UNIVERSITY OF GOTHENBURG

SCHOOL OF BUSINESS, ECONOMICS AND LAW

Performance of Light Electric Freight Vehicles in Urban Areas

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Adapting the Performance Prism framework to manage CEP stakeholder relationships and improve the performance of Light Electric Freight Vehicles in the last mile

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Preface

Abstract

Urban areas and specifically the logistics providers responsible for the last mile in these environments have become under more pressure over recent years. Reasons for that could be seen in the growing trend of economies having more globalized supply chains. Also, more and more people around the world move into urbanized areas while at the same time e-commerce platforms and companies have risen over the past years, which basically offer customers to order everything online within a short time window. These circumstances have led to negative consequences on the quality of life in urban areas, as well as growing inefficiencies and costs for the operators affected within the last mile of delivery. Therefore, it is crucial to consistently explore alternative solutions that could potentially improve the last mile delivery within dense urban areas. One of these solutions is presented in this report in the form of Light Electric Freight Vehicles (LEFV), mainly cargo bikes, being used for the final delivery in the parcel sector and how the performance of this alternative could be improved. The report shows that the LEFV has advantages, as well as disadvantages to the regular vehicles used for parcel deliveries. Still, to increase the operational efficiency of the LEFV, certain characteristics, such as dimension, weight and speed would need to be changed, which would go against the definition of a LEFV. The result shows that the performance enhancement has to come through a better relationship and more cooperation between the operating company and its external stakeholders. Specifically, the local authorities need to understand the importance of their roles and the influence that they can have on the issues arising from urban freight. They need to realize that they can be an active part of the solution instead of only defining the regulatory terms for others.

Keywords: *last-mile, LEFV, logistics, supply chain, parcel deliveries, city logistics, urban freight, performance prism, triple bottom line, CEP, urban freight stakeholder*

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Abbreviations

B2C:	Business-to-Customer
CEP:	Courier-, Express- and Parcel delivery services
LEFV:	Light Electric Freight Vehicle
PP:	Performance Prism
SF:	Success Factors

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1. Introduction

1.1 Research Background

The word “globalization” is a frequently used term that describes the growing interdependence of economies and cultures around the world (Kolb, 2019). An important aspect of that process has been the progress in the development of efficient and effective modes of transport as well as the creation of a global supply chain network which is interconnected by flows of goods, services and information. Different actors make use of this global network to order or send goods around the globe. With private citizens often representing the end of these supply chains, most of these goods end up in city centers (OECD, 2003). In consideration of that and the demographic process of urbanization, urban freight transport has become one of the most critical logistics operations. The reason for this is that cities and their inhabitants are highly dependent on the supply of goods or services as well as the removal of waste products (Dablanc, L., 2010). A disruption of these supplies or an ineffective supply chain could cause stress to businesses and private residents, most possibly affecting people's conditions and their living standards.

The types of demanded goods and services are manifold. Within the urban freight domain, the distribution of parcels has become one of the most interesting and important areas. In a study about the future of the last mile, the consulting agency McKinsey (Hausmann et al., 2020) described the global parcel market as highly dynamic with large growth rates in both mature and developing markets. According to Deloison et al. (2020) the last mile underlies great changes with consumers expecting more control and faster deliveries, while increasing their number of orders. Both the increasing customer demands as well as the growing parcel numbers are driven by e-commerce which has increased the market share of B2C deliveries (Hausmann et al., 2020). Between the years 2014 and 2019 the global sales ratio in e-commerce almost tripled (Deloison et al., 2020) contributing heavily to economic growth. In 2020 this trend accelerated even more due to ramifications of the Covid-19 pandemic (Tsakalidis et al., 2020).

In order to facilitate this growth and satisfy the demand of customers, logistics service providers have to adapt their operations by enhancing their handling and transport capacities. The related efforts represent a challenge, but capacity-related investments offer the opportunity to benefit from above mentioned developments and to participate in the growth of the e-commerce sector. As a result, the number of delivery vehicles has increased and is expected to do so also in the future. It is projected that in the top 100 global cities, there will be 36% more delivery vehicles by 2030, also adding almost a third (32%) of delivery traffic emissions (Deloison et al., 2020).

Besides the raised environmental impacts caused by pollution, there are further results of increased freight traffic. A higher level of noise and more congested transport infrastructure just represent two of the most significant consequences.

These far-reaching effects of an up-scaled logistics operation caused by e-commerce are contrary to the goal set out by the European Union to achieve CO2 free city logistics by 2030 (CIVITAS, 2013). Considering a steady, non-changing mix of delivery vehicles until that year, the fulfilment of this objective would be far out of reach. In order to meet the required emission levels, the substitution of vehicles using combustion engines with vehicles that run on or with electricity (e.g., battery, fuel cell, hybrid) is seen as a feasible solution (Altenburg et al., 2017). These vehicles offer substantial advantages both in the reduction of emissions or the lowering of noise.

In general, electric vehicles have received a lot of attention over the last couple of years with a steady growth of product offerings on the market (Tsakalidis et al. 2020). Various manufacturing companies have started to develop and produce different types of them as the demand of people, as well as private and public business increased substantially. The product offerings range from hybrid electric busses to fully electric bikes. In the context of last mile urban freight logistics, “light electric freight vehicles” (LEFVs) have been identified as potential alternatives or complementary vehicles for the operation. Consequently, many logistic service providers offering courier, express- and parcel delivery services (CEPs) have run pilot projects to test these vehicles, partially implementing them permanently into their operation.

Though, this implementation yields different effects as a transition from delivery vehicles using combustion engines to smaller freight vehicles using electricity disrupts operational procedures that have been in place for several years. Hence, CEP services have to adapt their approach of delivering on the last mile while ensuring to perform in a productive and profitable manner. Beyond that, they have to make sure to follow the interests of other stakeholders that are involved in city logistics (e.g., customers and city authorities). How successful CEPs are in meeting these mentioned internal and external requirements is dependent on the performance of the LEFVs (Cambridge Dictionary, 2021a).

1.2 Problem description and research questions

In order to evaluate the performance of LEFVs and with that the success of an implementation of these vehicles in last-mile deliveries in urban areas, it is necessary to develop a

comprehensive understanding of the term “performance”. As pointed out by Lebas (1995) or Folan, Browne and Jagdev (2007), the perception of the term can vary from person to person and is often dependent on the context it is being used in. A detailed assessment of that issue will follow in the literature review. To create a common understanding for the reader this thesis will use the paraphrasing of “how well a LEFV is executing the activity of last-mile delivery” as a working definition (Cambridge Dictionary, 2021a).

Based on that, the focus on performance-determining factors in the last mile itself is really important. These factors are often related to the concepts of effectiveness or efficiency, which in broad terms reflect the degree to which a LEFV is successful in achieving a desired result (effectiveness) and the level of resource that are being utilized in the process of it (efficiency) (Lexico, 2021; Cambridge Dictionary, 2021b). In this context it was pointed out by Ranieri et al. (2018) that the final part of the supply chain, the last mile, is the least efficient stage, also comprising up to 28% of the total delivery cost. CEP service providers have realized this and have increased their focus on that topic, especially in urban areas, by establishing designated positions to find and manage solutions that would improve their operation (e.g., UPS - Project Manager City Logistics, DPD - Group Manager City Logistics & Sustainability).

Besides businesses, researchers have identified the significance of this topic and discussed it in various LEFV-related articles with different kinds of foci such as the measurement of performance indicators using GPS data (Conway et al., 2017), simulations (Melo and Baptista, 2017) or ex-ante analysis (Gruber, Kihm and Lenz, 2014). Even though the different approaches by the researchers have yielded valuable insides and results, data collection in city logistics and urban good distribution represents a challenge (Cardenas et al., 2017). This is mainly due to lack of measuring consistency among the diverse field of stakeholders that are involved in the last mile delivery (Cardenas et al., 2017). Additionally, it can be assumed that there is little interest in sharing data, especially among CEP service providers as they are operating in a highly competitive environment where they don’t want to give away valuable information that could potentially lead to competitive advantages of other market players. Also, there has been no research specifically dealing with logistics providers and their approach of LEFV operation, which means there is no knowledge on how these companies perceive this new type of vehicle and how they conclude the success of its implementation or operation.

As implied before, especially the CEPs play a crucial role in the transformation of the last-mile parcel distribution. Providing logistic services utilizing different kinds of vehicles, their operation directly impacts the city environment in various ways (e.g., emissions, noise,

congestion). This means finding a solution to decrease transport- related effects lies within their scope as well (Quak and Nesterova, 2014). With logistic stakeholders like city inhabitants or governmental authorities (e.g., UK Local Governmental Association) asking couriers to adapt new zero-carbon transport options (Lokesh et al., 2020), many different companies have started implementing light electric freight vehicles.

But just the implementation of some of those vehicles does not present a comprehensive and final solution. The vehicles characteristics differ a lot to the ones that are usually used in the last-mile distribution. In comparison to common delivery vans they are smaller and offer less loading capacity. As a consequence, new operational processes and infrastructures need to be implemented that, in combination with the vehicle itself, have to fulfill certain requirements. Besides improving sustainability of parcel distribution, they need to meet the local demands for logistics services. Melo and Baptista (2017) highlight that the overall usability and effectiveness of the new electric vehicles depends on the satisfaction of those demands as well as their ability to reduce traffic disturbances and its impacts. Furthermore, LEFVs have to be cost effective and perform reliably. Two factors that are also crucial for fleet managers when it comes to the acquisition of new LEFVs (Tsakalidis et al. 2020) If the electric vehicles are not able to do that, companies have no reasons to adopt them in their operation (Altenburg et al., 2017).

