Shared Logistic Systems with Logistic Hub: A durable contribution to Sustainable City Logistics?

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Abstract

Urban transport is causing urban congestion as well as emitting a high percentage of pollutants, increasing, creating unhealthy, unpleasant and unsafe situations. Sustainable city logistics is one of the most pressing current day issues and there is increasingly action taken by governments and logistic stakeholders. A lot of initiatives are seen around Dutch cities. By interviewing 5 in-practice experts with managing functions and comparing the outcomes, this paper tries to identify key considerations for effective functioning of these systems. Results show that capacity for electric charging of the vehicles is insufficient and problems are expected to worsen as further growth of SLS with logistic hub is expected. Location of the hubs is considered to be an important factor taking into account two indicators found in the literature, whereas another indicator can be added from the interview results. In addition, the results show that the hubs seem to be performing well on current accessibility with regard to loading/unloading and possible problems in spatial land use.

Background and research problem

City centers are seen as vibrant areas. They often got lively streets, filled with both residents, everyday users and tourists. Meanwhile, residents, entrepreneurs and public facilities order more and more of their goods online and transportation of goods into the city is increasing. CBS (2021) have seen an 11% increase in online ordering in the first half of 2020, Betaalvereniging Nederland (2021) has observed an increase of 27% in the total number of orders (335 million) and Nasdaq (2017) is even expecting that by 2040, 95% of purchases will be facilitated by e-commerce. Taking into account that the population in urban areas is still rising, these numbers are expected to rise even more (United Nations, 2018). As a result, urban freight transport is seen as a major contributor to unhealthy and unsafe situations, contributing to urban congestion and different pollutants (Behrends et al., 2008; Nathanail et al., 2017). A rise in initiatives aiming to improve urban sustainability is seen. Seen as a promising initiative by many is a shared logistic system with a logistic hub (Macharis & Kin, 2017).

Municipalities, universities or companies with big or many buildings in city centers, can provide a good example by contributing to the initiatives aiming for more sustainable urban freight systems (Quak et al., 2019). Goods as printing paper, coffee and sanitary supplies are often delivered by different logistical companies, which may cause inefficient deliveries, which successively can contribute to negative outcomes as urban congestion and pollution for example. Initiatives of shared logistic systems (hereafter referred to as SLS) with logistic hubs aim to bundle supplies so that the different suppliers do not have to go into the city separately. This thesis will thus look into SLS with logistic hubs, with a main focus on supplying municipalities, universities or other big organizations.

Current studies are mainly focussing on policy/governance aspects, as can be seen in for example the research by Gonzalez-Feliu & Salanova (2012), or economic and environmental effects (Ambrosini & Routhier, 2004). Also, the relationship between the movement of goods in the city and spatial land use is not considered a major topic and is underdeveloped (Ambrosini & Routhier, 2004; Cui et al., 2015). In the transition towards sustainable city logistics, spatial land use should be taken into account to keep up with the urban growth and to prevent health and safety problems (Browne et al., 2012). This research aims to describe to what extent the SLS with logistic hubs can be seen as a durable contribution to sustainable city logistics. It aims to address what arguably should be considered for planning such SLS and hubs by some key considerations, connected to spatial land use, found in literature, which will be examined in real-life cases. The aim is to set lessons for future planning of these systems.

Looking at the aim of the research we have created the following research question;

''To what extent can shared logistic systems with logistic hub have a durable contribution to sustainable city logistics in The Netherlands?''

To help answering the research question, the following sub-questions have been formulated;

1. What are shared logistic systems with logistic hubs and how can they be conceptualized as part of sustainable city logistics?
2. What are the key considerations in the current functioning of shared logistic systems with logistic hub?
3. Which lessons can be learned for sustainable city logistics planning when implementing a shared logistic system with logistic hub?

Structure

The theoretical framework in this thesis will go deeper into the concepts of shared logistic systems and logistic city hubs. Next to that, the theoretical framework provides theories about key considerations with regard to electrification, location and accessibility. After the theoretical framework, the methodology section will describe how these theories will be investigated by interviewing experts with hands-on experience in 5 different Dutch cities. The results section will discuss the results found in the interviews by placing them in tables and comparing contributions/barriers found in the 5 different SLS with logistic hub. The conclusion will give a summary of the most important findings out of the interviews with the experts. The expectations about the key considerations will be discussed and if necessary the theory can be adjusted. The conclusion will also show methodological reflection and lessons to be learned for sustainable city logistics planning, with regard to SLS with logistic hubs.

Shared Logistic Systems with Logistic Hubs as part of sustainable city logistics: A theoretical framework

Towards sustainable city logistics

Currently, 55% of the world's population is living in urban areas, but by 2050, this number is expected to increase to 68% (United Nations, 2018). As a result, the United Nations (2018) see sustainable urbanization as a key to successful development, to ensure shared benefits with regard to for example a healthy and safe environment. A still widely shared definition of the concept of sustainability is the one by Brundtland (1987), saying that sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. In addition to the United Nations' goal of sustainable urbanization, Russo & Comi (2012) argue that sustainable urban development is necessary since the urban areas consume 70% of energy and produce about 80% of Greenhouse Gas emissions.

Sustainable urban transport is argued to be an important part of sustainable urban development. Behrends et al. (2008) write that sustainable urban transport can contribute to sustainable development by six sub-objectives, namely: economic efficiency; liveable streets and neighborhoods; protection of the environment; equity and social inclusion; safety; and contribution to economic growth. In addition, urban mobility accounts for 32% of energy consumption and for 40% of the CO2 emissions of road transport and up to 70% of other pollutants from transport (Russo & Comi, 2012). And although city logistics is seen as a key catalyst for the urban economy, it comes with a lot of problems like congestion, air pollution, noise, crashes and reduced accessibility due to obsolete infrastructure or environmental and traffic congestion (Nathanail et al., 2017).

Urban freight transport is seen as a sector with a high impact on city logistics, since it accounts for 6-18% of total urban travel, for 19% of energy use and 21% of CO2 emissions (Russo & Comi, 2012). In addition, Lindholm & Behrends (2012) show that urban freight transport accounts for 16-50% of the emission of air pollutants by transport activities in cities. Furthermore, Behrends et al. (2008) state that vehicles serving urban delivery operations are a well-established contributing factor to urban traffic congestion and increasing atmospheric pollution. To keep up with the current demand growth in freight flows to support the growing urban population, urban freight transport even contributes to problems as premature mortality, disability and sleep disturbance (Browne et al., 2012). These challenges are common to all European cities, even though they are different in terms of geographical, historical and cultural circumstances (Lindholm & Behrends, 2012). Kauf (2016) argues that smooth functioning of cities is not possible without efficient logistics and that designing sustainable systems for city logistics is considered one of the most pressing issues faced by modern cities. In the literature, it is thus a widely shared opinion that city logistics have to become more sustainable and thereby also contribute to sustainable urban development.

This goal of making city logistics more sustainable is also set by the Dutch government with the 'Green Deal: Zero-Emission Stadslogistiek'' (Rijksoverheid, 2021), which refers to the Climate Agreement stating that 30 Dutch cities need to have zero-emission city logistics in 2025. This goal has led to many new initiatives in the country. An initiative that is seen in many cases is the concept of using transfer points for consolidation, combined with sharing of logistics resources (Kauf, 2016). This concept of shared logistic systems with a city hub is also seen in different Dutch cities.

Shared logistic systems (SLS)

To understand the contribution to sustainable urban development by shared logistic systems there should first be an understanding of these systems. A shared logistic system is a system that is used by different actors in which the flow of goods will be streamlined by bundling different flows, which according to Masson et al. (2017) potentially results in less vehicle traffic within the city and more efficient use of these vehicles. Big transport vehicles will do the longer distances and smaller vehicles will travel into the city center because they have less effect on urban congestion, can more easily park and thus will be more effective (Masson et al., 2017). Goldman & Gorham (2006) state that these SLS are now yet in an experimental phase, exploring the innovative outcomes, but will at some point in the future belong to the definition of sustainable transport.

Goldman & Gorham (2006) state that shared logistic systems have proven to have substantial positive effects on sustainable urban transport. In Bremen, where neighboring retailers were working together, the number of truck trips was reduced by 70%, in Freiburg, a shared logistics system reduced the number of truck journeys and truck operating times, respectively by 33% and 48% (Goldman & Gorham, 2006). The effectiveness of the trips is thus going up and the number of trips is going down. Also, the deliveries are mostly done by small electric vehicles (UBR, 2019), which thus also reduces the environmental footprint. Masson et al. (2017) also mention that a shared logistic system is only effective when the vehicles are loaded close enough to their customers since these vehicles are smaller and can thus carry fewer goods. This is the reason why such shared logistic systems in dense urban areas also need a loading spot close to the dense urban areas, this is often called a 'logistic hub' or 'city hub'.

Logistic hub

Urban vehicles use a continuously smaller fraction of their load capacity and at the same time, they drive longer distances (Olsson & Woxenius, 2012). Urban consolidation centers, also called city hubs or logistic hubs, are seen as a promising solution to this (Macharis & Kin, 2017). Systems using a logistic hub consist out of two stages from which the first stage is the delivery of goods to the hub, and the second stage is about bundling and transporting the goods into the city to the clients by a shared logistic system (Macharis & Kin, 2017). By effective consolidation, logistic hubs have the ability to avoid poorly loaded vehicles delivering goods in urban areas and thereby reduce goods vehicle traffic (Allen et al., 2012). Making use of logistic hubs even seems to cause a reduction of truck distances traveled by 60% (Charisis et al., 2020). As mentioned before, the last part of the supply chain is done by small electric vehicles, contributing significantly less to urban congestion (Masson et al., 2017). The kind of logistic hub this research will focus on is a logistic hub used for bundling supplies, like printing paper, coffee, coffee cups and sanitary supplies, for different organizations/institutions. However, literature about these shared logistic systems with logistic hubs also shows some key considerations.

