde & Uil, 2004) and reduce noise (Baybars & Browne, 2004).

Another important restriction is load factor control. To improve the accessibility and livability in urban areas, local authorities use load factors to limit the entrance into city and force the companies to maximize the utilization by consolidation outside the restriction area (Quak, 2008). Copenhagen in Denmark has a load factor restriction of 60% for trucks over 8 years, which means only the trucks with utilization more than 60% (if they have been used more than 8 years) can enter city center. (Taniguchi et al., 2001)

2.5.3. Incentives and Charges

Incentives are another kind of method to adjust traffic flow. Since incentives are not compulsory, they sometimes can achieve better performance compared to taxes and charges. Sweden has a policy since mid-2009, for people who buy a green car, to have five year of exemption in other taxes. Road traffic emissions decreased by 1% after the first year of implementation (Dreblow et al., 2013).

Among all the charges in traffic regulations, congestion charges are one of the most common and important ones. Congestion charging or congestion pricing is a system of surcharges to adjust excess demand such as rush hour traffic (Small, 1992). This is what many cities are doing to lessen the congestion problem. Former research in UK had revealed a 15% reduction in driving time for freight goods delivery in the congested area, showing high possibility of service improvement.

The congestion charges are designed according to different situations. Most cities use a simple mode of setting a fixed price or a ladder pricing system, but innovations turn up with new technologies and emerging concerns. Singapore uses a variable pricing system based on accurate prediction of traffic flows while London has a system based on potential CO_2 emission (Beevers & Carslaw, 2005).

London is a typical case for congestion charges. The city implemented congestion tax in 1960s and now has a sound system of congestion charges in the city. Average travel speed increased by 21% in the fee-paying area since the first year of the implementation (Santos & Shaffer, 2004). There is a chance to have increased benefits in the long run as people change their behavior. If external effects are considered, the benefits also include changes in factors which may influence traffic flows in the long term such as travelling habit (using private or public vehicles). But some of the researchers argue the long-term effect of the congestion charges (Börjesson, Eliasson, Hugosson, & Brundell-Freij, 2012). Unlike low emission zones with rolling plan, congestion charges can be more effective in the short term. Researchers (Börjesson et al., 2012) evaluated the Stockholm congestion charges system. The city uses a toll cordon around the inner city, which has been carried out since 2006. There is significant effect of congestion toll as shown in Figure 20. Apart from the basic function of adjusting traffic flows, congestion charges have effects on reducing greenhouse gas emissions and air pollution as well (Pike, 2010). Yet, after people got used to the charge, the toll became less important, and travelers who value their time use the road to avoid congestion.

2.5.4. Establishing Special Loading Zones

Parking spaces in busy retailing locations have huge competition between passenger cars and delivery vehicles. Therefore, delivery vehicles have their own special un/loading zones. These places are dedicated to trucks and forbid passenger cars from parking in those zones. This removes the problem of trucks touring around the delivery location in order to find a parking place. Since these special loading zones are designed especially for loading and unloading activities; they have enough space to use the elevators behind the trucks. They are most

efficient if used together with time restrictions, because they can be used by the private cars as well since loading zones will be free after usual delivery times. (Browne, Allen, Nemoto, Visser, & Wild, 2008)

2.5.5. Fees for Parking

Fees can be applied to certain zones which are critical for the flow of the traffic and have high pedestrian density. This regulation deters private vehicles to park on streets, and delivery vehicles can be forced to make loadings and unloading faster. Popular streets usually have higher parking fees due to demand. These parking places can be used by delivery trucks as well, if allowed. As it comes to parking fees, there are different discussions.

Glazer & Niskanen (1992) created two different models for parking fees. Their first model shows that "optimum parking fee per time equals to marginal cost of providing a parking place" (Glazer & Niskanen, 1992, p. 127). The first model implies that when a parking fee increases, drivers tend to see this as increased driving cost; which they are willing to pay because of their existing consumer surplus. Their second model concludes that a lump-sum parking fee will reduce the number of parkers. On the other hand, reduced congestion would be replaced by drive-through vehicles. Therefore, they conclude that increasing parking fees might not reduce the congestion as expected. However, they also add that parking fees add to social welfare if the profit is used for the society. In the aspect of consumer surplus, as parking fee per unit time increases, consumer surplus would decrease; causing a shorter parking time. As a result, the same parking spot can be used by more drivers, which adds to both social and individual welfare. (Glazer & Niskanen, 1992)

Odani & Tsuji (2001) conducted an experiment in a Japanese city to measure the effectiveness of on-street parking places for delivery vehicles and found out that they have many benefits for transport companies, such as less time spent to find a parking place, and a decrease in frequency of parking since more deliveries can be made on a single instance. However, they also give three advices to increase the efficiency of parking places: Reviewing parking places by getting delivery information from companies; separating parking time intervals for trucks and private vehicles; promoting on-street parking for deliveries by receivers.

2.5.6. Night Deliveries

Night deliveries are the deliveries made during a particular time-frame in the morning or the night; especially early in the morning and late in the night. Browne et al. (2008) mention two kinds of night deliveries: Night deliveries that take place in a particular area and night deliveries that take place in the whole urban area. This measure no-doubt decreases the day time traffic; however its implications may be a lot bigger. Browne et al. (2008) mention the need of more trucks as being less efficient; and having potential to increase delivery costs for some companies. In their paper, night deliveries are also examined from citizens' perspective. A concern such as disturbance from high loading/unloading sounds was mentioned as a negative aspect. However, they didn't mention retailers at all. Night deliveries require the

retailers to be open at hours which they normally would be closed. This might be a big problem for shopkeepers in terms of life quality and financial.

2.5.7. Pedestrian Zones

Private vehicles are completely forbidden on pedestrian streets. Delivery vehicles can only park if there are special places allocated for them. These zones are popular for dense city centers which have high pedestrian traffic, and many cities around the world have pedestrian zones. As mentioned earlier in 1.4, Gothenburg city center has two pedestrian streets. Klein & Avensberg (1974) argue that pedestrian zones decrease pollution and noise levels caused by vehicles; and increase retail sales.

2.6. Investing Problem

Changing existing way of services may not be achieved easily since many policy changes require huge investments in order to work. For example, a policy which aims to lower the carbon dioxide emissions will usually need new vehicles which will have huge cost of investing, thus not all companies would be able to compete in the new market. These investments therefore usually happen in a partnership of public and private sectors.

Mallard & Glaister (2008) explains four different types of investment models: The Scandinavian, German, Mediterranean and Anglo-Saxon. The first one requires strong local authorities who have power to make their own decisions. The second is a federal structure model in which the decisions are made centrally and affects the whole country. In addition to Germany; Austria, Switzerland and Belgium are also included in this model. Yet, domestic policy is possible where regions cooperate in decision making and investment. The third model is based on “centralized decision-making based on competition between different interest groups, with weak local authorities.” (Ibid, p.226). The last one is based on the UK, Ireland and the Netherlands systems. Policies are done by the party in power and financially weak local authorities are dependent on central funding, in addition to using their own trusts.

Based on these models, it can be said that Sweden belongs to the first model. Swedish cities have powerful political will to create policies and are financially strong to fund them. Yet, the only source of funding is not local trusts; there are also external budgets and funds. Some of these are the Commission Budget, Structural Funds, The Cohesion Fund, European Investment Fund, European Investment Bank, and the Trans-European Networks. The details of these funds have been well described in Mallard & Glaister (2008, p226-228).

Based on the funds mentioned above, new projects can be subsidized by the local authorities if the project has a positive cash flow opportunity during its lifetime. One example is Stadsleveransen Project (Section 4.7), which is subsidized by the municipality with the help of the EU funds which will continue until the project starts to generate a positive cash flow.

2.7. Freight Divisions and Features

Generally speaking, there are two types of freight into a city area: investment goods and consumption goods (Uzawa, 1960). The former refers to the buildings, plants, machinery, tools and other equipment that enable production. Basically, they act as a tool for producing other goods or to provide services. These kinds of goods are also called capital goods because of their function as capital expense (Mccracken, 2014). The latter; consumption goods or consumer goods, basically refer to those purchased by individual customers without profiting intention (Mccracken, 2014). Oxford Dictionary (2014) gives the definition of consumer goods as "*Goods bought and used by consumers, rather than by manufacturers for producing other goods.*". But there is no absolutely right demarcation between consumer goods and investment goods. For example, cars are usually viewed as consumer goods but if companies bought cars to provide service for customers and make profits, then cars are considered as investment goods in this case.

Furthermore, consumer goods can be divided into convenience goods, shopping consumer goods, specialty consumer goods, and unsought consumer goods by the buying habit of consumers as shown in Figure 5. Convenience goods refer to those easy to acquire, such as tobaccos, cigarettes, fast food and drinks with low value. Convenience goods are mostly sold by wholesalers or retailers, so customers can easily buy in bulk. Shopping consumer goods are the ones where the consumer takes time to make a shopping decision. Examples can be apparels, cosmetics, furniture, etc., and these products usually demand for time to select and compare before making decision. Unlike convenience goods, shopping goods are usually sold in shopping malls, department stores and professional stores. The third is specialty goods, which stand for the luxury, such as high-end customized items. The last category is unsought goods, which are always available in the market but with less demand compared to others, such as flood insurance. (Mccracken, 2014)

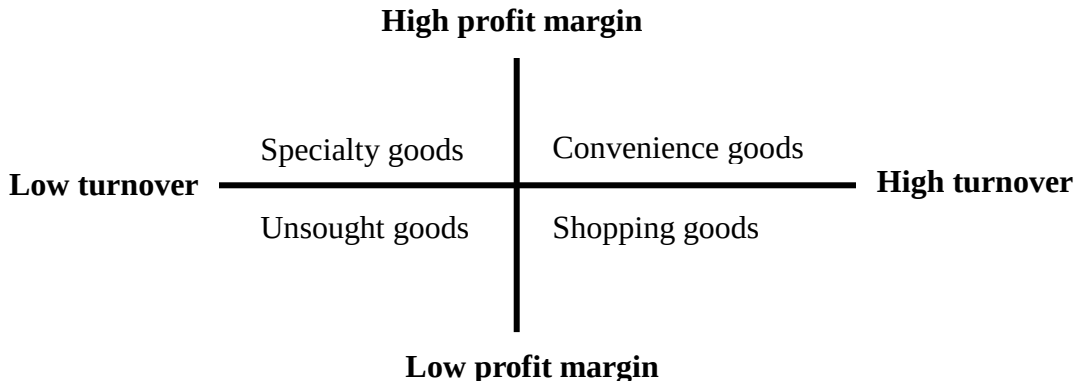

Figure 5: How to Classify Different Businesses.

Source: Mason, MAYER, & Ezell, 1988

Categories introduced in Figure 5 are divided based on the buying habit, but when it comes to freight delivery, researchers care more about convenience goods and shopping goods. They are delivered more frequently and to a larger geographical area. When it comes to specialty goods, producers and retailers do not care much about the cost. There is little research about freight categories from the perspective of operators, but Tsolakis & Naude (2008) have made a comprehensive division for freight transport, as shown in Figure 6.

2.8. Light Freight Transport in Urban Areas

According to Tsolakis & Naude (2008), light freight transport is defined as the transport activity in a city done by light commercial vehicles (LCV) and rigid trucks. Although the definition is true, it is incomplete. Electric vehicle technology is improving from day to day, and it can be added to the definition since electric vehicles are being used in cities all around the world for freight transport in cities.

Tsolakis & Naude (2008) divide freight transport into 'Goods Carrying' and 'Services' as shown in Figure 6. 'Goods Carrying' has two subcategories which are bulk and non-bulk. Urban freight transport deals with non-bulk goods which can be categorized as heavy and light goods depending on their weights. Goods which considered light can be sampled as office supplies, retail, electrical equipment, post and parcels, and medicals. Services such as residence and business maintenance are categorized as light by their nature. According to the authors, these light goods and services can be done using LCV.

New studies are being done in order to shift the transport vehicles from diesel powered to more environmental vehicles, usually working with batteries. This shift is very important in terms of environmental effects, since a research had estimated goods transport in city is responsible for 42% of goods and services related trips in Sydney in late 1990s (Tsolakis & Naude, 2008).

A counter argument on this issue comes from David Banister. In his book, *Unsustainable Transport: City transport in the new century*, Banister (2005, p.166) argues that new technological improvements might help reduce resource consumptions and pollutions but he also adds that these will not completely eliminate them. He also points out that the entire life cycle of a product should be assessed when calculating emissions; from birth to grave. However, his pessimism comes from the fact that total elimination of the pollution is not possible. Yet, he adds that with the use of ITS, the pollutions can be minimized by increasing the loading factor and the capacity of the vehicles.

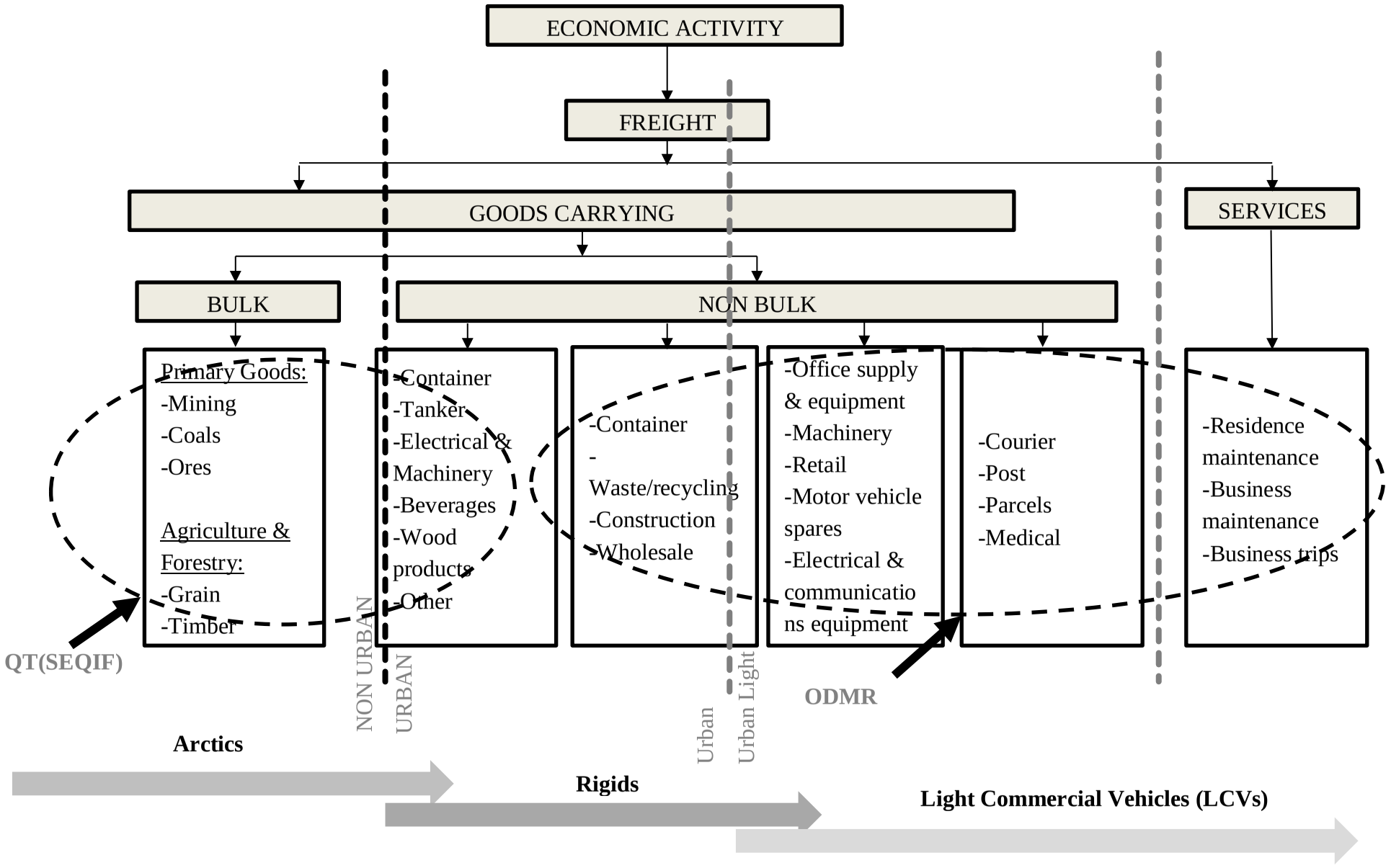

Figure 6 Classification of Freight Activity. Tsolakis & Naude (2008)

Source: ARRB

2.9. Specialized Vehicles

Environmental friendly vehicles have been increasing while their operation costs decrease (Dizikes, 2012). Produced for different needs, they can carry majority of consumer goods, in addition to parcels. When the projects of Bestfact & Bestufs have been examined, it could be seen that these transport tailored electric vehicles come in different shapes and sizes; depending on the project and needs of the city in question. For example, electric small vans are used in London, the UK; whereas electric wagons are used in Gothenburg, Sweden. The nature of the product plays an important role in this design process. Small parcels can be carried even by conventional or electric assisted bicycles, whereas big parcels need higher volume and traction power. If carried products are perishables, refrigerated vehicles or modules can be designed in order to keep the cold chain intact (European Commission, 2014a). Another option might be, for short distances, to use wagons designed to act as a thermos. These wagons would need to be loaded in a cold environment or in a cold room in a warehouse. After they are sealed, extra energy would not be needed to keep products cold.