In consideration of the previous paragraphs, it can be concluded that there are a variety of challenges that play important roles in the study of LEFVs and their last-mile deliveries in urban areas. CEPs need to bear those in mind for the actions they take either for the implementation of LEFVs or during their normal operation. Overall, these factors can be summarized as follows:

- **Stakeholder management:** For the operation in the last mile CEPs have to deal with different stakeholders, their interests, needs, as well as applicable rules and regulations.
- **Operational Differences:** As LEFVs have different characteristics in comparison to delivery vans, new operational processes and operational infrastructure need to be implemented and utilized.
- **Last-mile inefficiencies:** The operation in the last mile makes up a large portion of the delivery cost and needs to be optimized to ensure profitability and competitiveness of CEPs.

These issues share one common aspect - they all impact the performance of LEFVs in urban areas. While striving for the best operational performance, CEP-operators need to satisfy the diverse demands of the stakeholders, create the best operational set-up for their LEFVs and increase the efficiency to become more profitable. Balancing these requirements represents a great challenge for the CEP-operators. In consideration that following research questions can be derived:

RQ1: How are stakeholders influencing the last-mile operations of LEFVs in urban areas?

The first research question focuses on identifying how the stakeholders of CEP-operators are influencing the implementation and operation of LEFVs and will try to address the following:

- Identification of relevant stakeholders in the context of urban freight
- Evaluation of importance of stakeholders to the CEP-operators

RQ2: What conditions can make the implementation of LEFVs in urban areas successful?

The second research question tries to assess the LEFV, identifying its characteristics, its advantages and disadvantages, as well as what factors need to be considered for it to be operated successfully. The question will try to address the following:

- The vehicle's characteristics
- The vehicle's advantages and disadvantages for its utilization in urban areas
- Requirements for a successful implementation of the vehicles

RQ3: How can the performance of LEFVs in urban areas be improved?

The third research question tries to evaluate how the overall performance of LEFVs could be improved from a CEP-operators perspective and will try to address the following:

- Improving the operational efficiency of LEFVs in urban areas
- Improving the cost efficiency of LEFVs in urban areas

1.3 Purpose of the thesis

The utilization of LEFVs for last-mile deliveries is neither a very new idea nor a very innovative approach to city logistics. As indicated in the problematization, researchers have done studies about these types of vehicle already in the middle of the last decade. Nevertheless, it still represents a very relevant research topic today as logistics providers are beginning to upscale their LEFV operation in various cities in Europe and around the world (Chung, Hopton and Reid, 2020). Based on this it can be assumed that the vehicles are seen as a viable delivery solution by the CEPs. Though, there has been only few research that could either prove this assumption or give details about the underlying reasons. Furthermore, the operation of LEFVs has mostly been investigated with a focus only on the vehicle itself, leaving out important performance-influencing factors such as stakeholders.

For that reason, the purpose of this thesis is to gather industry-wide information about LEFV operations from different logistics companies that operate in the field of courier, express and parcel deliveries. More specifically, the goal is to draw a comprehensive picture of the companies' perspective on performance management, their perception of LEFVs, and the reaching of performance objectives, all in consideration of stakeholder's requirements. Besides that, the findings can serve different purposes like the exposure of further research gaps or questions. Beyond that, this thesis aims to develop and apply a framework that facilitates the improvement of the performance of LEFVs in urban areas.

1.4 Scope and delimitations

To achieve the described objectives and fulfill the defined purpose, this study will follow a certain methodology that will be outlined in the next part of this study. Before that, it is important to mention that there are certain limitations both in the quantity of the written text as well as for the researching process itself, as the research will be conducted as part of a master thesis with limited resources (e.g., time, personnel, financially). Due to these given confinements, the thesis comprises only one perspective on the topic, which is the one of the CEP-operators. Even though there are many actors that have a stake in city logistics, they present the most relevant population as they are the operators of the unit of analysis, the LEFV.

Furthermore, it needs to be added that the information that will be gathered throughout the research process are mostly based on specific pilot projects or research studies that can be linked to a small number of cities. This means that even though the findings of this thesis will be

generalized, there might be cases of cities or companies for which the final results or statement will not be applicable due to extensive differences (e.g., urban infrastructure or political authorities).

2. Research methodology

2.1 Research Approach

The broad investigation of LEFV performance at CEPs in the context of last-mile urban logistics and its stakeholders was identified as the general objective of this thesis. This was due to a lack of existing research about LEFVs performance and its perception from a CEP perspective, which means that there was not much information available about this subject. Hence, to fulfill its purpose, this thesis had to collect new information to develop novel perspectives or conclusions. For that reason, this thesis followed the approach of an exploratory research with the objective to find patterns, create ideas and develop an understanding of the unit of analysis, which in this case was the LEFV in the urban areas (Collis and Hussey, 2014).

With that type of approach, a large focus had to be put on the data collection. As pointed out by Allen, Browne and Cherrett (2012) there are different ways to collect data in urban freight transport and the decision on which one to choose depends on different factors like the study issue itself or the availability of data that has been collected previously. The data and information collected for this thesis mainly consisted of qualitative data, in the form of research literature and interview results. A reason for this is that the research field of operative performance for LEFVs in urban areas, even though it has been investigated to some extent, still is a comparatively young research area, where hard, statistical data is not easily available. Also, given the outlined limitations of time and resources, a comprehensive gathering of sound quantitative data would not have been feasible.

The use of qualitative data consequently implies that the analysis will be subject to a degree of subjectivity. Accordingly, the research underlay the interpretivist paradigm which supports the exploratory approach of the thesis' topic. However, it also leaves room to some level of biases as assumptions and conclusions are based on the researcher's personal perceptions (Collis and Hussey, 2014). How this affects the validity of the thesis will be examined later in the text.

Overall, the thesis has made use of two different qualitative data collection methods - a literature review and a series of interviews. This means that secondary as well as primary data were used to gather information. By combining data from existing sources with the one that is newly generated, different objectives were achieved. On the one hand it was possible to test older information against very recent one, to either verify the statements made in the secondary sources or to recognize new situational perceptions or developments. On the other hand the primary data helped to build upon existing knowledge and to enable research on more specific

aspects which have not been part of the secondary data. This again facilitated the exploratory approach of this thesis. For both methods, literature review and interviews, specific main emphases were determined to serve as focus areas for the respective analyses. In those, the aim was to identify certain patterns or individual observations, which then served as foundation for a more generic conclusion. This means that the research went from specific to general and therefore can be characterized as inductive (Collis and Hussey, 2014).

Following the analysis, the thesis applied a theoretical framework that focused on the LEFVs performance with the aim of unveiling potentials for improvements. Furthermore, it helped to emphasize relationships between performance aspects of the vehicle itself and existing conditions that are distinctive for city logistics (e.g., stakeholder, last-mile inefficiencies). The knowledge that was gained in this process was then reflected in the last part of the thesis and in the conclusion.

2.2 Literature review

The literature review, which analyzed available secondary data, was used to understand the contextual background of this thesis' topic by assessing and comprehending existing research and knowledge. For performing this kind of evaluation, a systematic review approach was applied. Based on a preliminary assessment of the research area and related articles, areas of interest were defined, and a list of keywords was determined. This list included, among others, following words that were used either alone or in combination with each other:

urban freight transport, urban goods distribution, city logistics, courier services, parcel delivery, last-mile logistics, light electric freight vehicles, electric vehicles, delivery vehicles, cargo-bikes, cargo-cycles, e-bikes, sustainability, environmental impacts, stakeholder, stakeholder management, performance indicators, performance management, key performance indicators, urbanization, e-commerce, supply chain, data, data-management, decision making

These words were then used to search scientific databases like the University of Gothenburg's online library (Göteborgs Universitetsbibliotek), Google Scholar, sciencedirect and emerald insight. Adding to that, information was gathered on company websites (e.g., DHL, UPS), websites of official research institutes (e.g., DLR, Fraunhofer Institut), or political organization and organs (BMVI, European Commission). The information gathered over the search tools

consisted of a variety of different materials containing research reports, studies, books and single book chapters, news articles, company statements or reports, conference papers, as well as in parts information from official websites.

Important to mention is that there were two different kinds of foci for the literature search. For one thing, articles were gathered that cover relevant issues of the main topic of LEFVs as well as related aspects of city logistics and urban freight transport. Furthermore, literature was collected that deals with more theoretical, research process-related subjects like theoretical frameworks or the research theory (e.g., Business Research by Collis and Hussey). Due to the above-described topical differences, the time horizons of the available literature varied as well. Since the research area of LEFVs and the domain of city logistics is comparatively new, most of the scientific reports in the area were published in the last decade. In contrast, most of the relevant literature dealing with general performance, research theory or theoretical frameworks has been released over the course of the last three decades.

Once the literature was gathered, the sources were read, and relevant statements or paragraphs were highlighted and saved. Based on the problem description and research questions, those text parts were then further categorized in the following main categories that will also serve as subsection of the literature review:

- Urban freight transportation
- Light electric freight vehicles
- Performance management

Each of these broader categories includes further subcategories that are supposed to cover the main aspects of the designated area of interest. Besides gathering and contextualizing the information, these categories were also utilized to establish a uniform understanding of the most relevant terminologies. Overall, this part of the data collection mainly supports the fundamental part of the thesis, as it sets the background information and knowledge, as well as defines the scope and terminology used and evaluated within the thesis. Therefore, the knowledge and insights obtained through the literature played an important role later in the analysis part of the thesis. Also, it presented the base for the interviewing process.

