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The Opportunities for Off-peak hour deliveries in Gothenburg

A case study addressing the stakeholder interactions

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Abstract

Today, many cities are experiencing problems with deteriorating traffic conditions and congestion – particularly during the peak hours in the early mornings and afternoons. As a result, the decision-makers and stakeholders of transports are steadily realizing the importance of sustainable transport solutions. Among the different initiatives for urban freight, the concept of off-peak hour deliveries has received increased attention as a solution to more efficiently use the transport infrastructure. In most cities, the highway roads are less frequently used during the night hours – which produces great opportunities to initiate transitions of urban freight deliveries.

Several off-peak trials have been conducted in cities around the world, but many cases have experienced difficulties with persuading the involved stakeholders to participate and apply the transitions on long-term. One of the main reasons is the conflicting interests of the stakeholders which still are unavoidable issues along with the transitions. Therefore, the objective of this thesis is to investigate the stakeholder interactions, as well as the key factors that could enhance the implementation process. At the current state, the off-peak hour deliveries has not been conducted in the city of Gothenburg. Subsequently, there is an interest to discover the opportunities for the concept in this city. To fulfill the objectives of this case study, the relevant information is collected through semi-structured interviews with high positioned managers, researchers and specialists with skills related to urban freight transports and OPHD applications.

The final results of this project demonstrated complexities among the stakeholder interactions within the inner-city area; as a result of the inconveniences created by the off-peak hour deliveries. On the other hand, there are existing key factors that could enhance this application. From an overall perspective, the findings indicated that the use of low-noise technologies, trucks with alternative fuels, and appropriate incentives have great potential to facilitate the transitions in a more successful way. The greatest opportunities lie in conditions where the benefits of the off-peak hour deliveries are instantly attained and includes less systematic changes such as in integrated carrier-receiver operations and companies with decentralized distribution systems. Essentially, if only 10-20 percent of the deliveries could be shifted, there could be several different benefits for the stakeholders involved.

Keywords: *Off-peak hour deliveries, sustainable transports, urban freight traffic, city logistics*

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OHD – Off-hour deliveries

OPHD – Off-peak hour deliveries

S-OHD – Staffed-Off-hour deliveries

U-OHD – Unassisted-Off-hour deliveries

Introduction

The initial chapters of this paper present a background on the chosen research area and consist of problem description, research question as well as two sub-objectives, and then ends with the study's scope.

1.1 Background

The society has to a large extent been affected by urbanization, and more than half of the world's population already live in urban environments (Sánchez-Díaz and Browne, 2018). In Europe, the level of urbanization is expected to increase from today's 74% to about 75% in 2020 (European Commission, 2018). As the world continues to urbanize, the growing number of megacities globally continues to rise. Alongside, the demands for goods and services by commercial and domestic users keep increasing and putting more pressure on urban freight transports services (Sánchez-Díaz et al., 2017). This is particularly evident in the densely populated cities, where the infrastructure is heavily exploited during daytime hours. Traffic congestions are more recurrently now being reported as the megacities' most persistent infrastructural problem, even surpassing issues concerning power and water supply, in addition to health and safety (Bretzke, 2013). As a response to the rising levels of freight traffic, the public sector and the transportation community are intensively seeking for alternatives that mitigate the negative impacts that freight activity generates without harming the local economy (Holguin-Veras et al., 2014)

In recent years, the policies for shifting freight logistics operations away from oversaturated times and locations have received increased attention by policymakers and analysts. These policies are often described as off-peak hour deliveries (OPHD) or off-hour deliveries (OHD) (Holguin-Veras et al., 2014; Sánchez-Díaz et al., 2017). The concept has been applied in many locations around the world to induce more efficient utilization of the transportation infrastructure (Holguin-Veras et al., 2014; Browne et al., 2014a; Bertazzo et al., 2016; Verlinde and Macharis, 2016).

The existing literature demonstrates that the transitions to OPHD can contribute to positive effects for the main stakeholders involved (Holguin-Veras et al., 2014; Verlinde and Macharis, 2016; Marcucci and Gatta, 2017; Koutoulas et al., 2017). Accordingly, the receivers can experience increased levels of reliability, lower delivery costs as well as reduced inventory due to the logistics efficiency, while shippers and carriers can take advantage from improved asset utilization and reduction in parking fines. As a result of the transitions, the citizens and the local

communities can also experience an increased quality of life, by the reductions of daytime truck traffic and environmental pollutions (Holguin-Veras et al., 2018).

Nevertheless, along with the potential benefits of the transitions, both theory and practice have also revealed several obstacles to apply OPHD; finding the balance between the tradeoffs of benefits and costs seem to be even more difficult because of the conflicting interests of the different stakeholders involved in the process (Holguin-Veras et al., 2014; Browne et al., 2014a; Verlinde and Macharis, 2016; Sánchez-Díaz et al., 2017).

1.2 Problem description

Many researchers in urban freight have highlighted the challenges associated with the transitions to OPHD, particularly from the stakeholders' perspectives where an overall support for the concept is uncertain (Verlinde and Macharis, 2016). In an off-peak hour delivery scenario, the tradeoffs between the receivers and carriers' benefits are unbalanced: during regular daytime hours, the receivers do not face any incremental costs, although the carriers must tolerate longer times spent in traffic. In contrast, during the application of OPHD, the shippers and carriers benefit from faster travel times and increased productivity, but there are additional costs for the receivers (Bertazzo et al., 2014).

From the receiver's point of view, the concept of OPHD contributes to increased uncertainties and pressures on; staff availability, extra costs (salaries-, electricity, security and insurance charges) as well as changes in employee shifts. As a consequence, the receivers often oppose the mandate of the concept because it forces them to comply with the additional costs and risks without any compensations (Holguin-Veras et al., 2017). Since the receivers are typically the ones with the power to decide on delivery times, the outcome that mostly take place is regular daytime hour deliveries. It is estimated that roughly 95% of the deliveries are made during regular hours and only about 5% during off-peak hours (Holguín-Veras et al., 2007).

As an additional obstacle related to the OPHD application, there is also a concern that the concept might disturb the people living close to the receiver's properties due to the increased noise impacts of the trucks when; entering and leaving the area, maneuvering or unloading the goods (Bertazzo et al., 2014). Concurrently, the local authorities have also restrictions and regulations imposed in several cities around the world that prevent deliveries at night to avoid noise-related effects on the local residents; making this implementation even more difficult to facilitate (Holguin-Veras, 2008).

Consequently, these complex interactions between the stakeholders make it a challenging task to realize the implementation of OPHD (Holguin-Veras et al., 2005). Currently, there are only some few successful examples of the pilot programs that have shown positive results of OPHD transitions (Holguin-Veras et al., 2014; Browne et al., 2014a; Koutoulas et al., 2017). These conclusions make it difficult to evaluate whether the concept is preferable in a given context to initiate transitions to off-peak hours on long-term.

1.3 Purpose

The purpose of this study is to gain an increased understanding of the possibilities to induce a shift of freight traffic to OPHD in the city of Gothenburg. To achieve the objectives of this report it is relevant to investigate the interactions among the involved stakeholders and the factors that could increase the opportunities to induce shifts in the deliveries to off-hours on long-term.

Subsequently, by conducting this study in Gothenburg it is possible to determine the key elements that enhance the implementation process of the involved stakeholders.

1.4 Research question

To what extent can the lessons of the OPHD conducted in other cities be applied in the city of Gothenburg, and what could be learnt from this case?

Along with the above-mentioned, there are two sub-objectives which aim to clarify and analyze:

- The stakeholder interactions
- The key factors that can enhance the implementation process

1.5 Scope

The framework of this case study will put attention on the possibilities of implementing OPHD in the city of Gothenburg. The main focus will be in the inner-city area where the traffic conditions are more concentrated during the regular daytime hours. Some additional insights from Lyon and Stockholm will also be taken into consideration to gain some additional perspectives.

The limitations of this study will be to not contribute to any new findings concerning the environmental impacts, in addition to any cost-benefit analysis or specific aims at statistics.

1.6 Disposition

- In section one, an introduction and problem description is presented which forms the basis of the study. The purpose of the thesis, the research question, as well as the scope of the study are also formulated.

- Section two presents the literature study and the theoretical framework. In this section, the reader is given knowledge about various cases conducted in OPHD, and the lessons learned from these. In the second part of this section, the theoretical framework appears which forms the basis for the forthcoming analysis.

- In section three, the methodology used to establish the study is presented. Essentially, the method used during the process of the work is portrayed; the construction of the interview guide, how the interviews were constructed, the justification of the reliability and validity, as well as the method criticism.

- Section four consists of the empirical analysis part. This part is based on the respondents' contributions, and is further presented through analytical reasoning, in which empirical data and theory are linked.

- In section five, there is the study's conclusion. In this part of the paper, a development course takes place from the earlier arguments in the analysis, to refute the research question and the sub-objectives. On the second part of this section, the author’s reflections and ideas for further studies on the research area are presented.

Literature review and theoretical framework

2.1 Introduction of the literature review

In the literature review, three themes are explored from the topic concerning OPHD: the stakeholder interactions, the role of incentives, and staffed versus unassisted deliveries. These themes have been chosen due to their acknowledgment in several pilot cases previously conducted in different cities around the world. Historically, the concept has been tried in different ways and at different points in time (Churchill, 1970; Noel 1983; Campbell, 1995).

A pioneering example of the transitions to OPHD is the Operation ‘’Moondrop’’ in 1968 which took place in the city of London (Churchill, 1970). The experiment was conducted by trade associations and unions who collaborated in an experiment to establish ‘’out-of-hours’’ goods deliveries. The four retailers (in addition to 21 distributors) who participated in this project remained their stores open for deliveries one night a week from 6 p.m. to 10 pm. The project did not turn in to success since it was abandoned six months later. However, the attempt contributed to many insights for future experiments within OPHD (Churchill, 1970).

Several challenges were identified by Churchill (1970) in the ‘’Moondrop’’ project, and some of the most important seems to have been the lack of communication between stakeholders and opposition from receivers which still are issues existing in today’s transitions to OPHD.

2.2 The stakeholder interactions

While observing the cases of several pilot programs previously conducted around the world, the discoveries have demonstrated complexities within the stakeholders’ interactions (Holguin-Veras et al., 2014; Browne et al., 2014a; Verlinde and Macharis, 2016; Koutoulas et al., 2017; Bertazzo et al., 2016).

The main opposition from the stakeholders mostly derived from the receivers because of their preferences of receiving deliveries during regular daytime hours, and their lack of interests in making the required changes (Browne et al., 2014a; Holguin-Veras et al., 2014; Verlinde and Macharis, 2016). The general attitude of the local authorities was also that the urban freight activities belonged to the private sector; because these activities were not something that they would interfere with (Holguin-Veras et al., 2014). Moreover, they expressed reluctant attitudes to implement changes on the regulations and restrictions which were applied in the urban areas during certain hours of the day. In this context, the negative effects of noise and the disturbances of the local residents were critical issues (Verlinde and Macharis, 2016).

Despite the small number of complaints during most of the pilot programs mentioned, the findings still indicated that the impacts of noise should be more guaranteed if the transitions to OPHD extends further and intends to be accepted by the society (Holguin-Veras et al., 2014; Browne et al., 2014a; Verlinde and Macharis, 2016, Koutoulas et al., 2017).

From the private sector's point of view, the general impression of the pilot programs was that the majority of the carriers would be in favor of OPHD because of the lower costs. For instance, the extra charges that derived from personnel and equipment for carriers were not considered as crucial parameters because they were in balance with the benefits descending from; the reduced travel time, fewer parking fines, as well as increased transport efficiency – about 45% decrease in operational costs (Holguin-Veras et al., 2014; Verlinde and Macharis, 2016; Bertazzo et al., 2016; Koutoulas et al., 2017). Because of the operational efficiencies gained by the OPHD, the delivery trucks could also produce around 55-67 percent less emissions (on account of the decreased idling) than they would during regular-hour deliveries – producing a net reduction of 2.5 million tons CO2 per year. As a result, the citizens could further experience an increased quality of life because of the reduced conflicts between delivery trucks, cars, bicycles and pedestrians (Holguin-Veras et al., 2018).

Nonetheless, regardless of the potential benefits of the OPHD, the findings have still revealed difficulties to attract and maintain the willingness of the involved stakeholders to initiate transitions on long term. For instance, the study in London demonstrated that only a few number of participants (5% of all businesses and 3% of all freight operators) continued the transitions to off-peak hours following the Olympic Games in London 2012 (Browne et al., 2014a). Likewise, Sánchez-Diaz et al. (2017) point out that the duration of most pilots conducted in OPHD have only been between 1 and 6 months, whereas the exceptions are in Stockholm, New York, and cities in Denmark and England; where the length of the pilots have lasted maximum 2 years.