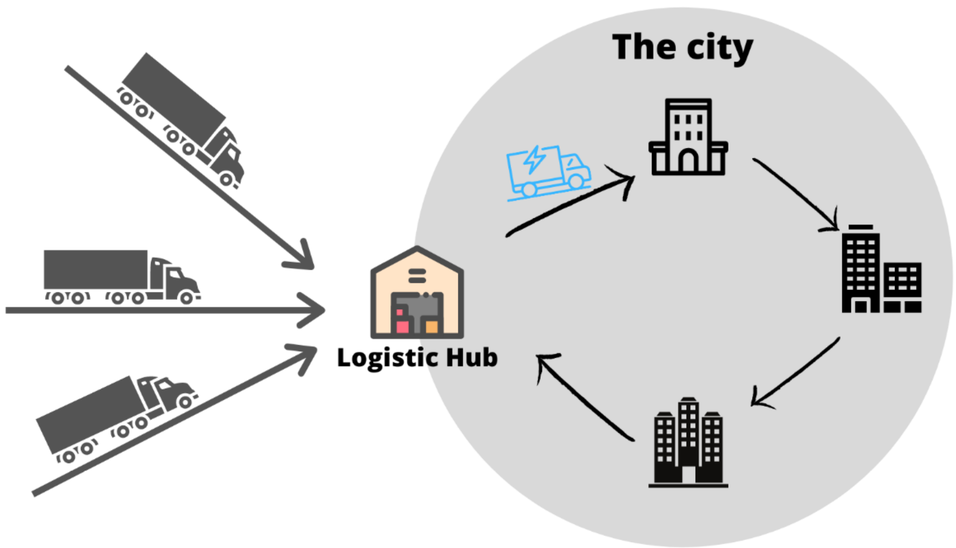


Figure 1: *A visualisation of a Shared Logistic System with Logistic Hub. Stage one: the goods are being delivered to the hub. Stage two: bundling the goods at the logistic hub and delivering them to the clients by a shared logistic system using small electric vehicles.*

Key considerations

This paper investigates to what extent SLS with logistic hub can have a durable contribution to sustainable city logistics on the basis of three key considerations found in the literature. Namely electrification, accessibility and location.

1. Electrification

As mentioned, small electric vehicles are used in shared logistic systems. Small electric vehicles are seen as one of the most promising solutions contributing to sustainable city logistics, particularly because they have no direct CO_2 emissions and produce minimal noise (Muñoz-Villamizar et al., 2017).

Technologies and business developments are not standing still and new success factors and barriers are emerging, to keep research relevant it is important to keep up on these developments in the scientific field (Quak et al., 2016). These vehicles are having battery capacity limitations and thus may need recharging during the delivery process (Li et al., 2020). The current logistic systems are designed for fossil fuel powered vehicles and are not yet feasible for electric vehicles (Li et al., 2020). As a result, more charging points might need to be placed. Ehrler et al. (2019) also mention that the charging infrastructure is missing, the density might not be high enough which can result in situations that someone has to wait or take a detour to charge their vehicle. To avoid waiting or taking a detour for charging a vehicle, building private charging infrastructure can be seen as a solution (Koháni et al., 2017). Effective bundling of goods is argued to be important to use the range of a vehicle in an efficient way. Satisfaction with the range of electric vehicles is argued to be really case-specific depending on the length of the route (Quak et al., 2016). The proximity of the hub to the clients and to the city is an important factor, finding an appropriate location for logistic hubs is seen as a major challenge (Anderluh et al., 2020).

2. Location

The location of the hub generates important consequences for the traffic and the environment (Browne et al., 2005). A location further away from the final customers in urban areas has the advantage that the hub is easily accessible for deliveries and big trucks will not have to enter the urban area, although the number of trips and kilometers to be driven with the SLS could increase (Browne et al., 2005), which in the SLS will have a negative impact taking into account a maximum range of electric vehicles. If the hub is located close to the delivery area, the advantage would be that it will reduce the distance traveled for the electric vehicles. Olsson & Woxenius (2012) conclude from their research that a balance needs to be found between the two issues and that the hub should be located close to intermodal nodes (from big trucks to small electric vehicles), where on the hand, the hub is accessible for the delivery of goods and on the other hand able to minimize the kilometers that the small electric vehicles have to drive to the clients. Although it should be considered that hub location selection traditionally deals with minimizing costs (Farahani et al., 2013). In these locations close to the city centers and close to access roads, land prices are higher and companies might not be able to have as much storage space as preferred. This can cause that trucks from suppliers as well as trucks from the SLS have to load- and unload more often at the hub (McLeod & Curtis, 2020), which will again create congestion. Accessibility of the hub should thus be taken into account to prevent a rise of this problem.

3. Accessibility

Considering the problem mentioned above by (McLeod & Curtis, 2020), loading/unloading at the hub is thus considered as a possible implication. Next to that Muñuzuri et al. (2005) mention that urban logistics often play a secondary role in urban planning, this lack in land use management for the 'last mile' can create different problems like parking and loading/unloading of vehicles. Although the research of Muñuzuri et al. (2005) is not specifically focused on smaller electric vehicles, whereas this paper is. More recent work of Aziz et al. (2018) confirms that in cities these land-use problems are still current problems, with for example the lack of parking space, not wide enough roads and lack of infrastructure dedicated to delivery/pickup. This paper will thus look into the accessibility of hub and clients in a SLS with logistic hub, focussing especially on loading and unloading of trucks. This factor consists of the three subgroups found above; first, the loading/unloading of the trucks delivering supplies at the hub; second, the loading/unloading of the small electric vehicles used in the SLS at the hub; third, the loading/unloading of these small electric vehicles in the city centre at the client. Action to improve this accessibility of the hub and the clients can already be seen in cases, by for example allowing the use of certain access roads, as bus lanes, and parking at non-loading areas for vehicles of the SLS (Quak et al., 2016).

Towards a conceptual model

SLS with logistic hubs are conceptualized as a part of sustainable city logistics. Bundling supplies reduces the number of trips and makes them more effective, for example reducing urban congestion, and using small electric vehicles, reducing emissions. A SLS with logistic hub contributes to sustainable city logistics and is therefore placed as a part of it in the conceptual model. Nevertheless, a SLS with logistic hub comes with key considerations found in the literature. The arrows from the SLS with Logistic Hub point at the key considerations to emphasize the importance of taking these into account. By doing research into the key considerations by literature and by looking at in-practice experience, this research shows to what extent a SLS with logistic hub can have a durable contribution to sustainable urban development. The situation in 5 Dutch cities will be examined to see if the expectations from the theoretical framework can be invigorated for the case of The Netherlands. The research is thus placed within the boundaries of The Netherlands. The relations explained above are shown in the conceptual model (figure 2). This model thus shows the boundaries for the research.

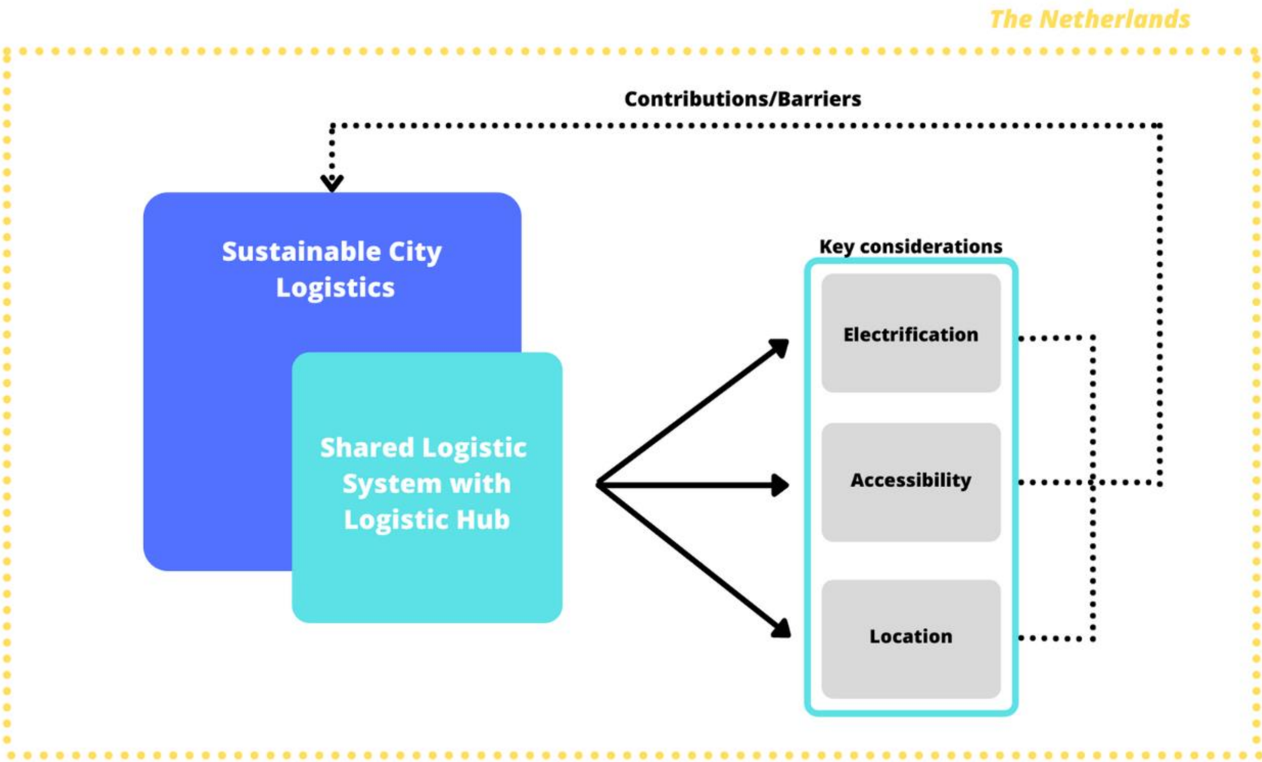


Figure 2: *Conceptual model showing the conceptualization of 'Shared Logistic System with Logistic Hub' as a part of 'Sustainable City Logistics'. The arrows pointing at the key considerations show that these are taken into account in this research to gain a broader understanding of SLS with logistic hubs. The dashed arrow is showing whether the SLS with Logistic Hub can contribute to Sustainable City Logistics*