2.3 Interview

A series of interviews has been the second way of collecting information for this thesis. Beyond the explanation made in the beginning of the first methodology subchapter, this approach for gathering primary data was chosen because it allowed to get a perspective on people's views or perceptions about the performance aspects of light electric freight vehicles in last-mile delivery activities. As pointed out by Arksey and Knight (1999), this goes hand in hand with the underlying interpretivist paradigm under which interviews are concerned with the exploration of understandings and opinions.

For the reason of executing an exploratory research, open questions were chosen for conducting the interviews. This type of questions allowed the interviewee to answer in a more open way, leaving room to reflect the questions and to develop the extent and details of the answers. Hence the researchers were able to gather broader information than with closed questions and explored topics that were not in the focus until that moment (Collis and Hussey, 2014). This approach was complemented by using a semi structured interview layout, which means that besides prepared questions, also additional, more spontaneous questions were asked (Collis and Hussey, 2014). These questions were derived from the answers that were given by the interviewees so that the interviewers were able to react to new insights by asking for more detail. Again, this supported the exploratory research character. The prepared questions were formulated based on the analysis of the literature review. Both the questionnaire as well as the justification for why each question was chosen can be found in the appendix.

The selection of the people to be interviewed also followed the review of the literature. Due to the large number of stakeholders involved in city logistics it was decided to focus specifically on one type of stakeholder. This happened for two main reasons: The time constraints of writing the thesis which limited the number of interviews as well as the validity of statements. The more statements and views can be gathered from one type of stakeholders, the more valid the conclusion and generalization are. Therefore, the CEP companies and their responsible city logistics managers were selected as potential interviewees. Since they also operate the LEFVs their knowledge about the performance of them also seemed to be the most important. By interviewing the delivery facilitators, the interview could also be characterized as freight operator survey - a type of survey that has been used widely in the context of urban freight (Allen, Browne and Cherrett, 2012). This kind of survey offers various advantages like the chance to gather a wide range of data from the operators and the possibility to receive qualitative information about potential operative issues, which suits this kind of research really well.

Additionally, it allows the interviewer to get data of the entire fleet that is in operation, instead of receiving feedback about just one vehicle (Allen, Browne and Cherrett, 2012).

The identification of potential interviewees was based on the literature review as well as on the inspection of news articles or company websites. In this process the main emphasis was put on the larger players in the CEP sector as the goal was to get the perspectives of the companies with the biggest market shares and most experiences. Also, there was the focus on choosing different companies operating in various countries. The reason for that was the possibility to reduce the gathering of redundant information which is more likely to occur when interviewing people of the same company or within the same city. By searching for city logistics projects involving LEFVs it was possible to get information about the project-realizing companies and their managers.

The interviewees were contacted via LinkedIn or email, in case the contacts were known. In total 12 people were approached of whom 6 replied and volunteered for the interview (Table 1). For conducting them, it was decided to make use of online interviews using platforms like Zoom or Microsoft Teams. The utilization of these online channels enabled the opportunity to interview people in different countries or time zones and considering the Covid-19 crisis it could be seen as the only viable option to proceed with face-to-face like interviews. As highlighted by Allen, Browne and Cherrett (2012) this type of interview offers the advantages of facilitating more in-depth interviews and to query responses. The replies were recorded upon the consent of the interviewee and later transcribed. After finishing the transcription, the results from the interviews were then put into perspective with the previously gathered theoretical foundational information obtained through the literature review, so that an extensive analysis of the topic was executed.

Company	Country	Interview Partner	Position	Type	Duration
UPS	Germany	Rainer Kiehl	Project Manager City Logsitics	Video-Call	1h
A2B	Finland	Tero Kakko	Managing Director	Video-Call	1h
DHL	Sweden	Michael Källbäcker	First Choice Senior Director	Video-Call	1h
Jalon (Purolator)	Canada	Mickael Brard	Practice Leader in Sustainability	Video-Call	1h
DPD	Germany	Gerd Seber	Group Manager City Logsitics & Sustainability	Video-Call	1h
FedEx	Netherlands	Vera ten Hacken	City Logsitics Program Manager	Video-Call	1h

Table 1*:* List of interview partners (self-made, 2021)

2.4 Credibility and Validity

As previously stated in 1.4 there are certain limitations that are shaping this thesis. These limitations influence the way the research is being conducted and thereby also impact credibility and validity. It must be emphasized that all findings and results that are being outlined throughout the thesis are based on a small sample size of interviews and therefore only represent the opinions of a few professionals working in the CEP sector. In consideration of that and to give more weight to the statements, the focus in the selection of the interviewees was grounded on the idea that these persons should work for CEP-operators that hold the largest market shares. Even though this might have enhanced the validity of the thesis it also led to the issue that smaller CEP-operators are underrepresented in the research. As only one smaller operator was interviewed, only little weight is given to these companies. Another underrepresentation in the sample size is given by the locations of operations. Whereas five professionals were interviewed that gained their experience in Europe, only one interviewee was based in North America. Other locations that also are known for larger LEFV operations (e.g., Asia) are being left out in the research. In consequence this means, as rules and regulations can differ between countries and cities, that some of the findings that have been made might not apply to other places in which LEFVs are being operated.

Further statements have to be made about the research approach and research design. The exploratory approach to this research and the qualitative characteristic leaves a lot of room for interpretation and bias. The same hold for the adaptation and application of the theoretical framework. Another aspect that needs to be considered is that the questions that have been asked as part of the semi structured interviews, only partly reflect the topics that have been discussed. Throughout the interviewing process the main topical focus shifted from the pure performance topic towards performance in relation to the stakeholders in city logistics. This shift is not being reflected in the predefined questions. This implies that the questions differ to the general objective of the research, which limits their importance for this thesis.

2.5 Research Design

The research design of the thesis, which is being summarized in Figure 1, followed a simple approach. Based on the problems that have been identified in the problem description, the three main research questions were formulated. As these questions were targeting three different topics, these topics served as main categories and areas of research for both literature review and the interviews. Based on those two chapters, a theoretical framework was selected and

adopted to reach the objectives of the thesis by answering the research questions. These answers were given and edited in the analysis part, in which the adapted framework was also applied in.

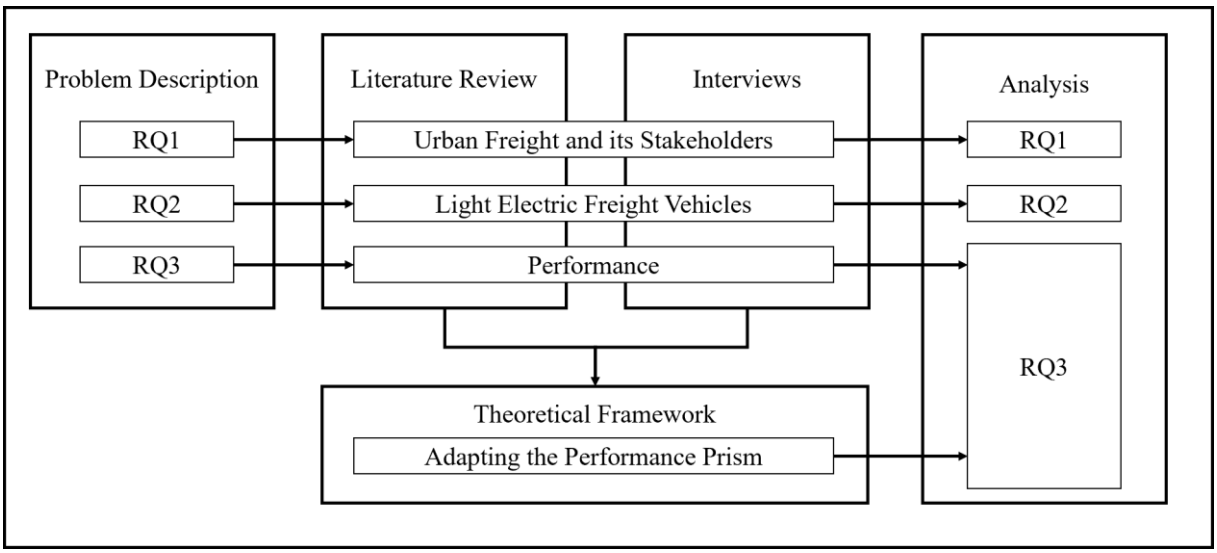


Figure 1: Research design (self-made, 2021)

3. Literature Review

3.1 Urban freight and its stakeholders

3.1.1 Urban freight terminology

“Logistics and transportation” is a wide ranging subject that focuses on the management of the flow of goods, services and information between the point of origin and the point of consumption in order to meet the requirements of companies and customers (Niels, Hof, and Bogenberger, 2018). In the introduction of this thesis, it was pointed out that more and more of these flows end with the delivery of consumer goods in cities and suburban areas - a process that outlines the topic of urban goods transport (OECD, 2003). The necessity of transporting goods into, through, or out of city borders is given by the demands of goods and services or the removal of waste products (Dablanc, 2010). It can be seen as essential to functioning urban economies (MDS Transmodal Limited, 2012). For this reason, urban transport is of high relevance for research, which also holds scientific variety.