2.3 The role of the incentives

The findings in the New York project suggested that the public sector's incentives for the receivers were a critical factor to realize their participation in the initiatives of OPHD. The use of incentives and penalties had further been a successful solution which ensured that all of the involved stakeholders benefitted, or at least remained unbothered from the transition (Holguín-Veras et al., 2014). In comparison to other pilot programs such as; London, Brussels, Stockholm and Sao Paulo, the use of incentives had not been applied for the stakeholders involved (Browne

et al., 2014a; Verlinde and Macharis, 2016; Bertazzo et al., 2016; Koutoulas et al., 2017). Subsequently, the question remains whether the incentives are required or not. The existing literature reveal differing arguments concerning this matter.

Earlier research conducted by Holguin-Veras et al. (2006) and Holguin-Veras et al. (2008) suggest that a combination of incentives (financial incentives, shipping discounts, and public recognition) is the most effective solution to attract the receivers to accept transitions to off-hours. Holguin-Veras et al. (2017) elaborate further that the right combination of incentives can increase the overall acceptance of OPHD by receivers from about 5% to 40%. The authors explain that the monetary incentives (e.g. tax deduction and one-time incentives) are the most effective policies to encourage the acceptance of OPHD. In terms of the non-monetary incentives, the relationship with the vendor was suggested as the most effective, followed by shipping discounts, public recognition and business support from the authorities (Holguin-Veras et al., 2017).

2.4 Staffed versus Unassisted deliveries

Previously, there have also been some studies examining differences between staffed (S-OHD) and unassisted deliveries (U-OHD) in order to understand the application of the incentives in different modalities (Holguin-Veras et al., 2011; Holguin-Veras et al., 2012; Holguin-Veras et al., 2017).

The study conducted by Holguin-Veras et al. (2011) examined the tradeoffs of the risks and rewards between S-OHD and U-OHD. The findings in this study revealed that the receivers that used S-OHD shifted back to regular daytime hours after the pilot program; because without incentives they could not afford to maintain the transitions on long-term. On the other hand, the participants from the U-OHD decided to continue with the deliveries during off-hours. Once the participants had tried the concept of the U-OHD without any disruptions, they were able to benefit from increased reliability, reduced inventories as well as more efficient use of employees. The study concluded that about 90% of the receivers that implemented U-OHD continued, whereas the requirements of on-going incentives were not needed to maintain the participations of the receivers (Holguin-Veras et al., 2011).

Finally, Holguin-Veras et al. (2017) emphasize that the requirements of policies are important to encourage receivers to participate in the transitions of the deliveries. The authors point out that without any influencing policies it is more difficult to accomplish support from the majority

of the receivers; otherwise, they would have already applied the transitions to OPHD on their own.

2.5 Summary of the literature review

The insights from the literature review have revealed several obstacles in the transitions to the OPHD concept. In a nutshell, there seem to be great challenges to guarantee that all of the involved stakeholders' benefit, or at least remain unbothered from the implementation. The findings of the pilot programs demonstrated that some of the stakeholders were not able to fully take advantage of the concept of OPHD. Moreover, the discoveries also indicated that the stakeholder interactions were characterized by conflicting interests and objectives.

Most of the conflicts mainly derived from the receiver's perspectives, where the increased personnel costs and additional charges were not tolerable. The local authorities also expressed reluctant attitudes towards changing the restrictions of the night deliveries because of the disturbances on the local residents. The concerns of noise levels, as well as other negative impacts, still remained as an issue in most of the pilot programs conducted around the world. Another obstacle concerned the low participation levels of the receivers and limited durations of the projects. These complex interactions reveal a gap in the existing literature which indicate low interests in long-term operations of the OPHD concept. Because of these limitations of the pilot programs, there seems to be an interest in the literature for new long-term solutions to attract and maintain the stakeholders' willingness to initiate transitions to OPHD. As a result of the findings in the literature review, the framework of this study will focus on investigating the stakeholder interactions. As an extension, the key elements that can enhance the implementation of OPHD will also be examined.

2.6 Theoretical Framework

2.6.1 ‘’Winners and Losers’’

Verlinde and Macharis (2016) explain that the stakeholders constitute a system whereas the relevance of increased worth, or in any case not a loss for each member, is required for the system to support a significant change. Arvidsson et al. (2011) accentuate that the preferred solution for one member in the system does not necessarily mean that the entire system will benefit from this solution. One of the difficulties in urban freight is that there are several stakeholders with different interests involved, and it is a great challenge to find sustainable solutions for all the involved stakeholders (Lindholm and Browne, 2013)

Muñuzuri et al. (2005) emphasize that it is necessary to consider the behavior of stakeholders associated with urban freight transport in examining and evaluating city logistics measures. The authors identify three main stakeholder groups in urban freight transports namely: carriers/logistics operators (companies that deliver goods into the urban area), receivers (companies that receive goods deliveries by carriers) and local authorities (responsible for the implementation of regulations). The stakeholders mentioned above are described as the most apparent stakeholders that directly influence transport operations (Muñuzuri et al., 2005).

Ballantyne et al. (2013) also argue that there is a large group of stakeholders that are rarely considered in the freight context: the visitors and citizens of the urban freight areas. These groups have indirect interests in freight transport through their desire for an attractive urban area, free from noise and visual intrusion caused by freight vehicles. Along with these reasonings, the authors further distinguish between actors and stakeholders, and proclaims the public transport operators, trade associations, commercial organizations and property owners as passive stakeholders (Ballantyne et al., 2013).

The existing literature in urban freight indicates that certain policies may produce unintended or distorted outcomes for some stakeholders (Stathopoulos et al., 2012). In terms of the legislation and regulation policies, Quak (2011) claims that the initiatives taken by the local authorities have mainly been characterized by intentions to change the carriers’ operations in order to become more sustainable (or at least cause less annoyance) by complying with legislation. The authors distinguish between different policies imposed by the authorities such as: vehicle restrictions, vehicle load-factor controls, low-emission zones, time-access windows and dedicated infrastructure. The intentions of these restrictions have essentially been to improve traffic safety, reduce traffic problems and protect the infrastructure from damages. As

a result of these imposing restrictions, the carriers have often been forced to use smaller vehicles in their transports; contributing to more negative impacts on: the accessibility of cities, emissions and logistical costs (Quak, 2011).

As an extension, Taniguchi et al. (2016) mention that longer periods of congestion known as peak spreading is now being experienced on traffic networks in many urban areas which is resulting in: additional vehicles and trips for daily operations, longer distances travelled by freight vehicles, as well as undesirable conditions for loading- and unloading of goods; because of insufficient parking spaces (Taniguchi et al., 2016; Behrends, 2016). Likewise, Quak (2011) claims that the application of low emission zones; where only trucks that fulfill the motor type Euro 4 and newer are allowed – are having negative impacts on the operational costs for carriers (depending on the number of zones and the vehicle replacement cycle). The author also mentions the time-access window restrictions imposed by the authorities. These are prohibiting the trucks from entering the city center during certain periods of the day which have additional negative effects on the carriers' operations (Quak, 2011)

Stathopoulos et al. (2012) highlight that another problem in urban freight is the difficulty to find appropriate policy instruments to effectively influence the behaviors of receivers. One of the main reasons is the limited knowledge of the relevant factors that determine the relation between receivers and freight operators. In several stakeholder interactions, Holguín-Veras et al. (2005) reveal the obstacles to collaborative off-peak deliveries. In this context, the main barrier is described to be the asymmetry in sustained costs, where the benefits and costs from off-peak deliveries are difficult to contemplate. Some experimental results indicate that one method to make off-peak deliveries acceptable is to use monetary incentives or tax-reductions rather than access restrictions (Holguín-Veras, 2008).

Existing research on OPHD reveals that shifting more urban deliveries to off-hours has positive and/or negative impacts for different stakeholders (Verlinde and Macharis, 2016). In an OPHD scenario, Holguin-Veras et al. (2013) summarize all the positive and negative outcomes for the stakeholders involved:

- From the carriers' perspective, the benefits from the transitions are characterized by increased productivity of truck assets, faster travel time, and reduced parking fines. On the other hand, the carriers might accrue increased labor costs.

- In terms of the receivers' point of view, they take advantage of increased reliability and accuracy of the deliveries. The actors might also accomplish enhanced public perception as a good public corporate citizen (provided that the noise impacts do not become a community issue). Although, the receivers are negatively impacted by higher operational costs (S-OHD), increased risks (U-OHD), or both.
- The highway users that drive during peak hours (buses, passenger cars and other vehicles) benefit from reduced congestion, increased parking availability and accident reductions, along with other factors).
- From the local communities' perspective, the benefits are characterized by increased livability and quality of life, due to the reductions in truck obstructions, pollutions, and congestions on local streets. However, they are negatively impacted by noise if mitigation technologies are not applied (Holguin-Veras et al., 2013).

Den Boer (2007) elaborates that noise pollutions in general terms consistently rank high on the list of citizens' concerns. The most widespread issues created by noise is quite simply annoyance; transports annoys people, causes stress and illness and may sometimes even have a fatal impact. Tobías et al. (2015) highlight that traffic noise often surpasses the guideline values published by the World Health Organization and those exposed by traffic noise often suffer from a wide range of negative health effects (Tobías et al., 2015). From the citizens and the society's point of view, there are several benefits to gain by alleviating negative noise impacts. For instance, the decline in noise-related health problems can contribute to lower expenses on the health system. In addition, if noise is reduced at its source, the local and national authorities can also reduce the funds currently spent on building and maintaining noise barriers and insulation (Den Boer, 2007). However, the consequences of the noise mitigation initiatives might have undesirable outcomes for the businesses involved. From the private sector's point of view, they would likely to be concerned with costs and benefits as noise abatement policies would add costs and no financial benefits to the businesses concerned (Rushton et al., 2014). (More information related to low-noise solutions appears later in the forthcoming section, 2.6.2.2, Low-noise technologies)

2.6.2 Existing technologies and its application

2.6.2.1 Different modalities and the practice of risk mitigation technologies

Holguin-Veras et al. (2013) mention that there are a number of technologies that could be used to foster participation in OPHD by either reducing the risk to receivers or decreasing noise impacts on local communities. In terms of the risk mitigation technologies, the authors explain that their significance depends mainly on the modality of the OPHD. Holguin-Veras et al. (2012) highlight two main modalities of OPHD namely: staffed OHD (S-OHD), and unassisted OHD (U-OHD). The authors explain that the key insight is essentially that these two modalities represent different tradeoffs between operational costs and risks for the receivers. The application of S-OHD reduces the risk of a negative outcome to the receiver (e.g. theft, physical damage) – but it entails increased costs due to the expenses for staff or security (Holguin-Veras et al., 2012).

In the context of S-OHD, Holguin-Veras et al. 2012) describe two different methods of S-OHD applications:

- Staffed OHD: This method includes the staff being present at the receiving establishment when the deliveries are made. By applying this approach, the personnel can verify the precision of the shipments, and ensure the security of the property.

- Two-stage systems: This scheme involves distributions to large traffic generators' (e.g. large buildings and malls, etcetera) delivery rooms. In this concept, the deliveries pass through two steps. At the first step, the delivery rooms receive the deliveries during off-peak hours. On the second step, the deliveries continue from the delivery rooms to the actual delivery point during the regular daytime hours. The advantage gained from this approach is that it does not require the receivers to be involved. (Holguin-Veras et al., 2012)

As an additional aspect, Browne et al. (2014b) mention the use of urban consolidation centers which are mostly situated close to commercial districts, shopping centers or constructions sites. In this approach, the part loads are consolidated and delivered to the consolidation center from either a single or multiple suppliers. In the following step of the process, the deliveries are further directed from the consolidation center – to the target area by appropriate vehicle types on the last-mile of the delivery (Browne et al., 2014b). Along with these reasonings, Marcucci and Gatta (2017) suggest a method of combining the consolidation center and OHD; where the

goods are delivered at night to the consolidation center close to the receiver, and then delivered via electric vehicles to the receiver at its most preferred time. This method involves lower risks of negative outcomes but entails increased transportation costs (Marcucci and Gatta, 2017).