There is a relatively new technology named passive-cooling system. Contrary to standard refrigerators, this system does not need a compressor to work, decreasing the negative effect given to environment. The project is named EFRUD; *Emissions Free Refrigerated Urban Distribution*. The refrigerator being developed is 20-30% more efficient compared to a standard refrigerator powered by a diesel van engine. (EFRUD, 2012)

On many occasions, traditional vehicles can create an efficient solution. Bicycles specialized for carrying post and parcel are not new; they have been used for years and have been quite efficient when too many stops have to be made in a small geographical area since fossil fuel vehicles burn most of the fuel when initiating the move (Ahn, Rakha, Trani, & Van Aerde, 2002). Trailers can be mounted behind the bicycles or tricycles in order to increase the load capacity. Office materials are started to be delivered by electric assisted tricycles in London, which has been a big success (Michael Browne, Allen, & Leonardi, 2011).

However, one downside of using LCV is they generally require one or multiple urban consolidation centers due to the vehicles' limited range of operational area.

2.10. Urban Consolidation Centers

Urban consolidation centers (UCC) are warehouses located just outside the city which may also function as cross-docking centers and short-term depots. As Quak & Tavasszy (2011) mention in their paper, UCC are highly efficient in most cases in theory, but they are quite hard to implement since a behavioral change needed in stakeholders of the supply chain.

Their working strategy is simple, yet efficient. FTL and/or LTL trucks deliver their shipments to UCCs and in there; they are consolidated or broken up before the last-mile shipment. These shipments are usually made with green vehicles since one of the main reasons for switching to UCC is to reduce environmental pollution. Among their many advantages, if FTL trucks are required to use UCC as well, it may lead to extra kilometers since many small trucks are needed to carry the load of standard lorry. There are some key points in order to be efficient in

operations in a UCC. For example, standardizing delivery unit boxes may maximize un/loading speed and loading factor.

UCC can give value added services such as waste collection, making return shipments, temporary storage, and home deliveries for big items etc. (Quak & Tavasszy, 2011) More information can be found in Section 5.1.4 for a sample case.

There are now new types of consolidation centers which are located inside city for distributing retailing goods. Since there is no general-accepted concept for this kind of consolidation center they will also called as UCC in this research. But it should be noted that some scholars use the phrase "freight consolidation center" (FCC) to refer to this kind of smaller-scale inside city UCC. Usually FCC is assumed as a transportation center located in an urban area with the function to serve for retail freight transport. Olsson & Woxenius (2014) defines FCC as a "*cross-docking terminal in which small consignments are coordinated into batches matching different vehicle capacities"*. TTR Ltd (2011) defines FCC as *"Freight consolidation involves grouping individual consignments or part loads that are destined for the same locality so that a smaller number of full loads are transported to their destination"*. FCC is not always cost-saving compared with traditional UCC. It is suggested that areas applying FCC have external stimulus such as LEZ, road charges, access restrictions (Chalker, 2011).

Apart from increasing utilization and efficiency, the most important function of UCCs or FCCs is that they serve as terminals for intermodal transport. Intermodal (freight) transport, defined as units travel from the origin to the destination by at least two transport modes (Barnhart & Laporte, 2006), is the term describing a transport chain without changing the container of freight or the package unit (Macharis & Bontekoning, 2004). Container transportation is the major type of intermodal transport in Sweden, but there is also increasing application for urban freight distribution. In recent years, many cities have tried using eco-friendly vehicles to take the last mile delivery (see Chapter 5). In Sweden intermodal transport takes up only 4% of total market share, and most of the intermodal transport is long-haul type such as rail-road or sea-road transfer (Bergqvist & Flodén, 2010).

The main function of a terminal is to provide transfer facilities. It is not necessary to make a detailed presentation of intermodal transport here, since the goal is to get it easier to understand what UCCs can do in intermodal transportation.

2.11. City Logistics with ITS

ITS, intelligent transport systems, are generally used to describe the advanced system of combination of technology, infrastructure, services and planning, and operation methods (Crainic, Gendreau, & Potvin, 2009). EU Directive has defined intelligent transport systems as systems using information and communication technology in the area of road transport (van Geenhuizen, 2011), thus ITS sometimes also called ICT systems for short of information and communication technology. The incentives of ITS are to solve the problems of growing demand of transportation without constructing new infrastructure. Thus, research about ITS

started from the application in public traffic. For instance ITS are more widely-used in public traffic instead of private freight operators. However, private freight operators have started to implement and use ITS. One example of common public traffic ITS application is a method of automatic tolling. In private sector, although not all freight operators are using ITS at the moment, they could benefit from it by reducing delays and costs arising from congested traffic. This would also help reducing the emissions like CO_2. Researchers also suggest that the application of ITS can reduce freight distribution cost by increasing productivity of local delivery vehicles, reliability of vehicle operations and safety. An impact of ITS would be smoothing out road usage by stringing out the traffic into time without adding traffic infrastructure as well. (Taniguchi et al., 2001)

Evaluation by the European Commission has predicted a reduction of congestion by 5-15% and emission by 10-20% with the deployment of ITS. In Europe ITS project ERTICO, ITS are developed to support eco-driving and adapt flexibly to speed changes. By using ITS to help electronic stability control, there will be less injuries and accidents, with an estimated decrease of 5% - 10% (International Transport Forum, 2009).

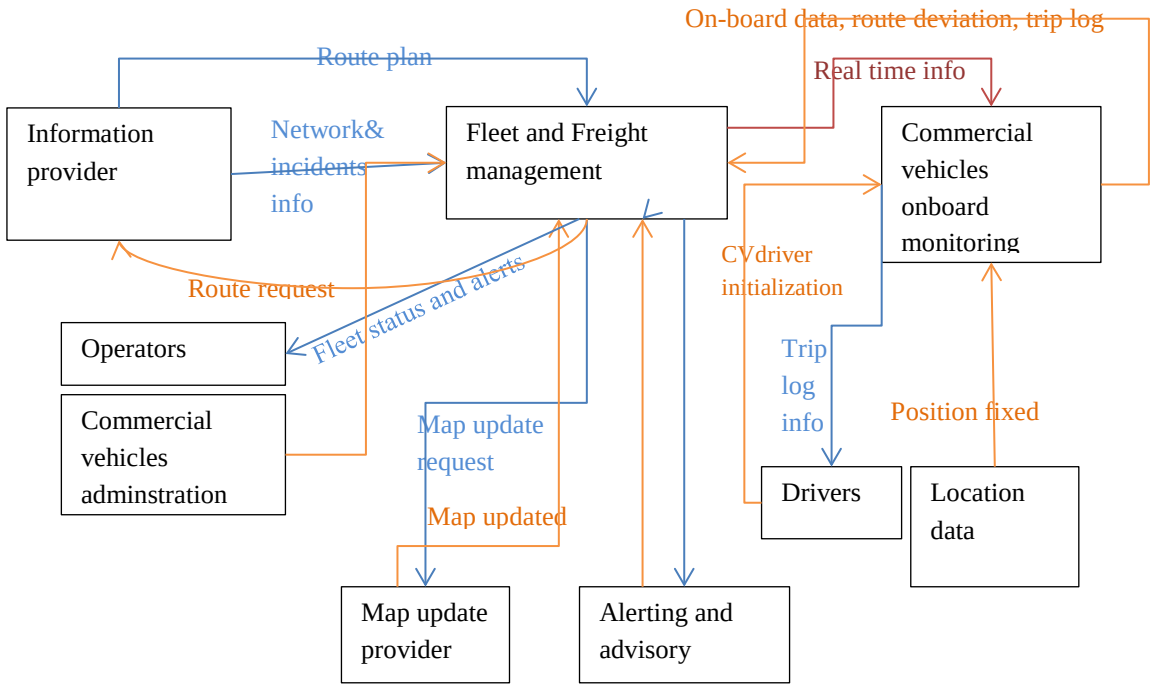

Figure 7 Service Package of Typical Commercial ITS

Source: Michigan Department of Transport, 2012.

The core of intelligent transportation systems is to obtain data and turn that into information, and use the information for better transportation service. The development of technology lowers the cost of using ITS, but business cases are often difficult since the cross-function of inter-modality and multi-regional application is not going well. The main reason is the lack of effective cooperation among different parties.

Optimum control system of ITS for urban traffic management has an increasing range of

demands. Freight operations and fleet management can be optimized by ITS. A physical diagram for ITS service package is shown in Figure 7, explaining how the system works.

2.12. Sustainable Transport

Sustainability is an important concept in transport. It does not just refer to the eco-related aspects of transport, but more about how to make transportation planning, policy-making, and citizen activities in a direction of great social and environmental benefit to both society and environment (Schiller et al., 2010).

Schiller, Bruun, & Kenworthy (2010) divided modern transport service into two categories, business as usual and sustainable transport (p. 3). Compared to business as usual, sustainable transport emphasize accessibility, quality, plurality, interconnection, and integrated planning while the former just responds to market demand and is more profit-driven. Sustainable transport should be the combination of planning and policy factors, background factors and technical and infrastructure factors (Ibid., p. 230).

Table 4 Elements composed of three dimensions of sustainable transport

Planning and policy factors	**Background factors**	**Technical and infrastructure factors**
Critical event Policy makers Citizen and community leaders Careful analysis or evaluation Adequate data Etc.	History, culture and values Geography-topology Accountable government systems Social organizations Existing systems for transport Etc.	Appropriate infrastructure and energy resources Availability of appropriate hardware Standards and measurements Technical personnel Etc.

Source: Schiller et al., 2010, p. 230-235

People have noticed the importance of sustainability and sustainable transport, but the concept sustainable freight delivery has not received much attention as passenger transport. It should be noticed that in this research sustainability will be the standard to measure whether a solution is applicable in the future, with the intention to increase awareness of how freight transport can meet the requirements of sustainability. Here authors use the three dimensions of definition of sustainability: economy, society and environment.

2.13. Summary

The previous sections reviewed the development of city logistics research and practice to better understand the literature framework of the research questions. City logistics, generally defined as freight operation with efforts from operators to optimize the system, is a reflection and base of urban commercial activities. There are four entities involved in transport: residents, authorities, shippers and freight operators. Each of them acts based on their own function and benefits, so sometimes there will be conflicts between theses stakeholders.

For many reasons such as the increasing population and number of vehicles, conflicts between different stakeholders, freight delivery in urban area faces challenges to establish a more eco-friendly and an efficient system. In the past decades, research and practices used to focus on improving the efficiency. Though there are arguments about authorities' impact on optimizing city logistics, researchers believe that without the driving power the private operators will not initiate these innovations because their main concern is profits.

Large cities concern more about efficiency, for they are currently troubled by the traffic congestion and inefficient performance. Medium-size and dense cities have the potential to initiate innovations aiming at sustainability, so in this research a city of this kind will be discussed: Gothenburg. As innovation is often initiated by the authorities; general measures and policies to solve environment, safety, and congestion problems are summarized in Section 2.5. While doing this, the balance of interests among stakeholders should be kept, since there is a subtle balance among them.

Then a question arises: What should be considered in the process of city logistics innovation? City logistics need to be optimized, but there are limitations of technology and profitability for operators, especially requirements of expensive R&D processes and new vehicles. Section 2.7, 2.8, and 2.9 introduce freight operators-relevant factors. For further innovation, these limitations have to be known.

Section 2.9, 2.11 and 2.12 introduces trends of urban freight optimization. One important trend is to use UCC to consolidate all the goods into city. Since UCC have ability to improve load factors and efficiency of vehicles, many cities and private companies have built UCC to manage the freight delivery flows. Section 2.11 introduces the development of ITS in recent years and effect of ITS application. Researchers have proved that ITS can reduce congestion and emission. Currently ITS technology is usually used for optimizing public traffic, but as governments pay more and more attention to ITS, widespread use of commercial operation does not seem far.

The ultimate aim and trend of city logistics is making it sustainable. Sustainability of transport does not only refer to the profitability, but more to the social and environmental aspects. In future optimizations, the sustainability has to be considered.

3. Methodology

3.1. Research Philosophy

This thesis is a qualitative study, which is trying to develop new solutions for the explained problem within scopes of the research questions. An interpretivist approach was followed in this paper. Interpretivism tries to understand the situation of the selected phenomenon. Therefore, it is possible to say that there are multiple realities which depend on different parties. (Collis & Hussey, 2009)

3.2. Research Design

In order to find a phenomenon to research, a deductive approach has been followed. A deductive approach takes the subject in question in a very broad way and delimits it as research continues. Therefore, a vast knowledge on the subject has gained and the focus shifted gradually to specific areas. This helped greatly to find problematic areas in city logistics and narrowing the scope. After narrowing and deciding the scope, an inductive approach has been followed. Inductive approach takes one narrow part of the subject and expands it gradually. This was necessary since the groundings of the thesis are based on interviews. Information which has been gotten from the interviewees increased the knowledge on the phenomena and lead to make research for specific subjects of city logistics. As this research went on, it forced a change of the purpose, research questions and limitations. So, research questions discussed in this paper were not the initial aim of this thesis. Yet, this approach is popular among research. (Collis & Hussey, 2009, p.111).

By design, this research does not aim to solve a global issue. Global city logistics theories which aim optimization are quite limited in scope; since cities have different infrastructures, cultures, and needs. Thus, this research rather deals with local issues mentioned in relevant sections. In order to achieve these, a balance between theory and case studies is insured.

Case study method has been applied in this research. A case can be a particular business, person, group, event or other phenomenon (Collis & Hussey, 2009). Accordingly case study is the method to seek for deeper knowledge about a case. In this research, the authors acquired data through mainly documentary analysis and interviews. However it should be noticed that generalization of results of case study depends. Each case happens under different circumstance, so researches should use comparison between cases very carefully (Collis & Hussey, 2009). There are also some disadvantages of case studies, for example, it is not easy to access mass statistic data in case study.

3.3. Data Collection

3.3.1. Primary Data

Primary data were accessed through interviews which were conducted with experts in the relevant area, e.g., project managers of city logistics, private freight operators, and researchers. Under the interpretive paradigm, interviews will help explore the data about how

people understand certain problems and what they do (Collis & Hussey, 2009, p.144). In qualitative research, most frequent-used interview methods are unstructured and semi-structured interviews because structured interviews are usually used to gain quantitative data (DiCicco - Bloom & Crabtree, 2006). Accordingly there is in fact no absolute unstructured interviews since interviewers have to think about topic and scope before the interview taken. However, if interviews are "less structured and less equivalent to guide conversations (DiCicco - Bloom & Crabtree, 2006, p. 315)", researchers can refer it to an unstructured interview. Since the authors could not expect what kinds of problems would be stated by different interviewees, all the interviews were unstructured or semi-structured in this thesis. An unstructured interview means interviewers do not prepare the questions in advance but come up with questions during the interview. These kinds of interviews can be time-consuming, but gives in-depth information about the issue. For the authors it was necessary to understand how city logistics innovation is developing and how experts are feeling on the subject. Thus, many open-ended questions were asked during the interviews. Semi-structured interviews have general outline of questions to be asked during the interview, but they are subject to change or to add new questions depending on answers. In this case, when interview is taken via phone or email, there will be part of the questions designed before the interview since there will not be suitable to discussing a lot. But there are questions coming up during the interview and being removed according to the answer, so authors still refer them to unstructured interviews in the next section (note that this is based on how Collis & Hussey define unstructured interviews, in fact they have only two dimensions: the unstructured and structured interviews, thus the semi-structured are already included).