Throughout logistics literature there have been different definitions of what can be paraphrased as the activity or the process of transporting goods in urban areas. Cardenas et al. (2017) point out that there is a diversity of keywords and their adequate definitions. “Urban freight transport” and “city logistics” are the most common terms. However, there has not been a fully accepted categorization of them as the extent of the definitions varies. “Urban freight transport” can be defined as the transport of goods carried out by professionals in an urban environment, either excluding shopping trips by private households (Dablanc, 2007) or including them (ALICE, 2020). A definition of “City Logistics” is given by Rodrigue and Dablanc (2021) stating that it describes the means over which freight distribution can occur in urban areas and the strategies that can improve its overall efficiency while mitigating externalities such as congestion and emissions. Based on that it could be concluded that the term “city logistics” describes a larger set of activities or processes with “urban freight distribution” being one part or a subset of it. However, in literature both terminologies are also described as having a conceptual overlap (Alho, de Abreu e Silva and Pinho de Sousa, 2014).

The categorization or classification of these terms is only playing a secondary role. Yet, they outline the context of this thesis with a focus on the urban freight domain and logistical process taking place in city areas. A higher relevance for this research has the term “last-mile-delivery”. It is defined as the final step of the delivery process from a distribution center or facility to the end user (Robinson, 2021). Also, “last mile delivery” is often used to describe business-to-

customer (B2C) home deliveries (Cardenas et al.,2017). Important to note is that last mile is not referring to any measurable distances that are covered in the delivery process. As mentioned above, it only denominates the activity of carrying out the last step in delivery-chains, which can take place in different environments (e.g., in urban or rural areas).

For this thesis, the term "last-mile delivery" will be used to describe the final step of parcel deliveries between micro-hubs and customers in urban areas only (**Figure 2**). Therefore, the last mile can be characterized as part of the urban freight domain and city logistics in general. Both terminologies will also be mentioned when talking about the broader context of the research.

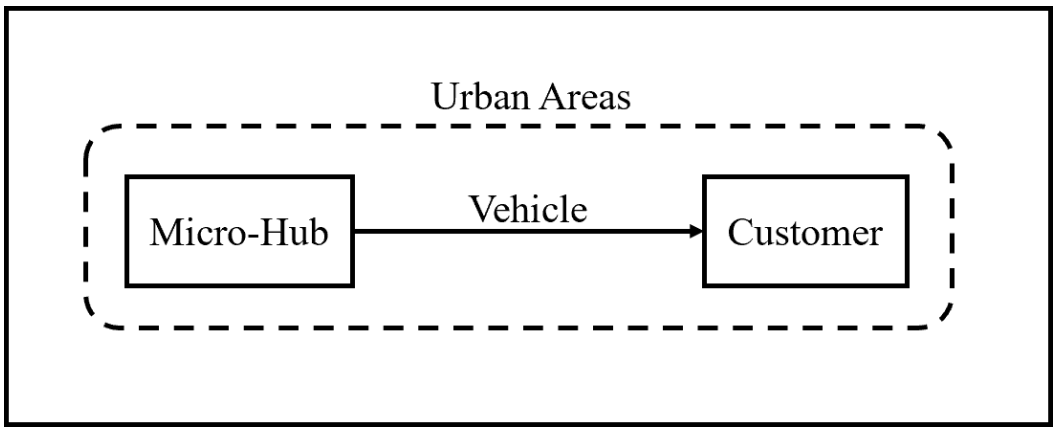


Figure 2: Last Mile in Urban Areas (self-made, 2021)

With that it is important to mention that in this thesis hubs represent the starting point of the last mile. In general hubs play a critical role in city logistics as their position is the last point in a multi-hub-and-spoke network. Due to this position, they are often seen as a bottleneck that is likely to create inefficiencies (Gevaers, 2013). To overcome this, CEP companies try to create micro-consolidation platforms as close as possible to the final delivery location (Cardenas et al., 2017). Therefore, micro-hubs in city centers are a preferred solution. According to research these hubs would also contribute to cost-effective operation of LEFVs as the overall distance between the depot and customer can be shortened (Ploos van Amstel et al., 2018).

Within the last-mile domain different players are involved in the transport activities. Besides established CEP service companies, also new startups have discovered business opportunities for themselves. The attractiveness of the sector can be emphasized with high investments of venture capital firms. As shown in a study of McKinsey written by Hausmann et al. (2020),

these firms are heavily investing in innovative service offerings in the last mile. One of the reasons for that is the growing number of parcel deliveries. The focus on parcel deliveries in the last mile arises from the increasing importance of e-commerce. As pointed out by Deloison et al. (2020) the sales ratio almost tripled globally between 2014 and 2019. This significant growth was further strengthened by the Covid-19 pandemic which forced private people to more frequently shop online (Arval Mobility Observatory, 2020). This however is accompanied by a few consequences.

First, an increase of parcel deliveries in the last mile sector will lead to rising total operating costs. According to research the delivery of parcels in the last mile is between 5 to 23 times more expensive than in-store purchases (Allen et al., 2018). These costs are usually passed on to the customer. However, in case of parcel deliveries they are less willing to pay the additional cost (Allen et al., 2018). A way to minimize the transport costs is mentioned by Allen et al. (2018), stating that an increased transport quantity per vehicle combined with a denser drop density could reduce the operating costs.

Another consequence of increasing parcel deliveries is the growing demand for transport capacities leading to a rising number of delivery vehicles. Whereas the parcel sector has already accounted for 5-10% of freight traffic in cities in the past (Ploos van Amstel et al., 2018), it is expected that the number of delivery vehicles in the largest 100 cities globally will increase by 36% until 2030 (Deloison et al., 2020). That on the other hand, results in various other negative effects that can be characterized as very typical for urban freight.

3.1.2 Negative effects of urban freight

In the literature various effects of urban freight transport have been researched and discussed. The scientific efforts are originating from the importance of these city-logistics activities to society and the volume of the daily operation. As stated in the previous chapter it is projected that the transport volume will increase even more, consequently enhancing negative effects in different ways. The results of this trend are difficult to predict since it is not developing in a linear way (Deloison et al.,2020). This means that there are fluctuations in the development of delivery volumes influenced by different external factors (e.g., Covid-pandemic or prices of goods). In this context Quak and Nesterova (2014) talk about different affected sustainability factors that are people, planet, and profit. These terms and their meanings are also often referred to social, environmental, and economical effects, that together present the concept of the triple

bottom line of economics or triple bottom line of sustainability (Freight Transport Association, 1996; Elkington, 1998; Browne et al., 2012). Below they get explained in more detail.

In city logistics the *social* aspect of the triple bottom line concept deals with the physical consequences that freight transport can have on humans in urban areas (Freight Transport Association, 1996). This includes potential traffic accidents resulting in injuries or even deaths, an enhanced noise and stress level, the emission of particulate matter potentially harming public health, and congestion (Freight Transport Association, 1996; Browne et. al, 2012; Quak and Nesterova, 2014; Deloison et al., 2020). Focussing on the *environmental* impacts Deloison et al. (2020) point out that delivery vehicles already disproportionately contribute to city emissions in comparison to passenger cars. According to a French study, goods movements are responsible for up to 50% of emissions by transport activities even though they make up only 20 - 30% of the vehicle kilometers (LET Systems Consult, 2006). The emissions that primarily consist of greenhouse gases (e.g., CO2) that contribute to climate change. Beyond that freight traffic produces waste and can cause harm to wildlife (Freight Transport Association, 1996). In terms of *economics* or profit, transport logistics in urban areas, especially in the last mile can show inefficiencies, cause congestion or waste resources (Quak and Nesterova, 2014). These impacts can be viewed as single problems; however, they can also be directly associated with each other, e.g., when transport of goods by vans leads to congestion, creating inefficiencies in the delivery schedule.

The diverse issues that are caused by the movement of goods in cities have increasingly received attention both in public and in private. Gruber and Narayanan (2019) describe that politics and society are willingly to come up with solutions to deal with the negative impacts. Local authorities and national governments are trying to regulate the impacts and the European Commission's objective is to have an emission-free urban freight transport sector by 2030 (Quak, Nesterova and van Rooijen, 2015). The replacement of field vehicles with electric alternatives is therefore seen as a plausible approach to solve the problem (Altenburg et al., 2017).

3.1.3 Courier, Express- and Parcel Delivery Services (CEPs)

The implementation of these new electric alternatives lies in the responsibility of the courier, express and parcel delivery services (CEPs), which operate the vehicles on the last mile. For this reason, it is important to look at these companies in more detail. CEP’s can be characterized as logistics service providers that deliver parcels or documents to different kinds of customers

such as businesses or private people (Globe Newswire, 2021). The type of goods they deliver sets them apart from other logistics services in city logistics that are focusing on transport services of food or beverages.

According to Ducret (2014) the CEP firms, that work separately from postal services, are usually able to deliver small and light parcels of up to 31.5 kg. To provide reliable deliveries they make use of global, sophisticated transport networks (Ducret, 2014). The three activities within the CEP sector can be distinguished based on their characteristics. Courier services offer same-day deliveries over short distances, while express providers transport also over longer distances within a given timeframe of mostly one to two days. In contrast to that, parcel services can be characterized as deliveries of consolidated, standard-sized parcels in a period of more than one day (Ducret, 2014).