In contrast to the S-OHD, Holguin-Veras et al. (2012) also mention the U-OHD approach which can be accepted at no cost to the receiver. However, the risks of a negative outcome might increase in this method due to the lack of supervision from personnel. In terms of the U-OHD applications, the authors explain that the receiver has to decide whether to provide restricted-(driver and the delivered goods are separated from the rest of the establishment) or full access. The most optimal choice of the alternatives of U-OHD depends on many different factors such as: the relationship between the carrier and receiver, the risk and cost the receiver is willing to assume, the type of commodity being handled, the size of the deliveries, and the type of technology available for the receiver (Holguin-Veras et al., 2012).

In the case of restricted access, there are existing technologies that could be applied to facilitate this implementation. For instance, Datanet-IT (2019a) states that it can provide a web-based integrated system which includes: access control, intrusion detection and surveillance cameras to companies that strive to protect their assets. The company further claims that it offers the opportunity for a mobile security management tool which allows access from any location through a phone or tablet; improving productivity and response times. These surveillance systems enables the possibilities to create track records of people entering and leaving the establishment, and to quickly handle incidents such as break-ins, a door left open, or a significant temperature change that may indicate a fire or flood; by the authorization of a lockdown of the facility (Datanet-IT, 2019b)

The company Camrascan-Security (2019a) also states that it can provide IP CCTV cameras and photo-electric sensors. According to the company, the CCTV function is now widely recognized as one of the greatest contributors in detecting and deterring criminal activity; these systems enable the possibility to integrate to a computer network where the images can be viewed anywhere in the world by the support of remote viewing capabilities. Camrascan-Security (2019a) further mentions the applications of video analytics which uses intelligent software that can count the number of individuals entering/exiting a building, and provide visitor traffic pattern information. In combination with thermal imaging, the video analytics software can provide a very robust all-weather solution; the thermal imaging cameras are considered as the cutting edge of perimeter security (Camrascan-Security, 2019a).

In the context of the surveillance technologies, Holguin-Veras et al. (2013) claim that the costs for these implementations vary significantly depending on several factors such as: the camera's location, the desired picture quality, the viewpoint range, and networking capabilities. Despite the costs of the new technologies; the surveillance devices are capable of sufficiently mitigating the security risks associated with U-OHD (Holguin-Veras et al., 2013).

Considering the restricted access areas, Holguin-Veras et al. (2013) mention that there are two types of delivery staging areas which are currently used in practice for U-OHD: double doors and virtual cages. The double door setup is appropriate for companies that already have this establishment in place or own enough space available for a cage or new construction (higher cost). In terms of the virtual cages functionality, the authors explain that the concept is established by a laser system which defines a space inside the store where the deliveries are directed. In this context, the sensors are connected to the store's private security systems and respond if an attempt is made to intrude the zone of the virtual cage. These technologies allow deliveries to be made at large traffic generators, as well as lobbies or corridors of buildings without any access to the establishments (Holguin-Veras et al., 2013).

In terms of the full access technologies, Marcucci and Gatta (2017) mention the option of key deliveries. This choice could be established by different alternatives that could facilitate the full access such as a copy of the key, or the use of a key box with an electronic code. The system can easily be applied and does not require any advanced technologies. However, Camrascan-Security (2019b) states that when keys are lost or stolen, changing locks and re-issuing keys can be an expensive and inconvenient process. The use of keys also come with additional security risk because they can be copied without the issuer's knowledge. The locks and keys simply do not offer enough protection against the possibility of theft or other unfortunate events (Camrascan-Security, 2019b).

In response, Camrascan-Security (2019b) addresses the use of electronic access control systems which provides more efficient and convenient way of securing an establishment, and the assets within it. The most typical options for the door entry systems are operated by: fobs, swipe cards or tokens which allow access through electronically controlled doors. If one of these alternatives is lost or stolen, it is possible to deactivate it without affecting the rest of the system. Additional options available include keypad entries; where the keypad code is updated on a regular basis to restrict access, along with cutting edge biometric readers which use fingerprint or iris technology (more expensive) (Camrascan-Security, 2019b).

Holguin-Veras et al. (2013) explain that the costs for these keyless setups depend on different factors such as the durability of the locks, the ease of installation, and the complexity of the access requirements. Some companies provide the service including both selling and installing the locks, and other companies only provide easily installed devices; the latter option has the possibility to reduce costs by eliminating the need for installation from an external firm (Holguin-Veras et al., 2013).

To conclude, the implementation of the different modalities represent different tradeoffs of risks and costs. In the case of the U-OHD, there is a wide range of technological solutions available that can facilitate the transitions, although the costs of these setups might be an obstacle to the implementation.

2.6.2.2 Low-noise technologies and other solutions

Currently, there are existing low-noise technologies and programs available that have the capabilities to contemplate the noise issues from OPHD. An important project that enhanced the possibilities of implementing OPHD while complying with noise standard is the PIEK program (Goevaers, 2011). This program was developed in the Netherlands and attempted to lower noise levels by fostering quiet behavior through various types of strategies such as: educating drivers in silent driving, improvements in handling equipment, development of low noise technologies, along with reshaping loading facilities (Goevaers, 2011).

Today, the PIEK standard has been implemented in several countries to facilitate noise mitigation procedures. Sánchez-Diaz et al. (2017) explain that the PIEK certifications have allowed the cities to apply the transitions to OPHD in a way that complies with local noise regulations. Wang et al. (2014) elaborate that the PIEK program sets different limits on the noise levels during different hours of the day (between 60-65 dB (A)). The maximum noise level of all activities is set at 72 dB (A), which is called the ‘PIEK light limit 72 dB (A)'. The light certificate is given to those truck drivers that follow the noise reduction behaviors in the loading- and unloading activities (Wang et al., 2014).

Wang et al. (2014) explain that the delivery operations of loading and unloading can be key sources of noise. Along with these reasonings, the authors emphasize the importance of encouraging quiet behaviors that aim to reduce the noise caused by typical loading- and unloading activities. In this context, some explicit locations can be designated to minimize possible impacts of noise sources. Another example is the use of quiet unloading equipment,

such as a hand pallet truck and a roll cage to handle shipments. The quiet versions of these accessories are about 50% more expensive than the standard version. However, without the application of these measures, the use of wheels, bearings, and collisions can cause noise levels of up to 92 dB (A) (Wang et al., 2014). Moreover, Goevaers (2014) also highlights additional conditions where the silent equipment is required to deal with noise annoyances such as; when slamming doors, removing onboard forklifts, the functioning of the refrigeration, the sound of the containers and the loading hatch. The author claims that the peak noise without quiet accessories can cause noise levels up to 80-90 dB (A).

2.6.2.3 The engine related noise and trucks with alternative fuels

Holguin-Veras et al. (2013) explain that an important source of noise relative to the average levels is the noise descending from the engine of the trucks; with the gearbox and brakes also causing noise during operation. To put existing engine-related noise into perspective: the noise level of standard diesel engines are estimated at around 80Db (A) during acceleration, while the engine of the liquefied natural gas-driven trucks (LNG) only reaches up to 72 Db (A) maximum (Goevaers, 2014). Along with the LNG truck, Wang et al. (2014) also mention the compressed natural gas-driven truck (CNG) that reaches up to similar noise levels as the LNG truck. Currently, there are great potentials for increasing utilization of both LNG and CNG trucks as a result of the technological innovations and increasing demands of these vehicles (Wang et al., 2014). The natural gas-driven trucks not only offer lower noise emission benefits, but also provide an economical option in comparison to the diesel truck (Scania, 2019a).

Scania (2019a) states that its new fleet of CNG trucks are using new technologies that can overcome the concerns regarding the distances that the CNG-powered trucks are able to cover before refueling. These trucks are the first models to use twin 26-inch diameter carbon fiber fuel tanks; they have the capabilities to store gas at 250 bar of pressure to increase range from around 300 miles (around 482 km) to as much as 500 (about 804 km). The development of these trucks allow the drivers to entirely switch to biomethane fuels, which is 35% to 40% cheaper than diesel and emits 70% less CO2 (Scania, 2019a).

Furthermore, Volvo-Trucks (2019a) claim that its new gas-powered LNG truck provides the same fuel efficiency as the diesel-powered equivalents. The truck also emits 20% less CO_2 than a regular Volvo FH diesel truck. According to the company, the natural gas has a huge potential as a substitute for diesel in trucks. When cooled down to low temperatures, the gas liquefies (LNG) and reduces in volume. This means that it is possible to accomplish enough fuel to drive

long-haul transports. Since the LNG truck is also often cheaper, there is a great opportunity from this option to reduce costs (Volvo-Trucks, 2019a).

In addition to the natural gas-driven trucks, Holguin-Veras et al. (2013) also highlight the use of hybrids (the combination of electric and diesel) which have the capabilities to operate under 65 dB (A). In terms of the hybrid trucks, Volvo-Trucks (2019b) claim that its Volvo FE Hybrid runs the electric motor from startup and up to 20 km/h. When the vehicle stops, the diesel engine automatically shuts down to avoid unnecessary idling. The emissions of NO_x and particulates from this truck is estimated at zero levels when it runs on the electric drive. According to Volvo-Trucks (2019b) the truck also has strong benefits when operating in sensitive urban areas, because of its low noise capabilities when accelerating and idling.

Another example of a hybrid truck is the chargeable hybrid from Scania that runs with a combination of electricity and fossil-free fuel (biodiesel called HVO) which reduces the emissions of particles and carbon dioxides significantly (90 percent reduction of emissions). The truck is currently being used in a pilot project to test silent overnight deliveries at six McDonald's restaurants in Stockholm (a collaboration between the City of Stockholm, HAVI, KTH, EU, McDonald's and Scania). Scania (2019b) claims that its hybrid truck has the capability to drive in silent electric mode for up to 10 kilometers, and can efficiently deliver goods on empty streets at nights. The plug-in hybrid truck is further linked and tailored with geofencing technology which can adapt the truck to the driving conditions in a predetermined area. During the longer distances between the city and the warehouse, the truck runs with its internal combustion engine on HVO. However, when arriving in environmentally sensitive urban areas, the truck switches over automatically to quiet and emission-free electric power by the support of the software tool Scania Zone and the geofencing technology. In terms of the battery of the truck, it is charged by external power sources, and via regeneration; which basically means that the truck movements are transformed into electricity each time the brakes of the truck are used. The vehicle is also able to charge its battery while loading and unloading near one of the restaurants in the pilot study (Scania, 2019b).

In terms of the fully electric trucks, Kolstrup et al. (2014) highlight that these trucks are now a known technology and can perfectly replace diesel trucks as long as they are used in shorter distances. An example of a fully electric truck is the recently developed, Volvo FL Electric, which is a two-axle 16-tonne heavy duty truck with an electric drive and engine storage system. Volvo-Trucks (2019c) states that the electric motor has a capacity to reach an operational range

up to 300 km and can accomplish around 69 dB (A) when accelerating; which is a large difference compared to the 79 dB (A) from the regular diesel truck (Trucks, 2019).

According to Hidrue et al. (2011) the advances in technological innovations will most likely increase the adoption of electric vehicles as a result of the extended driving ranges, charging times, lower battery costs and advances in recharging infrastructures. Likewise, the unit costs for electric vehicles are also likely to decrease as a result of mass production. For that reason, there are great potentials and benefits to gain by the utilization of electric trucks; not to mention from an environmental perspective, where this alternative is particularly appealing (Hidrue et al., 2011).

Conclusively, there are several technological solutions available that can mitigate the negative impacts of noise. Although, these solutions might also bring concerns regarding costs and benefits of these applications.

2.6.3 The use of incentives

Silas et al. (2012) explain that in order for the OPHD to take place, both carriers and receivers have to be made better off. As the implementation of the concept can contribute to increased costs or risks in the case of unassisted deliveries, Holguin-Veras (2008) suggests the use of incentive programs that can induce receivers to accept the transitions of the deliveries. Along with these reasonings, Silas et al. (2012) claim that it is advantageous to identify industry segments that are more willing to accept OPHD, and then carry out the incentives to those inclined to switch to the concept. By doing this, the use of the policies can be more efficiently used to maximize the participations in OPHD.

Holguin-Veras (2007) established that the concept of OPHD is particularly interesting for integrated carrier-receiver operations where the merchandises are provided by a parent company, or where there is a long-lasting relationship of trust between the involved actors. According to the author, the use of incentives seems more appealing and successful in these types of partnerships. The argument is that for independent operations, the incentives mostly impact one stakeholder and do not provide benefits to the entire system (Holguin-Veras, 2007).