Interviewees were selected in a way that ensures to get maximum perspective for the subject. Meaning, interviews were conducted with both scholars and business people. Interviews were not recorded, but important parts were noted during the interview.

3.3.2. Interviewees

To collect the primary data, the following interviews were made as shown in Table 5:

Table 5 Interviews conducted

Interviewee	Position	Method	Date
Michael Brown	Professor of Logistics, University of Westminster	Face to face, unstructured	Feb 18th, 2014
Niklas Arvidsson	Research student at Logistics and Transport Research Group, University of Gothenburg	Face to face, unstructured	Feb 5th, 2014
Magnus Kroon	Responsible for Trade Development, Svenskhandel	Face to face, unstructured	Feb 4th, 2014
Magnus Jäderberg	Planner, Trafikkontoret	Face to face, unstructured	Feb 27th, 2014
Jan Nilsson	CEO, GB Framåt	Telephone	Mar 2014
Christoffer Widegren	CW-Logistik (Consultant of Stadsleveransen)	Face to face, unstructured	Mar 13th, 2014
Sönke Behrends	PHD of Division of Logistics and Transportation Chalmers University of Technology	Email	April 21-23th, 2014
Sara Ranäng	Consultant of Schenker Consulting AB	Face to face	May 12th, 2014

3.3.3. Secondary data

Secondary data includes statistics, information and facts collected by other researchers (Collis & Hussey, 2009). Secondary data are to be retrieved from existing sources. As Weimer and Vining (2010) states, there are four categories of documents deserving consideration in the search for policy relevant information: academic source including journal articles, books, and dissertations; publications and reports of 3rd party intelligence from think tanks, interest groups, and consulting forms; official (government) publications and research documents; the popular press and blogs, e.g., social media source.

In this research, data from academic publications, authorities' databases are referred to give statistical information. Company documents and other sources such as news are also considered as backup after ensuring the validity and reliability. A major online source is official websites to access the best practices of other cities in Europe. Effects of city regulations can be seen and understood best after regulations put into practice and the newest practices are usually not accessible in academic source.

Literature review has been an important part to build a solid basis for the thesis. Former research helps the authors to gain better understanding of the research.

3.4. Validity & Reliability

There are two widely-accepted measurements to assess the quality of data: Validity and reliability. Patton (2002) states that validity and reliability are two factors any researcher should consider in a research design process.

A good qualitative study can help to explain the situation with the purpose of generating a solid understanding (Golafshani, 2003). In order to ensure the validity and reliability of the study, different methods can be used. One approach is the triangulation process. It will be used to test the validity and reliability of a research. As defined by Collis and Hussey (2009, p. 85), triangulation is "*the use of multiple sources of data, different research methods and/ or more than one researcher to investigate the same phenomenon in a study*". In this research, the authors acquire data from different sources; thus a comparison was made among different sources to ensure the validity. Data triangulation will be the major method to ensure the quality.

After all the interviews, it became clear that the information gotten from different interviewees are consistent with each other. They gave different insights on different topics, but there were small consistent points of intersection among them. When all the information was gathered and organized, it is seen that different information helped to create one big picture –though still incomplete- which is consistent. Some facts and figures were also published by the municipality, which helped to validate the data gotten from interviews. Information from secondary data is much harder to validate since it requires deep research on the subject. However, since the secondary data used in this thesis is consisted of peer reviewed papers, their validity and reliability have already been checked. When it comes to websites; governmental websites, company websites, and Wikipedia were used in the paper. Pages from Wikipedia were always cross checked with the sources of the specific article which are located at the very bottom of every article page. Thus, sources were filtered to maximize validity and reliability.

3.5. Analysis Approach

Measuring effects of a policy is not easy due to several factors. A typical policy affects three pillars which are economy, environment, and society. The first is self-explanatory and can be calculated by numbers based on facts. The remaining two cannot be easily calculated due to several reasons. For the environment, the effects can be measured in terms of pollutant amount, but translating these to monetary values is hard. Value of a unit CO_2 or NO_x is not known and cannot be estimated easily. As it comes to society, there are some norms which can be applied to analyze benefits. For example, decrease in pollutants improves the overall health condition, so it is beneficial for the society. But it is hard to estimate the real cost savings of decreasing pollutants on society.

4. Background (Gothenburg)

Gothenburg is the second largest city of Sweden, after its capital Stockholm. As of 2013, 533,271 inhabitants are living in the Gothenburg region (SCB, 2014). The population of the city keeps its tendency to increase each year. To show this increase, previous population stats can be checked. For example, the population was 510,491 in 2005. This translates to 23,000 increase just in 8 years, makes 2,875 people on yearly average. Most of these people were immigrants; changing location within the country. This situation proves the UN projection of urbanization as well (See Figure 1 World Urbanization Projection). Being the fifth biggest city of the Nordics, it also attracts many local and international tourists. Having so many popular attractions such as the amusement park, Liseberg; the biggest shopping mall of the Nordics, Nordstan; variety of museums and natural places, 4,058,036 nights had been spent at the accommodation places in the area of Greater Gothenburg; a geographically defined area which includes eleven communities besides Gothenburg (Årsstatistik Göteborg, 2012). As a result of local and foreign tourists as well as locals, the city has considerable amount of retailing activity. There is a formation named Gothenburg & Co Industry Group which is working to increase the retailing activity by attracting local and foreign tourists.

4.1. Making the City More Attractive

In 2009, Gothenburg & Co Industry Group has discussed the ways of how different parties may work together to create a common platform for marketing Gothenburg city and transforming it as a shopping destination in the local area as well as internationally. Research of Gothenburg & Co, together with large number of parties, showed that shopping tourism represents an increasingly important part of the Swedish retailing. Consumers today are willing to travel further distances in order to find bargains and certain product assortment. In Sweden, tourists generate 13% of total retail sales today, which accounts for 37% of total turnover. Based on these statistics, the company aims for two main objectives: To increase the trade, in and around Gothenburg; and to transform the city into an attractive shopping destination. (Uppman & Ekenstam, 2010)

To achieve these, the company plans many improvements and attractions for the tourists including constructing new buildings on the water, new transportation ways for passengers through water using water buses and water taxis, visual animations created by light near the canals etc. The project includes many proposals which can be found on the planning report. (Uppman & Ekenstam, 2010)

Based on this project, it is expected to have an increase in retail sales not just in the centrum but in the other parts of the city as well. Thus, it is important to transform the existing transport systems to a more efficient and sustainable system.

4.2. Active Consolidation Centers and Transport Modes

In this chapter, current transport system is introduced to give general information.

4.2.1. Roads and Infrastructures

Roads and infrastructures are required for transport. The capacity and condition of roads in a city influence transport cost and trade volume (Limao & Venables, 2001), thus the influence on transport system cannot be ignored.

City of Gothenburg has a history from 1600s. There are few houses left from the 17th century, but streets and roads did not change a lot during the last hundreds of years. This also means inner city area has limited capacity and speed for transport. Narrow streets and high density in the city center makes it hard to deliver goods into shops and off to customers. Yet, there are hundreds of retailers in inner city, (see Section 4.3) and in 2012 there are 3.6 million guests visiting Gothenburg (Årsstatistik Göteborg, 2012), not including local visitors. Passenger statistics reached 80,000 in 2012 (Göteborg&Co, 2013).

With the largest port in Scandinavia, Gothenburg acts as an intermodal hub for freight delivery. Logistics infrastructures, especially consolidation centers, are necessary for a transport hub. These infrastructures do not only serve for the regional and international trade, but also commercial transport in the city. Gothenburg had a weeklong UCC (temporary) trail in autumn 2012 with 10 retailers. The result was quite promising, a 12 percent drop in UCC coverage area for numbers of deliveries (Volpe, 2014).

There are also UCC operating by 3rd party logistics companies. For example, one is located across the Göta River, owned by Havi Logistics AB. Big freight operators like DHL also have similar strategy for consolidation centers (Ibid). There is only one consolidation center which is used by several operators: Lindby. To explore the reason they do not have distribution center within city an interview was made to Sara Ranäng, a consultant in Schenker Consulting.

DB Schenker sets its consolidation center in suburban area Bäckebol which is located in the north of Gothenburg city, about eight kilometers from inner city. This UCC has terminals area of 133,000 m^2 with a turnover of 775 million SEK last year. Schenker does deliver goods to city and inner city area, but concerns for building a consolidation center outside city have two major reasons: one is cost-saving; the other is strategic deployment at regional level. Since Gothenburg is the second-largest city in Sweden it plays important roles in western part as hub of the region. So Schenker's consolidation center in Gothenburg does not only serve for local distribution for this city, but also work as hub for long-distance transport to other cities such as Malmö. Besides, Schenker cooperates with Volvo Group to develop new vehicles (to be exact, heavy trucks for long-distance delivery, e.g. duo-trail trucks with maximum capacity of 80 tons), so there is also a need to test these vehicles around the consolidation center, which makes it impossible to locate consolidation center in urban area. (Sara Ranäng, personal communication, 2014)

Big freight operators like DHL also have similar strategy for consolidation centers (ibid). In the last three years there is only one consolidation center in urban area which is used by

several operators: Lindby. But with the Stadsleveransen Project going on, another small UCC established at Gullbergsvass (near Central Station, the train station located in city center), according to Magnus Järderberg (personal communication, 2014).

4.2.2. Public Transport

In this part public transport in Gothenburg inner city area will be briefly introduced to get better understanding of overall profile of transport in the city center. Public transport system is composed of bus, tram, ferry, and railway (which is still under construction). Currently all the public transport is operated by Västtrafik, which is owned by the regional council.

There are over 80 km of double track for Gothenburg trams since 2011, which is the largest light rail network in Scandinavia (Spårvagnsstäderna, 2014). Tram and bus are the major public transport modes, while boats and ferries also work on the river. Currently Gothenburg does not have railway for passengers in the city, but there will be two lines available in 2018, going across central station and inner city area to main streets in the southern part of Gothenburg city. The overall public transport network in the city for passengers is shown in Figure 21.

4.2.3. Commercial Freight Transport

Major logistics operators in the city include: Posten Meddelande AB, Göteborgs Hamn Aktiebolag, Västsvensk Tidningsdistribution KB, Schenker AB, Volvo Logistics Aktiebolag, DHL, Green Cargo, Luftfartsverket, and Orusttrafiken Aktiebolag. In inner city area the most active operators are DHL, Posten, DB Schenker, and GLC.

One problem Gothenburg faces is that retailers work with separate operators, and often they do not choose the operators but let the suppliers make the decision (Hussain & Sinaga, 2003). Schenker Consulting studied Gothenburg commercial transport in inner city area in December 2012, and results showed an average of 45 medium-size trucks and 210 small trucks from 175 different operators entering this area daily (Volpe, 2014). Another investigation was done in December 2013, which had similar data (Dr. Sönke Behrends, personal communication, 2014).

4.3. Statistics on Retailing and Retailers

Retailing activities, by itself, create a turnover of about 60 billion Swedish kronor (SEK) in Greater Gothenburg region. Gothenburg city is responsible of 37 billion SEK of this amount, of which 10 million SEK just comes from inner city of Gothenburg, where lies the big shopping centers named Nordstan and NK (Nordiska Kompaniet) as well as many small individual shops. Nordstan, by itself, creates 4 billion SEK of this turnover, whereas NK is responsible for 1 billion SEK, leaving the remaining shops a turnover of 5 billion SEK. (Svensk Handel, 2014)

Breakdown of retail turnovers based on geographical areas and two big shopping malls shown in Table 6.

Table 6 Retail turnover in 2013.

Area	Turnover (billion SEK)
Gothenburg region	60
-Gothenburg	37
--Centrum	10
--- Nordstan	4
--- NK	1
-Others	5

Source: M. Kroon, personal communication, Feb 4th, 2014

Although there is a high turnover of retailing businesses, this raises some problems. Customers coming to centrum with their private vehicles, and delivery trucks which supply the retailers increase the traffic congestion as well as exhaust gas emissions. This is a serious problem for modern big cities since congestion and emission affects the citizens' health negatively (Sydbom et al., 2001; Woodcock, Edwards, & Tonne, 2009). In order to minimize adverse effects, some regulations are being applied in the city.

Besides the retailers, this inner city area includes offices of companies and organizations, whose demand for freight delivery will also be considered. Their demand focus on consumption items like stationary and office use materials, which are usually low in weight and do not require special equipment.

Business sectors in inner city area cover various types, including both shopping spots and professional service. Profiles of retailers can be found in Table 7.

Retail stores are classified depending on their ownership and basis of merchandise offered. According to (Pandya & Bajpai, 2011), when two or more shops under the same brand are under the same ownership, they form chain retailers or corporate retail chains. Yet, other definitions do exist with slight differences. For example, in BusinessDictionary.com ("chain stores," n.d.); chain stores are defined as "Group of retail outlets owned by one firm and spread nationwide or worldwide, such as Body Shop, K-Mart, Wal-Mart. Chain stores usually have (1) similar architecture, (2) store design and layout, and (3) choice of products." Two definitions contradict each other when it comes to store numbers. Nationwide chains should be more than two stores, yet local chain stores might still act similar to nationwide chain stores in terms of operations. In Table 7, chain store definition will be used as according to Pandya & Bajpai's (2011) definition. In order to determine the number of chain stores and non-chain stores, each store's website was visited and checked for how many shops they do have. There are a few points that should be pointed out:

- Some websites were out of service; they counted as non-chain stores.
- Some stores do not own a webpage; they counted as non-chain stores.
- Some chain stores have more than one branch in the area; all of them are counted in the total number.

- Same shops can fall into different categories because of their business model. These kinds of shops were not filtered in Table 7.

There is one main drawback in this approach. Some stores have only few branches located just in Gothenburg, whereas some brands have one store each in every big city. Although they are counted as chain, there is high possibility of each of them acting as a single store since they are the only one in the city. However, number of those stores is very low that they do not change the dynamics of the table.

Table 7 Gothenburg inner city business profile

Category (Total)	**Types of retailers in inner city area**	**Number (Non-chain)**	**Number (Chain)**	**Total**
Catering **(125)**	Café	18	13	**31**
	Kiosks	3	7	**10**
	Confectionery	5	2	**7**
	Food	35	9	**44**
	Restaurants	28	5	**33**
Service **(25)**	Bank and post	-	7	**7**
	Gothenburg city offices	-	-	**5**
	Parking areas	-	-	**9**
	Others	4	-	**4**
Shopping and entertainment **(249)**	Accessories	17	28	**45**
	Flowers	5	-	**5**
	Books and magazines	3	6	**9**
	Health and beauty	11	17	**28**
	Furnishing & Decoration	15	14	**29**
	Clothes	25	70	**95**
	Toys & Hobby	6	11	**17**
	Shoes	7	14	**21**
Offices of companies and professional services **(83)**	Company and school branches	-	-	**83**
Total		**182**	**203**	**385** **482**

Source: Innerstaden Göteborg

4.4. Regulations in Gothenburg

Gothenburg city has environmental zones which limit heavy lorries and buses entering into specific areas and/or roads depending on the vehicles' Euro level classification. Here are the regulations regarding environmental zone limitations (Göteborg Stad, 2014):

1. There are no restrictions to vehicles for six years, starting from the registration year of the vehicle.
2. Euro 3 vehicles can be used for first eight years of their registration date, which allows them to be used until 2015.
3. Euro 4 vehicles can be used until 2016 (included) or eight years after their first registration date. Vehicles adapted to Euro 4 can be used until 2016.
4. Euro 5 vehicles can be used until 2020, or eight years after their first registration. Vehicles adapted to Euro 5 can be used until 2020.
5. Euro 6 vehicles or the vehicles adapted to Euro 6 currently have no limit.

In order to decrease the traffic in the centrum, the municipality had decided to implement some regulations about vehicle entry and types of vehicle in the centrum in 2009.

Apart from environmental zone, which covers a vast area, the city has location specific regulations as well. The area this paper specifically deals with, the inner city (see Figure 2), has a length limit for vehicles except buses. Delivery trucks over 10 meters including their load are not allowed driving in the area except between 06:00 and 08:00 in the morning. This regulation had very little effect since as stated by (Anderson et al., 2005), companies were affected differently according to their fleet configurations. Delivery trucks working for the area were already less than 10 meters (about 8 meters) so this regulation had no negative effect on transport companies servicing the area.