Expectations

From the literature, it is expected that SLS with logistic hubs can have a durable contribution to sustainable city logistics. Although some key considerations have to be taken into account. It is for example expected that vehicles have to wait or take a detour for charging because of a lack of charging infrastructure. It is also expected that SLS with logistic hubs work best if their location is a balance between being accessible for deliveries and being in a short enough range to keep the SLS effective. At last, implications are expected with the accessibility of the hub and at the clients due to a lack in land use management, especially looking into loading/unloading situations with for example an expected lack of infrastructure dedicated to delivery/pickup and not wide enough roads.

Methodology

This explorative study concerns a qualitative comparison of the key considerations of SLS with a logistic hub. The first sub-question is answered by a literature study in the theoretical framework, which conceptualizes the SLS with logistic hubs as a part of sustainable city logistics. In addition, this research is investigating the key considerations of SLS with logistic hubs found in literature and by gaining real-life experiences from experts in five different already existing systems by doing interviews. These experts are those currently running a SLS with a logistic hub. These outcomes will be compared to each other.

Literature study

The articles are found on sources as Google Scholar, SmartCat and Scopus. Also articles have been found by snowballing from reference lists from different articles. Important search terms for the research were 'sustainable city logistics', 'sustainable urban freight transport', 'logistic flows', 'shared logistic systems', 'City Hub', 'Logistic Hub', 'Urban consolidation centers', 'Spatial Problems', 'Location', 'Small electric vehicles', 'Electric charging', 'Accessibility' and 'Last Mile'. A criteria used is that the articles are about urban systems or urban situations of European cities.

Data collection: Interviews

The aim of the interviews is to investigate to what extent SLS with logistic hubs can contribute to sustainable city logistics by analyzing three key considerations found in the literature. Because of the possibilities to ask for further explanations of answers given, interviews are an appropriate method to go further in-depth into the reasons behind why certain key considerations can cause opportunities or implications. The interviews are inductive, to gain possible new insights and add to the theories about electrification, location and accessibility. Since SLS with logistic hubs are relatively new initiatives, it is important to keep options for possible additional findings open. The interviews will thus be semi-structured (Clifford et al., 2016). The author prepared a list of predetermined questions about the key considerations of SLS with logistic hubs, but the participants are offered an opportunity to explore issues they feel are important (Clifford et al., 2016). The interview guide can be found in the appendix.

The recruitment of interviewees has been carried out as follows: The SLS with logistic hubs are selected by the criteria that they have experience with, or currently aiming at, supplying organizations and/or companies. These logistic systems are thus not focussing on the delivery of private goods. A second criteria is that the vehicles used in the SLS are electric. The selection started by identifying various initiatives of SLS with logistic hubs via the internet, those that seemed suitable were approached by email and phone. The interviewees are considered suitable when they have a clear overview of the current situation and different ongoing developments. The interviewees ideally serve a managing function. Next to this selection, snowballing took place in the interviews by asking the experts for other relevant contacts.

	Location	Company	Interviewee	Function of interviewee
1.	The Hague	Stadslogistiek Den Haag/UTS Abbink/Djinny	Martijn van Ardenne	Administrative assistant
2.	Amsterdam	Deudekom	Eric Sens	Director operations
3.	Nijmegen	Stadslogistiek Nijmegen/UTS Verkroost	Tom Willems	Business partner/account manager
4.	Groningen	StadLogistiek/Jan de Jong Verhuizingen	Oscar Renken	Director
5.	Zuid-Limburg	Stadslogistiek Zuid-Limburg/UTS Bernardt	Noël Tijssen	Business partner

Figure 3: *An overview of the hub locations, companies and the interviewees and their function.*

It has to be taken into account that the research is done following the rules of the RIVM regarding the Covid-19 virus, 3 interviews are held online (via Zoom/Teams/Meet) and 2 interviews are done in a physical meeting.

Data analysis

The interviews are recorded and transcribed. The transcriptions are made and analyzed in Word. The code tree in figure 4 shows how the data is coded using the different indicators of the key considerations explained in the theoretical framework. All indicators are marked with a separate color in Word, as can be seen in the code tree. The results from the interviews are placed in tables showing the different indicators in the rows and showing the different cities in columns. This table will describe negative aspects (-), neutral things to keep in mind but are not real implications (o) and positive findings for an effective SLS with logistic hub (+). This will be an overview from which an analysis can be done. With the data from the interviews, the hypotheses will be tested and eventual new insights and theories will be discussed in the results section as well.

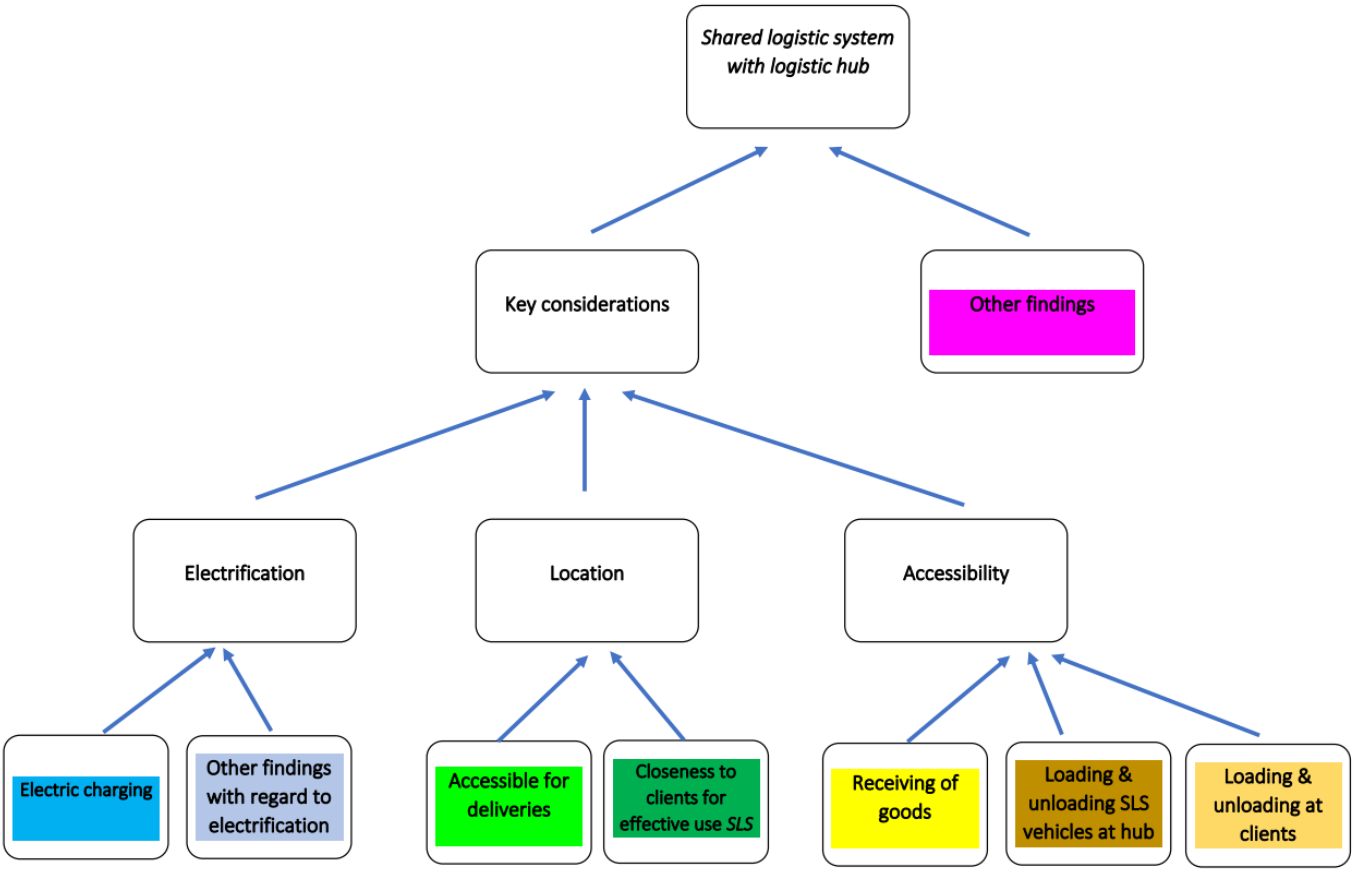


Figure 4: *Code tree for data analysis; in the transcripts, with regard to electrification, quotes concerning 'electric charging' are marked bright blue and 'other findings with regard to electrification' are marked light blue; with regard to location, quotes concerning the 'accessible for deliveries' are marked bright green and 'Closeness to clients for effective use SLS' are marked dark green; with regard to accessibility, quotes concerning 'receiving of goods' are marked yellow, 'Loading & unloading SLS vehicles at hub' are marked dark gold and 'loading & unloading at clients' are marked light gold; quotes concerning 'other implications' are marked purple*

Ethical considerations

The interviewees accepted the interviews and agreed that the shared information is used in this bachelor thesis. The interviewees accepted on recording the interview to make a transcript. The thesis will be made available for the companies involved and for teachers and colleague students at the University of Groningen. The interview recordings and transcripts are saved in a place on the laptop of the author with a password only the author knows. Transcripts can be shared with supervisors if requested, also the companies are free to receive their own recordings/transcripts. As described the rules of the RIVM regarding the Covid-19 pandemic are followed throughout the research.