As an extension, Holguin-Veras et al. (2017) further determined that food and beverage stores, press and books, clothing stores, apparel manufacturing, and accommodation establishments are more inclined to accept the transitions to OPHD. These reasonings comply well with

Sánchez-Diaz (2018) arguments who also suggests that the concept is particularly interesting for the AFS (Accommodation and Food Services) sector; involving a widespread range of businesses such as: basic/luxury hotels, catering, café and bakery services, fast food, and luxury restaurants. The author explains that the establishments in these types of sectors varies in size, and whether it is part of a chain or an independent establishment; the latter option is described as relevant in the context of logistics purposes – since it determines the level of integration with the suppliers and carriers.

In the case of the independent actors, Cherrett et al. (2012) claim that they have larger impacts on the traffic because of their decentralized distribution systems (companies that receive goods from several points of dispatch which can include a variety of different suppliers), while larger chains given their centralized systems produce fewer trips of a larger size (Cherrett et al., 2012). This knowledge can be instrumental in planning and implementing efficient incentive strategies; more specifically aimed at businesses where the reduction of deliveries and alleviating traffic conditions are the greatest (Sánchez-Diaz, 2018).

In terms of the financial incentives, Holguin-Veras et al. (2012) describe different strategies that the local authorities could apply to enhance the OPHD implementation:

- To maximize the participation in OPHD; a monetary incentive in the forms of tax deductions or a one-time incentive could be used.
- To facilitate the installation of security equipment in the context of U-OHD; the receivers could be provided with a financial incentive to pay or offset the extra charges of security devices.
- To protect the receivers during the OPHD from accidental damages, vandalization and/or theft; insurance-based policies could be used to compensate those suffering from these types of unpredicted events.

In terms of the non-monetary incentives, Sánchez-Diaz (2018) highlights the use of public recognition programs, along with other necessary incentives such as more or better access of loading zones to the establishments involved in the OPHD implementation. This is also discussed by Holguin-Veras et al. (2012) who further include the use of curb management, changes in traffic ordinance, public acknowledgment and preferential parking to companies that have shown commitment to sustainable delivery practices. These non-monetary incentives are described as important factors to enhance the participation in OPHD.

Holguin-Veras et al. (2012, p 44.) conclude that there is no ‘’single approach’’ that can work for all types of businesses because of the different security needs, operational practices and business cultures of the different sectors. Therefore, it is important to establish a broad variety of alternatives for businesses to increase the willingness of the potential participants to choose one approach. In terms of the low noise technologies, and utilization of trucks with alternative fuels, the authors further claim that the carriers would be willing to invest in these acquisitions, if there was a sustained public sector commitment to OPHD. In this case, the use of additional incentives related to these investments, along with the cost savings gained by the OPHD - would enable the carriers to recover from the early investments; facilitating an easier adoption of the new technologies (Holguin-Veras et al., 2012).

3. Methodology

This chapter highlights the process of the methodology and describes the way the data collection has been conducted to answer the purpose of the thesis. The section will further present the framework of the methodology including sections such as the research approach, interview process, sample selection, research quality along with the method criticism.

3.1 Research method

Collins and Hussey (2014) distinguish between two different research methods that can be used in a research study; qualitative and quantitative research method. Jacobsen (2017) emphasizes that the quantitative method mainly involves the researcher collecting data and carrying out a number of measurements which are subsequently summed up in statistics and figures. Denscombe (2010) explains that quantitative data generally takes the form of numbers. They are primarily associated with strategies of research including; surveys and experiments, as well as questionnaires and observations in research methods contexts (Denscombe, 2010). The main objective of this research method is essentially to discover relations and to make general conclusions. Consequently, this approach suggests more devotion to several areas and provides fewer opportunities to go into depth and acquire all individual variations within a group of people (Jacobsen, 2017).

In contrast, Collins and Hussey (2014) explain that the qualitative research method refers to the researcher's approach to perceive the world from the respondent's perspectives. The authors point out that the qualitative data primarily takes the form of words, and are mostly associated with interviews (Collins and Hussey, 2014). Quinlan (2010) elaborates that the focus of the qualitative method is essentially to investigate the interviewee's perspective, and facilitate open thoughts on the phenomenon being explored. The fundamental aim is essentially to create a deeper and comprehensive understanding of the phenomenon examined (Quinlan, 2010).

To create an understanding of the named phenomena for the purpose of this study, the qualitative research method was considered to be more suitable. The reason for the choice of this research method was mainly because of the subject which required a more open approach to enable an increased understanding of the views of the respondents involved in the study. Jacobsen (2017) highlights that it is also more appropriate for qualitative research methods when collecting new and unexpected information. Likewise, Quinlan (2010) claims that the loose structure and flexible approach of qualitative research enhance the creation of rich and complex data.

3.2 Research approach

Blumberg et al. (2011) explain that the choice of research approach is largely based on the role of the theory which is directly linked to two different reasoning approaches: *deduction* and *induction*. The authors claim that the deductive method is mainly characterized by starting with a general theory, and then applying this theory to a specific case. Ghauri and Grönhaug (2010) elaborate that this method involves the researcher formulating hypotheses from the existing theoretical framework that are empirically tested. This approach is also often called the *hypothetical deductive* method, whereas the objectivity is strengthened by the existing theories (Sekaran and Bougie, 2013). Jacobsen (2017) points out that the disadvantage in this method is that the data collection might be characterized by findings that the researcher only believe is relevant. By starting from general conclusions, there is also a risk that the existing theoretical framework can limit the scope of the research and disregard important new information (Jacobsen, 2017).

The inductive approach works in the opposite direction, it is mainly developed from the observation of the empirical reality. Since it involves moving from individual observations to general patterns, it is referred to as moving from the specific to the general (Denscombe, 2010). Sekaran and Bougie (2013) explain that the researcher starts from observations on a specific phenomenon, and on this basis arrives at general conclusions. Moreover, Jacobsen (2017) elaborates that this method mainly involves the researcher going out to the reality without any expectations. The goal is essentially to reduce the factors that could limit the findings of the study. On the other hand, Sekaran and Bougie (2013) mention that the risk in this approach is that the researcher does not know about the generalization of the theory (referring to the swan example, p 26.), because it is based on empirical findings which are solely representative of a particular situation. The approach thus means a risky leap from a collection of individualities to a general truth (Sekaran and Bougie, 2013).

Initially, this study was characterized by a qualitative case study which can be described as a method that collects information about a specific object, event or activity (Sekaran and Bougie, 2013). Collis and Hussey (2014) point out that the case study approach is the most optimal approach when the researcher wants to explore a topic in depth and provide explanations that can cope with the complexities and particulars of real-life situations. The authors further explain that the case study approach has mostly been used to discover new information and has predominantly been characterized by qualitative research and principals of the inductive

reasoning. In this case study, the research mainly involved a description of the reality based on the respondents' point of view, which makes it inductive in its approach.

Furthermore, Collis and Hussey (2014) mention the use of exploratory research which is appropriate when there are few studies to which it is possible to refer to for information about the issue. The authors claim that the objective in these type of studies is essentially to search for patterns and ideas, and develop rather than to test a hypothesis. However, Sekaran and Bougie (2013) point out that the results of the exploratory studies are typically not generalizable to the population which is important to consider when reflecting on the validity and reliability.

Nevertheless, the objective of this study was not to accomplish statistical generalizations to demonstrate that the sample can be generalized to a larger population. The intention was rather to attempt theoretical generalization where the theory applied in one set of circumstances can be generalized to another. Subsequently, the similar cases in the topic of OPHD will help to show whether the theory can be generalized, and dissimilar cases will help to extend or modify any given theory (Collis and Hussey, 2014).

3.3 The case study

In terms of the framework of the case study, Blumberg et al. (2011) explain that the single case design is adequate when the intended case study provides the closing critical study to a longer series of cases written by others. Therefore this case study will be characterized by a single case design. Collis and Hussey (2014) highlight the main stages involved in this process. In the figure below, the different stages illustrate an overview of the different activities conducted during each step of the process. In the following sections below, a more extensive description of each phase will be elaborated in more details.

Figure 1: Case study model. (Collis and Hussey, 2014, p 69.)

3.3.1 The selection of the case

At this stage of the process, the case in OPHD was established, as well as the determination of the scope. To collect relevant information in this case study, it was vital that the potential respondents had knowledge about the themes discussed. For that reason, the determination of the scope was characterized by respondents that were represented by: decision-makers, researchers and specialists with skills that were either directly or indirectly connected to urban freight and/or OPHD applications (See appendix 1). This selection was established with the purpose of receiving differentiated responses that were generally targeted for the topic of OPHD. The intention was essentially to achieve as relevant facts as possible for the purpose of the study.

The geographical focus of this case study was mainly concentrated in the city of Gothenburg, more specifically focused within the city center; in Innerstaden (involving several businesses), where a considerable amount of deliveries were frequently conducted to various types of establishments during the regular daytime hours. Some additional insights were also included from the cities of Lyon and Stockholm. However, the findings from these cities were only intended to provide additional aspects; they do not have any direct impacts on the results discovered in Gothenburg. The scope in Lyon and Stockholm were both characterized by the same geographical settings as in Gothenburg (within the city center areas).

3.3.2 Preliminary investigation

Collis and Hussey (2014) address the preliminary investigation as the process of becoming familiar with the context in which the researcher conducts the study. According to the authors, the most optimal approach at this stage is to keep the mind free of any prior beliefs and to learn from the naturalistic evidence at this stage. To determine the right approach, it may be helpful to reflect on the current paradigm and consider the purpose of the research (Collis and Hussey, 2014).

Along the process of the preliminary investigation, the initial findings suggested that the notion of sustainability has become increasingly important in different contexts around the world, particularly within urban freight and its relation to society at large. How to reduce the environmental impacts and to accomplish increased sustainability, as well as the technology's contributions in different contexts have become increasingly prominent. As a consequence of these reasonings, more reflections about the concept of OPHD was generated, and how this phenomenon can contribute in a positive way in our society.

Sekaran and Bougie (2013) claim that exploratory research studies often rely on secondary research such as literature reviews. Subsequently, during the preliminary investigation, the use of a literature review was made which predominantly consisted of previous pilot cases conducted in OPHD. In order to get a comprehensive image of the topic OPHD, the research further included scientific articles and books concerning the general topic of urban freight as well as other themes discussed in this thesis. Since the preliminary investigation demonstrated that the OPHD had not been applied in the city of Gothenburg, this topic was particularly interesting to examine and understand.

Based on these reasonings, the ideas concerning the topic of OPHD was developed together with the supervisor on how a study within the chosen area could be performed. At the initial stages of the process, the emerging keywords in the conversations involved the stakeholder interactions, the role of incentives, along with staffed and unassisted deliveries. These keywords were based on the findings from the literature review.

In the literature review, the stakeholder interactions had been identified as a problem in several trials of the transitions to OPHD. Subsequently, this theme was considered to be worth investigating further and was included in the theoretical framework. In the theoretical framework, the section ‘’winners and losers’’ was formulated as a consequence of the stakeholder interactions from the previous cases in the literature review which implied both winners and losers. As an extension, the findings of the literature review further revealed different modalities of the concept of OPHD; staffed and unassisted deliveries where the outcomes of the modalities had indicated differing results on the participation levels of the stakeholders involved. Therefore, these different modalities needed further investigation, particularly in the case of unassisted deliveries where the use of risk mitigation technologies were required to facilitate the implementation. These themes were included in the theoretical framework under the section of ‘’the existing technologies and its application’’.

Moreover, the negative effects of noise levels had also been identified as an important obstacle to be considered in order for the transitions to be accepted. Accordingly, the evaluation of existing technologies that could contemplate noise issues were also included in the theoretical framework. These themes represented two additional sections under the technology section. Moreover, the use of incentives had also been identified as a key factor enhancing the implementation of OPHD in various ways. As a result, this theme required additional investigation, and was further included in the theoretical framework in a separate section named ‘’the use of incentives’’. Finally, the theoretical framework included: the winners and losers,

existing technologies and its application (with three sub-sections), and the use of incentives. These themes were chosen to obtain maximum extraction of what would be possible to achieve through the study.

3.3.3 Data collection

At this stage of the process, it is important to determine how, where and when to collect the data. The methods used to collect data in a case study include documentary analysis, interviews, and observation (Collis and Hussey, 2014). In this case study, the original data (i.e. primary data) is characterized by the information collected through the conducted interviews. The collected data was specifically aimed with the intention to answer the research question of this study (Blumberg et al., 2011).

In order to generate an increased understanding of the respondents' perceptions, the most optimal approach in this study was to have a dialogue. Saunders et al. (2009) elaborate that it is through conversations we get to know individuals, their knowledge about their experiences, feelings and the world they live in. Grönhaug and Ghauri (2010) support these arguments and emphasize that it is more appropriate with interviews; because it offers the possibility of more complex issues to be elaborated with answers and attitudes. The authors also claim that this method of data collection is highly appropriate for exploratory and inductive types of studies as it matches their purposes.