4.5. Incentives

There are some incentives to decrease the congestion. These can be seen as privileges in return of an act or set of acts which generally cost higher to develop and apply, but the returns are beneficial for society. For instance, delivery trucks that consolidate their loads higher than 65% loading factor, or 'clean vehicles' which consolidate (without load factor limit) are exempt from parking restrictions on some spots (Sundell, n.d.). Additionally, those vehicles are allowed to use bus lanes. This may be a competitive advantage for the companies which consolidate their deliveries. Thus, this is a win-win situation both for the society and the logistics operators. An important point is that while imposing restrictions to transporters, it is important to give incentives to be successful with the desired outcomes. In the long term, CO_2, NOx and particulates are expected to be reduced by these incentives.

Another incentive is for purchasing CNG operated distribution vehicles, which will be discussed in the next section.

4.6. Measures Taken & Current Situation

There are many measures taken by the city in collaboration with a European Union project; CIVITAS. It takes its name from the words city, vitality and sustainability, which are considered as three key components of a modern European society. Funded by the EU, CIVITAS has tested over 800 policies on urban transportation, some of which can be shown as examples to best practices in the area. (CIVITAS, 2014a)

In Gothenburg, in collaboration with CIVITAS, a project named TELLUS (Transport and Environment Alliance for Urban Sustainability) was applied. The aim had many goals related to urban sustainability including lowering congestion, reducing traffic related pollution. The project included the following cooperating cities: Rotterdam, Berlin, Gothenburg, Bucharest, and Gdynia. The project had total of 48 measures in all cities, where Gothenburg took only seven measures where six of them dealt with commercial transport and the remaining one was about public transport. (CIVITAS, 2014b)

4.6.1. Environmental Zone

Gothenburg city has implemented an environmental zone in 1996 for heavy vehicles, which makes it the first city in Europe. The criteria of which areas are defined as environmentally sensitive are not set by the law. Instead, Swedish cities use common sense to define the areas. Areas which include many apartment buildings; pedestrian and cycle streets; "contains buildings that are sensitive environmentally"; contains parks and green areas can be defined as environmental zone if needed (Axelsson et al., 2005, p11). According to Axelsson et al., after one year this measure had led a reduction in particle emissions by 15-20%, hydrocarbon emissions by 5-9%, and nitrogen oxide emissions by 1-8%. In 2004, the initial zone for environmental zone had expanded, covering more environmentally sensitive areas. Table 8 shows the improvements made with the measurement: (Ibid.)

Table 8 NOx emissions time-series in Gothenburg and its environmental zone areas.

Year	NOx emissions from road traffic in Göteborg (In tons)	NOx emissions from heavy traffic in Göteborg excl. Environmental Zone (In tons)	NOx emissions from heavy traffic within the Environmental Zone in Göteborg (In tons)
2002	2,350	1,027	60.1
2003	2,183	981.9	61.4
2004	2,028	946.4	62.2
2005	1,864	906.6	59.5

Source: TELLUS Report , 2005, p. 23 (Axelsson et al., 2005)

4.6.2. CNG/CBG Operated Distribution Vehicles

Fossil fuels are the most pollutive type of fuel used in vehicles. They emit CO_2, NOx, SOx and other particulates while burning. These substances cause environmental and health damages to both local people and others living in other side of the globe (Kampa & Castanas,

2008). In order to decrease emissions from distribution vehicles, 3 companies were committed to buy clean vehicles out of 50 companies. There were 6 types of clean vehicles which were specially produced for the project. Although there were some operational problems on the side of vehicle manufacturers, the project succeeded by shifting 500,000 diesel km to CNG every year. Clean vehicles had increased 5 fold from 2001 to mid-2005. (Axelsson et al., 2005)

4.7. Stadsleveransen Project

Information about Stadsleverannsen project has gotten from Christoffer Widegren by conducting an interview on March 13th, 2014.

4.7.1. Background Information

Stadsleveransen, which is translated to English as *The City Delivery*, is an EU and government subsidized initiative to provide efficient deliveries to critical areas. It started its operations in autumn 2012.

The company owns two cars which are currently operating in two different locations in the city; Innerstaden and Lindholmen. They are preparing to expand the service area by adding seafood delivery to their portfolio. Innerstaden area consists of the area around Kungsgatan, Korsgatan and Vallgatan. Main goal is to decrease the traffic congestion created by delivery trucks in the area. Prior to its launch every store was getting different deliveries from different transport providers. Causing so much congestion, many safety concerns and environmental damages; the city of Gothenburg initiated a tender for cleaner transport methods.

A research was made by the city and three possible actions were defined to optimize the delivery situation.

1. Rescheduling the opening hours of the shops.
2. Consolidations of parcels in city consolidation center and ensuring their deliveries early in the morning by a security firm.
3. Arrange drop points for the shops.
4. Consolidations of parcels in city consolidation center and distribute them with electric vehicles by 10a.m. latest.

First option was not approved by the shop owners. Most of them open their shop between 9 a.m. and 10 a.m. in the morning. They did not want to open early when there are no customers since this will increase their expenses greatly. Second option was not approved by the shop owners as well. Simply, they were very uncomfortable of the idea of someone else opening their shops. Third option is hard to achieve since there are not enough spaces in each shop to allocate for this. Shop owners had maximized their area usage because of the high rents for the area. Fourth option succeeded, after discussing it with trade association of the area named *Innerstaden*.

According to new plan; major logistics companies such as Schenker, DHL and Posten have to abandon making individual deliveries to shops, but to make their deliveries to a consolidation center near Central Station of Gothenburg. In the consolidation center, products are to be loaded to electric vehicles to which wagons can be attached. These vehicles are quiet, so they do not create any disturbance to people around, and can make sharp turns on narrow streets, thus they gain exemption from all the access restrictions. (Innerstaden Göteborg, n.d.) This consolidation process is delaying the delivery by 2-3 hours. Yet, they manage to finish the deliveries by 10 a.m., by making two rounds per day.

Stadsleveransen project currently does not make any profits and is subsidized by government funds. Although urban consolidation centers might seem to increase the transport cost, when all related factors are evaluated such as vehicle capital, fuel, insurance, excise duty, maintenance costs; it can be seen that overall cost decreases when implemented and planned properly (Michael Browne et al., 2011). Final delivery costs to shops were lowered with the project (M. Jäderberg, personal communication, February 2014). This can be explained by regular trucks driving shorter distance and electric vehicles having very low operation cost. Although staff expenses increased, the first overcomes the latter.

Besides shops, offices are also served with this project. The initiative also uses tricycles to make deliveries, although their main customers are offices which are in need for office supplies and document transportation.

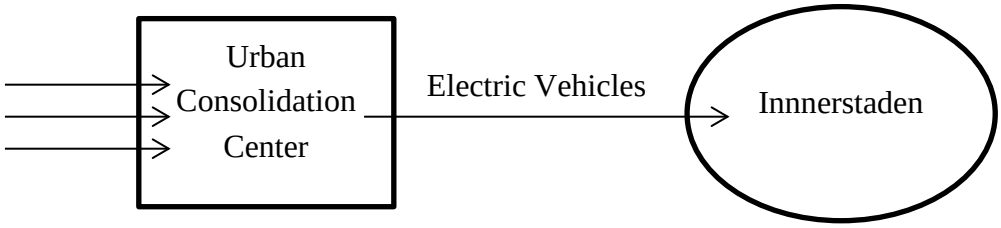

Figure 8 Workflow of Stadsleveransen

4.7.2. Business Model

The project has a promising business model. Assets do not cost high, compared to employees. Table 9 is a rough costs distribution table provided by Stadsleveransen:

Table 9 Cost distribution of Stadsleveransen.

Component	Share (%)
Employees	75
Cars	10
Facility	8
IT & Others	7

Source: M. Jäderberg, personal communication, Feb 27th, 2014

Electric wagons are being rented for long terms. They are very efficient and do not consume much power. The estimation is each round costs between 3 to 5 Swedish kroners of electricity.

However, the business does not make any profits right now and runs on advertising and funds provided by the city and the EU for now. Each wagon has two surfaces which are suitable for advertising. Selling those places currently brings one third of the turnover. In the following periods, they also would like to start value added services such as reverse logistics of secondary packaging material such as cardboards, plastic bags and pallets to recycle centers. Currently, the shop keepers have to dispose these. For a small fee, the company thinks that all shops would participate in this service. Since the vehicles already return back after deliveries, the cost for transferring lightweight packaging material is negligible. This service is similar to what Dablanc (2007) states in his paper.

4.7.3. Vehicle & Load Information

Electric vehicles used by the company have a volume capacity of 3 cubic meters. Attached wagons have 5 cubic meters each. Usually, 2 wagons are attached to the vehicle which makes about 13 cubic meters of parcels per ride.

Parcels that are high in volume and low in weight are being transported with the vehicles. Fashion products and souvenirs can be given as examples. Special wagons such as wagons for food and pallets are planned to be designed in the future. Currently, no food is being carried since the company is still trying to figure out a way without disrupting the cold-chain delivery.

4.7.4. Suggestions

The authors agree with Quak & Tavasszy (2011) as they imply Value Added Services (VAS) is required in order to have profits in businesses such as Binnerstadservice. Similarly, Stadsleveransen could easily adapt new VAS strategies to broaden its income areas. As waste collection have been considered, they could think of adding extra services such as temporary storage for retailers which do not have in-store depot due to expensive rents and small shops. As a result, retailers may order in bulk and buy cheaper, while enjoying always in stock situation. This will be explained in detail in Section 6.2.2. Another opportunity could be delivering big-size products directly to households after expending the operations throughout to the city.

To put these ideas into reality, new wagons should be developed for foods and pallets. Food containers stated in Section 2.9 could be a good solution. If there is enough demand for pallet transportation, electric pallet trucks can be used to handle pallet deliveries.

When it comes to maximizing asset usage, electric vehicles are currently operational in a limited area due to their capacity limitations. Given the fact that electric vehicles are free afternoons since all delivery finishes before noon, it might be possible to use electric vehicles for delivering goods to non-chain retailers in other central parts of the city.

5. Urban Transport Practices around the Globe

5.1. Best Practices

When best practices in urban freight transportation are examined, it turns out that many cities have solved great portion of their problems mainly by constructing an urban consolidation center and making the last mile deliveries with electric vehicles. Some chosen examples are summarized below. The common ground of these projects is that they have led to a reduction in greenhouse gases and particulate matters by switching delivery vehicles from diesel vans to electric vans and/or wagons; and adding electric assisted bi/tricycles which have special parcel carrying compartment.

5.1.1. London (Gnewt Cargo)

Similar to Gothenburg, London too has dense streets in its centrum. Gnewt Cargo is an initiative to decrease trips from suburban depot to stores. Prior to project, diesel vans were delivering parcels to high density customer area. For the project, a micro consolidation center has been built just outside the area, and diesel vehicles were replaced with electric tricycles and small electric vans. This setup has decreased total distance driven by 20% per parcel. However, being a spot-on project it has some limitations with scalability. Due to nature of vehicles, they can't operate in hilly areas due to limited traction power. (Leonardi, 2013)

Their operations are demonstrated in Figure 9.

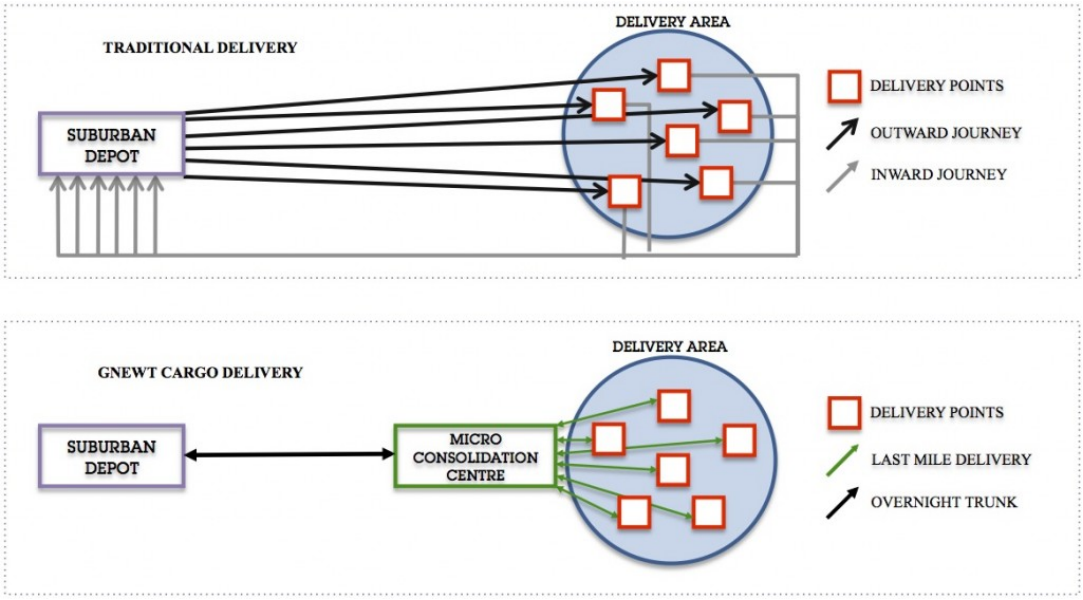

Figure 9 Differences between Traditional Delivery and Gnewt Cargo's Delivery.

Source: gnewtcargo.co.uk

Gnewt Cargo's official website has limited information related to their operations. They stated that emissions reduced by 62% per parcel Gnewt Cargo has delivered (Leonardi, 2013). The calculation method/formula for this is not disclosed, but just stated that it is 'independently verified'. Figure 10 is taken from their *Our Services* page, which demonstrates how cargo

cycles reduce CO_2 emission when cargo cycles added to last-mile transport chain, but without giving more information related to how this is calculated. This rises up thoughts as these graphs and figures look like tools for marketing purposes.

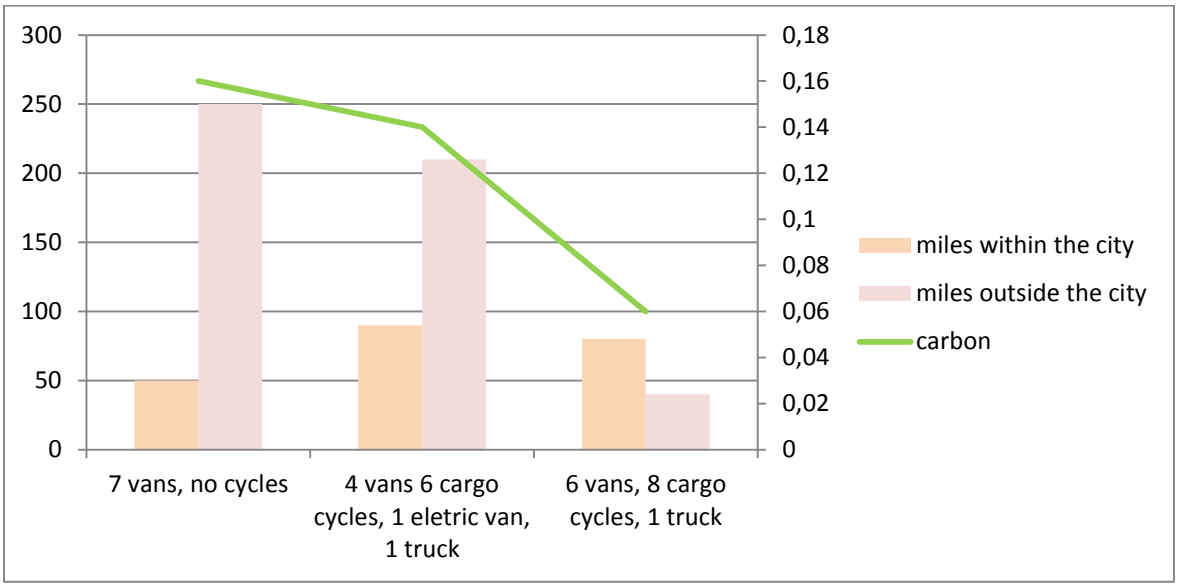

Figure 10 Effects of Electric Vehicles on Carbon Emissions

Source: gnewtcargo.co.uk

Gnewt Cargo's website has a carbon calculator which requires two inputs: Distance driven per day/week/year and number of trucks and drivers. As an output; it gives carbon emissions, diesel requirement per year, congestion charge fees, and energy bill which companies are obliged to pay for every ton of carbon emission. Again, the page does not state its assumptions.