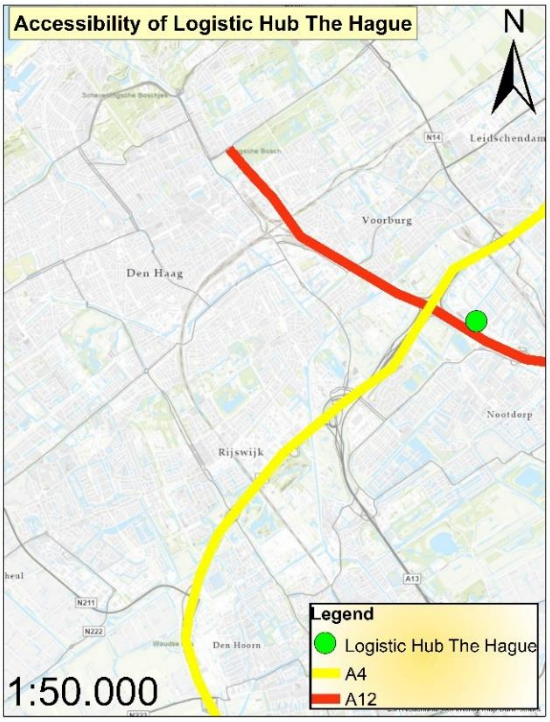
Results & Discussion

This section will first give a brief explanation of the five participating companies running an SLS with Logistic Hub. After that introduction of the participating companies, the results will be shown and discussed in four sub-headers: 1. Electrification; 2. Location; 3. Accessibility and 4. Other findings.

Introduction of the analyzed SLS with logistic hubs

1. The Hague: *Stadslogistiek Den Haag/UTS Abbink/Djinny* – Martijn van Ardenne

This hub is part of the 'Stadslogistiek' organization, which is an initiative from PostNL, working together with 6 local entrepreneurs throughout The Netherlands. Stadslogistiek Den Haag is mainly focussing on supplying government buildings, embassies, municipal buildings and other big organizations. The hub is placed next to highways A4 and A12 (seen in map 1), which is running all the way into the city of The Hague. This makes the city center reachable in around 10/15 minutes. The hub is closely located to the exit/onramp of the highway (seen in map 2). Many clients can be found in the city center but some clients are a bit further away. The small trucks that are used have a range of around 100km (figure 5). Martijn van Ardenne is administrative assistant at Stadslogistiek Den Haag.



Map 1: *Location of the Logistic Hub The Hague; close to the A4 and A12 highways*

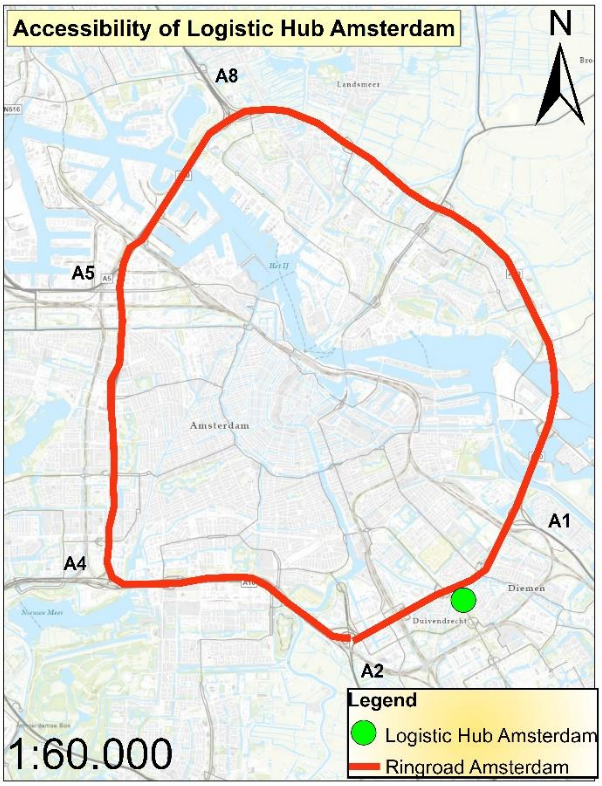
Map 2: *Close up of the access road of the Logistic Hub in The Hague; connected to the highway A12*

Figure 5: *The small trucks used: Fuso Canter (source: postnl.nl)*

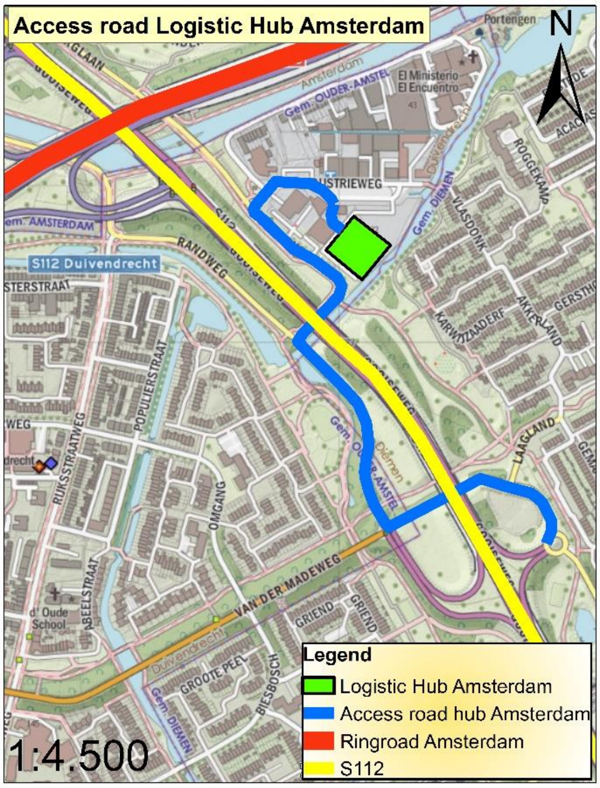
Figure 6: *The Logistic Hub in The Hague (source: logistiek.nl)*

2. Amsterdam: *Deudekom* – Eric Sens

This hub is placed just outside the 'milieuzone' of Amsterdam, near the Ringroad A10. This ring road is connected to the important highways A1, A2, A4, A5 and A8 (as shown in map 3) and to important S-roads into the city center. The hub is also connected to the S112 (shown in map 4), which is a connecting road into the city center and makes it around a 10-minute drive to the center. This hub is focussing on supplying institutions with multiple locations in the Metropole Amsterdam Region, that have a large facility purchasing department or desire to make their purchasing more sustainable. Big clients are the 'University of Amsterdam' and the 'Hogeschool of Amsterdam', from which the buildings are supplied by Deudekom. The small trucks that are used have a range from around 100km (comparable to the one in figure 5). Eric Sens is director operations at Deudekom.



Map 3: *Location of the Logistic Hub Amsterdam; close to Ringroad Amsterdam*

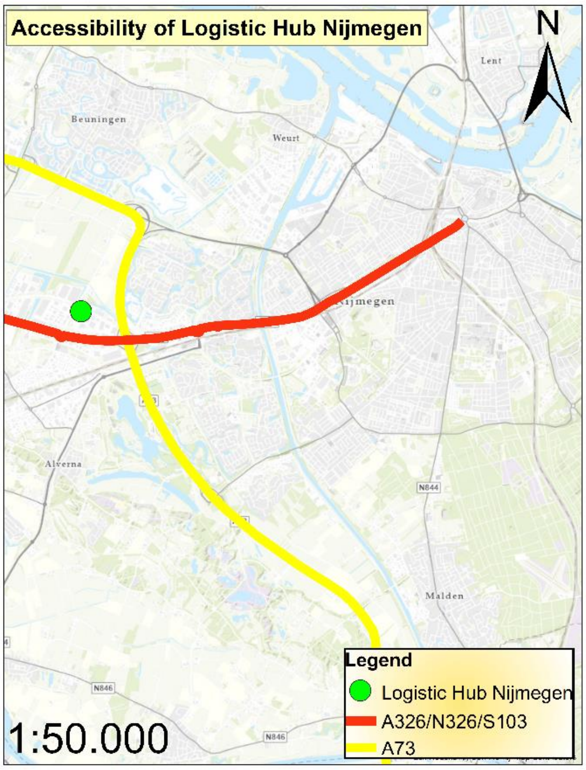


Map 4: *Close up of the access road of the Logistic Hub Amsterdam; connected to the highway A12*