The competition among the CEP service providers is quite strong. In order to stay competitive, the companies need to work as reliably, effectively and cost-efficient as possible (Park, Park, and Jeong, 2016). Due to the resulting cost-pressure, CEP service providers are constantly trying to optimize their networks (Kunkel and Schwind, 2011). This is especially important as the margins per delivered parcel are very low (Joerss et al., 2016). However, due to an increasing number of parcels, the overall revenue has increased over the last years. According to Effigy Consulting 12.3 billion parcels were delivered in Europe alone in 2019, a 7% growth to the previous year (Effigy Consulting, 2020). Even though the repercussions of the Covid-19 pandemic are not fully predictable, it is likely that this trend is going to continue (Logistik Heute, 2020).

A continuation in the CEP sector can also be observed in the way the different competing companies are co-evolving together. As pointed out by Taylor and Hallswort (2000) the service providers are facing the same challenges like a growing complexity of the last-mile and its stakeholders or issues related to sustainability. With these conditions they are adapting strategies, tools or organizational structures that are quite alike which means that they are converging and become very similar in the way they are approaching their business. A common example of adapting similar strategies is the commissioning of subcontractors by the CEPs. These subcontractors can take over various tasks of the CEPs, such as transporting of goods or even the recruiting of personnel.

3.1.4 Stakeholders of urban freight

As stated above there are various negative impacts of urban logistics. Overcoming these issues and starting a problem-solving process however appears to be difficult. This is due to many different stakeholders that are either directly or indirectly involved in urban freight transport and which are visualized in Figure 3. To evaluate the different stakeholder involved in urban areas and specifically in urban freight and city logistics, the actual term of stakeholder should be defined first. Stakeholders can be seen as persons or entities that have a vested interest in some "common item" or "problem. To acquire the status of a stakeholder, it must have an interest in a problem through three different ways, as it needs to be either affected by it, or mainly affecting it, or both, be affected by it and affecting it (Banville et al., 1998). Stakeholders can also be differentiated by being an internal or external stakeholder, which means that they are either situated within the organization or outside the organization (Mazur and Pisarski, 2015). The traditional stakeholders identified in logistics are considered to be the receivers, carriers, and forwarders (Ogden, 1992), while over time more specific stakeholders were identified, as policy makers, decision makers and local authorities were added to that list. (Lindholm, 2012; Stathopoulos, Valeri and Marcucci, 2012). Kiba-Janiak (2016) and Russo and Comi, (2010) also talked about residents, consumers, transport companies and public transportation operators as relevant stakeholders in urban areas. Ballantyne, Lindholm and Whiteing (2013) and the MDS Transmodal Limited (2012) report make another distinction and categorize stakeholders between those who directly affect urban freight (actors), such as receivers, shippers and transport operators and those that have an indirect, passive interest in urban freight (stakeholders), such as residents, visitors, organizations, companies, etc. They state that all actors are stakeholders but not all stakeholders are considered actors, which is important for assessing stakeholders of urban freight and city logistics.

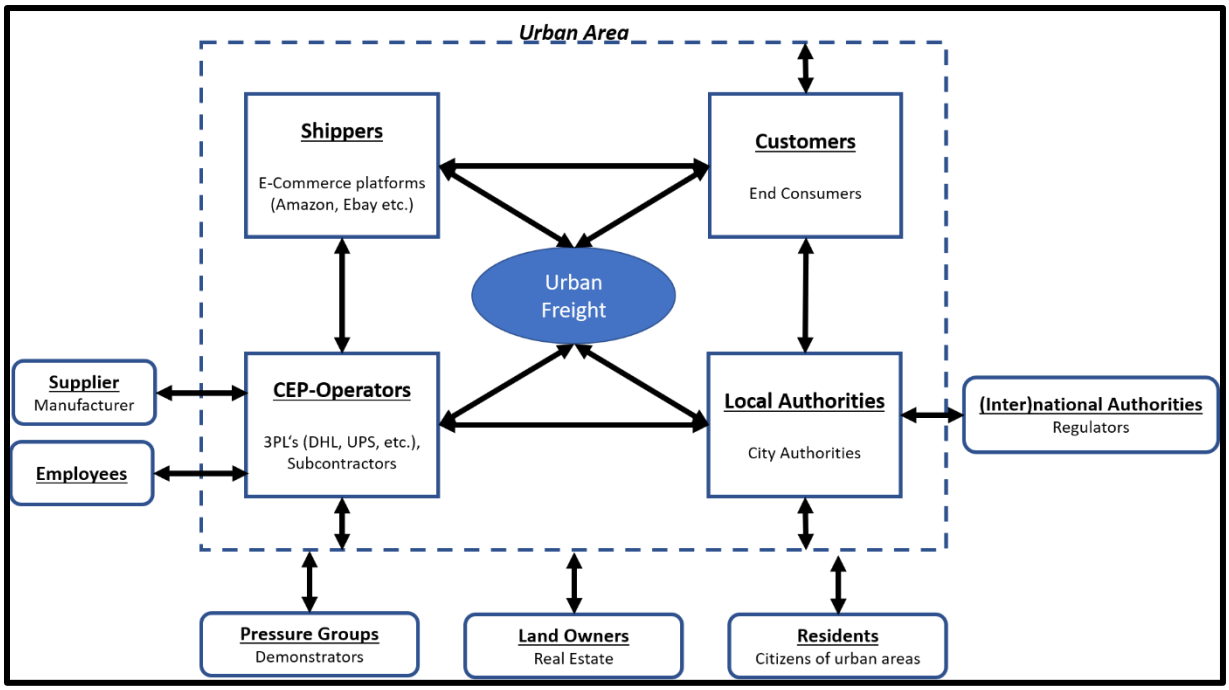


Figure 3: Urban Freight Stakeholder Overview (self-made, 2021; based on Ballantyne et al., 2013)

Researchers such as Lindholm (2012) and Russo and Comi (2010) identified the carriers, end-receivers, and local authorities as the most relevant stakeholders in urban distribution chains. Carriers can vary in size, economy and influence and can function as subsidiaries of wholesalers, independent companies providing third party logistics (3PL) services and other smaller transport providers, such as subcontractors working for larger 3PL providers. They seek to collect and deliver goods as efficiently as possible and constantly try to optimize the load capacity, co-loading, and delivery routes, while also minimize their costs and maximize their sales and therefore also profits (Taniguchi and Tamagawa, 2005; Bjerkan, Sund and Nordtømme, 2014). End-receivers can include retailers or other companies operating stores, restaurants, as well as hotels, public institutions, and other businesses. This of course also includes customers, which can be residents, as well as visitors within an urban area (Russo and Comi, 2010; Stathopoulos et al., 2011; Bjerkan, Sund and Nordtømme, 2014). Local authorities consist of a range of departments with at times conflicting goals and motivations, while at the same time they have significant influence on how and when urban distribution is performed. They are responsible for developing the policies along which private stakeholders, such as carriers and receivers, then have to operate (Stathopoulos, Valeri and Marcucci, 2012). It is argued here that in creating new strategies and policies for a more sustainable urban freight, public administrators should try to focus on solutions that both tend to solve issues at hand, as well as help transport operators to stay efficient and meet the constantly changing demands by

customers (Behrends, Lindholm and Woxenius, 2008; Melo, 2010; Ploos van Amstel et al., 2018), Lindholm (2012) identified that there is a large variation to the degree to which local authorities consider urban freight and distribution as a public responsibility, as the optimization of transportation is considered to be a business-driven interest. Some try to frame the issues deriving from urban freight as infrastructural problems, while some even consider it as non-existent issues. A lot of local authorities therefore fail to recognize the possibilities they have on influencing urban freight through regulations and other policies related to freight transportation. One of the major issues identified in research regarding city authorities' involvement in city logistics was the lack of general knowledge and expertise about that topic overall (Lindholm, 2012). While freight transport is recognized as a driver of urban economies, it is also considered a disturbing factor in regard to attractiveness of the urban environment, still, when it comes to land use planning in urban areas, Ballantyne, Lindholm and Whiteing (2013) identified that most local authorities do not put much consideration in handling freight issues. Urban freight is often only discussed in a negative context, for instance when one of the various stakeholders files a complaint in connection to it, for instance noise, safety, and access etc. This has to do with the public taking freight activities for granted, while most have very little knowledge of the freight movements going on around them. Residents, including customers, as well as authorities therefore want the convenience of always having goods available to them within the city, but do not want the inconveniences of delivery vehicles being in inner cities, when they go about their daily business (Ballantyne, Lindholm and Whiteing, 2013).

This lack of action by local authorities in setting adequate legislation has led to a vacuum in urban freight, which allowed uncoordinated activities and a lack of cooperation between actors in urban areas. The underlying problem of a diverse field of actors in the transport area is even enhanced by the need of different inputs such as traffic data from city authorities and vehicle data from private operators (Jaimes, Semaand and Cardenas, 2014). Especially the assessment of consistent data of transport operators remains challenging. The reason for this is the high competition among them and their interest in outperforming their rivals, leading to a minimum of shared data and knowledge. Due to the competition among private transport operators acting in their own interest, comprehensive attempts or approaches to create sustainable solutions faster are difficult to initiate. Browne, Rizet and Allen (2014) describe how this competition in general leads to a duplication of efforts in the parcel distribution summarized as "everyone-delivers-everywhere". Stakeholder involvement and consideration is therefore crucial for advancing urban freight efficiency (Bjerkan, Sund and Nordtømme, 2014).