5.1.2. Paris (Distripolis)

A large road transport operator, GEODIS, has started a new project named Distripolis in Paris, France. Prior to project, parcels and pallets were being delivered with conventional trucks by three subsidies of GEODIS. For the project, eight small urban consolidation centers are scattered in the center of Paris and fed with goods from a central consolidation center just outside Paris. The satellites (named as BLUE by the company) are located closely to main shopping districts in Paris. The satellite consolidation centers are serving for CNG or hybrid operated trucks. The last-mile delivery can be handled with small electric vans and electric assisted tricycles depending on the weight of the parcel. Parcels up to 200 kg can be carried easily by electric tricycles and electric LCV. Deliveries over 200 kg are being made by Euro 5 trucks, which are planned to be upgraded to Euro 6 trucks in the future. (Barillot & Bodin, 2011; Gouvis & Rizet, 2013)

At the time of the Press Report was written, the year 2011, the project has just begun to be implemented and it was planned to be finished in year 2015. The initial calculations foresaw 85% reductions in CO_2, other greenhouse gases and particulate matters. However, no updates have been published ever since. Thus, real reductions are not available to public yet.

Vehicles operating in the project are as follows (Planned for 2015):

- 75 LCV which have $20m^3$ carrying volume
- 56 electric assisted tricycles
- Electric pallet trucks for handling pallets

City routes had been optimized by an IT system, which led to 5% distance reduction of deliveries. (Barillot & Bodin, 2011)

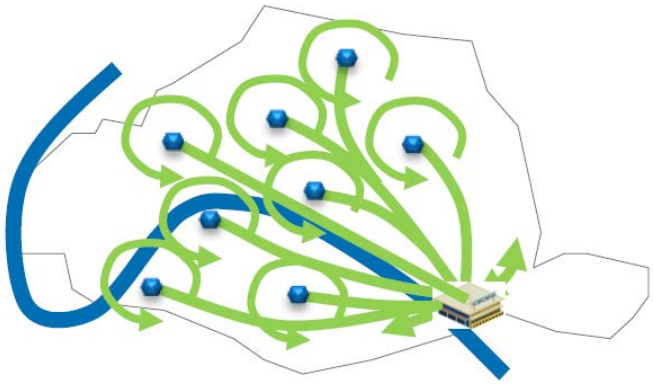

Figure 11 Operating diagram of Distripolis.

Source: Press Release of Geodis (Barillot & Bodin, 2011)

Operating diagram of Distripolis is shown in Figure 11. As seen above, one main distribution center (down right) feeds 8 satellite distribution centers (blue dots) and from each satellite environmental vehicles make deliveries for the retail area they are responsible of.

5.1.3. Amsterdam (DHL)

Amsterdam also has the problem of not having enough road capacity to deal with increasing freight delivery traffic. The city used to explore using public traffic system to deliver goods for retailers, and then DHL noticed it would be better to use canals in Amsterdam. Amsterdam has a well-known network of canals reaching major or important commercial area in the city. 25% of the city is covered by water. As Figure 12 shows (green lines show fast traffic while red means congested), the center area has most of retailers and office branches around the canals. The unique geographical and commercial environment makes it possible for operators to deliver goods via canals.

The canals have been using only for passenger transport until 1997. In 1997, a special boat designed for freight transport on canals and it started to be operated by DHL. It acts as a floating distribution center. On the land, a team with bicycles is cycling around to collect and deliver parcels and documents. Communication is done by radios between the base and the team. This helped DHL to reduce their number of vans operated in the centrum by 10 per year, and saved 150,000 km which is equivalent of 12 tons of diesel. (Theresa, 2007)

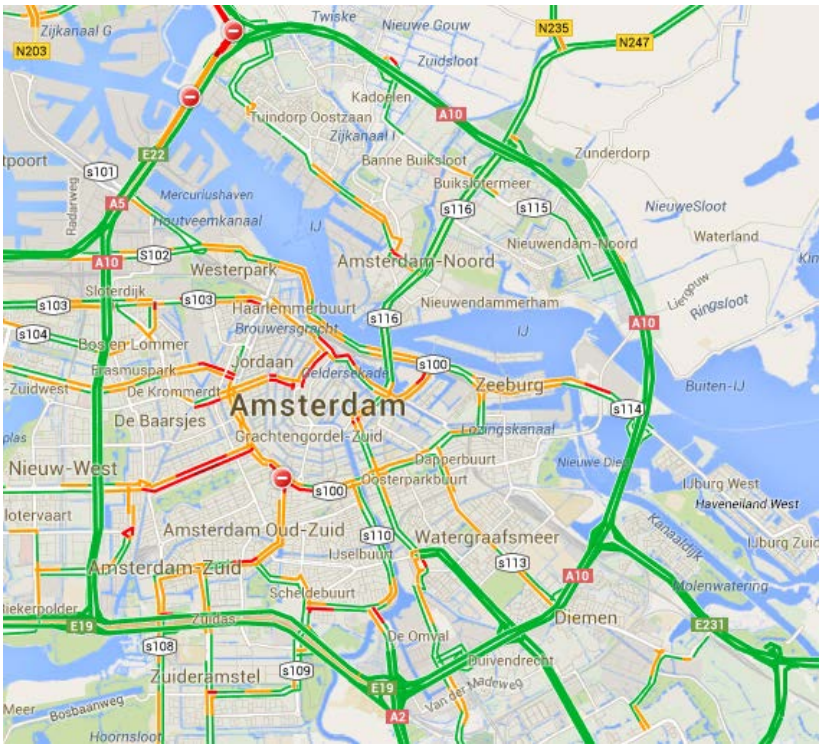

Figure 12 Map of Amsterdam showing traffic congestion.

Source: Google Maps

Years later, in 2010, a company named Mokum Mari Team has introduced a new business of commercial delivery. Boats used in this case were larger than DHL fleets, a barge type of vessel which is 20 meters in length and has 4.25 meters beam. The power is supplied by an electric engine; thus neither emission nor noise is created during the operation. The capacity of the vessel is 38 pallets, estimated to be 3 to 4 times the capacity of normal trucks operating in Amsterdam city center. The new business is especially popular for retailers located in old buildings since they already had had a delivery window for the fleet. The new delivery vessel can definitely reduce the emissions, congestion, and road traffic. Yet, no statistics about profitability is available, so it is still to be discussed whether it can make a successful business mode. (“Maritime Propulsion | Amsterdam Delivery Service by Boat,” n.d.)

Image 1: Mokum Mari Team vessel.
Source: http://articles.maritimepropulsion.com/article/Amsterdam-Delivery-Service-by-Boat-1194.aspx

5.1.4. Binnenstadservice (The Netherlands)

The Netherlands has the similar situation as many of the European cities: limited capacity due to old streets, increasing traffic flows, insecurity and unwanted side effects ("binnenstadservice nederland," n.d.). Thus funded by local authorities in the beginning, a project of 5 years had started in April 2008.

Binnenstadservice started as a non-profit company in a city named Nijmegen. Following a bottom-up strategy, they accepted to give service to retailers who wanted to join the initiative. Today, it is a company which gives urban consolidation service in 15 cities in the Netherlands. Their customers are retailers, residents, and other organizations in city centers. Transport companies deliver shipments to consolidation centers instead of direct delivery into shops, which makes consolidation the goods into smaller vehicles possible. Thus, shipments can be done by fewer vehicles instead of many trucks. The deliveries are done by electric bi/tricycles in addition to CNG trucks which are emission free. Binnenstadservice focuses on small and independent retailers, because their delivery system are not as optimized as chain stores (Blom, 2009).

Image 2: Electric assisted tricycle of Binnenstadservice

Image 3: Electric assisted small van of Binnenstadservice

They offer some value adding services for the retailers such as*;

- Storing goods (temporarily) in their warehouse,
- Unpacking deliveries and checking the delivery note,
- Entering SKUs in inventory systems of retailers,
- Disposing of waste such as packaging paper, plastic and Styrofoam,
- Sending and receiving packages and mails for the shops,
- Sending orders from warehouse to retailers' customers,
- Delivering parcels to customers in the region by appointment.

*Translated by Google Translate from (Binnenstadservice, n.d.)

These value adding services gave an opportunity to make profits; and retailers were very satisfied from the services, since their service quality have increased. To attract retailers to join the service, receiving, collecting and delivering the goods is free of charge. This is because the primary aim of the project is to reduce trucks in inner city area. Finally together

with the cost reduction from less stock and delivery time, it is estimated to achieve a 10% reduction of operating cost. Benefits for the society is also remarkable, with 40% less emission and obvious effect on congestion (Jorna, 2013).

Except tricycles and small vans, the company also has large vans which are electric operated. It is named *Cargo Hopper 2* and it has 10 Euro pallets' capacity. Although its maximum speed is 50 km/h, it is enough the distribute pallets from distribution center to retailers.

Image 4: Cargo Hopper 2 electric truck.
Source: www.duic.nl

One drawback of the company is that they are not able to handle fresh foods and frozen products deliveries since they do not own proper equipment. It should also be noted that none of the sources mention the market availability of fresh and frozen foods.

5.1.5. Support of Infrastructure: Paris ULS

During the 1990s, people believed UCC are one of the best solutions to decrease the commercial traffic flows in urban area, but because of high input and low efficiency, many of the established UCC have been abandoned. On the contrary, Urban Logistics Space (ULS) is seen as a more practical solution (SUGAR, 2011). Most important differences between ULS and UCC are scale and location. ULS is much smaller in size and capacity, which lower the cost for operation and makes it possible to be set up in urban areas and even in city center. On the other hand, UCC are usually located outside the city as stated above (Section 2.10).

Urban Logistics Space (ULS) in Paris is a successful case of providing infrastructure for operators. The size of ULS varies from 100 m^2 to 250 m^2 for each, initiated for innovative logisticians (freight delivered by tricycle and electronic vehicles). The project has been started in 2006, and is still on going. Because innovative logisticians are involved, the project is also named Esapces Logistics Urban (ELU). The ULS project is funded by the French government, so investment is ensured for the long term. As demonstrated on Transport Research & Innovation Portal website, the project is an entirely private tool despite the government investment. It allows light vehicles to make last mile delivery within city center and reduces the numbers of trucks used. Vehicles unload goods at ULS and then these goods are collected by light innovative vehicles, in this case tricycle and electronic vehicles.

Implementation of ULS project in Paris can be divided into 4 stages:

1. 2001-2003: Test period. The Paris City Council provided an underground car park as ULS for 2 years with very low cost.
2. 2004-2006: Starting a new service “Consignity” for auto- delivery and pick up.
3. 2004-2005: Converting to business mode, operators bidding.
4. 2007-2009: Setting up more ULSs for another intermodal project Monoprix. Adjustment of operators and enlargement of ULS coverage.

Until 2011 there were 7 ULSs in use in Paris and with a total 65 clean vehicles, 1,500,000 parcels were delivered each year. The project achieves sustainability in economic aspects, thus there is a possibility for further development. Also the project has positive effect on environmental aspects. (TURBLOG, 2011)

Stakeholders in this project involve all the four stakeholders, but with focus on operators and authorities. Operators and retailers forge two consulting organizations, one is Chamber of Commerce of Paris (CCIP), the industry and commerce organization, and the other is GATMARIF, a carrier’s combination. (TURBLOG, 2011)

Since ULS is not an academic concept for now, in following parts of the paper, the authors will use the concept UCC to represent both the traditional UCC and the new type ULS.

5.1.6. ITS Application: Vienna ILOS and i-Ladezone

ILOS (Intelligent Freight Logistics in Urban Areas), is a project of Freight Routing Optimization in Vienna.

Objectives of ILOS are to develop and define possible indicators to show the potential time and/or distance savings based on information of traffic flows, and applying these indicators to transport models to optimize transportation. In short, delivery routes are optimized by the help of traffic data. Motivations of the project are to have less emission, energy consumption, and operating cost. In fact, the first stage has achieved 60% reduction in travelling time, 15% reduction in distance, 20% reduction in fuel, and 30% in cost. (Schrampf, 2013)

Vienna has another project using ITS technology named i-Ladezone. Initiative reasons of the project are the continuous shortage problems of loading bays in urban city area. Vienna is estimated to have 2,000 to 3,000 loading bays in urban area, but this new project has two major aims: The first one is to effectively and efficiently develop methods to monitor the loading bays. The latter one is to establish a management system for maximizing the availability of loading zones and reducing negative effects caused by loading activities. (SUGAR, 2011)

There are not many cities working to implement ITS system for freight transport, because large mass of data will be needed and it means extra cost to collect and process the data. Cities like Gothenburg are still in the period of collecting traffic information and the application in public traffic planning. The EU has set up a standard for traffic information

called Datex. Member states should have their traffic information in a specially developed Datex format. With current technology, it is quite possible to see commercial applications of ITS in a few years. (“datex2,” n.d.)

5.2. Failed Practices

The failed practices examined below are projects which had tried to optimize city logistics but failed for various reasons. These practices had had positive effects as well, but most of them had failed due to unsustainability. Some of the projects had achieved their initial goals, but once authorities had withdrawn supporting, social investment had stopped, or compulsory regulations had expired the operators had no chance continue anymore.

The aim by examining the failed practices is to take valuable lessons to avoid the same mistakes in the future projects.

5.2.1. Tram Delivery: Amsterdam (City Cargo) & Zurich (Cargo Tram)

Amsterdam and Zurich both have tried using tram to deliver goods in city center a few years ago, yet none of them had further measures (though Zurich still have trams collecting waste now) for tram delivery after the termination of the pilot project. To reveal what may be the reasons for unsustainable tram delivery projects, information about the two projects will be introduced below.

Amsterdam had a project named City Cargo back in 2007. The initiative of this project is to find a solution for the problem of increased traffic flows of freight delivery on old city streets built in the 17th century. To solve the problem, a transport company (public-private cooperation partnership) named City Cargo had launched a project in 2007 and its operations had started in 2008. At that time Amsterdam had load factor control for trucks and it was not easy to reach the required load factor, thus shifting goods from trucks to trams had not met with strong opposition from operators. (Arvidsson, Woxenius, & Lammgård, 2013)

According to their calculations, they were going to decrease pollution by 20% by reducing the number of trucks by half. The network had two stops; first stop where goods carried by trucks were loaded to trams and the second stop where the loads were unloaded to electric vehicles for the final delivery. Pilot phase was successful and operation had started. The estimation was really promising after the pilot testing: The system is expandable to 50 trams and 400 electric vehicles. As a result, estimated environment impacts were reduction in particulate matters, CO_2, and NOx by 16%. However, expansion was needed by constructing new tracks which city had refused to invest in. Therefore, bankruptcy was inevitable for City Cargo, in 2009. Details of the project and analysis of failure can be found in the article of Arvidsson & Browne (2013).

The project which Zurich has is quite similar to Amsterdam, named Cargo Tram. This project can be called a success if not considering about limited coverage area. Authors introduce this project to make a comparison with the case of Amsterdam. The obvious difference from Amsterdam case is that Zurich has a recycling center in the west of city for the tram delivery,

which allows efficient loading and unloading, and the delivery system is specially designed for household waste collection. Because of the successful campaign and minimized investment, the project reached better result than Amsterdam's City Cargo. Referring to financial figures the project, the investment needed for operation (data in next paragraph) is a small expense compared with local government finance status. But as of today there is no further development of the project. However, project managers thinks there is still potential to widen the business (SUGAR, 2011).

Table 10 Comparison of the two tram delivery projects

Comparison	Amsterdam City Cargo	Zurich Cargo Tram
Funding	Private	Public
Beginning time	2007	2003 (2006 Electronic articles collection)
Scale	Large	Small
Delivery frequency	Daily or so	Monthly
Coverage	City center	Ten stations in the city
Stakeholders response	Investors not convincible	Supported by transport operator, waste management office (government) and residents
Freight type	Goods	Waste or other articles to be recycled

Source: SUGAR guidance for authorities (SUGAR, 2011)

By comparing the two cases, it's obvious that Zurich's Cargo Tram project achieved more sustainable results. In Table 10, two differences should be noticed: The scale and funding, and the coverage and freight types. Large scale projects will require more investments. In Zurich Cargo Tram has the two trams in use which were adjusted from old passenger trams, but they still cost 35,000 Euros as an initial investment and around 3,200 Euros for every ride (SUGAR, 2011). For example in 2004 the tram system had 94 rides for waste collection, so the total cost for the year would be around 300,800 Euros. There are no statistics for Amsterdam's City Cargo project, but according to the scale and delivery frequency, and demand for new supportive infrastructures (while Zurich Cargo Tram only uses existing infrastructures); costs can be extremely high and this explains why private investors are not willing to continue sponsoring the project. As stated above, bankrupts in financial crisis worsen the situation while Zurich project is being supported by government funds and has little economic concerns. Meanwhile, since Zurich project only covers ten collection points in the city and the frequency of collection is quite low (once a month at the first year), there will be less competition with passenger transport. This is important because city tram network is usually specially designed for passengers, which limits the use of freight operations. Another problem is the degree of saturation of passenger transport. Since the freight trams have to

share the tracks with passenger trams, residents may not support this innovation if there is a high possibility to worsen passenger travelling experience.