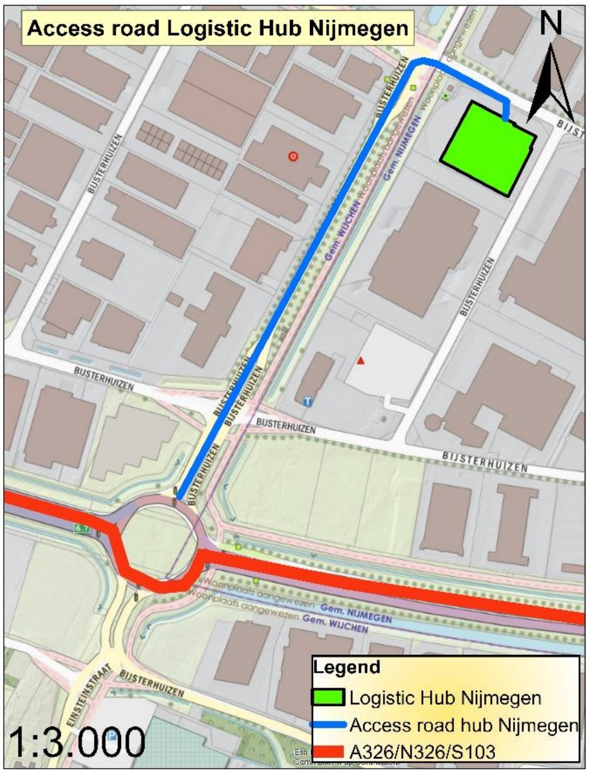
Figure 7: *The Logistic Hub in Amsterdam (source: deudekom.nl)*

3. Nijmegen: *Stadslogistiek Nijmegen/UTS Verkroost* – Tom Willems

The logistic hub in Nijmegen is also part of the PostNL initiative 'Stadslogistiek'. This hub has a focus on supplying different municipal organizations and companies. Big clients are educational institutions Radboud University, the HAN (Hogeschool Arnhem Nijmegen) and the RadboudUMC. They supply buildings in the city center as well as at the Heijendaal Campus. The hub is located near highways A73 and A326 (seen in map 5). There is a close onramp/exit of the A326 (seen in map 6), which turns into N326 and later on into S103, which leads all the way into the city center. It is around a 15-minute drive to the Campus/RadboudUMC. The small trucks that are used have a range from around 100km (same one as shown in figure 5). Tom Willems is business partner at Stadslogistiek and account manager at UTS Verkroost.



Map 5: *Location of the Logistic Hub Nijmegen; close to the A73 and A326 highways*



Map 6: *Close up of the access road of the Logistic Hub Nijmegen; connected to the highway A326 and the S103 into the city centre*

Figure 8: *The Logistic Hub in Nijmegen (source: utsverkroost.nl)*

4. Groningen: *StadLogistiek/Jan de Jong Verhuizingen* – Oscar Renken

As can be seen on the maps below, StadLogistiek is located near the Ringroad Groningen and to the A7 highway. The Ringroad Groningen is connected to A7, A28, N-roads and access roads into the city center, which is a 10/15 minute drive from the hub. They have experience with supplying organizations in the city center. For example, supplying governmental buildings with printing paper. Although they stopped supplying the printing paper they are exploring different new initiatives for supplying. StadLogistiek is an initiative from Jan de Jong Verhuizingen and thus not part of the 'Stadslogistiek' initiative. StadLogistiek used a small truck (as seen in figure 5), but is currently using a van that has a range of around 120km (figure 10). Oscar Renken is the director of StadLogistiek and Jan de Jong Verhuizingen.

Map 7: *Location of the Logistic Hub Groningen; close to the Ringroad Groningen and the A7 highway*

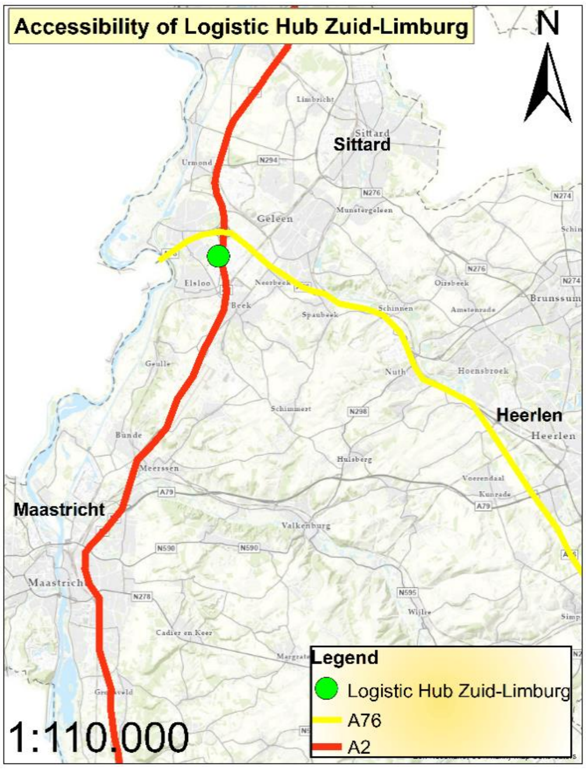
Map 8: *Close up of the access road of the Logistic Hub Groningen; connected to the Ringroad Groningen*

Figure 9: *The Logistic Hub in Groningen (source: jandejong.nl)*

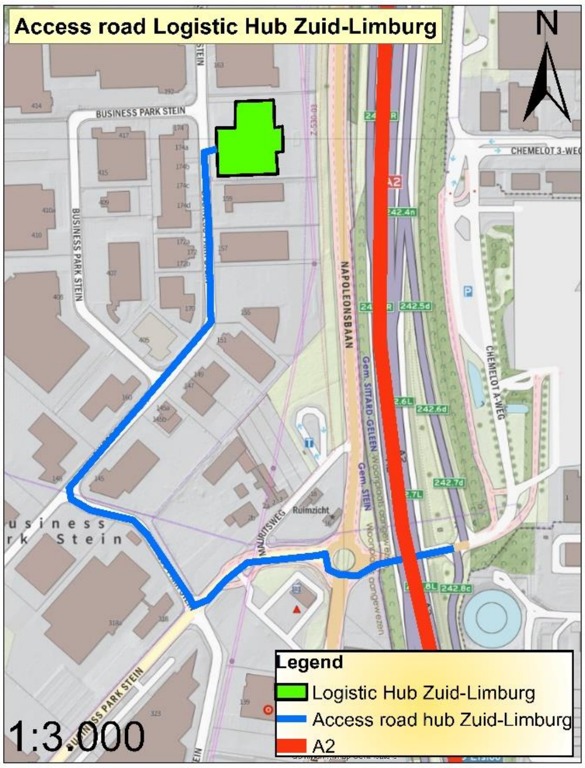
Figure 10: *The currently used vehicle: Peugeot e-Partner (source: jandejong.nl)*

5. Zuid-Limburg: *Stadslogistiek Zuid-Limburg/UTS Bernardt* – Noël Tijssen

Stadslogistiek Zuid-Limburg, also part of the PostNL initiative, is focussing on supplying institutions with for example printing paper, sanitary supplies and coffee. The hub is still in a starting phase but is already running. The hub is not linked to one city per se but does have multiple cities in a close range, for example Sittard, Heerlen and Maastricht. As seen in the maps below, the hub is located next to the A2 and A76 highways. The A2 highway is an important road when driving to Maastricht, which is a 10-minute drive. The A76 is an important route when driving to Heerlen, which is around a 15-minute drive. The center of Sittard is around a 10-minute drive. The small trucks that are used have a range of around 100km (figure 5). Noël Tijssen is business partner at Stadslogistiek.



Map 9: *Location of the Logistic Hub Zuid-Limburg; close to the A2 and A76 highways*



Map 10: *Close up of the access road of the Logistic Hub Zuid-Limburg; connected to the A2*

Figure 11: *The Logistic Hub in Zuid-Limburg (source: stadslogistiek.nl)*

Key considerations in current function SLS with logistic hub: The results

1. *Electrification*

From the theoretical framework, the expectations are that electric vehicles might have to take a detour or wait for a charging point (Ehrler et al., 2019). This can be confirmed by some cases (table 1). There is a possibility of public charging points being full so the driver has to wait or has to drive to another charging point in the city (Interview The Hague; Interview Groningen). When using private charging points, this problem is not found (Interview Amsterdam; Interview Nijmegen; Interview Zuid-Limburg). This indicates that the expectations of taking a detour or waiting for a charging point can be argued as valid when using public charging infrastructure. Since in many cases growth is expected, this problem is likely to increase. Interviewees mention a solution for this, namely private fast charging points.

From the interviews, it became clear that fast charging is seen as a major motive to make the SLS with logistic hub work. In most cases the vehicles are able to drive around 100km, this is not enough for a whole day. Charging while loading/unloading at the hub and in breaks is a solution to keep the vehicle sufficiently loaded for driving the whole day (Interview Amsterdam). Fast charging needs around 30/45 minutes to be loaded for around 80% again (Interview Nijmegen). It is mentioned that if fast charging is or will not become available, night shifts are needed to change the vehicles at the charging points (Interview Amsterdam; Interview Groningen). And although fast charging is seen as a solution, it comes with problems. Not all current vehicles are ready for fast charging yet (the reason why investments are postponed), although looking at the technical progress, it is expected that soon all vehicles will be able to fast charge (Interview Nijmegen; Interview Groningen). Another problem is that the electricity grid is often deemed not suitable for fast charging. Problems with the electricity grid are for example explicitly mentioned in Amsterdam, Groningen and Nijmegen. The current state of the grid is sufficient but any future rise of electricity use is expected to overload it. The electricity grid capabilities differ per location, depending on electric activities and the capacity of the net in an area. In the case of Amsterdam, solar panels are not seen as a real possibility because the grid operators do not want to use the opportunity to receive energy back. Storage would then be needed at the hub. Other companies are not able to place solar panels because the hub is rented and not self-owned (Interview Nijmegen; Interview Groningen). It is expected that these grid problems will increase in the coming years since the current energy transition is enforcing an increase in energy consumption. The interviews show that changes to the electricity grid to support fast charging would contribute to the working of SLS with logistic hubs. The interviews also argue that grid capacity in areas should be taken into account when selecting hub locations. Since activity on the net is expected to increase, possible hub locations might be located further away from the center, which would influence the effectiveness of the SLS.