Each stakeholder has different expectations and needs within city logistics, as some maintain complex relationships and interactions with each other, other stakeholders, such as the city authorities, hold more political power over others (Stathopoulos, Valeri and Marcucci, 2012). Adding to that stakeholders also have their own interests and perceptions on the issues of urban freight, which increases the complexity even more (MDS Transmodal Limited, 2012). Deloison et al. (2020) described that especially the objectives of private and public players might differ and therefore would require different interventions. Each stakeholder will only adhere to new measures if they will not carry negative consequences on their side or of the positives outweigh the negatives, as most stakeholders will consider negative impacts and consequences as more important than new measures or policies implemented (Rogers, 1983; Schuitema and Steg, 2005). Not attending to the interests and perspectives of stakeholders can lead to poor performance overall or even failure and disaster, which means that it is even more important that strong public-private, as well as collaboration and partnerships are necessary in order to achieve more sustainable urban freight transport, as long-term public-private partnerships can have significant positive effects for both groups and therefore all stakeholders connected to them (Bryson, Patton and Bowman, 2011; Crainic, Ricciardi and Storchi, 2004; Lindholm and Browne, 2013).

In summary it can be said that there is a lack of coordination between public and private actors in the field of urban freight transport. A standard procedure of measuring, sharing and analyzing consistent data is non-existent which makes it difficult to optimize the entire transport system. These reasons make it even more important for authorities to understand that the wants and needs of all relevant stakeholders (Table 2) need to be recognized and understood, so that new city logistics policies can successfully be implemented (Stathopoulos et al. 2011).

Stakeholders in (UFT)	**Parcel Industry equivalent**	**Role in Urban Parcel Delivery**
Carriers	CEP-operator	Active
Small-Carriers	Subcontractors	Active
Competitors	Other CEP-operators	Active
Local Authorities	City Authority, Politicians	Active
Residents, Consumers	Residents in urban areas	Passive
Visitors, Tourists	Visitors, tourists	Passive
End-Receivers	Customer (B2C)	Passive

Table 2: Summary of relevant stakeholders in urban freight transport (self-made, 2021).

3.2 LEFV

3.2.1 LEFV terminology

In logistics research literature various definitions and abbreviations exist and are used to describe smaller electric vehicles that also can be utilized in the last mile delivery sector. Ewert et al. (2020) make this point in their journal article stating that the term for light electric vehicles (LEV) is currently not clearly defined and that it includes a wide range of different vehicle types, e.g., vehicles dedicated for the movement of goods. Therefore, to fully understand the application of those vehicles and in order to strike clear statements throughout the thesis it is necessary to classify the different terms and establish a standardized understanding of the terminology.

In the literature different standardization approaches are being used. These approaches make use of differentiating factors to put LEVs or respectively LEFVs into specific categories. Whereas Melo and Baptista (2017) utilize weight characteristics to classify electric cargo vehicles, Altenburg et. al (2017) use the dimension of speed as a differentiator. Quak and Nesterova (2014) delimit LEFVs to other, larger electric vehicles by the need of operating with a vehicle registration. The three examples outline the different ideas on how to define LEFVs which makes it difficult to create a common understanding.

For that reason, this thesis will follow the definition and categorization of Ploos van Amstel et al. (2018) that is being summarized in Table 3. Their research paper on light-electric freight vehicles classifies LEFVs as vehicles that fill the gap between bicycles and delivery vans, that are powered by electricity and have limited speed. While this definition already sets limitations to what an LEFV can be, they further describe three distinct categories that are separated by certain differentiators: Electric cargo bikes, electric cargo moped, and small electric distribution vehicles. As stated in the table below they are divided by the need for national testing procedure, the need for a registration, and maximum speed. Beyond that, ranges for loading capacity and vehicle weight are stated. However, these ranges have overlapping areas and can therefore be regarded as additional information on characteristics but do not play a defining role in the process of classification.

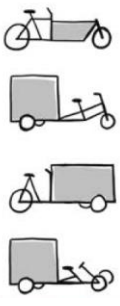
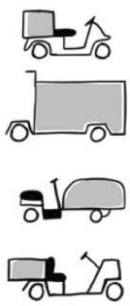
Characteristics	Electric Cargo Bikes	Electric Cargo Mopeds	Small Electric Distributio Vehicles
			
Vehicle Registration	Registration not obligatory	Registration not (yet) obligatory	Registration is required
Vehicle Speed	Max 25 km/h	Max 25 km/h	Max 45 km/h
Vehcicle Capacity	50 - 350 kg	100 - 500 kg	200 - 750 kg
Vehicle Weight	20 - 170 kg	50 - 600 kg	300 - 1000 kg

Table 3: Classification of LEFVs (taken from Ploos van Amstel et al., 2018)

3.2.2 Advantages and Disadvantages of LEFVs

With the start of different projects or initiatives (e.g., KoMoDo or Colibri) the utilization of electric vehicles in cargo transport has just started to gain scale in the past recent years. The transition from vehicles with combustion engines to the ones using electricity is driven by different factors such as the pursuit of environmentally friendly and sustainable means of transport or possible economic incentives. Beyond that, due to given, previously described characteristics of LEFVs, these vehicles are also being operated in a different way which comes along with potential advantages or new application possibilities. At the same time, there might be disadvantages related to the implementation and use of LEFVs. Since these potential benefits and drawbacks can also impact the delivery efficiency and performance, it is necessary to understand them to the full extent. Even though the literature mostly talks about electric vehicles, statements in regard to characteristic advantages are applicable to LEFVs since they can be seen as one part of a larger EV picture.

From a value chain perspective Ewert et al. (2020) highlight that in comparison to cars, LEVs require less energy and resources in production and operation. Beyond that they state that these vehicles are less space demanding in traffic. Feng and Figliozzi (2012) argue in a similar way emphasizing on the high energy efficiency of electric motors that also need less maintenance effort and cost. Lokesh et al. (2020) connect the energy efficiency to a long-term reduction of urban logistics related CO2 emission. Besides mentioning the environmental effects of LEFVS,

Melo, Baptista, and Costa (2014) talk about social benefits such as noise reduction or an increasing pedestrian safety. They further point out that electric vehicles in general pollute less or no emissions (e.g., particulate matter) and thereby increase quality of life in the cities. In another article Melo and Baptista (2017) make remarks about operational advantages such as finding parking spots easier and decreasing the use of curb-side spaces. Of high interest to the operation is also the vehicle speed. As shown in the part discussing the characterization of LEFVs the speed limit played an important role. Ploos van Amstel (2018) states that the delivery speed of LEFVs in cities is similar to the ones of delivery vans with a combustion engine, as LEFVs can make use of bicycle lanes. For this reason, they can drive shorter routes making them faster than normal delivery vans (Ploos van Amstel et al., 2018).

The above-named advantages need to be compared against the drawbacks of LEFVs. In the literature the limited load capacity is pointed out as one of the major drawbacks. This means that the weight and size of the parcel being delivered need to be rather small, and therefore cannot cover every kind of delivery (Melo and Baptista, 2017). Ploos van Amstel et al. (2018) similarly mentions the smaller payload as a con-argument. Beyond that, their report also states that the urban infrastructure and the applicable rules are not in line with a rising number of LEFVs (Ploos van Amstel et al., 2018).

Even though these traits of LEFVs represent limiting factors, they also help to underline the potential of the vehicles and the areas within logistics they could be utilized for, as they also narrow down operational niches. Balm et al. (2017) define four main criteria of LEFVs that could influence their potential. These are small and light shipments, a high network density, time-critical shipments and sufficient opportunities for growth and innovation (Balm et al., 2017). Ploos van Amstel et al. (2018) are going in a similar direction explaining that LEFVs would be suitable for logistic flows with five principal characteristics that namely are time-critical shipments, flows with small numbers of shipments per trip, trips with short distances between stops, delivery operations in busy areas where the speed of cars is relatively low, and areas with strict vehicle restrictions or privileges for LEFVs. Both statements emphasize on factors that are speed- and dimension-related - attributes that, as described in the paragraph about terminology, help distinguish between certain vehicle categories.

In regard to smaller shipments like letters or lighter parcels, LEFVs represent a sufficient option. Compared to delivery vans they might have loading limitations, but they offer similar accessibility advantages of normal bikes, that are utilized for CEP services. They allow them to carry greater loads on larger distances, also reducing driver fatigue (Gruber, Kihm, and Lenz,

2014). Focusing on the potential of delivering in high dense areas, LEFVs often show that they are performing with a higher speed than delivery vans highlighting their suitability of making time-critical shipments in urban neighborhoods (Ploos van Amstel et al., 2018). Beyond that, the demand for LEFVs is likely to increase in general over the coming years. While the share of electric vehicles in city-logistics might still be low (Ploos van Amstel et al., 2018), statistics, like in the case of London, show that light commercial vehicle traffic is growing in urban areas (Allen et al., 2018). This illustrates the demand for these types of vehicles.

With the identification of potential application areas, the emphasis on LEFVs operative benefits and statistical patterns are implying a potential rise of utilized LEFVs in the future, it is important to understand the impact that this could have on city environments. The reason for this is that urban transport infrastructure has mostly been constructed for cars. However, as previously described, LEFVs yield their advantages from existing cycle paths and the possibility of using one-way roads (Ploos van Amstel et al., 2018). Consequently, an increased use of LEFVs in last-mile deliveries would lead to a higher utilization of designated cycle infrastructure stressing existing private bike users. Overloaded bike paths and lanes could then again affect the operation and initial impacts of LEFVs negatively. This is because usability and effectiveness of these vehicles also depends on their ability to reduce traffic disturbances while satisfying logistical demand (Melo and Baptista, 2017). In their research Melo and Baptista (2017) also point out that LEFVs cannot replace vans equivalently. Instead, they estimate that there is potential room for 10-15% of LEFVs replacing common delivery vehicles. Everything beyond would lead to operational disturbances or restrictions. Furthermore, to maintain the overall network efficiency, it is recommended that the area of last-mile delivery should not be more than 2km (Lokesh et al., 2020). Quak, Nesterova and van Rooijen. (2015) add on to this stating that replacing conventional vehicles with electric freight vehicles cannot be seen as an optimal solution, as the processes of the transport companies were designed for vehicles with combustion engines.