Zurich officials also reviewed the key outcomes of the tram delivery and concluded that it is a sound network and successful control in scale and organization (SUGAR, 2011, pp. 116–119). The reason why Zurich's project is categorized under failed projects is because without government funding, it would be economically unsustainable to operate.

Similar approaches can be seen in other large cities such as Paris, where metro or train is used instead of trams, related mainly to the capacity. (Ibid.)

Gothenburg also has a well-designed tram network, but whether tram delivery will be applicable for inner city remains to be seen. As mentioned above, success for tram delivery is not easy. Possibility of tram delivery in Gothenburg city will be discussed later in Section 6.2.1.

5.2.2. Linköping (SAMLIC)

Sponsored by VINNOVA (Swedish Government Agency for Innovation Systems), the project (SAMLIC) initially aimed at solving the congestion and queue problems in city center, and in loading and unloading bays. The pilot project has started in 2004, which was to set up a consolidation center for distributing goods to the retailers in inner city area. The first 9 weeks were a trial period in cooperation with major operators: Schenker, Posten, and DHL. The city was divided into three zones and each operator chose one zone to operate in. The consolidation center worked as an allocation area for all three operators. (Eriksson et al., 2006)

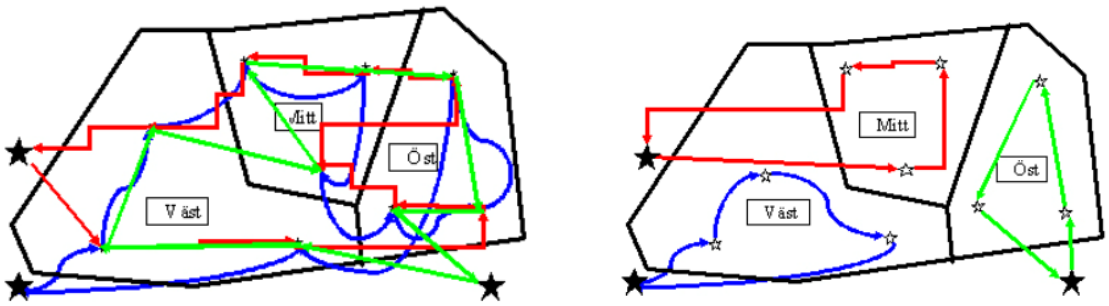

Figure 13 City center distribution system with three major operators.

Before the project (left) and after the project (right).
Source: Efficient Distribution Systems for goods to the City center (Shahzad & Tenti, 2009)

The targets were achieved soon after the beginning of the project:

- Total time for loading bays decreased by 66%;
- Total number of driving distance in the city center decreased by 50%;
- The total delivery time decreased by 75%;
- Number of stops in the city center decreased by 33%.
- Number of lorries reduced by 33%.

Note that data is from master thesis *Efficient Distribution Systems for goods to the City centre*. (Shahzad & Tenti, 2009)

Although initially the project seemed to be very efficient, it did not last for long due to stakeholder based reasons. For example, DHL wanted to have its logo/trademark on the trucks and to keep the original brand color. The conflicts in interest had finally led to the collapse of the project. Economic reasons should also be noted because large amounts of investment are needed for this kind of projects. In 2006 this project had come to an end (Eriksson et al., 2006).

5.3. Lessons Learned

5.3.1. Funding

Innovative projects usually involve new infrastructures to be built, and/or new technologies to be implemented. Thus, investment is essential at the beginning. From cases above, major funding sources are bank investment/private investment, and/or government funding. In the EU major funding can be grant transfer (which does not require payback), low-rate loan, fiscal incentives and guarantees (loss compensated if the project makes no profit) (European Commission website, mobility and transport). Most innovation projects are funded by the EU or local authorities, while some of them are supported by private sectors (e.g., Amsterdam City Cargo), making it important to have sustainability.

This research does not focus on who should be responsible for the investment, or which kind of funding is better; but rather focuses on what should be noticed about investment. In fact there are advantages and disadvantages of every funding scheme (Section 2.5.7). For further development, business model is essential because freight operators are intrinsically concerned about profitability (Taniguchi et al., 2001). It is quite common that projects of innovation are not profitable even in long terms because of requirements for building or upgrading of existing infrastructures and technology. This kind of situation will be viewed as a market failure which requires intention from authorities to achieve redistribution (Weimer & Vining, 2010, pp. 219–230). Accordingly, subsidies aimed at correcting externalities can enhance the efficiency. Otherwise, there is inevitably some net deadweight loss or misuse of subsidies.

It is obvious that if projects are not funded by non-repayable investors, the ability to gain profit can be the key to decide whether the project will be successful. As stated above, failed cases usually face the problem of convincing investors. Projects which need high investment during startup phase and higher investments during expansion phase must secure the source of the investment before entering into the business. In this kind of private funded projects, profitability will be needed to be evaluated continuously with methods like cost-benefit analysis (Taniguchi et al., 2001, pp. 92–100).

In the recent years there is a trend to combine different sources by public-private partnership (PPP). This kind of cooperation can promote equity and help projects execute faster compared to projects with only public resources. PPP is more widely used in the US than the EU, but the

application should be cautious because of the possibilities of higher total cost. (Schiller et al., 2010, p. 178)

Since scale and frequency may be proportional to total financial cost/investment, it's better to test new method within smaller geographical area first to avoid unnecessary loss.

5.3.2. Getting Stakeholders Involved

It's important to get stakeholders involved in the innovation projects. The failed cases have shown that conflicts between different stakeholders or different actors may finally lead a project to failure. If we refer to the successful ones, one feature they have in common is that they usually have campaigns to introduce new projects and to persuade stakeholders for support.

Since the 1960s many countries have public involvement in major transport projects. Depending on the level of civilization, forms of public participation varies. Major forms include: media communication, town meetings, public consultations and hearings, committees and commissions, study circles, social movements and politically oriented participation. Thus, technology for participation in public transport project decision is developed: Analytic hierarchy process, charrette, visualizations and simulations, visioning, visual preference survey and citizens' jury. Some of the projects will use the bidding method to choose freight operators (e.g. Paris ULS, Section 5.1.5), that is to say, if no operator is willing to join the project, it won't be implemented. In this way, participation of freight operators is ensured.

In many of the cases consultants are hired to provide professional opinions and technique support. For example, in Vienna ITS application innovation projects (i-Ladezone and ILOS), a consulting company named Ecosult participated. Nowadays it is a trend that authorities cooperate with consulting companies seeking for best solutions. Consultants consider about almost all the stakeholders' possible responses in addition to provide professional opinions, therefore the 3rd party service represent opinions of multiple stakeholders.

As for the form of stakeholders' participation, many of the projects will also establish a public company led by local authorities wherever the fund comes. There is no conclusion whether this is more efficient in performance but it helps keep a balance between stakeholders.

5.3.3. Stakeholders' Conflicts

Although stakeholders should be involved in city logistics innovation process, there are always conflicts of interest between different stakeholders or different actors of stakeholders. For example, In Linköping's SAMLIC project division of areas and distribution of benefits or cost is one of the major reasons why this project did not continue. Interestingly, many of the innovations initiate to aim at solving the problems of conflicts. As stated in Section 2.5.2, policies like access limitations are related to conflicts between operators and residents.

In Linköping's SAMLIC project one important reason for the failure was that it was impossible to satisfy all participants. By dividing the inner city area into three zones and assigning those to single operators one by one do help achieve the goal of less traffic and

emission, but some part of the inner city will have more retailers or better turnover than others, which may lead to more profits for the operator. So operators have conflicts in the arrangement of zone given.

From city freight delivery practice we can see that most of the innovations have positive effects on environment, but this cannot ensure support of residents or even government, who are supposed to consider more about environmental impacts. Sometimes there will also be political interventions.

Conflict of interests is not always possible to avoid, so it is important that project managers to find a compromise.

5.3.4. Sustainability of Innovation Projects

Sustainability of innovation projects is important for further development and for application of new policies and/or technology. Undoubtedly, authorities act as leaders in most logistics innovations in terms of initiatives and funding (Schiller et al., 2010, p. 299), but whether a project has the ability to continue depends more on the existence of a successful business model. Different from public logistics, freight transport is operated by private businesses and public subsidies should not be major financial supports for a sustainable project (Schiller et al., 2010, p. 131).

There are quite a lot remarkable innovation projects giving benefits to the environment and the local communities, but the problems is that they cannot be sustainable in economic performance. Funding ability of local authorities may vary from time to time, so it is important to make projects sustainable to be prepared for certain risk. In Amsterdam case it is seen how global economic crisis challenged the financial ability and failed the initiative.

6. Discussion

Empirical results of the policies (e.g. reduction in carbon emissions etc.) have already been discussed in Chapter 2. In this chapter, policy discussions will take place as well as new suggestions for the city. In addition, inadequacy of some policies will be discussed.

6.1. Effects of Policies

As stated before, public policies are effective way of achieving desired results. Yet, this does not mean that the cost of achieving the desired effect is effective. For example, car manufacturers are investing huge capitals for each step of their research and design process to reduce the emissions from vehicles (Sanchez, Bandivadekar, & German, 2012). However, the efficiency of each European emission standard gradually decreases. Speaking for fossil fuel vehicles, improving the existing technology is hard and expensive. Figure 14 compares required emission regulations by years:

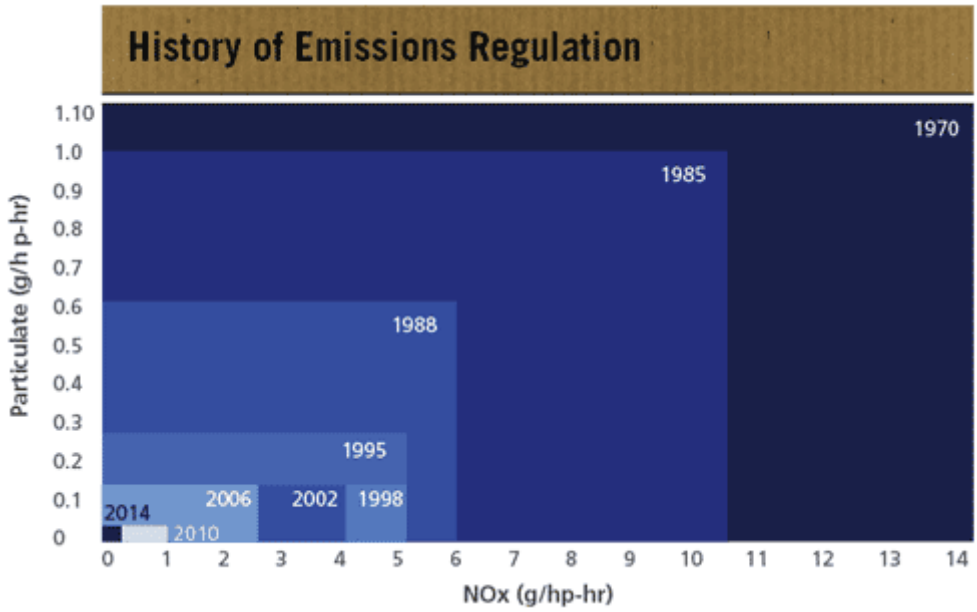

Figure 14 History of Emissions Regulation
Source: agrocorp.com

As can be seen in Figure 14, big improvements were made from 1970 to 1995. After 1995, only small incremental improvements were possible. Although it is an improvement, it will hardly save the environment since the number of vehicles is increasing drastically. Sousanis（2011) stated that world's vehicle population had topped 1 billion units in 2011, showing a gradually increasing trend. Therefore, government regulations can work until a certain point. The real necessity is to switch to low emission vehicles which are not powered by fossil fuels; such as electric operated vehicles.

However, there are other policies which dissuade people to use private vehicles, and forces transport companies to find new methods for deliveries. These policies basically charge people and companies depending on their vehicle usage. For example, Gothenburg has a congestion tax which charges private vehicles passing through the city. Price is dependent on

the time of the day; excluding weekends and public holidays, which are free. Stockholm has a similar policy as well. In England, there is CRC Energy Efficiency Scheme where companies are obliged to pay 12 pounds for each ton of CO_2 they emit if their energy bill is over 500,000 pounds per year (Department of Energy & Climate Change, 2014). For companies, these regulations act as a forcing factor to find new solutions; whereas for people, they shift from private cars to public transport. For example, congestion policy might change habits of customers, which would affect the retailers' transport strategy.

People might waive going shopping by car when congestion charge is present. This would lead them to go shopping either on evenings (if no fee is applied on evenings), or on weekends. There might be couple problems tied to this change. Firstly, people might have to go to shopping centers which are closed later in the evening than small retailers, which will eventually force small retailers to operate their shops longer hours at a cost of higher operating costs. Secondly, people might choose to go to shopping on the weekends, which will create extra congestion on the roads, as well as parking place shortages. Retailers, on the other hand might have to get more deliveries to stock goods for the evening or weekend shoppers. Big part of transport chain would be affected by similar policies, which may actually cost more in the long term when relevant factors considered.

6.2. Suggestions for Gothenburg

The following suggestions are mostly based on previous trials among city logistics. Although most of them are similar in principal, e.g. electric vehicles, operations differ for each city. Different strategies will be gotten from projects where the authors see a potential integrating those in Gothenburg. In this section, suggestions will be made for the optimization of the selected area; however applicability is important as well. For some suggestions, testing their applicability might be easier than others since some of the suggestions require radical changes in the system.

In addition to possible optimization solutions, projects which are not suitable for the city will be assessed as well, by explaining why they would not be a good solution.

6.2.1. Not All Ideas Are Suitable

As discussed above, not all projects are suitable for implementation to Gothenburg. Gothenburg is known as Little Amsterdam due to its canals, therefore DHL's idea of floating distribution center might sound implementable. However, there would be several drawbacks of investing floating distribution centers in Gothenburg. First of all, Gothenburg has only about 2.85 km of canals around the selected area, excluding Göta Älv (Göta River) side. Amsterdam, on the other hand, has over 100 km of total canal length (Dombrowski, 2013). It is also needed to construct loading and unloading platforms for freight distribution through canals. Another problem is, a vehicle and many bicycles on the land should feed the floating boat all times due to limited capacity of boat. This is only sustainable if there is transport activity all day long. However, in the central Gothenburg, most transport activities are done in

the mornings and they are enough for a day. Thus, this type of investment might not be feasible for Gothenburg city.

Tram delivery is also not suggested for Gothenburg. Thanks to the Amsterdam and Zurich cases, the disadvantages of tram delivery are quite obvious: High investment but low return, and requirement of a vast tram network. Though Gothenburg has the longest double track in Scandinavia, tram delivery is still not a good idea. One and maybe the most important reason is the investment needed for adapting passenger-based tram system to freight operation suited one is not worthwhile. A project for large scale application in inner city will not create profits to make up for the investment, so implementation of tram delivery has to be subsidized by authorities. If the only aim is the environment benefits, tram delivery is not irreplaceable. Other measures or actions can also reduce emissions and energy consumptions as well as traffic flows. At the same time, since tram delivery will let the tram network serve both the passengers and the freight delivery; it is highly possible to trigger conflicts between residents and operators, which is not consistent with the target of creating an attractive Gothenburg City.

6.2.2. Centralized Urban Consolidation Center

As stated in Section 4.2.3, there are more than 250 trucks and 175 operators entering the inner city area of Gothenburg every day. Among all the retailers, the chain stores have a national or regional distribution system, which can hardly be changed. But for small retailers such as food shops and cafes, there is a possibility to change the delivery mode if the new mode can create value for the retailers or their transport operators.

The best approach to optimize the logistics of the area would be to continue transportation of goods via specialized electric vehicles. To increase the existing customer base of electric delivery vehicles, existing UCC can be used or a centralized warehouse can be built since the individual stores are too small to store goods.