A suitable location for a logistic hub, with regard to the electricity network, depends on the current situation but also on the possibilities for expanding the electricity grid in the future. From the interviews, it can be argued that for hub location selection, a suitable electricity connection should be considered as a selection criteria.

Table 1

		Den Haag	Amsterdam	Nijmegen	Groningen	Zuid-Limburg
1. Electrification	***Electric charging***	- No own charging point, charging at public point near the hub or in the city centre - Some points are really far away, then driver has to charge the vehicle to do the trip - Sometimes in line for public charging point - Charging 2-3 times a day for 1 hour at a time (100km range is not enough)	+ Lot of charging points (6 own and 9 shared) so no problem with that. Also 1 fast charger + 100km radius always able to fulfil two routes a day, charging while being loaded/unloaded at hub (half an hour loading/unloading and half an hour break so 1 hour of charging)	+ Enough own charging points (5/6) + 2,5/3 times up and down to the centre with fully loaded vehicle (close to city centre)	+ Own charging point enough for now + 2 stations with each 4 fast charging points nearby - If fast charging points are full at one station you sometimes have to take a detour to come to other station - Range is problem, vehicle can only drive for halve a day, battery empty at the end the morning so not possible to drive after that (5 hour charging needed). Fast charging would be solution.	- Range is problem, vehicle can only drive for halve a day, battery empty at the end the morning so not possible to drive after that (charging needed). Fast charging would be solution.
	Other findings with regard to electric vehicles/system	- Have to take into account temperature of vehicle (if cold, battery empties faster) and weight in vehicle (if heavy, battery empties faster) - Problems if tailgate is not straight: not possible to load pallets on a sloping tailgate (non-electric tailgate)	o Where using too much electricity, but 2nd transformer house solved this problem. If 2nd transformer house was not placed, there should be a night shift for changing vehicles at the charging points. - Electricity grid limitations expected to become a problem in the future. - Solar panels create energy at day time when vehicles are gone. Storage needed because grid operators do not want to receive energy back at the grid.	o If enough vehicles; fast charging point will be a solution to keep up (30/45 minutes loading in break means vehicle loaded for 80%) - City is behind with electricity grid, municipality has to work on grid - Not all vans suited for fast charging yet (wait with investments until further developed) - Problems if tailgate is not straight: not possible to load pallets on a sloping tailgate (entry truck too low for docks, sometimes not accepted at docks which takes time and effort and tailgate cannot handle weight)	- Grid is full, maybe only 2 extra charging stations possible. Fast charging not possible. (Also looking for new Hub location but grid is a problem everywhere) - Not all vans suited for fast charging yet (wait with investments until further developed) - If it becomes problematic you need a night shift for changing vehicles at the charging stations - Have to take into account temperature of vehicle (if cold, battery empties faster) and weight in vehicle (if heavy, battery empties faster)	

2. Location

As Olsson & Woxenius (2012) showed in the theory section, it is argued that the location of a hub should ideally be a balance between being accessible for deliveries and being close enough to clients to keep the SLS effective. From the interviews, this expectation can be argued as valid. Looking at the location of the hubs as described in the introduction of the cases above (maps 1-10), it can be seen that most hubs are located on locations that seem suitable as intermodal nodes. All interviewees argue that their hubs are well accessible for deliveries. We can see problems that if the clients are too far away, the system becomes less effective since the vehicles for example have to charge more often (Interview The Hague; Interview Zuid-Limburg). As also expected by the theory, closeness of clients is thus argued to be really important for the SLS to function. In The Hague, clients are widespread which causes inefficiency, in Zuid-Limburg, the SLS is not focussing on one area but on multiple urban areas situated relatively far away from each other, which can create inefficiency since a vehicle cannot reach two urban areas in one day.

Table 2

		Den Haag	Amsterdam	Nijmegen	Groningen	Zuid-Limburg
2. Location	***Accessible for deliveries***	+ Location good accessible for delivery trucks	+ Located close to access roads for deliveries + Metropole region Amsterdam supported Hubs as a solution and made the hub good accessible for deliveries by big trucks (by for example broadening the access roads)	+ Accessible via different highways + No traffic jams	+ Located close to access roads for deliveries	+ Location good accessible for delivery trucks via highway A2
	Closeness to clients for effective use SLS	- Some points are really far away, then route might become inefficient due to lack of range	+ Located close to access roads for SLS - In the future more square meters needed for storage of goods (even more increase expected after the Covid-19 pandemic)	+ 2,5/3 times up and down to the centre with fully loaded vehicle (close to city centre)	+ Groningen relatively small city compared to for example Amsterdam, in couple of years high enough radius expected	+ Located close to access roads for SLS - In between different urban areas and not directly linked to one. Making deliveries in one city causes that there is no range left to leave other cities (Up and down to Maastricht already 35 km)

3. *Accessibility*

The expectations with regard to accessibility were that problems were expected with loading/unloading at the hub because of a high number of trucks (McLeod & Curtis, 2020). These specific problems are not found. This can possibly be linked to what is mentioned in the 'location' sector above: most hubs are located on really accessible points. In addition, interviewees link this to the fact that they have a high number of loading docks/places (Interview The Hague; Interview Amsterdam; Interview Nijmegen; Interview Zuid-Limburg). Also, a smooth flow can be found in the cases. This smooth flow is created by the circumstances around the company (in Amsterdam the roads have been broadened to make the area more accessible) or through own effort (time slots for loading/unloading in Groningen and active helping with unloading goods in The Hague).

Contrary to the expectations of possible problems at the loading- and unloading of own vehicles at the customers (Muñuzuri et al., 2005), also no real problems are found. Small streets and busy roads are not seen as a surprise for the interviewees, although it was expected by theory (Quak et al., 2016). The reason for this can be found in the use of small trucks (figure 5 & figure 10), which can be considered as an advantage over using the traditional bigger trucks (Interview Zuid-Limburg). In addition, the fact that drivers often drive the same route and thus know the roads is also argued to be an advantage (Interview The Hague; Interview Amsterdam). It can also be argued that the kind of deliveries at the clients have a positive contribution. The clients of these SLS are mainly big organizations as universities, municipality buildings and other big organizations, which are more often in more open and accessible public areas. These institutions are used to receive a lot of supplies and sometimes have their own loading docks (Interview Nijmegen).

Table 3

		Den Haag	Amsterdam	Nijmegen	Groningen	Zuid-Limburg
3. Accessibility	***Receiving of goods***	+ Many different docks for loading/unloading + Help with unloading goods so trucks will be gone faster	+ Many different docks for loading/unloading + Metropole region Amsterdam supported Hubs as a solution and made the hub good accessible for deliveries by big trucks (by for example broadening the access roads)	+ Many different docks for loading/unloading	+ Time slots for receiving goods and loading own trucks so it doesn't come at the same time	+ Enough docks for loading/unloading
	Loading- and unloading own vehicles at Hub	+ Many different docks for loading/unloading	+ Many different docks for loading/unloading	+ Many different docks for loading/unloading	+ Time slots for receiving goods and loading own trucks so it doesn't come at the same time	+ Enough docks for loading/unloading
	Loading- and unloading own vehicles at customer	+ Drivers drive same route very often, so they know smart tricks + People see that you are a delivery vehicle (logo PostNL on truck) and accept that you park in public space	+ Drivers drive route every day, so they found smart tricks o Many rules and regulations, but not really a problem when used to it o Does take 15 minutes from A to B, then searching a parking spot and then unloading, but that is a known fact in this city	+ People see that you are a delivery vehicle (logo PostNL on truck) and accept that you park in public space + Most clients not in middle of centre so a bit more space to unload (facilitating goods to big clients as hospitals, university buildings and big organisations seem to have loading docks and a bit more free space around) o City does not have ring road so manoeuvring from A to B through city which is built for pedestrians and cyclists	+ No problems with loading/unloading at clients	+ Electric vehicle is small so can deliver service other big trucks can not

4. *Other findings*

Table 4 shows that from the interviews, problems relating to stakeholders are found. This aspect which is showed by the interviewees is that partners or companies are often not willing to cooperate if they are not strongly enforced to change. Cooperation from suppliers as well as clients seems to be necessary to effectively bundle goods and make the SLS run in an effective way (Interview The Hague; Interview Amsterdam; Interview Groningen; Interview Zuid-Limburg). It is for example seen that if clients have enough power to decide about the delivery of their goods and in that way force suppliers, the suppliers are willing to work along (Interview Amsterdam). It is also said by interviewees that clients as municipalities, universities and other big organizations should be setting an example since they have the power to force suppliers (Interview Zuid-Limburg). Better cooperation with, and a more benevolent attitude of, stakeholders is expected to increase the effectiveness and sustainability of the system.

Other findings can be found in the technical part of the electric trucks (table 1). For example the tailgate of the trucks, which are often too low for loading docks or cannot carry the weight of heavy products, the weight restrictions of the truck and the reduction in kilometers range of the electric trucks when they are cold or heavily loaded (Interview The Hague; Interview Nijmegen; Interview Groningen). Interviewees mention that these technical aspects are expected to be solved in the near future (Interview Nijmegen; Interview Groningen).