3.3.3.1 Operationalization

The interviews in this study included a qualitative method in the form of semi-structured interviews and an interview guide based on the themes that would be discussed in the meeting with the respondents (Saunders et al., 2009). Denscombe (2010) explains that the semi-structured interview involves the interviewer preparing a flexible approach in terms of the order in which the themes are considered; allowing the interviewee to further develop ideas on the themes raised during the interview. Subsequently, there is a further emphasis on the respondent elaborating the points of interest in this approach (Denscombe, 2010).

In this study, the interview guide consisted of a questionnaire with different themes that were addressed during the interviews. The interview questions were formulated based on the purpose of the study, and on the basis of the theoretical framework. The interview guide was divided into different parts, with an introductory part where general questions were asked about the person's profession and responsibilities, as well as their relation to urban freight. The latter parts included more targeted issues related to the topic of OPHD, and the different themes involved.

The interview guide was categorized under seven headings: Presentation of respondent, General questions, Stakeholder engagements, Off-peak hour deliveries, Unassisted or Staffed deliveries, Incentives and Noise (see Appendix 2). In terms of the framework of the interview guide, the aim was to keep the questions as open as possible; allowing the respondents to further elaborate their answers (Blumberg et al., 2011). This was adequately taken into consideration in the interviews conducted with the respondents. The reason why the semi-structured interview was chosen for the research is that an unstructured interview would be too complicated to connect to the specific research areas. With the semi-structured interview, it was possible to direct the respondent in the areas that the study intended to investigate.

In terms of the timing and location of the interviews, they were based on the dialogues with the respondents; either via telephone or face to face. The ambition was to meet all the respondents in a personal meeting. However, in some cases, this was not possible due to the respondents' lack of time, as well as their location, which was sometimes at longer distances. In those cases where the personal meetings were not possible, a telephone interview was instead applied.

Sekaran and Bougie (2013) claim that the main advantage of telephone interviewing is that a number of different people can be reached across longer distances in a relatively short period of time. This approach further eliminates any discomfort that some respondents might experience when facing the interviewer; the interviewee might feel less uncomfortable revealing personal information over the phone than face to face (Sekaran and Bougie, 2013). Then again, the main disadvantage of telephone interviewing is that the researcher is not able to see the respondent to read the nonverbal behaviors, which makes it difficult to interpret possible uncertainties in the respondent's answers (Saunders et al., 2009). Moreover, Blumberg et al. (2011) highlight that telephone interviews can result in less thorough responses, and those interviewed by telephone find the experience to be less rewarding than a personal interview. Subsequently, these differences had to be taken into account in the data collection.

On the other hand, the telephone interviews were not considered as a direct weakness in this study because the end result would have most likely been the same if the interviews would have been conducted face to face. There were not any indications that the telephone interviews resulted in shorter durations or inadequate content of the information collected. In cases where the duration of the interviews were shorter than the average, it was mostly due to the lack of time of the respondents. Since the vast majority of the respondents were working on high positions within their field, this outcome was somewhat expected.

3.3.3.2 Sample selection

Jacobsen (2017) explains that the sample selection is determined by the purpose of the survey and what kind of information the researcher wants to receive. However, the determination of the selection can be difficult to establish in advance. In cases where the researcher is uncertain about the selection, the snowball method appears as a suitable solution (Jacobsen, 2017). This method involves not having a fixed criterion at the beginning of an investigation. In this approach, the flexibility of the qualitative structure is pushed to the limit. For instance, at the initial stages of the process, one respondent with relevant knowledge about a group or a phenomenon is chosen. In the following interviews, the researcher gets tips and ideas about which other respondents can be interesting; and the snowball rolls: whereas new impulses and ideas concerning respondents with relevant knowledge are highlighted continuously along with the interviews (Jacobsen, 2017).

The snowball approach was essentially what was chosen in this study, where one respondent's references led to another (see Appendix 3). This was considered as the most optimal choice along the process because of the lack of knowledge at the initial stages to include respondents that had links to the researched phenomenon.

Denscombe (2010) points out that the difficulty to determine the right quantity for the specific study. For instance, a small selection can prevent a comprehensive and credible analysis, while a too large selection makes it difficult for more in-depth interpretations of the existing data. In this study, the above mentioned was taken into consideration during the course of the research process. For this reason, the number of respondents in the semi-structured interviews involved a total of 15 respondents, with the intention of gaining increased credibility. This total was necessary in order to fulfill all the aspects that were required to achieve maximum extraction of this study.

3.3.4 Data analysis

Bryman and Bell (2013) highlight that there are different kinds of approaches in the analysis to describe, explain or interpret the data. The authors explain that quantitative research is mainly characterized by the paradigm of positivism, while qualitative research tends to be associated with interpretivism; including a greater belief that the social reality is not objective, but highly subjective because it is shaped by the researcher's perceptions. Collis and Hussey (2014) elaborate that this approach mainly involves the researcher interacting with that being researched. Subsequently, the act of exploring social reality has an effect on the results of the

study; since it is impossible to separate what exists in the social world from what is in the researcher's mind. While positivism puts attention on measuring a social phenomenon, the interpretivist approach focuses more on exploring the complexity of the social phenomena, and adopting a range of methods that aim to describe and come to terms with the meaning (Collis and Hussey, 2014).

Furthermore, Collis and Hussey (2014) mention that the interpretivist paradigm often involves a mass of qualitative data such as: published documents, field notes and interview transcripts that must be reviewed, analyzed and interpreted. In this context, the process of the data analysis is further described which involves three flows of activities: reducing- and displaying data, as well as verifying the validity of those conclusions. This approach is generally not a characteristic of an interpretivist study as it limits the collected data and the deeper understanding of the researched phenomena. However, reflection is a key part of an interpretivist methodology, and not until the researcher have spent a considerable amount of time it is possible to establish what is relevant to include in the analysis (Collis and Hussey 2014).

In this study, all of the interviews were recorded and transcribed by the help of a computer; transforming data from verbal to written language. Once an interview was processed, it was established as solid empirical data for the analysis. Along with the interviews, a broad variety of themes were highlighted, and consequently, some of the collected data in the study were later disregarded and not addressed in the final results because this data had not been relevant for the study. The reduction of the data was in this context conducted by the categorization of the collected information in relevant classifications - with connections to the theoretical framework. In essence, the findings that did not appear as relevant were not included.

Moreover, as the single-case design was chosen in this case study, the within-case analysis appeared to be the most suitable option (Collis and Hussey, 2014). This method involves being familiar with the material in the current study to build up separate descriptions of events, opinions, and phenomena which can be used to identify patterns. Yin (2014) elaborates that, if the case study is an exploratory one, the study may also be using the nonequivalent dependent variables as a pattern in the analysis. According to this design, the study includes multiple dependent variables; meaning a variety of relevant outcomes.

3.4 Research quality

In order to evaluate the quality of the report, the validity and reliability terms are consistently used by researchers (Merriam, 2010). With validity, the intention is essentially to understand how well the researcher succeeded with the measurement of the various variables, while reliability describes the study's credibility (Yin, 2014). Along with these reasonings, frequent criticism related to qualitative studies are the challenges involved to ensure that they achieve the requirements for validity and reliability (Bryman and Bell, 2013). For that reason, this acknowledgement may have an effect on the overall quality of the study.

Based on the knowledge of the previous mentioned, the discussions under this section will follow the framework proposed by Yin (2014); with some additional aspects provided by Gibbert et al. (2008). The reason for this approach is mainly because of the authors' reflections on how to accomplish an enhanced credibility of studies that are to a large extent characterized by the case study approach. With the framework conducted by Yin (2014), the author highlights four tests that have been commonly used to establish the quality of the case study research. These four tests are described and introduced below, followed by arguments about their application to this report.

Construct validity

The first option mentioned by Yin (2014) includes the process of *constructing validity*, which basically means identifying correct operational measures for the concept being studied. This aspect should be considered during the data collection. The author explains that this is particularly challenging in a case study research where researchers often fail to develop an adequate set of operational measures; whereas subjective judgments consistently tend to confirm preconceived notions. In this context, Gibbert et al. (2008) highlight a number of strategies that could be used to enhance this process, and some of them are revealed below:

- To establish a clear chain of evidence - where the researcher reconstructs the process from the initial research questions to the final conclusions.
- To apply multiple sources of evidence - involving the triangulation approach: where the researcher observes the same phenomenon with different angles (Gibbert et al., 2008).

In this case study, the ambition has been to explicitly clarify and reason about the choices made along the process, as well as the effects of these findings. Furthermore, by adopting an exploratory approach, through the semi-structured interviews, the study has also revealed a

comprehensive view of the researched phenomenon; which might be considered as a strength in the process of constructing validity. On the other hand, there might be some uncertainties whether another selection of respondents would contribute to contradictory effects in the analysis. To minimize the risk of this outcome, the selected respondents in this case study were represented by important decision-makers, researchers and specialists with wide-ranging knowledge concerning the themes covered; which generated an overall image of the interviewees' arguments and perceptions from different perspectives. In order to further strengthen the construct validity of the report, a great emphasis was put to get in touch with the right people for the purpose of the study. Several respondents at different positions were contacted, and when it was established that they were not suitable representatives to interview, other more appropriate respondents were chosen.

Nevertheless, the construct validity could be criticized due to the lack of triangulation. Since the discoveries were entirely dependent on qualitative data achieved from semi-structured interviews, this could have been complemented by the use of a quantitative research approach. The application of surveys could have provided an additional aspect that would confirm the conclusions revealed in this study. However, because of the comprehensive work from the interviews conducted, as well as the limited time frame of this study, this was not possible to achieve.

Internal validity

In addition, Yin (2014) highlights the second test, *internal validity*, which has received great attention among scholars in experimental studies. This test is particularly a concern for explanatory case studies where the researcher is trying to explain how and why the event x led to event y. In this context, Gibbert et al. (2008) elaborate that the issue is whether the researcher provides causal arguments and logical reasoning that is powerful and compelling enough to defend the conclusions in the data analysis phase. However, Yin (2014) points out that this logic is inapplicable in descriptive or exploratory studies, whether it involves a case study, survey or experiment, because they are not concerned with this kind of causal situation.

Instead, the author claims that the concern over internal validity, for case study research, extends to the broader problem of making inferences (Yin, 2014). These inferences occur in a case study every time an event cannot be directly observed. The researcher will infer that particular events resulted from some earlier occurrences, based on the interviews and documentary evidence collected as part of the case study. In this context, the question is whether

these inferences are correct, and if the research design has dealt with the overall problem of making inferences (Yin, 2014). As an extension, Gibbert et al. (2008) describe different measures that could be used to enhance the internal validity such as: using pattern matching; where researchers compare empirically observed patterns with either predicted ones or patterns established in previous studies, and in different contexts. Another measure involves the use of theory triangulation which enables a researcher to verify findings by adopting multiple perspectives.

In relation to this study, the pattern matching was introduced by comparing patterns with those findings in previous pilot cases concerning OPHD. Subsequently, the similar patterns in this topic provided a framework to which the study could confirm or develop any given theory. In this context, the internal validity could have further been strengthened by the pattern matching of predicted ones or cases from other contexts, along with the use of theory triangulation. Since this was not conducted in this study, this could be considered as a weakness of the research. Nonetheless, this weakness was not considered to be a negative aspect of the quality of the study because it compensates with valuable and wide-ranging knowledge in the field of OPHD.

External validity

Yin (2014) mentions that the third test, *external validity*, deals with the issue of knowing whether a study's findings are generalizable beyond the current study. In the context of case studies, the issue is directly linked with analytical generalization. Gibbert et al. (2008) differentiate between statistical generalization and analytical generalization. The latter option indicates a process separated from statistical generalization; as it refers to the generalization from empirical observations to theory, instead of a population. The authors claim that neither single- or multiple case studies allow statistical generalization; determining conclusions about a population. In contrast, Gibbert et al. (2008) explain that case studies can be a starting point for theory development; whereas a cross-case analysis involving four to ten case studies may establish a good basis for analytical generalization. To enhance this process further, the researcher could also demonstrate a clear motivation for the case study selection, and provide sufficient details on the case study context; allowing the reader to understand the researcher's sampling choices (Gibbert et al., 2008).