3.2.3 Cost of LEFVs

Even though the transition from conventional combustion engine vehicles to electric freight vehicles is not optimal from an operative perspective, a shift to cleaner freight vehicles is unlikely to increase overall costs according to Niels, Hof and Bogenberger (2018). This finding could be vital since it potentially enhances the utilization of LEFVs in the future as the total

costs are often seen as an important argument for or against the implementation of innovative technologies as business cases.

The overall costs can be further specified as the vehicles not only create purchasing cost but also generate running expenses (e.g., operation and maintenance). Over the last couple of years LEFVs have become cost competitive with combustion engines (Tsakalidis et al., 2020). The reason for this is that LEFVs are getting mass-produced, driving down the production cost and consequently decreasing the purchasing cost for the customer as well (Altenburg et al., 2017). Additionally, the operative knowledge that has been gained in the past years, helps to drive down the operational cost. As pointed out in the conference paper by Taefi et al. (2014) an early implementation has helped to learn about the new vehicle technology and the processes that have to be adjusted accordingly in the daily workflow of the operators. From a LEFV-operator perspective the declining cost is important to facilitate a transition towards a larger LEFV fleet. Since most of the transport operators' customers are focusing on price and delivery service, higher cost caused by LEFVs are seen as a reason to not choose the service, despite the advantages that come with it (Ninh, 2013).

3.3 Performance

3.3.1 The performance terminology

In this part of the literature review the term and concept of performance will be looked upon, evaluated, and defined. What does performance mean in general, how can it be measured and how and in what context is it already used in the field of logistics and last mile logistics. In general, the terminology “performance” can be seen as a very broad topic and a word that can describe a variety of things. The Cambridge Dictionary (2021a) defines the word “performance” as a noun which can be used to describe an activity, entertainment or a noun for doing something. Examples are described as “how well a person, machine, etc. does a piece of work”, “the act of doing something […]” and “[…] how well an activity or job is done”, also the context of business is considered within the dictionary, as here it states, “how successful and investment, company, etc. is and how much profit it makes”, creating a financial connection with the word, but also mentions possible uses in connection with measure and measurements. Folan, Browne and Jagdev (2007) state that the term performance seems as it is being used as something of a given, having reached a certain ubiquitousness and generality in its use and that often authors are working on common assumptions based on the meaning of performance without having defined what the terminology means to them. These issues often are true when

the term is being used in context and connection with other terms such as, “model”, “framework”, “development”, as well as with “-measurement”, “-management”, “-assessment” and “-evaluation”. Lebas (1995) also acknowledged that it is hard to fully agree on what performance actually means, as it can take the shape of different meanings. He also states that performance must be defined by everyone involved surrounding a business, meaning the firm itself, its stakeholders, and other organizational actors relevant to the business. It is implied in his work that performance itself may not be definable in detail and that it always will be understood contextually, from the perspective of the user and its purpose. Performance itself may not be objective and only be used to describe and define where one wants to go. Folan, Browne and Jagdev (2007) also state that the idea of performance is one of the least understood, which incorporates that big leaps of intuition is used, therefore making it hard to assume what one understands by using it. Performance not being an objective reality is also agreed upon by Wholey (1996), who looks at the term from the perspective of it being not a natural phenomenon which can be measured and evaluated, but that it is a socially constructed reality. It is stated that performance first of all exists only in people's minds and therefore it needs to be defined first so that it can be measured accordingly.

In general, the authors in the literature often agreed that the term performance should be connected to some kind of outlook into the future. For Lebas (1995) it is about capability and therefore about the future. It is also case specific and decision maker specific, which means that it should be noted that context and subjectivity are important factors in defining performance overall. Also, Folan, Browne and Jagdev (2007) state that they connect the term performance with positive progress, therefore also having a future oriented view connected with the term. Still, for performance to be used as a concept in connection with measurement, management, assessment and evaluation, it needs to be formalized to be adequately understood and applied and cannot remain a random entity without a formal logic. This means that a standardization of procedures is needed, limiting parameters need to be set individually by oneself. Performance therefore can be very dependent on the parameters one sets to capture, which can lead to performance becoming a set of subjective viewpoints (Folan, Browne and Jagdev, 2007).

3.3.2 Performance from a business strategy perspective

The reasons why organization measure performance can vary from organization to organization, but may include aspects such as identifying success factors, identifying whether they meet customer requirements, help understand their processes and identify problems, as

well as control if planned improvements were successful or not and many more (Parker, 2000). Most of the nineteenth century, purely financial methods like accounting-based measures and cost accounting were considered as performance measures for a company's success (Yadav, Sushil and Sagar, 2013). In the early 1990s a shift took place for performance measurement approaches in that regard, which was mainly initiated by the introduction of the Balanced Scorecard (BSC) framework from Kaplan and Norton (1992), which concluded that the traditional way of measuring a company's performance mainly through its financial performance was not the best way to drive innovation and improvements in critical areas important for the company's business. Eccles (1991) already realized that financial measures should only be treated as one among a broader set of measures. The BSC therefore expanded the view on performance measurement by adding a customer perspective, describing how the company wants to be viewed by its customers, an internal business process perspective, describing the business processes which a company needs to improve to be able to tend to the customers and shareholders and an innovation and learning perspective, describing the changes and improvements that need to be realized to achieve its vision, to the financial perspective, which describes how the company would like to be perceived by its shareholders (Kaplan and Norton, 1992). One of the major differences to the traditional way of measuring performance was therefore that the BSC was now including an external focus by also looking at customers and shareholders in its evaluation, as well as combining financial and non-financial factors (Bourne, Franco and Wilkes, 2003, Yadav, Sushil and Sagar, 2013). Kaplan and Norton (1992) intended with the BSC, that companies would start to integrate their strategy and vision at the center of their being and not only focus on control, as these new measures would help align the company to strive towards one vision, while helping management to better understand interrelationships between different measures and areas, meaning that the BSC indicates that companies should use performance measurement more to look forward and not only measure the past. Yadav, Sushil and Sagar (2013) identified the BSC to be a method in which companies are able to link their performance measure to their vision, objectives and strategies and therefore take a more strategic perspective. They also stated that according to Atkinson and Epstein (2000) and Gumbus, Bellhouse and Lyons (2003), several companies had reported improved operational efficiency and profitability as a result from introducing the BSC approach.

At the same time, as with any model and/or framework, also the BSC was identified to have its flaws and limitations overall, which led to it being enhanced and further developed since its creation. Here, two key points are identified in which the BSC is considered not sufficient enough, although it still accounts as the base framework for most companies (Yadav, Sushil

and Sagar, 2013). One major limitation for the BSC framework was that it only covered a limited number of stakeholders, as only shareholders and customers are considered in this framework. Over time researchers criticized this aspect within the BSC and made cases for other relevant stakeholders' perspectives to be added, as these could also be considered viable to a company's success and therefore would need to be included from a performance perspective (Akkermans and van Oorshot, 2005). Stakeholders that were considered missing including for instance the employees of a company, which had been left out of the BSC framework entirely, but according to Sureshchandar and Leisten (2005) should be included as key stakeholders of any company. Adding to that Cavalluzzo and Ittner (2004), as well as Neely, Adams and Crowe (2001) mention stakeholders such as suppliers, alliance partners, intermediaries within the direct business environments of a company, and external stakeholders such as regulators, local communities or pressure groups. All the mentioned stakeholders can have substantial impacts on a company's performance and therefore its success. Neely, Adams and Crowe (2001) also created an adapted framework for performance measurement, the performance prism, in which they decided to put generally more emphasis on stakeholders around a company and their impact on its business, as they argue within the five facets of their framework, that all stakeholders need to be included and that stakeholders are the reason that companies have strategies in the first place, as these strategies are only there to create value for them. They argue that every stakeholder has a reciprocal relationship with an organization, which means that on the one hand stakeholders contribute to its business, while on the other hand stakeholders also benefit from its business. This in turn implies that an organization needs to consider its relationship to all stakeholders before defining its performance measures and objectives (Neely, Adams, and Crowe, 2001). The second overlooked aspect within the BSC that has become a growing factor for any company's success is the aspect, Sureshchandar and Leisten (2005) call the social perspective, which today would be best described with Corporate Social Responsibility (CSR) (Yadav, Sushil and Sagar, 2013). The term sustainability in an economic environment gained popularity through the Brundtland (1987) report, which defined the term "sustainable development" as "development that meets the needs of the present generations without compromising the ability of the future generations to meet their own needs". This led to Elkington (1998) later defining the term triple bottom line (TBL), which should function as a framework for measuring performance along the three aspects of sustainability: economic, social and environmental. Elkington also called them profit, people, and planet. In an analysis Alhaddi (2015) showed that the term sustainability often is used inconsistently, as it is often referred to only one of the three aspects, mainly environment, but

in fact should always be considered in the context of all three aspects. Companies today need to carry more responsibility for their actions and business ventures, since they can have tremendous impacts on the society, they operate in. Yadav, Sushil and Sagar (2013) mentioned that more and more companies decided to also integrate the social and environmental aspects into their strategy, which is also mentioned by Figge et al. (2002). According to Funk (2003), a "sustainable" company or organization is designed in a way, in which it can create a "desirable future state" for all stakeholders. Therefore, companies that actively incorporate sustainability within its company profile will also be able to create better value for all of its stakeholders. According to Länsiluoto and Järvenpää (2008), Wagner (2007) integrating sustainability can also have positive impacts on a company's overall performance, as it can contribute to a bigger impact on the market, a better image, more efficiency, and lower risks.