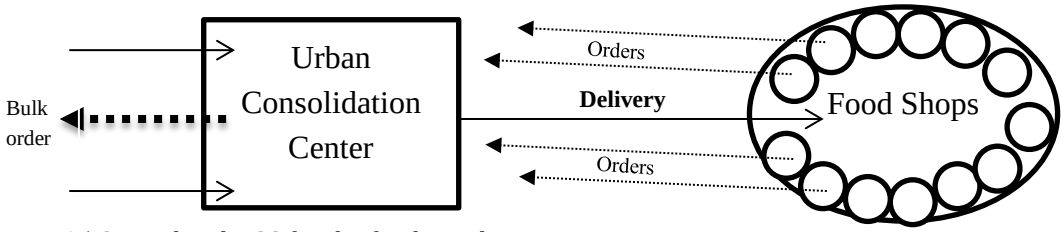

Figure 15 Centralized UCC for the food retailers

Food transport with electric vehicles currently has not started in the defined area. Yet, after examining Table 7, it can be seen that 71% of food stores are not chain stores, which means there is a high chance that they do not have their own private transport providers. This research did not do a research on retailers and their business strategies, but new applications could be developed if a research focused on retailers by conducting interviews would be done. Some possible optimizations can include buying raw materials together and in bulk as it was discussed previously in suggestions to Stadsleveransen. This act would give birth to another

need such as forming a centralized ERP system where orders can be given and tracked. The outline of the operations shall look similar to this:

This setup would need a non-profit association which is working in collaboration with Stadsleveransen. It would act as an intermediary partner between Stadsleveransen and food shops. Currently, Innerstaden Association acts as an intermediary between the retailers in the area and Stadsleveransen. It could also work as organizing the food retailers. After the organization has done, every shop would need to report their daily raw material usage. This is needed to know the preliminary order amount. Orders should be given in bulk by the association to get a cheaper rate. After consolidation in the warehouse, deliveries should be made with electric wagons specialized for food. If the trial period would be successful, an Enterprise Resource Planning (ERP) system could be installed where stores could give orders to the association. This option would eliminate many trucks which are delivering raw materials to food retailers and maximize profits for food retailers due to more bargaining power.

Of course, retailers now have their own suppliers, so before a distribution system for small retailers in Table 7 is achieved, several steps would be needed to make the adjustment. The most important change is that instead of sending orders to suppliers directly, the orders are sent to consolidation center, and then forwarded to suppliers. For some of the materials or items which are not strategically important for retailers, for example flowers needed for a bakery store or cafe, retailers would not care about which the supplier is. Definitely it would be better if retailers could decide their suppliers for the minor products. As for the negotiation of price or payment, the authors believe that there is a potential to get higher discounts with orders of larger quantity. In this case efficiency, in other words, reaction time can be a challenge, but it can be solved by precise demand forecast and inventory in UCC for the fast turnover items.

Also operators and suppliers should get benefits from the new modes. Theoretically, the benefits of consolidation are greater if the demands are not capable to fully load a truck cased on cost estimation (Nguyen, Dessouky, & Toriello, 2013). Their research shows that cost for fully loaded truck delivery is consistent with the volume, while less loaded truck delivery cost is segmented (See Figure 22). No investigation about freight volume is done by authors because of time limitation, but former research (Hussain & Sinaga, 2003) has revealed a delivery frequency of 2-3 times a week divided by separate operators. Together with the daily/ weekly turnover information, it can be predicted that most of the small retailers won't have goods up to a truck-full every time, so there is potential to benefits the operators and suppliers by saving the cost with consolidation transport.

Stakeholder interests are better off in this suggestion, thus the authors cannot foresee a clash of interests. However, one possible problem might be the investing problem. If Stadsleveransen needs new vehicles because of increased volume of incoming / outgoing goods; they might need support from the EU or government funds.

6.2.3. Strict regulations

The city may impose a restriction on all small vans which enter the city, unless they are hybrid or completely run by electric. This is a high cost regulation for the transport companies, but if enough time was given to logistic companies they would not have any other chance but to replace some of their old fleet with electric or hybrid vans. This might not be the easier regulation to enforce, since politicians have always vote concerns. Yet, there is no reason not to enforce this in the long run.

If a regulation was applied, companies could buy vans such as *Cargo Hopper 2* which costs between 65,000 to 80,000 Euros depending on the model (Daggers, 2013). These might seem high as an initial investment cost, but would save from maintenance and diesel costs as well as being environmental.

Possible effects of strict regulations on retailers and consumers would be cost-based. New investment necessities can increase the transportation price through the supply chain. This would eventually reflect in consumer goods sold in retails. Thus, consumers might have to take the burden of decreasing externalities in transport such as air pollution. This might lead to a decrease in consumption due to price increase. Both retailers and consumers would be affected negatively in an economical approach, but socially, they would be better off due to cleaner environment.

6.2.4. Further Applications of ITS

Today, ITS are widely used in public transportation in Gothenburg. Busses are connected to a central system where the public transport traffic is coordinated. By this way, bus drivers know their ideal speed in order to abide by the time table. Having their own lanes in some parts of the city, bus transport is faster than travelling with private vehicles.

On the other hand, ITS are not so popular in urban freight transport in Gothenburg. Keeping chain stores separate, existing usage of ITS by Stadsleveransen is just limited with recording delivery times to stores (C. Widegren, personal communication, March 2014). However when the service area expands, ITS usage could be vital in order to minimize to costs. Route planning gains an importance in a wider area, which saves time and cost if done properly.

Just as in ILOS project in Vienna (see Section 5.1.6), real time traffic data can best be gotten from vehicles in the traffic. With the improved technology, smart phone and tablet prices are getting lower which can be a huge advantage for getting real time traffic data. There are some softwares which act as a free navigation software in exchange for sending the real time speed and location data of the user. These softwares are publicly open to anyone and can be found on multiple mobile platforms. Applications like Waze and Yandex Navigation give a chance to contribute to real time traffic data and can be utilized highly as their user base increases. These applications are not only used by commercial vehicles including delivery trucks, but also by private vehicle drivers in order to see any road blocks caused by accidents beforehand and respond by re-routing. Yandex Traffic service is currently operational in large cities in

Russia, Ukraine, and Turkey (Yandex, n.d.). This service or similar services will eventually be in operation for all major cities of major countries. Thus, using real time data will be cheap and accurate in the future.

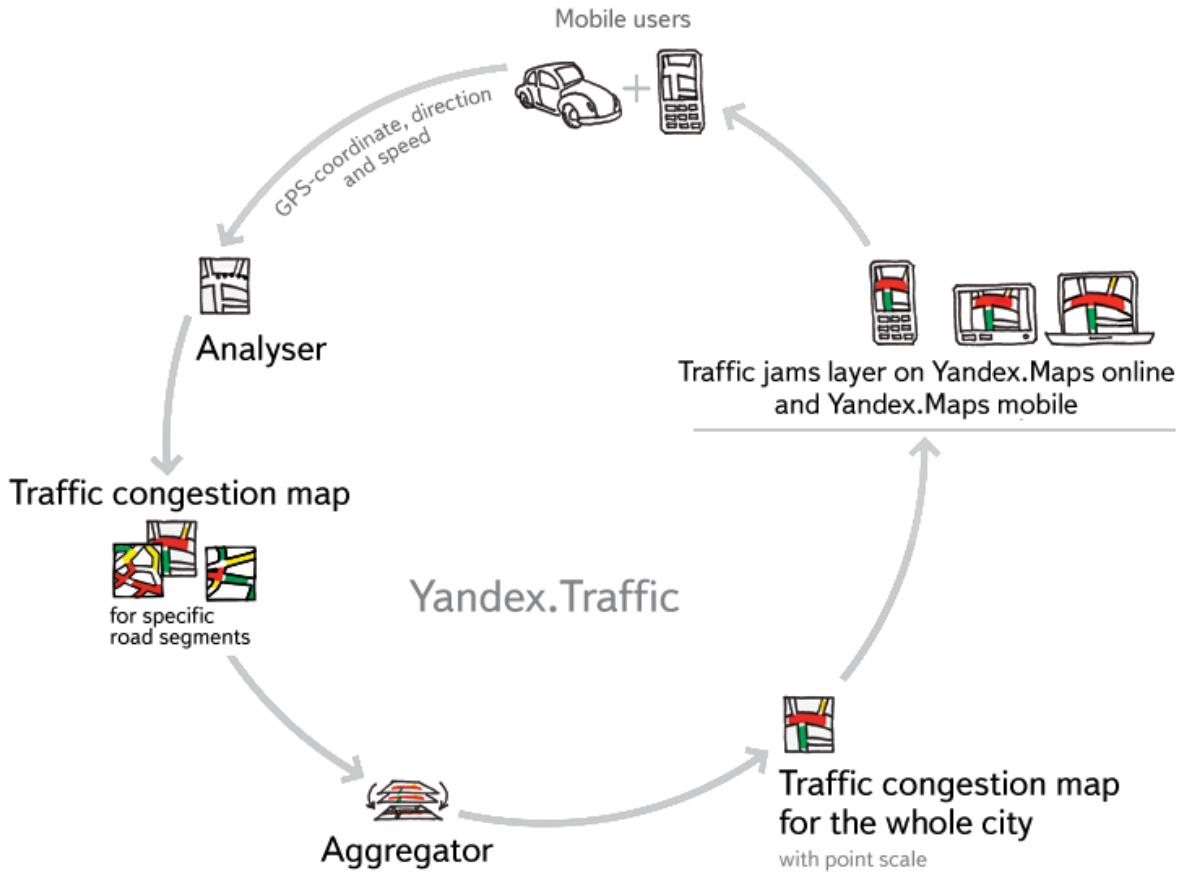

Figure 16 How Yandex.Traffic works?

Source: Yandex website. http://api.yandex.com/traffic-jams/

In Gothenburg, similar system can be started by installing GPS devices and GPRS transmitters to rental vehicles, taxis, public transport vehicles, and post trucks etc. Once the system starts to give accurate traffic information, vehicle users too would eventually start to use the application on their own. Although this technology is only slightly related to central Gothenburg, it is more relevant for the bigger picture.

6.2.5. Delivery Space Booking

Delivery spaces for chain stores can be converted to remote controlled parking places where chain store delivery trucks can book a time-slot online to make their loading and unloading activities. These spaces could have RFIDs located nearby parking areas, which control whether parked vehicle has a booked place or not. In collaboration with security forces, booking can reduce the morning traffic created by vans. At other times, these places can be converted to short-time passenger vehicle parking to utilize the space and to generate an income.

However, there might be several drawbacks of this system. First, initial system setup might need significant amount of investment. Second, external factors in traffic might cause vans to be late and therefore could cause them to miss the booking time. Solution for these special cases should be decided in order not to hinder the businesses.

6.3. Stakeholders Management

Researchers never stop exploring the stakeholders' relationship. From the case in Section 5, it is clear that in city logistics innovation, stakeholders sometimes act as the crucial party to determine the outcome. Authorities cannot and should not force the participation of stakeholders, thus a mechanism to attract stakeholders is necessary.

A typical method of getting stakeholders involved is to establish a PPP (Public-private partnership) mode for funding and monitoring (Schiller et al., 2010). Operating mode of PPP has already been introduced in Section 5.3.1. It is mentioned here to act as a basis of another cooperation mode: Freight Quality Partnership (FQP), which is also called freight network or freight Forum (Blumenfeld, Burns, Diltz, & Daganzo, 1985). The concept was put forward decades ago, but the application has not been well-developed until recent years. Researchers (Michael Browne & Lindholm, 2013) have implemented the "new" mode in server cities including Gothenburg (yet at the beginning stage now). Typical PPP mode includes a profit re-distribution mechanism, e.g., the construction of expressways in the US widely uses the PPP mode.

Compared with PPP, FQP focuses more on the involvement of stakeholders and gathering different opinions and intelligence. Meetings will be held at regular intervals to get opinions from stakeholders. One advantage of Gothenburg is having Volvo Group in the city, which creates many chances to cooperate and design new vehicles for special needs. Authorities should make fully use of the resources like this in FQP mode. But FQP is effective only under certain circumstances. One important tip is that there should not be too many members. Although this partnership is designed to get stakeholders involved, management and communication within the participants group is the primary target. Suggested number of members is 10-20 (Ibid.).

Minimum requirements of FQP includes a description of the policy and the distribution system, strategic involvement of freight operators, the business and the local community, effective partnership with local authorities, and potential to improve freight distribution system. To make a good FQP at a local level, it requires all the elements listed below: (Collings, 2003)

- Evidence of progress in establishing FQP, making sure that key organizations and companies are involved.
- Comprehensive assessments of existing operational and non-operational freight infrastructures within the area.
- Clear strategies and identification flows for alternative transport modes, including assessments of truck journey to be saved.

- Strategy to balance efficiency (economic aspect) with social and environmental aspects.
- Clear evidence of freight routing strategies.

From the descriptions above it is obvious that Gothenburg does not have a “good” FQP for now: The organizations do have key actors involved in and try to make a balance, but the strategies are neither clear nor being organized as a system.

The potential benefits of FQP are numerous but forming such a relationship is not the end and it can only be seen as a success if it leads the way to establish a sustainable freight distribution system. Once the FQP is established, it would need a strong leadership to be managed. It is suggested that the authorities assign a dedicated freight champion to work as a leader of overall FQP, since authorities can be fair among participants and do not concern much about economic benefits. Also, the FQPs will meet the challenges from funding and keeping the interest of stakeholders. Usually the initiative funding comes from the local authorities. Some of the FQPs will have formal contract with the key actors to ensure their participation. Some other skills may also work, for example, adjusting the frequency of meetings according to the progress of projects, and setting accessible targets for short time to keep the confidence of stakeholders.

7. Conclusions

With people becoming concerned more about city logistics, there are many efforts to optimize the freight transport. In recent years within the EU, there are numbers of measures that have been taken to mitigate the negative environmental and social effects.

By comparing the policies in different cities and countries, it can be concluded that some of the policies are more acceptable and efficient, but some are too early for the time or have little value in return to implement.

Stakeholders respond differently to the policies. However, this does not and should not imply that stakeholders are completely different entities. Management of stakeholders' relationship is quite important where it could determine the final result. It is important to get them involved in the city logistics innovation processes and try to keep the balance of interest. Since they have an inseparable bond among them, each stakeholder affects the others when its behavior changes.

Gothenburg freight operation in the city center is going –almost- smoothly now. Regulations and incentives have been well-designed. Congestion, parking space, loading bays situation have been improved during past years. Potential for freight transport mainly lies in improvement of efficiency and collaboration of operators to reduce the traffic flow. New technologies and their applications, accompanied by appropriate measures are to be expected in the near future. Recent progress in ITS and sustainable transport can be the first option for Gothenburg City since they are the most promising trends.

The importance of knowledge exchange should also be noticed. Among all the cases the authors reviewed, no matter if it is introduced in this research or not, cases of innovations are quite alike. Cities are using similar technology and measures, and they end up with similar results, mainly in terms of improvements. This means that information related to and sample cases of other cities are worthwhile to track. Under the framework of the European Union, Gothenburg has an advantage to build close connections with other cities, and together, what could be done for freight transport could be explored. There are few databases or sources about freight transport practices in cities. These should be closely followed and a communication forum should be formed with the other cities' administrations for information and experience exchange.

Currently only authorities collect real-time transportation information and share it with the public. Private owners do the data collection also, but the information is not published at all or published in a very limited way. With all the organizations of stakeholders, it is possible to acquire mass data and optimize transport accordingly. If information boundaries between public and private were to be removed, both parties would benefit from this action.

8. Further Research

This research has missing areas which could not be examined deeply due to time constraints. It was only possible to conduct interviews with few transport companies, a trade association, and Trafikkontoret of Gothenburg. Therefore, the researchers could not get a complete picture of all stakeholders of city logistics. It is possible to interact with retailers and customers to get their ideas on the subject since they too are an important part of the system.

Possible further research areas could be:

- Finding operation patterns of retailers to optimize that part of the supply chain.
- Finding shopping habits of customers and determining their peak times with peak items to make better stocking.
- Discussing the optimization for specific kind of vehicles or goods.
- Possibility and ways of cooperation of chain stores.
- Possible solutions to do optimization within the same group of stakeholders.

Operation patterns of retailers are very important in city logistics as it was discussed before. It is a necessary step to create a collaboration of ordering raw materials to restaurants, cafes, and food shops.