Taking growth into account

As seen in the results, growth of SLS with logistic hubs is expected by many interviewees. Growth can considerably come with new implications. As to this moment loading and unloading at the hub does not seem to be a problem, it can for example be argued that new implications might arise if the loading/unloading activity will go up drastically and more trucks will have to load and unload. Another possible consequence could be an increase in logistic hubs, which could change the serving areas and have an influence on the closeness of clients and thus effectiveness. Growth can also create new implications in the area of charging, with for example longer waiting times for charging points. As explained above, possible increases in charging and fast charging points will might overload the grid. Growth can arguably be seen as an important factor to keep in mind for city logistic planners.

Table 4	Den Haag	Amsterdam	Nijmegen	Groningen	Zuid-Limburg
Other findings	- Have to deliver the goods all the way inside buildings, that is sometimes hard to find. When inside some goods outside are sensitive to theft. - Some customers are bounded to visiting times (good bundling not always possible) - No real bundling yet (would be easier if known beforehand when goods will be delivered and people expect to have goods as soon as possible)	+ Success when partners are willing to bundle goods (bundle 3 pallets as 1 pallet) + Use storage at client - Suppliers and transporters often do not want to cooperate because transporting belongs to their business model. Client should have the power to decide about the delivery of goods - Bridges and quays are crumbling, needs 12 years of reparation and as a consequences smaller and lighter vehicles. Possible weight restrictions of 7,5 tonnes, that number is currently higher, also taking into account heavy batteries. - Possible new regulations of only accessing traffic into the city through two access roads will double the number of kilometres and the number of time.	o Number of clients is increasing and expected that after covid-19, the volume of goods will increase as well. That might bring more challenges along (possibly too much volume for one trip/route) - The Hub is rented, so no own decision about for example solar panels	- Goods as printing paper are very heavy, vehicle cannot be fully loaded and number of trips does increase instead of decrease (volume of truck cannot be used), thus not sustainable - Clients do not feel a strong need to make the logistics more sustainable. Everyone wants to change as late as possible, they only change if it is really necessary. Very late change expected. Feels like market is not ready yet. - Possible clients often do not want to pay more - Some deliveries need aftersales, driver needs to learn that as well (for example replacing towel systems) - The Hub is rented, so no own decision about for example solar panels	- Companies only change if strong need to change is enforced, if it is free of obligation, companies will not change. - Hard to bundle different suppliers, they are not ready for it - Clients as municipalities, universities and other big organisations should be setting an example. They have the power to force suppliers

Conclusion

This research aims to answer the question to what extent SLS with logistic hub can have a durable contribution to Sustainable City Logistics, taking into account three key considerations which will be analyzed by looking at in-practice experience, namely electrification, location and accessibility.

Considering the literature reviewed and the conducted interviews, this research created some main outcomes. SLS with logistic hubs can be argued as contributing to sustainable city logistics, although some key considerations should be taken into account. First, electrification: waiting or taking a detour for public vehicle charging is seen. Private fast charging is seen as a solution to this problem, although this often seems to be impossible because of electricity grid limitations. Grid limitations are argued to possibly play an important role in future sustainable city logistics planning. Location is also argued as a key consideration since the effectiveness and performance of a SLS with logistic hub seems to be dependent on the accessibility of the hub for the deliveries on the one side, and on the closeness of clients and customers on the other side. Accessibility of the hub and the clients is also a key consideration. It can be argued that in the participating Dutch cases, a high number of loading docks, a good connection to access roads, well-facilitated receipt of goods at clients and small vehicles are seen as advantages contributing to a good performance of the SLS with logistic hub.

The outcomes of electrification are in line with the literature, explaining that taking a detour or waiting for public charging points is found in the cases. Next to that, the literature found on a balance in location between being accessible for deliveries and being close enough to customers, can be substantiated by the findings from the interviews showing the importance of the location. The literature found on possible problems with accessibility with regard to loading/unloading and spatial land-use problems were not in line with the findings from the interviews, in the participating Dutch cases, no problems were found.

From the interviews, it can be considered that some aspects in the theoretical framework are missing. First, for improvement of the theoretical framework, research on fast charging and on electricity grid capacity are discussed to be important additions. Electricity grid capacity can be discussed as a third location selection criteria next to the two mentioned criteria from the literature on being accessible for deliveries and on being close enough to customers. Another addition is suggested on incentives for cooperation. The research suggests that incentives for cooperation can be seen as a pre-condition for an effective SLS with logistic hub. It is suggested to add this concept in the theoretical framework and therefore a revised conceptual model is suggested in figure 12, including this pre-condition.

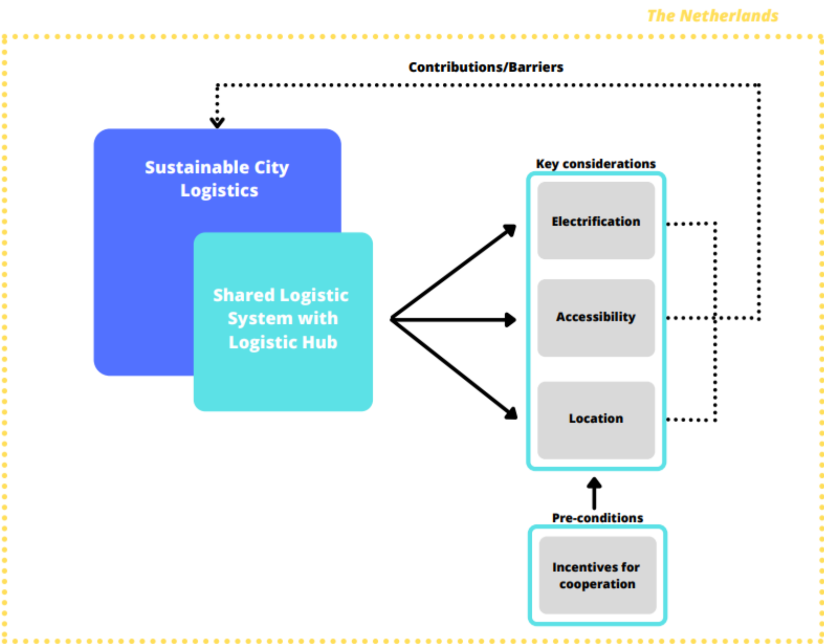


Figure 12: *Revised conceptual model. 'Incentives for cooperation' is added as a pre-condition for an effective functioning of a SLS with logistic hub*

Reflecting on the research the author suggests a methodological improvement. Since the three key considerations have an overlap on many subjects, for future research it could be considered to not look at it the research from key considerations, but to develop a 'subject-oriented' approach. Certain subjects could then more easily be discussed with regard to the different key consideration areas it affects. Another suggestion is to perform the research in cities in different countries than The Netherlands to come to a more broad understanding.

Reflecting on the process, it is suggested to contact more interviewees than necessary. Mails and phone calls are for example often not directly linked to the interviewee but to another employee of the company, which can cause it to take longer to make an appointment. Also, interviewees can until any moment cancel the appointment, so it is recommended to have some extra security with more interviewees. A solution to this could be trying to come in contact with more different companies and via different ways.

It can be discussed that the semi-structured interview setup has been useful because it gave us new insights, with regard to fast charging, electricity grid capacity and needed incentives for cooperation. Future research is suggested on these three areas. Since apparently in-practice experts expect a rise of problems in these areas, which should be tackled.

Three lessons for sustainable city logistic planners can be advised from the research. It is advised to take electricity grid capacities into account as a third criteria for location selection by working together with responsible parties as the grid operators and government. Second, for location selection, it is advised to always try to find the balance between being accessible for deliveries and being close enough to customers so to keep up with possible future growth. Last, it is advised to try to find incentives for cooperation, since this cooperation can be seen as a pre-condition for the effective functioning of a SLS with logistic hub.

References (scientific articles)

Allen, J., Browne, M., Woodburn, A., & Leonardi, J. (2012). The Role of Urban Consolidation Centres in Sustainable Freight Transport. *Transport Reviews*, *32*(4), 473–490. https://doi.org/10.1080/01441647.2012.688074

Ambrosini, C., & Routhier, J. L. (2004). Objectives, methods and results of surveys carried out in the field of urban freight transport: An international comparison. *Transport Reviews*, *24*(1), 57–77. https://doi.org/10.1080/0144164032000122343

Anderluh, A., Hemmelmayr, V. C., & Rüdiger, D. (2020). Analytic hierarchy process for city hub location selection-The Viennese case. *Transportation Research Procedia*, *46*, 77–84. https://doi.org/10.1016/j.trpro.2020.03.166

Aziz, S., Benmoussa, R., & Irhirane, E. H. (2018). City Logistics Problems' Identification: A First Step Toward an Analysis Approach. *Colloquium in Information Science and Technology, CIST*, *2018-Octob*, 578–582. https://doi.org/10.1109/CIST.2018.8596321

Behrends, S., Lindholm, M., & Woxenius, J. (2008). The impact of urban freight transport: A definition of sustainability from an actor's perspective. *Transportation Planning and Technology*, *31*(6), 693–713. https://doi.org/10.1080/03081060802493247

Browne, M., Allen, J., Nemoto, T., Patier, D., & Visser, J. (2012). Reducing Social and Environmental Impacts of Urban Freight Transport: A Review of Some Major Cities. *Procedia - Social and Behavioral Sciences*, *39*, 19–33. https://doi.org/10.1016/j.sbspro.2012.03.088

Browne, M., Sweet, M., Woodburn, A., & Allen, J. (2005). *Urban freight consolidation centres final report. Available from:. University of Westminster, Report for Department for Transport (Dft), Transport Studies Group.* 190. http://ukerc.rl.ac.uk/pdf/RR3_Urban_Freight_Consolidation_Centre_Report.pdf