Since this study was conducted as a single-case study, the generalizability of this research could be criticized, and considered weak. The studied phenomenon had not previously been explored in the specific setting (in the city of Gothenburg) which subsequently generated difficulties to

determine if any conclusions from the results were representative in general terms. On the other hand, the similar pilot cases in the topic of OPHD helped to confirm some theories that were generalized from this study, while the new divergent results provided a foundation to be explored for further studies in Gothenburg. Due to these inferences, this study did not entirely fulfill this criteria. In order to further enhance the generalizability of this case study, additional cases in the same topic are required to be investigated and compared in the city of Gothenburg. Only by doing this, the theory can be confirmed and generalized.

Reliability

The final test described by Yin (2014) includes the measures of *reliability* which essentially demands that the research instrument is neutral in its effect, and consistent across multiple occasions of its use. The author claims that the goal of reliability is essential to minimize the errors and biases in a study, and to allow a subsequent researcher to arrive at the same conclusions if they would have conducted the study along with the same steps again (Yin, 2014).

Gibbert et al. (2008) highlight the keywords involved in the process of enhancing reliability: transparency and replication. The authors claim that transparency can be enhanced through measures such as careful documentation and clarification of research procedures by using a case study protocol – a description of how the entire case study has been conducted. The second option, replication, may be achieved by establishing a case study database which includes the notes, documents and the narratives collected from the case study.

In this study, the transparency has been achieved through a comprehensive description along the entire process: from the preliminary investigation – to the final phases of the process. The extensive description has further been characterized by an explicitly detailed protocol including the structure of the interview guide as well as the selection of the respondents. These transparencies could be considered as a strength in the context of replicating this study; since it enables a future researcher to follow every step of the procedure. Then again, as this study involved the use of semi-structured interviews, this could make it more difficult to arrive at the same conclusions. To enhance this aspect further, the database approach could have been made in this study – involving the documents and recordings achieved from this study; but this was not applied.

Confirmation

Last of all, Bryman and Bell (2013) also mention the criteria of confirmation, where the possibility of strengthening and confirming the results of the study is the last basis for the study's credibility. This criterion includes the researcher's role and the measures that have been taken to ensure that the researcher has acted with honest intentions. In this context, Denscombe (2010) highlights the importance of informed consent in accordance with the research ethics guidelines. The author emphasizes that the involved participants should never be forced or pressured into helping with research. The basis of their participation must always be voluntary, and they must have adequate information about the intention of the research to arrive at a reasoned judgment about whether or not they want to participate. Consequently, these are the guidelines of informed consent (Denscombe, 2010).

In this study, the above mention were taken into consideration. In the interview situations, the researcher participated with the intention of avoiding a personal interpretation of the respondent's answers. The objectivity was a central feature of the results obtained in the study. Different perspectives were taken into account through the process with the aim of generating a fair image of the respondent’s perceptions; where open questions were asked to avoid steering or influencing their responses. Likewise, the respondents in this study were in advance informed that the interview was intended to be recorded for the purpose of an investigation and that they also got the opportunity to refuse or to accept the participation. Subsequently, this study acted with respect to the good faith and ethics which Denscombe (2010) and Bryman and Bell (2013) emphasize in the research process.

4. Empirical Analysis

In this section, the collected data in the study is presented and analyzed. The analytic part is mainly characterized by empirical data; where the perceptions and opinions of the respondents appear with links to the theoretical framework. The results are further described by the use of summarized text and quotes that form parts of the interview transcripts.

To contribute to an increased understanding of the empirical framework and facilitate an easier structure for the reader, various theoretically related themes were given as headings in the section. In terms of the subheadings, they were based on the study's empirical data. With this approach, an open discussion was made possible within the framework of the research.

4.1 The ‘’Winners and Losers’’ in Gothenburg

4.1.1 The collaborations of the stakeholders’

Along with the discussions concerning the possibilities for OPHD in the city of Gothenburg, several perspectives from different stakeholders were taken into account. In all the interviews, it was clear from the representatives that the implementation of the concept was relatively complex.

Today, the vast majority of the deliveries in Gothenburg are conducted during regular daytime hours (Nilsson). The reason for this framework is mainly because of the time access restrictions imposed by the local authorities and the property owners within the inner-city; these actors have the power to establish local traffic regulations and how the city should be developed. At the current state, the heavy trucks cannot enter after 10.00 a.m. After this time, the carriers are often forced to deliver the goods to the consolidation center in Gullbergsvass; where the electric vehicles transport the goods to the receivers at a different time (Jäderberg). This solution is called Stadsleveransen, and was introduced as an initiative to create a better and more attractive urban environment within the inner-city; which prohibits heavy truck to operate and stand in the way of pedestrians during specific hours of the day (Widegren).

The concept of Stadsleveransen includes four small ‘’trains’’ that distribute to roughly 600 companies aligned with this implementation (Dalerup). This solution has been widely extended, and Örtengren highlights that the city of Gothenburg currently cannot do without Stadsleveransen.

‘’If the concept would be removed, there would be a crisis descending’’ (Örtengren).

On the other hand, Örtengren reveals that Stadsleveransen currently does not have a good business model because it is not profitable for the businesses involved. To put this notion into perspective: when the receiver orders a package from A to B; there are a few steps in between depending on where the goods come from. In many cases, the delivery requires additional stops along the route for the carrier: either to a consolidation center or to the care of address where Stadsleveransen leaves from – creating additional costs for the actors involved. Because of the different steps along the process, there is also an existing uncertainty of when the goods arrive to the receiver (Örtengren). In parallel, Jäderberg points out that Stadsleveransen has some limitations in terms of volumes and sizes (only smaller parcels) it can deliver.

In response to the concept of Stadsleveransen, Lindkvist highlights that OPHD can have a greater impact on the operational activities if the carriers can deliver larger quantities.

4.1.2 Off-peak hour deliveries

From the carrier's point of view, they do not experience any difficulties setting up drivers to deliver at night (Nilsson). However, in an OPHD scenario in the inner-city: there is not anyone who can accept the goods because there is nowhere to deliver it. For instance, in Kungsgatan, the only way to get access to the establishments is via the entrances to the stores. Dalerup explains that the implementation of the OPHD requires the stores to receive the goods, and if the stores are not open, it becomes difficult to distribute during the night hours in the inner-city. In this context, the goods must be received, either by staff or by the support of technological solutions to sign the goods as ''received'' and ''confirmed''. Along with these reasonings, the costs and risk questions appear, whereas staffing or technological solutions for nighttime deliveries entails additional costs to receive the goods in the stores (Dalerup). (More information about the reception of the goods appears in the technology section, 4.2.2.)

As an additional aspect, the carriers are also not able to fully benefit from the OPHD concept because of the way the supply chains are constructed in Sweden (Nilsson). The main obstacle is that the large transport operators' Postnord, DHL and Schenker do not have any inventory of their goods in the terminals (Jäderberg). For instance, in Bäckebol, all the terminals have cross-docking layouts: where the goods are carried in and out within two hours (often from other cities such as Stockholm or Jönköping) – and delivered with full utilization of the truck. In this context, Jäderberg highlights that the terminal-based goods represent the majority of the deliveries in Gothenburg, but also the rest of the country. Because of this system of delivering goods, Nilsson points out that there is no need to deliver one pallet at night hours for a bag store

on Kungsgatan; then you need to drive on the same street with the same truck later during the day to deliver everything else to other stores that still prefers daytime deliveries. This implementation basically means that the carrier needs to add another truck during the night hours which is not benefitting their operational activities (Nilsson).

Another issue concerns the receivers, where the postponement of the delivery is a critical matter. Today, the majority of the receivers are working with just-in-time solutions which basically involves keeping the stock levels at minimum levels (Nilsson). What is sold today in the store, the receiver gets delivered the day after. Although, if the delivery is to be postponed by one day because of night deliveries, it is a one day's postponement of all the goods which is not the most optimal solution for the receivers (Nilsson).

Furthermore, Årnes also stresses that there are people living in the inner-city of Gothenburg where local residents do not want vehicles or a person working during the night hours. In parallel, Krslak explains that Miljöförvaltningen (The Swedish Environmental Protection Agency) has local restrictions imposed for nightly transports that give rise to the sound levels exceeding 55 dB (A) close to residential buildings. The target value of 55 dB (A) is specified for ‘’temporary short-term sounds’’ which basically indicates a maximum level of any type of sounds. Because of these restrictions, the heavy trucks of 3.5 tons are not allowed to operate close to residential areas between the hours: 22.00 and 07.00. The motivation for these guidelines are essentially to decrease the noise-related health problems, and prevent people from being negatively affected by reduced sleep quality (Krslak). (More information about low-noise initiatives appears in the technology section, 4.2.2.)

4.1.3 The issue of congestion and accessibility

Sánchez-Diaz highlights that there are two main peak periods for freight traffic in most cities: in the early morning between 8.00-10.00, and in the afternoon around 13.00-14.00. In terms of the general traffic, the peak periods are between 07.00-09.00 and in the afternoon 16.00-18.00.

Considering the traffic conditions in the city of Gothenburg, Sánchez-Diaz explains that they are not as difficult compared to other cities around the world. The traffic congestion is mainly located in the outskirts of the urban areas; from vehicles driving towards the city, as well as in certain intersections such as Korsvägen. However, the traffic conditions are not that concentrated, and the peak hours do not last that long. Currently, the peak periods only last a couple of hours during the day which basically means that the carriers can still distribute during peak hours in Gothenburg without having the need to distribute during nights. In this context,

Sánchez-Diaz highlights that cities, in general, need to reach a certain level of congestion to acknowledge the benefits of the OPHD concept (Sánchez-Diaz).

''Initially, you need to have the right motivation to implement off-peak hours'' (Sánchez-Diaz)

The implementation has to make sense for all the stakeholders involved to initiate the deliveries during the night hours. On the other hand, the concept does not necessitate that all companies apply the transitions to off-peak hours because that would not be an optimal solution. However, if only 10-20 percent of the deliveries could be shifted, there would be several different benefits to gain by the concept such as: increased accuracy- and reliability of deliveries, improved transport efficiency, decreases in traffic congestion, reductions in environmental pollutions as well as increased quality of life (Sánchez-Diaz). In parallel, Jäderberg explains that Gothenburg is currently starting to have some problems with the accessibility of freight transports. The accessibility issue is very central today (compared to 5-10 years ago) because of all the construction created by the project ''Västlänken''. Subsequently, it is highly relevant to find measures that can solve the issue of accessibility (Jäderberg).

4.2 The technological applications

4.2.1 A mixture of receiving methods

Billsjö claims that the concept of OPHD requires a combination of solutions which are suitable for different actors. This can be different from one case to another, but it is important to have an understanding of the local conditions and business models. In essence, it is vital that the involved stakeholders experience the transitions to OPHD as beneficial and profitable. Subsequently, there are many aspects that determine if the deliveries are to be constructed by staffed- or unassisted deliveries (Billsjö).

In terms of the reception of the goods, Nilsson explains that the inner- city of Gothenburg has a lack of facilities and storage rooms where the deliveries could be received. In this context, Dalerup points out the possibility of identifying special hubs or underground cargo spaces that could receive the goods from different places within the area of the inner-city. This form of receiving the goods is also discussed by Örtengren who further emphasizes that the hub implementation would require staffed deliveries; since the technological solutions would not be enough to guarantee the security risks of the goods.

In contrast, Sánchez-Diaz highlights that there is not any real benefit of implementing a hub solution if the goods are still on the second step of the delivery distributed during the regular daytime hours. This would not make any large difference as the only reason to implement this

solution would be for the carriers to arrive at night hours. From the carrier's perspective, Cederstav also explains that the hub implementation is not something that the big players (e.g. DHL, DB Schenker and Postnord) in freight transport prefer because they optimize their own goods flows and they do not want an additional consolidation at a different location. In a possible hub scenario: the solution might be beneficial for some carriers, but it does not benefit the majority; because they would need to run an alternative route on the way to the hub – creating additional costs (Cederstav). In parallel, this solution would further require significant changes in the scheduling of the deliveries – creating a complex situation for the receivers. For that reason, there would not be any value for the stakeholders involved to initiate transitions to off-hours (Sánchez-Diaz).

Furthermore, Jäderberg claims that it is quite complex to implement unassisted deliveries in the inner-city of Gothenburg. Since the carriers, in general, make deliveries to several different stores; this would require many different keys or digital cards for the establishments involved. At the same time, if any cargo would disappear along the process, the carrier would also be responsible for the goods; prompting a possible legal issue for the actors. In this context, Örtengren further explains that the unassisted deliveries would certainly not be appealing for commodities such as luxury or premium products because of the high value and large theft risks. On the other hand, Nilsson highlights that pharmacy chains are far ahead in conducting the concept of unassisted deliveries. In many cases, the establishments of the pharmacies have an area in the store that the carrier has access to via electronic cards and codes; an area which is not alarmed, while the rest of the establishment is alarmed. When the carrier arrives, they can deliver the goods to the specific area, and then leave the establishment. Then again, the pharmacies are generally located on a street where there is a door that the carrier can enter. By taking this account, in most cases in the inner-city, the carrier can only have access via the entrance to the store which makes this solution more difficult to implement for other types of businesses (Nilsson).