Determining customer habits might be a good marketing research, which could lead to increased sales in the area. Today, supermarkets are very much aware of shopping habits of their customers with the help of loyalty cards. Small shops, of course, do not have this kind of marketing strategy since it is not viable for a single small shop. However, a collaboration of shops together with the associations or the municipality can create new opportunities. Customer loyalty cards can be published for the locals which are valid in all shops of city and detailed statistics could be collected. The city has a *Gothenburg Card* which provides entrance to Liseberg, unlimited public transportation, free visits to museums etc. This card can also be used as a special discount card in the shops, and all activities of tourists can be analyzed together with their shopping habits.

Optimizing vehicles is a Research and Development matter which needs huge investments. However, optimizing loads to vehicles seems much cheaper than the first option. Standard load units could be designed to maximize the loading space usage and to minimize loading / unloading time.

As it was mentioned, the chain stores in the area have not included in this research. Yet, they account for almost half of the stores in the area. A research on possibilities and ways on optimizing chain store deliveries might add value to the literature and to the sector. If they could cooperate in some way to reduce total number of delivery trucks entering into the centrum, it would be a win-win situation for everyone.

Also, it will be interesting to look into optimization within the same group of stakeholders. For example, how the behavior of subcontractors of operators can be monitored and improved. Although there are many small operators of companies like DB Schenker acting as

subcontractors entering the city every day, ordinary performance indexes such as load factors are not monitored or evaluated, which means a lot work can be done to make improvements.

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Appendix

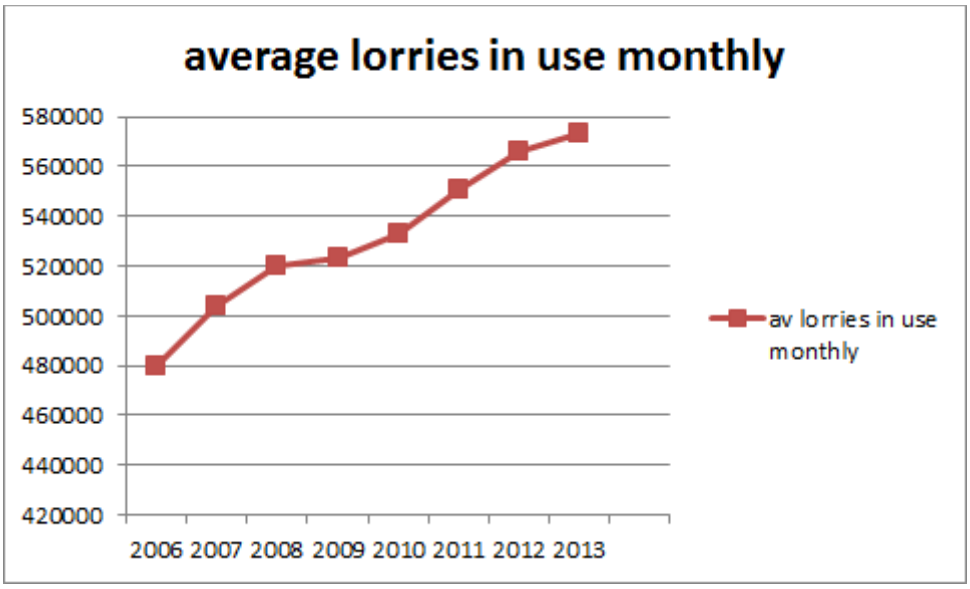

Figure 17 Average Lorries in Use per Month in SE

Source: SCB traffic analysis. http://www.trafa.se/statistics/

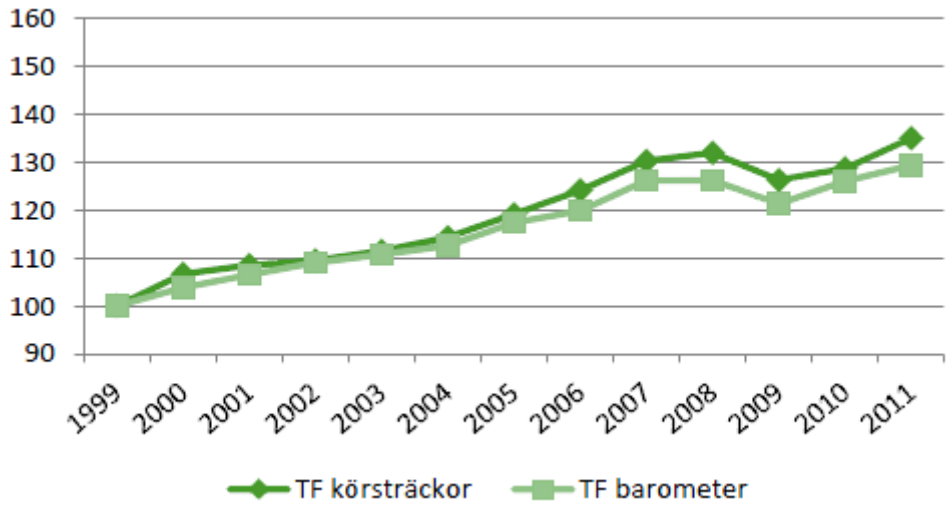

Figure 18 The Traffic Volume of Heavy Vehicles on State Roads under the Traffic Survey Compared With the Development of the Swedish-Registered Heavy Goods Vehicle Driving Distances.

Source: Trafikanalys and Trafikverket report.

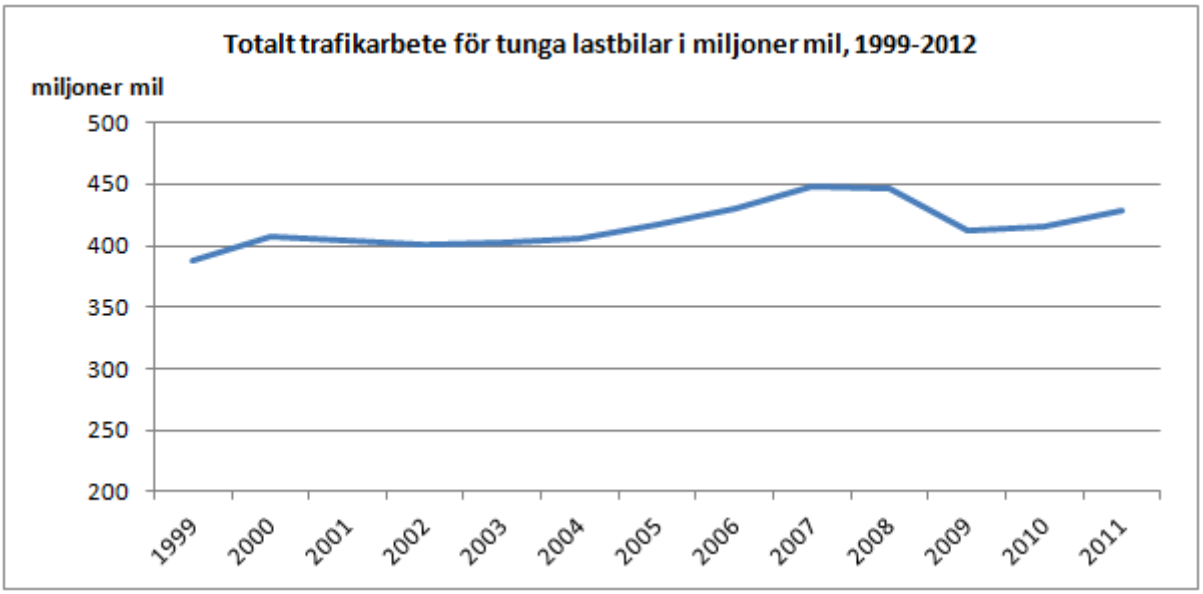

Figure 19 Total Mileage for Heavy Trucks in Millions Mile, 1999-2011

Source: Trafik Analys.

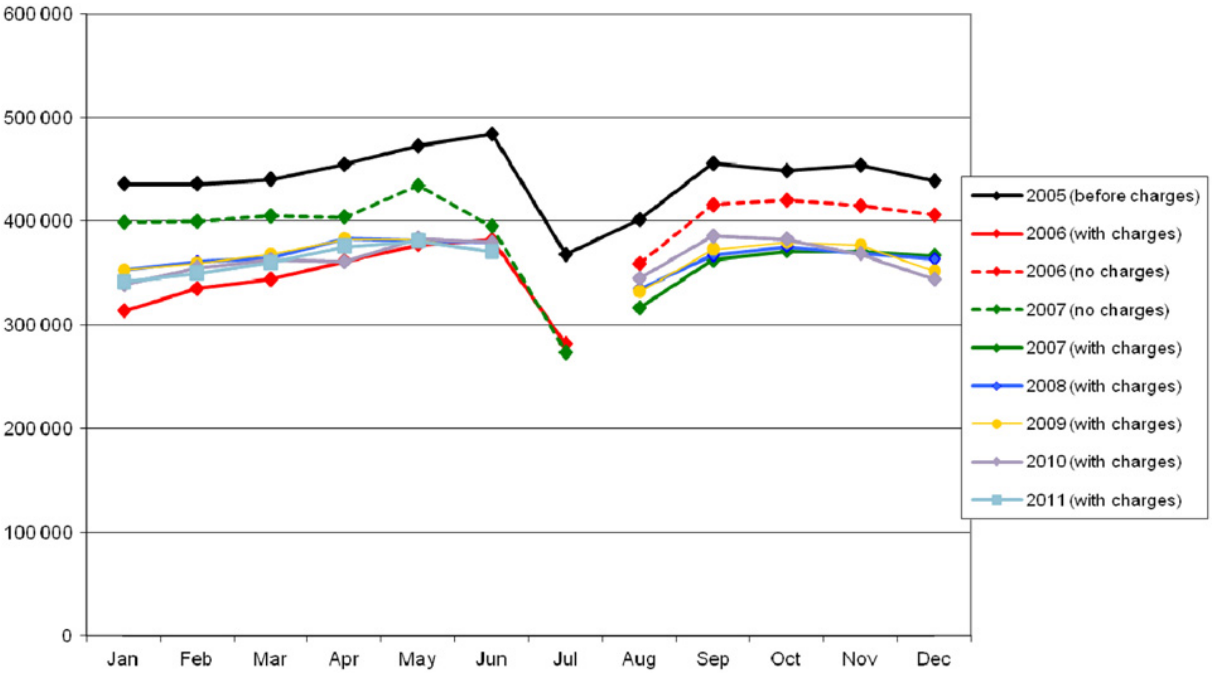

Figure 20 Average Number of Passages Across Cordon (weekdays 6–19).2005–2011

Source: The Stockholm congestion charges (Börjesson et al., 2012, p. 3)

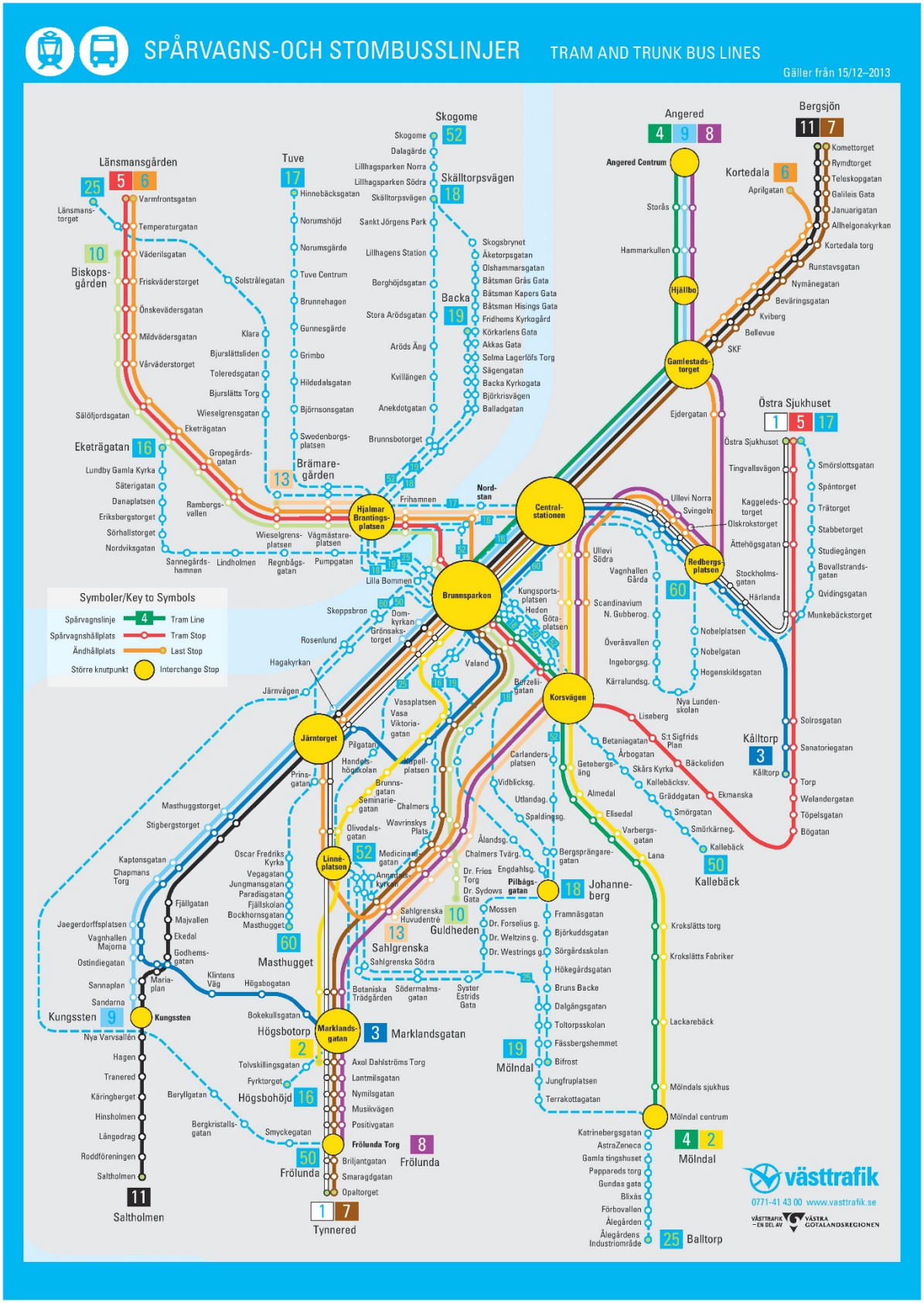

Figure 21 Tram and Trunk Bus Lines

Source: vasttrafik.se

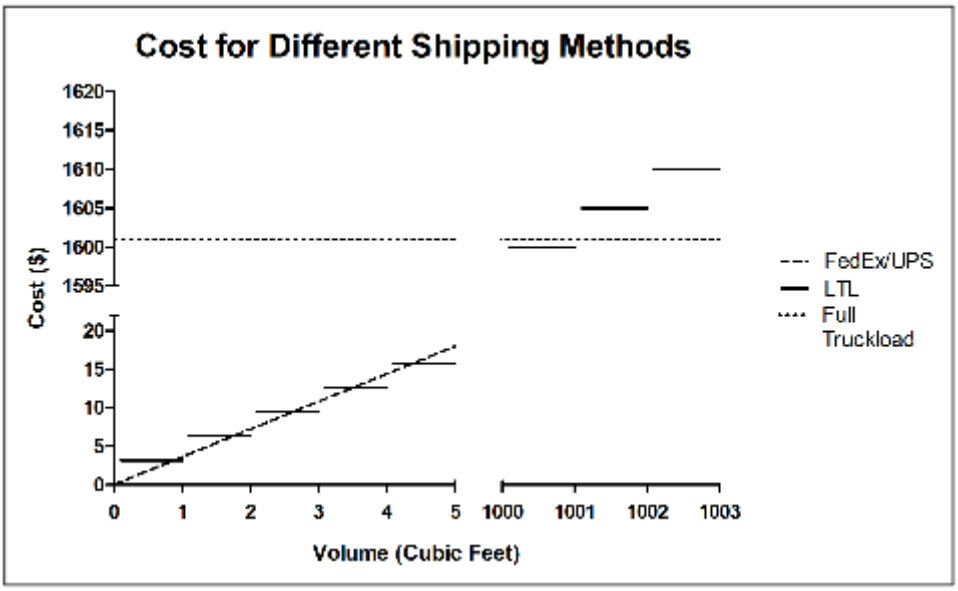

Figure 22 Cheapest Shipping Option Depending on the Volume

Source: Nguyen et al., 2013