Charisis, A., Spana, S., Kaisar, E., & Du, L. (2020). Logistics Hub Location-Scheduling Model for Inner-City Last Mile Deliveries. *International Journal for Traffic and Transport Engineering*, *10*(2), 169–186. https://doi.org/10.7708/ijtte.2020.10(2).04

Cui, J., Dodson, J., & Hall, P. V. (2015). Planning for Urban Freight Transport: An Overview. *Transport Reviews*, *35*(5), 583–598. https://doi.org/10.1080/01441647.2015.1038666

Ehrler, V. C., Schöder, D., & Seidel, S. (2019). Challenges and perspectives for the use of electric vehicles for last mile logistics of grocery e-commerce – Findings from case studies in Germany. *Research in Transportation Economics*, *December 2018*. https://doi.org/10.1016/j.retrec.2019.100757

Farahani, R. Z., Hekmatfar, M., Arabani, A. B., & Nikbakhsh, E. (2013). Hub location problems: A review of models, classification, solution techniques, and applications. *Computers and Industrial Engineering*, *64*(4), 1096–1109. https://doi.org/10.1016/j.cie.2013.01.012

Goldman, T., & Gorham, R. (2006). Sustainable urban transport: Four innovative directions. *Technology in Society*, *28*(1–2), 261–273. https://doi.org/10.1016/j.techsoc.2005.10.007

Gonzalez-Feliu, J., & Salanova, J.-M. (2012). Defining and Evaluating Collaborative Urban Freight Transportation Systems. *Procedia - Social and Behavioral Sciences*, *39*, 172–183. https://doi.org/10.1016/j.sbspro.2012.03.099

Kauf, S. (2016). City logistics - A Strategic Element of Sustainable Urban Development. In *Transportation Research Procedia* (Vol. 16, pp. 158–164). https://doi.org/10.1016/j.trpro.2016.11.016

Kohání, M., Czimmermann, P., Váňa, M., Cebecauer, M., & Buzna, Ľ. (2017). Designing charging infrastructure for a fleet of electric vehicles operating in large urban areas. *ICORES 2017 - Proceedings of the 6th International Conference on Operations Research and Enterprise Systems*, *2017-January*(January), 360–368. https://doi.org/10.5220/0006194403600368

Li, Y., Lim, M. K., Tan, Y., Lee, S. Y., & Tseng, M. L. (2020). Sharing economy to improve routing for urban logistics distribution using electric vehicles. *Resources, Conservation and Recycling*, *153*(June 2019), 104585. https://doi.org/10.1016/j.resconrec.2019.104585

Lindholm, M., & Behrends, S. (2012). Challenges in urban freight transport planning - a review in the Baltic Sea Region. *Journal of Transport Geography*, *22*, 129–136. https://doi.org/10.1016/j.jtrangeo.2012.01.001

Macharis, C., & Kin, B. (2017). The 4 A's of sustainable city distribution: Innovative solutions and challenges ahead. *International Journal of Sustainable Transportation*, *11*(2), 59–71. https://doi.org/10.1080/15568318.2016.1196404

Masson, R., Trentini, A., Lehuédé, F., Malhéné, N., Péton, O., & Tlahig, H. (2017). Optimization of a city logistics transportation system with mixed passengers and goods. *EURO Journal on Transportation and Logistics*, *6*(1), 81–109. https://doi.org/10.1007/s13676-015-0085-5

McLeod, S., & Curtis, C. (2020). Understanding and Planning for Freight Movement in Cities: Practices and Challenges. *Planning Practice and Research*, *35*(2), 201–219. https://doi.org/10.1080/02697459.2020.1732660

Muñoz-Villamizar, A., Montoya-Torres, J. R., & Faulin, J. (2017). Impact of the use of electric vehicles in collaborative urban transport networks: A case study. *Transportation Research Part D: Transport and Environment*, *50*, 40–54. https://doi.org/10.1016/j.trd.2016.10.018

Muñuzuri, J., Larrañeta, J., Onieva, L., & Cortés, P. (2005). Solutions applicable by local administrations for urban logistics improvement. *Cities*, *22*(1), 15–28. https://doi.org/10.1016/j.cities.2004.10.003

Nathanail, E., Adamos, G., & Gogas, M. (2017). A novel approach for assessing sustainable city logistics. *Transportation Research Procedia*, *25*, 1036–1045. https://doi.org/10.1016/j.trpro.2017.05.477

Olsson, J., & Woxenius, J. (2012). Location of Freight Consolidation Centres Serving the City and Its Surroundings. *Procedia - Social and Behavioral Sciences*, *39*, 293–306. https://doi.org/10.1016/j.sbspro.2012.03.109

Quak, H., Kok, R., & Nesterova, N. (2019). Public procurement as driver for more sustainable urban freight transport. *Transportation Research Procedia*, *39*(2019), 428–439. https://doi.org/10.1016/j.trpro.2019.06.045

Quak, H., Nesterova, N., & Van Rooijen, T. (2016). Possibilities and Barriers for Using Electric-powered Vehicles in City Logistics Practice. In *Transportation Research Procedia* (Vol. 12, pp. 157–169). https://doi.org/10.1016/j.trpro.2016.02.055

Russo, F., & Comi, A. (2012). City Characteristics and Urban Goods Movements: A Way to Environmental Transportation System in a Sustainable City. *Procedia - Social and Behavioral Sciences*, *39*, 61–73. https://doi.org/10.1016/j.sbspro.2012.03.091

References (websites and books)

Betaalvereniging Nederland, (2021). *Nederlanders deden ruim kwart meer online aankopen in 2020.* Available at: https://www.betaalvereniging.nl/actueel/nieuws/nederlanders-deden-ruim-kwart-meer-online-aankopen-in-2020/. [Accessed at 4 June, 2021].

Brundtland, G.H. (1987). *Our Common Future: The World Commission on Environment and Development,* Oxford: Oxford University Press.

CBS, (2021). *11 procent meer internetaankopen in eerste helft 2020.* Available at: https://www.cbs.nl/nl-nl/nieuws/2021/02/11-procent-meer-internetaankopen-in-eerste-helft-2020. [Accessed at 5 June, 2021].

Clifford, N., Cope, M., Gillespie, T. & French, S. (2016). *Key Methods in Geography,* 3rd edition London: Sage Publications Ltd.

Gemeente Groningen, (2021). *Ruimte voor zero-emissie stadslogistiek.* Available at: https://gemeente.groningen.nl/sites/default/files/RuimteVoorJou-visiedocument-2021.pdf. [Accessed at 23 February, 2021].

Nasdaq, (2017). *UK Online Shopping and E-Commerce Statistics for 2017.* https://www.nasdaq.com/articles/uk-online-shopping-and-e-commerce-statistics-2017-2017-03-14. [Accessed at 5 June, 2021].

Rijksoverheid, (2021). *Nieuwe afspraken om steden te bevoorraden zonder CO2-uitstoot.* Available at: https://www.rijksoverheid.nl/actueel/nieuws/2021/02/09/nieuwe-afspraken-om-steden-te-bevoorraden-zonder-co2-uitstoot. [Accessed at 10 May, 2021].

UBR, (2019). Uitvoeringsorganisatie Bedrijfsvoering Rijk. *Logistieke Hub Den Haag.* Available at: https://www.ubrijk.nl/service/ontwikkelbedrijf/innovatieagenda-bedrijfsvoering-rijk/logistieke-hub. [Accessed at 24 February, 2021].

United Nations, (2018). *68% of the world population projected to live in urban areas by 2050, says UN.* Available at: https://www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html. [Accessed at 25 June, 2021].

University of Groningen, (2020). *University of Groningen General Terms and Conditions.* Available at: https://www.rug.nl/about-ug/organization/rules-and-regulations/general/voorwaarden-werken-leveringen-diensten. [Accessed at 24 February, 2021].

Appendix 1: Interview Guidelines

Interview guidelines

Opening (5 min)

The interviewee is welcomed and thanked for his/her time. Next up the structure of the interview is explained, same as for the duration. It will be explained what the research is about and how the information gained in the interview will be used. It will be mentioned that the interview can be ended at any time and it will be asked if it is alright to record the interview and that a transcript of the recording will be made. Also it will be made clear who will read the Bachelor Thesis. After the above points are mentioned, it can be said that the recording is started and the interview will start.

Role in the case (10 min)

1. Can you tell about yourself and the organisation?
    a. What is your function?
    b. How is the organisation structured?
    c. In what way were you involved in the process?
    d. From which point on did you participate in the process? (orienting phase/decision making phase/implementing phase/etc.)

Process and implications (20 min)

2. In the process, did you come across certain spatial implications?
3. What is the current situation with regard to vehicle charging?
    a. Are vehicles charged multiple times a day?
    b. How many charging stations are there?
4. Are there any spatial implications with regard to charging of the electric vehicles? And when did these implications arise?
    a. Waiting for charging point
    b. Taking a detour for charging point
5. With regard to the location of the hub, are there any implications found?
6. Are there any spatial implications with regard to the loading and unloading of the vehicles? And when did these arise?
    a. Trucks delivering supplies at hub (receiving of supplies)
    b. SLS vehicles at hub
    c. SLS vehicles at client in city centre

Ending (5 min)

1. Summarise most important points
2. Ask interviewee if he/she want to add something with regard to the interview?
3. Do you know any further interesting contacts for me?
4. Do you have any other questions?
5. Thanking interview for his/her time and end up. Ask if he/she wants to receive the final version of the thesis.