As an extension, Billsjö explains that unassisted deliveries are particularly something that property owners will see as valuable to achieve the increased value of their establishments. In essence, it is mainly about seeing an increased value in removing heavy trucks that generate noise annoyances and lower air quality in the urban areas (Billsjö). These arguments are further supported by Cederstav who also emphasizes that property owners have to rethink the way the construction of their buildings are made in the future. Today, the receivers do not have any goods receptions in a fashion that suits the unassisted deliveries. Subsequently, by constructing

goods receptions within the establishments, and including digital locks as well as other technical solutions; there would not be any requirements of personnel to facilitate the reception of the deliveries (Cederstav).

4.2.2 The low-noise initiatives and challenges

In the case of OPHD implementations, Billsjö points out three different sources of noise that are in general considered: the ambient noise (also described as background noise), engine noise and noise from loading- and unloading operations. At the current state, the biggest challenge is to contemplate the increased noise levels descending from loading- and unloading operations. This issue is further labeled as the main obstacle by the vast majority of the respondents in this study; because it is generally more difficult to initiate possible adjustments of the sound levels in these contexts. However, Lindkvist claims that improvements in technological solutions have resulted in significant potentials to deal with the key sources of noise.

With the above-mentioned, Billsjö highlights different sorts of low-noise equipment available such as quiet roller cages, pallet lifters, trolleys, etc. These have great potentials to deal with the negative impacts of noise that are mainly related to the ambient noise and noise in loading- and unloading operations. On the other hand, Cederstav claims that the main challenge is to manage the noise impacts on residential streets where the ambient noise is generally low. The perception of sound is to a great extent subjective; which basically means that if one individual feels disrupted in a particular area, then it might be perceived as disturbing (Cederstav). In parallel, Gardrat mentions additional sources of noise originating along with the activities of the delivery such as: when slamming doors, having high volumes on the radio, and rolling the goods over a curb. These types of noise causes are portrayed as equally important to manage. Although, in this context, there are different initiatives that could be applied to contemplate these issues by for example educating the truck drivers in silent behavior and adjusting the curbs of the asphalt (Gardrat).

Finally, Sánchez-Diaz highlights that noise regulations are generally strict in Europe because it is an important issue for society. For that reason, it is highly relevant to contemplate the issues of noise when implementing the OPHD. A lack of consideration in this aspect might endanger the entire concept for a few years or even decades; because the failed application would not encourage anyone to try it. Conclusively, the relevance of certifications (e.g. PIEK certifications) that validates the deliveries conducted during the off-peak hours could be a critical matter (Sánchez-Diaz).

4.2.3 Coping with engine-related noise and using trucks with alternative fuels

To further comply with existing noise legislation, and implement the concept of OPHD in an acceptable fashion – the shared viewpoints of the respondents highlight the use of natural gas- and fully electric trucks as substitutes of the internal combustion engine. Since the trucks with alternative fuels enable more silent driving in urban areas; they have considerable potential to be a positive factor in the transitions of the deliveries (Gache).

In an experimental trial conducted by Volvo-Trucks, Cederstav claims that electric machines reduce around 5-7 dB (A) engine noise; equivalent to approximately 50% reduction of the perceived sound effect. Given this knowledge, the noise impacts of the fully electric truck will be significantly more pleasant than a conventional diesel truck. On the other hand, Jäderberg mentions that the fully electric truck has some limitations with regard to its capabilities of volume and distance. At the current state, it is not possible to handle both heavy cargos and drive long-haul transports – the driving ranges of the batteries are simply not enough. In this context, Cederstav explains that the fully electric vehicles are more suitable within the urban areas, while the gas-driven trucks are more convenient in heavy and long-haul transports – by means of matching technologies.

Furthermore, Lindkvist mentions the application of hybrid vehicles that are tailored with geofencing technologies: a function that forces a switch from the internal combustion engine – to the electric engine – within a predetermined geographical zone. This solution has great potential in urban areas where the combustion engine has more negative impacts on pollutions (on account of idling) and noise levels (Lindkvist). The geofencing hybrid truck is currently being tested in an OPHD project in Stockholm and could be a key factor for the OPHD concept in the near future – given that the utilization of hybrid trucks extends further (Cederstav; Jäderberg)

4.3 The appropriate use of incentives

4.3.1 The monetary- and non-monetary incentives

Sánchez-Diaz emphasizes that the concept of OPHD demands a strategy that is oriented towards the receivers; the acceptance of the receivers is vital in the transitions of the deliveries. Provided that the carriers experience the traffic congestions as difficult – they are most likely to be benefitted by the OPHD implementation. As a result of the concept: the carriers can spend less time in traffic queues and experience improved transport efficiency. However, if the receivers do not accept the transitions, the carriers are still forced to deliver the goods during the regular

daytime hours (Sánchez-Diaz). For that reason, Eklöf explains that simplification on the receiver's side might increase the motivation for OPHD. Similar opinions are expressed by Nerell who highlights that the use of incentives could be an important aspect of the implementation process. The aforementioned arguments are further supported by Sánchez-Diaz who also claims that the monetary incentives could be a key factor in the OPHD application but is not necessarily required in all cases.

Along with the previous-mentioned, Sánchez-Diaz differentiates the use of monetary and non-monetary incentives. In an OPHD scenario: the monetary incentives could be used as a one-time stimulus at the initial stages – to influence the receivers' willingness to participate and accept the risks of the application. In parallel, the non-monetary incentives could play an important role along with the following steps of the process with initiatives such as trusted vendor programs and public recognition programs. The latter option involves enabling ''free advertisement'' (i.e. Public Relations) for companies that are seeking to improve their sustainable image. This kind of initiative is relatively cheap for the public sector to apply and the actors involved would gain large monetary values from these applications. Conclusively, it is important that the benefits are adequate in relation to the involved costs along the process – the OPHD needs to remain sustainable at all times (Sánchez-Diaz).

4.3.2 The most effective approach and other required incentives

In general, there are certain sectors that are more interested in applying the OPHD concept such as: the food- (e.g. restaurants, fast food chains, caterers and bakeries), grocery- and hotel sector; basically in conditions where the benefits are immediately attained and includes less systematic changes in daily operational activities (Sánchez-Diaz). In the case of the food- and hotel sector, there are great possibilities to apply staffed deliveries; where the establishments have open during the late-night hours and have personnel available. Likewise, there are potential in cases where there is a trust link between the carrier and receiver, the integrated carrier-receiver operations; where the carriers could be given a key or digital card (unassisted deliveries) without any liability issue for the receiver. Although, in most of these types of integrated relationships, the actors are quite efficient in their way of conducting deliveries – because of the centralized distribution systems. Subsequently, a big franchise fast-food chain (e.g. McDonalds) has generally around one or two deliveries per week, while an independent restaurant (with decentralized flows) can have up to five deliveries on a daily basis. In a nutshell, there are great benefits to applying incentives in both cases – but the greater potential

lies in businesses with decentralized distribution systems; where the impacts during the peak hours are the greatest (Sánchez-Diaz).

In terms of the low-noise technologies, the acquisitions of these (e.g. pallet lifters, roller cages, and trolleys, etc.) are not considered as a great challenge in the OPHD implementation (Nerell). Eklöf claims that the carriers' do not necessarily perceive these costs as an obstacle in the transitions because it is a one-time investment. For that reason, if the carriers have the right conditions to apply the OPHD there would be more inclination to invest in low-noise equipment; as a result of the cost-savings generated by the concept (Sánchez-Diaz). Although, if the transitions to OPHD demands the use of fully electric trucks; there would be greater obstacles for the carriers to apply these changes (Sánchez-Diaz). Eklöf explains that it is a big step to make the transition to a fully electric truck because the existing technology and infrastructure are not entirely operational. At the current state, the fully electric trucks are also more expensive compared to the conventional diesel trucks (Årnes). On the other hand, Cederstav highlights that the development is moving rapidly, and it is a matter of time before the internal combustion engine will be uninteresting for urban areas.

Considering the fully electric trucks, there are great opportunities to deliver in completely new ways (Cederstav). Today, a vast majority of the carriers operate their deliveries between the hours: 07.00-15.00; where it is not rational to invest in a fully electric truck that is only used during a few hours of the day. However, by expanding the time the truck is operated it is possible to achieve a better economy on the vehicle. The energy cost of a fully electric trucks is approximately 3-4 times lower than a diesel truck, and the margins will be even better as diesel prices rises. Additional benefits concerning the electric truck are also lower maintenance- and service costs, along with an improved driving experience which is considerably more attractive and pleasing for the drivers – because of the lower noise levels. This attractiveness will most likely facilitate an easier way to recruit new personnel for these types of occupations in the future (Cederstav). Undoubtedly, the notion of electric vehicles raises issues about the cost-benefits aspects – which are important issues for the carriers to contemplate. Then again, a truck that complies with existing noise legislation during the OPHD applications is vital (Eklöf).

With the aforementioned, Cederstav highlights that companies are increasingly demanding more sustainable actions from the carriers. At the same time, the carriers are also gradually realizing that they are obligated to make the required investments in order to reach their environmental goals and reduce emissions considerably until 2030; by electrifying a part of

their truck fleet or even making a complete shift (Cederstav). Along with these reasonings, Nerell points out that the use of incentives and policy instruments could play an influential role in the development of the infrastructure and application of electric vehicles. The politicians need to set a plan for the organization and possibly provide subsidies to influence the development of fully electric trucks (Nerell).

5. Conclusion

In the final chapter of this report, the conclusions will be presented and compared with other previous off-peak trials conducted in other cities to refute the research question and sub-objectives of this study. The following will take place with the empirical analysis as framework for these reasonings.

In terms of the first sub-objective, the possibilities for OPHD are to some extent perceived as undesirable in the context of the transitions; as a result of the inconveniences created by the concept in the inner-city area of Gothenburg. Nevertheless, despite these hindrances, the discoveries have still revealed great opportunities to apply the OPHD concept in a more successful fashion – this will be more explicitly discussed in the second sub-objective. The intention of this twofold layout of the conclusion is to demonstrate that the application of OPHD can be unavoidably complex; but there are existing solutions which can facilitate a more coherent and valuable scenario of the transitions. As an additional aspect, the reflections and propositions on further research will also be presented in this section.

5.1 Answering the research question

To what extent can the lessons of the OPHD conducted in other cities be applied in the city of Gothenburg, and what could be learnt from this case?

- **The stakeholder interactions**

Consistent with previous off-peak trials, the discoveries in Gothenburg have similarly revealed complexities among the stakeholder interactions. Within the area of the inner-city, neither the carriers nor receivers are able to benefit from the OPHD concept – predominantly because of the way the goods are delivered. The existing cross-docking layouts (i.e. the terminal-based goods) are creating difficulties for the carriers to distribute in other hours than the regular daytime hours; as it demands that all receivers on the route participates and fulfils the volumes required to make the application beneficial for the carriers. In a scenario where only a few receivers choose to adopt the OPHD concept: this results in an additional truck that is operated explicitly for those certain actors during the night hours; producing lower utilization rate of the truck and additional costs. This finding constitutes the largest difference compared to the off-peak trials applied in other cities whereas in most cases the carriers were able to benefit from the concept by the improved accessibility that enhanced their operational activities. Considering the level of congestion in Gothenburg, the current traffic conditions are also not that concentrated, and the peak hours do not last that long; making it rather uncertain whether it is

beneficial to apply the concept. As long as the carriers can still distribute during peak hours without having the need to deliver in other hours than the regular hours – the OPHD concept will neither be acceptable or valuable to apply by the actors involved.

From the receiver's perspective, they further do not have any goods receptions that can facilitate the staffed- or unassisted deliveries. Likewise, there are also existing uncertainties whether the OPHD concept is beneficial for the actors as they are forced to postpone the delivery until the night after; creating further complexities around the scheduling of the distribution – since the majority of the receivers are working with just-in-time solutions. In this context, the lack of interest and preference for regular daytime deliveries are still enduring characteristics of the receiver's attitudes towards the OPHD concept – which complies with the results from previous off-peak trials. There are also current restrictions imposed by the local authorities that prohibit heavy trucks in the inner-city between certain hours of the day; to increase the attractivity and reduce noise-related health problems. In the case of Gothenburg, there are people living close to the area of the inner-city which makes it difficult to manage the negative noise levels that originate from OPHD. As described in this report, there are existing noise-solutions (e.g. low-noise technologies and trucks with alternative fuels) that could contemplate these issues along the process of the deliveries. Although, in the inner-city, there are many residential streets with ambient levels that are generally low; where it is particularly a great challenge to contemplate the noise issues and existing local restrictions during the night hours (with a target value of 55 dB (A) specified for sound levels close to residential buildings between the hours 22.00-07-00).

Given this knowledge, the OPHD implementation in the inner-city appears quite difficult for all the stakeholders involved. Nevertheless, the accessibility issue is gaining more attention today in Gothenburg and will conceivably be more important in parallel with the rapidly rising urbanization and deteriorating traffic conditions. Along with these reasonings, the discoveries of this study revealed that there are existing key factors which can facilitate the transitions to OPHD in a more successful way. As the concept does not necessitate that all companies apply these transitions; only if 10-20 percent of the deliveries could be shifted, there would be considerable benefits for the stakeholders such as: fewer heavy trucks during the daytime hours, increased accuracy- and reliability of deliveries, improved transport efficiency, reductions in environmental pollutions, and increased quality of life of citizens.

Subsequently, the OPHD concept can be a great solution to better exploit the existing infrastructure and manage the accessibility issue in an effective way. As long as the concept is

applied in a suitable condition which is acceptable by the involved stakeholders; there are great possibilities to realize the beneficial outcomes of the transitions.

- **The key factors that can enhance the implementation process**

From the stakeholder's perspective, it is essential that the benefits are adequate in relation to the existing costs during the process of the OPHD – the concept has to make sense for all the stakeholders involved. Given this knowledge, it is necessary that the OPHD program fulfills the required conditions to be acceptable; either by the availability of personnel or a certain area where the carriers could deliver the goods (i.e. inside the establishment or in connection to it). In this context, the contemplation of local conditions and business models could be important features to reassure the value of the transitions. In general, there are different conditions where the benefits of the OPHD concept are instantly attained, and includes less systematic changes in daily operational activities. For that reason, the initiatives could vary from one case to another, and there could be a mixture of solutions which are suitable for different OPHD programs.

A successful example that was highlighted in this study concerned the pharmacy chains' application of unassisted deliveries; where the carriers were provided access in a certain area of the establishment and could perform the deliveries by the help of technological solutions (e.g. surveillance technologies, electronic cards or codes) – without the involvement of the receivers. However, this implementation is currently not possible to apply for other businesses; as the vast majority of receivers' in the inner-city area do not have any goods receptions that facilitate the OPHD in an acceptable way – which is creating many of the existing issues previously indicated by the involved stakeholders. Consequently, there are requirements of solutions which can facilitate the OPHD concept in an acceptable way.

With the above-mentioned, the concept of unassisted deliveries could be a key factor in the transitions of the deliveries as the concept does not necessitate any expenses for the receivers involved. For instance, by issuing construction developments for goods receptions within the establishments in the inner-city which embraces digital locks and other technical solutions; this could facilitate the OPHD application in an acceptable fashion; since the deliveries would be conducted inside the premises. In this context, there would further be greater opportunities to implement the transitions to other hours than simply during the night; e.g. early mornings between the hours 05.00-08.00 could be another prospect (with permission from the local authority). However, this application entails the property owners' involvement in the

development as they are the ones with the power to make the required changes, and facilitate unassisted deliveries in their establishments. The important role of the property owners was recurrently highlighted in this study – which is a relatively new finding compared to other off-peak trials. From their viewpoint, there is a great value to invest in these types of solutions since they can increase the value of their properties by the attained attractivity of the area; without any heavy trucks during the regular daytime hours.

Nevertheless, the fact remains that it is important to ensure the entire process of the OPHD, and contemplate different kinds of noise sources such as the ambient noise, engine-related noise and noise descending from loading- and unloading operations. Since the carriers would still operate the deliveries within the inner-city, the ambience noise and engine-related noise are important issues to consider for the local residents living in the inner-city area. Therefore, the application of certifications (e.g. PIEK or other types) could be an important factor that validates the transitions, and reduces the risks of endangering the concept. Provided that the carriers are given the right conditions to apply the transitions; they would be more inclined to invest in certifications as well as the low-noise technologies – whether this inclination also involves the use of trucks with alternative fuels depends on many different factors, but ultimately it is essential that the engine-related noise is handled in an adequate way. Along with the increased pressure on sustainable actions, and the current environmental goals of carriers; the replacement of the regular diesel truck is highly recommended to reduce any possible interferences with OPHD, or freight operations in general in the future. To achieve this transition to a larger extent, the politicians could play an important role by providing subsidies and other policy instruments to stimulate the development of infrastructure and acquisitions of fully electric trucks.

Last of all, the simplification on the receivers' side is still described as a critical factor to consider in order to facilitate the OPHD applications in a sustainable fashion – similar patterns with the case conducted in New York. Given this knowledge, the incentives could also play a key role in Gothenburg that influence the receivers' inclination to participate and apply the OPHD concept on long-term; by a mixture of initiatives during the application involving: monetary incentives at the initial stages (not required in all cases), and non-monetary incentives (e.g. trusted vendor programs or public recognition programs) along the following steps. From an overall perspective, there are potential to apply these incentives in a more optimal way and accomplish greater value of the OPHD. By simply focusing on conditions where the concept is the most appealing, or contributing to the largest impacts during peak hours such as: the

integrated carrier-receiver operations (where unassisted deliveries are more suitable), or companies with decentralized distribution flows e.g. food- and hotel sector (where staffed deliveries could be performed) – it is possible to identify the greatest opportunities to establish the OPHD concept, and accomplish more valuable outcomes.

5.2 Suggestions for Future Research

The aim of this report was to gain an increased understanding of the possibilities to induce shifts to OPHD in the city of Gothenburg. To accomplish this objective, a single-case was conducted to provide useful insights concerning the interactions among stakeholders – along with relevant key factors that could enhance the OPHD implementation. In order to generalize these findings, additional cases in the same topic are required to be investigated and compared in the city of Gothenburg. Once the opportunities for OPHD have been more precisely determined, it is possible for further studies to examine specific companies with more detailed facts concerning the costs and benefits involved. Convincingly, there are great potential in companies with integrated carrier-receiver operations, as well as decentralized distributions flows. For that reason, it would be interesting to conduct a quantitative survey with several different companies within these segments – to establish a map of companies with the most potential to implement the OPHD concept.

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7. Appendix

Appendix 1 - Respondent list

Respondents	Job title	Duration	Location	Interview	Date
Philippe Gache	Director at Programme Systeme de Transport & Intelligence	45 min	Lyon	In person	2019-02-06
Mathieu Gardrat	Resarcher at Laboratoire Aménagement Economie Transports	30 min	Lyon	Phone interview	2019-02-13
Christoffer Widergren	Strategist, Transport authorities Gothenburg	25 min	Gothenburg	Phone interview	2019-02-20
Lena Dalerup	CEO, Innerstaden Gothenburg	25 min	Gothenburg	Phone interview	2019-02-22
Peter Årnes	Project leader, Göteborgs stad	30 min	Gothenburg	In person	2019-02-21
Hannes Lindkvist	Project manager, Lindholmen Science Park	30 min	Gothenburg	In person	2019-02-14
Patrik Nilsson	Operative manager, TGM	60 min	Gothenburg	Phone interview	2019-02-21
Fredrik Cederstav	Senior Project Manager, Electromobility and New services, Volvo-Trucks	60 min	Gothenburg	In person	2019-03-04
Belma Krslak	Noise specialist, Miljö Förvaltningen	30 min	Gothenburg	In person	2019-02-27
Robin Billsjö	Strategist, Transport authorities, Stockholm stad	45 min	Stockholm	Phone interview	2019-03-01
Magnus Jäderberg	Freight Traffic Manager, Transport authorities Gothenburg	60 min	Gothenburg	Phone interview	2019-03-01
Jesper Örtengren	Head of Retail, Vasakronan	45 min	Gothenburg	In person	2019-03-06
Ivan Sánchez-Diaz	Senior Lecturer at Chalmers University of Technology	40 min	Gothenburg	In person	2019-03-13
Henrik Nerell	Head of PR, McDonald's	35 min	Stockholm	Phone interview	2019-03-11
Camilla Eklöf	Quality, Safety and Environmental manager, HAVI	40 min	Stockholm	Phone interview	2019-03-13

Appendix 2 - Interview guide

Presentation of respondent:

Name, profession and title

General questions:

Relation to urban freight activities

Current sustainable actions in urban freight

The most optimal strategy

Stakeholder engagements

Previous collaborations with the public sector and other actors

Motivation for these engagements

Existing conflicts with other actors

Future plans

Off-peak hour deliveries

OPHD – possibilities

Changes in the transport activities

Differences towards the current situation

Challenges/restraints

The most optimal solution

Unassisted or Staffed

What is the most preferable and why?

Challenges and risks

Requirements for implementation

Benefits

Incentives

The most appropriate use

Motivational factor for the transitions

Noise

Challenges with noise

Current solutions

New solutions in the future

Appendix 3 – The snowball approach

As the main focus of the study was in the city of Gothenburg, the selection of the respondents had to be mainly represented by individuals with knowledge based within this city.

At the initial stages of the process, one specialist from Lindholmen Science Park was chosen with relevant knowledge concerning urban freight and OPHD implementations. This was an obvious starting point along the process as the selected respondent had been involved in several different transport-related projects: having established a wide network with people from both the public- and private sector. As a consequence of this respondent's network, the person could recommend other actors involved in a possible OPHD implementation such as the local authorities, carriers and receivers.

Following the first interview, the second and third interview were booked with two respondents from Trafikkontoret (the local authorities' perspective). Moreover, one interview was also established with the CEO of Innerstaden (the receiver's perspective), in addition to one operative manager from the transport company TGM (the carrier's perspective). Along with these initial interviews, the important role of the property owners had also been repeatedly highlighted among the respondents. Subsequently, one more interview was required to attain the aspect of these stakeholders (the property owner's perspective). In this context, the selected respondent was a high positioned manager from Vasakronan (this interviewee had been reached through the previous mentioned CEO's network).

Some additional respondents were also selected which were represented by specialists with different skills and knowledge related to the OPHD implementation. The purpose for the selection of these respondents were because of their acknowledgement along the process to provide more specific knowledge about the themes concerned. For instance, the negative impacts of noise had been highlighted throughout the interviews, consequently the study required further research about this issue. The selection of these specialists were based on the recommendations from the different respondents along the process.

In addition, a number of respondents from the pilot project in Stockholm were also included to provide some additional insights and parallels to the city of Gothenburg. In this OPHD project, an integrated carrier-receiver operation was being conducted between McDonalds and their main distributor HAVI. A total of three respondents were selected from this project.

As an extension, two additional respondents were also selected from the city of Lyon to provide further insights. These respondents were represented by one researcher and one high positioned

manager and were chosen due to their involvement in various urban freight-related projects conducted in this city, as well as knowledge about the OPHD concept. Because of the limited time frame of this thesis, only two respondents were chosen.

To summarize and illustrate the above mentioned, the respondents were divided into different categories:

Gothenburg

The main stakeholders' perspective:

- Christoffer Widergren - (Strategist, Transport authorities)
- Magnus Jäderberg - (Freight Traffic Manager, Transport authorities)
- Lena Dalerup - (CEO, Innerstaden)
- Patrik Nilsson - (Operative manager, TGM)
- Jesper Örtengren - (Head of Retail, Vasakronan)

Specialists

- Peter Årnes - (Project leader, Göteborgs stad)
- Hannes Lindkvist - (Project leader, Lindholmen Science Park)
- Belma Krslak - (Noise specialist, Miljö Förvaltningen)
- Ivan Sánchez-Diaz - (Senior Lecturer at Chalmers University of Technology)
- Fredrik Cederstav - (Senior Project Manager, Electromobility and New services, Volvo-Trucks)

Additional insights

Off-peak hour delivery project – Stockholm

- Henrik Nerell - (Head of PR, McDonalds)
- Camilla Eklöf - (Quality, Safety and Environmental manager, HAVI)
- Robin Billsjö - (Strategist, Transport authorities)

Off-peak hour delivery experiences - Lyon

- Philippe Gache - (Researcher at Laboratoire Aménagement Economie Transports)
- Mathieu Gardrat – (Director at Programme Systeme de Transport & Intelligence)