3.3.3. Performance Measurement

Performance measurement could be seen as the process of quantifying action, where measurement is the process of quantification and action leads to performance. Still, the term performance measurement is quite diverse in research literature and often bound to a certain designed system. (Neely, Gregory and Platts, 1995). As business environments constantly change, the use of appropriate measures needs to be adapted to these changes accordingly (Yadav, Sushil and Sagar, 2013). To be able to measure performance, an environment needs to be set in which operation is set to take place and in which one wants to know how well one "performs". The creation of an environment will set a limited number of possible objectives, from which one would need to choose one or a set of objectives, so that these could be used to strive towards. Therefore, performance measurement always needs to be done in a relevant environment, for instance evaluating the market impact of a company within its specific market niche and not compared to an irrelevant market. It should always be conducted with a relevant objective in mind, so that it is clear what a company actually wants to achieve and where it wants to go. And lastly it should always reduce these objectives to recognizable characteristics and measurements relevant for the company to achieve its objective, for instance cost, quality, time etc. (Folan, Browne and Jagdev, 2007). This means that a system needs to be developed, which manages to convert and transform a complex reality into a limited number of symbols and indicators, that then in turn can be regularly reproduced under similar circumstances (Lebas 1995). Besides the circumstances having to be similar to apply the same measure repeatedly, the created measures should also be used and applied on a frequent basis from a time perspective

and should be part of a periodic measurement. This could mean, for instance, on a yearly basis or with an even higher frequency, so that management can include the measures in its decision-making processes, to support its management with relevant data and numbers or support improvement efforts within the company. To understand and recognize where the company actually stands with its measures, these need to be compared regularly to benchmarks, either set by performance numbers of the past or new objectives set for the future (Wholey, 1996). Folan, Browne and Jagdev (2007) recognize that it is impossible to capture performance in its entirety and that it should be remembered that performance should be seen as something that is continuous in its form, therefore implying that measurements should be adapted over time.

4. Interview Results

In this chapter the results and findings that have been made by conducting the described interviews will be outlined. As for the literature review, the results will also be distinguished into three categories. In the first part various stakeholders that participate in urban freight and last-mile deliveries will be presented and some of the experiences that CEP companies made regarding these stakeholders will be summarized. The second part of the result presentation deals with the light electric freight vehicle itself. All findings that will be presented here reflect the opinions and experiences that the interviewed managers of the CEP companies have gained in the operation of these vehicles. The third part about performance will focus on different performance aspects that have been emphasized by the interviewees in the context of LEFV operations.

4.1 Urban Freight and its stakeholders

City Authorities

Among the different players CEP services are dealing with, cities or the city authorities represent the most important one. They are liable for either maintaining or improving the infrastructure that facilitates logistics activities, they are responsible for the implementation as well as enforcement of rules and regulations both from national and local legislators, and they are accountable for providing a livable environment for city inhabitants. The last of these mentioned duties has been influencing the efforts of cities to adjust the current transport activities as they create various external costs. Whereas there are different kinds of them, the interviewees mainly named the reduction of traffic and congestion, or the improvement of air quality as the most important goals of cities in order to decrease external costs. To achieve these objectives, city authorities have taken the first steps engaging in dialogues with logistics companies to seek for potential solutions. In general, it was pointed out that cities do show a lot of interest in logistical improvements and have a very positive attitude towards city logistics projects. However, the level of commitment, the devotedness or ideas for constructive suggestions are varying from municipality to municipality.

> "There were discussions with local authorities, and they are interested. Our sister company has been in quite close contact with the authorities and works together on how to optimize and create different solutions."

> "So they [cities] are in favor of our initiatives and have a positive attitude but there is no consequence involved, for example in offering shared space for micro hubs. That's the difficulty."

> "The issue that we are encountering is that most of the cities have no experts in the area of logistics. Various ideas are being proposed, often taken from other places, without having an own conception or without considering requirements or challenges that are specific for their own city."

The statements made by three different interviewees from Germany, Sweden and the Netherlands emphasize that cities have recognized the importance of the urban freight transport domain attempting to take steps towards a more sustainable approach to it. However, besides showing interest in this topic, very often these steps are not elaborated enough and are not executed with the consequence that would be necessary from a CEP company's perspective. In that context micro-hubs have been a reoccurring talking point throughout the interviews. As it will be pointed out in more detail later, the micro-hubs are essential for LEFVs to be managed and operated in an economically sustainable manner. Though, with the current level of real estate prices in city centers CEP companies state that they are not able to develop a profitable business case for LEFVs operation in those areas. This means that city authorities would need to find ways to extend their efforts of improving urban transport e.g., by providing economical affordable locations for micro-hubs to the CEPs. It was also highlighted in the interview process, that not all cities have the legal rights to organized logistics and promote micro-hubs as they, like in the case of Canada, might not be allowed to subsidize those actions.

Regulators

In a similar manner the interviews highlighted the importance of rules and regulations in general and with that the role of the regulators as stakeholders. It was pointed out that regulations can

vary from country to country or city to city. To mention an example, there are regulative differences for the use of pavements by LEFVs. Whether the vehicles are allowed to use these areas for their operation or not can create a large impact on the effectiveness of the LEFVs. Another example that was referred to is the regulation of the vehicles. So, it can be that regulators, in the mentioned case it was the city of Toronto, limit the size or weight of vehicles so that every LEFV that exceeds the defined terms has to follow car regulation and therefore needs to be registered. The effects of that can be far reaching as vehicles again would not be able to use cycle path or pavements and drivers would need to have a valid license to be able to operate the LEFVs.

> "As we are delivering in urban areas we are operating in public space, which means that things around our business are regulated. There can be certain restrictions in place. [...] We have seen that sometimes exception permits are granted for some types of vehicles, especially for light, emission-free vehicles."

Even though regulators have put restrictions in place in the past, there are possibilities to overcome limiting factors like that for the operation of LEFVs, as the statement from a German interviewee above highlights. According to that, regulators, most likely cities, can make exceptions for the use of certain vehicles in city areas where driving is usually not allowed. Once these exceptions are made drivers would be able to operate them more effectively.

Drivers

Drivers can be identified as another group of stakeholders of LEFV operation in last-mile logistics. Their importance was outlined from all interviewees, even though the expectations to what kind of qualifications the drivers should have slightly differed. For the interviewed company in the Netherlands, for example, drivers need to have a valid driver's license to be allowed to drive an LEFV. Even though this is not a requirement by law, the interviewee argues that a license is likely to increase the driver's safety and the safety of other traffic participants as well. In contrast to that one of the interviewed experts in Germany stated that a driver's license is not mandatory as there are many skilled drivers with a courier background that are not in possession of one, which enlarges the recruiting pool for drivers. Also, many young people living in cities tend to not obtain a license as they do not rely on cars as means of

transportation. Based on that experience there is also a higher likelihood that these potential employees are willing to drive a LEFV rather than a car. Though, regardless of owning a license there was a common understanding among the interviewed managers that the skill level of a driver can be very crucial to the overall operation. In extreme cases the proficiencies of the person operating an LEFV can make a difference of up to 40%, which means the more skilled the operator is, the more effective the deliveries will be. Another aspect that contributes to that is the driver's knowledge of the delivery area. The familiarity with local circumstances was recognized as a valuable attribute, due to an enhanced productivity. This is why the retaining of personnel with a history of operating in certain areas is regarded as quite important. Besides that, the recruiting of qualified personnel is also viewed as very critical and challenging by all CEPs. Even though the focus in the recruitment process itself lies on people with a biking background (e.g., normal bike couriers or employees of food-delivery services), it can happen that van drivers are getting retrained to drive LEFVs. Though, as the job of operating them is less appealing due to unpredicted and at times uncomfortable weather conditions, it is unlikely for this to happen without any volunteering from van drivers.

Subcontractors

The act of recruiting can also be executed by subcontractors of the CEPs, in case they have been contracted to do so. Subcontracting is a very common practice in courier, parcel and delivery services and therefore also gets applied by CEPs in last mile deliveries with LEFVs. Besides being responsible for recruiting it was also mentioned by the interviewee from the Netherlands that the coordination of city logistics projects can be handed over to the subcontractors. The main reason for that is that this offers the CEPs more flexibility in their activities and the possibility to faster expand their business by using external resources. Yet, it can be challenging to find and cooperate with subcontractors in the context of LEFV projects. As outlined by one interviewee from Germany, the subcontractors feel like they limit themselves in their flexibility by procuring and operating LEFVs. In case a contract is canceled or runs out, it is easier for them to cooperate with other larger CEP companies having vans as the main vehicles of operation.

Suppliers / Manufacturers

For the expansion of city logistics operations that include LEFVs an important role also falls to the supplier or manufacturers of the vehicles. With an increasing speed of LEFV implementations across Europe and North America the demand for this type of vehicle rises accordingly. Due to this reason, the interviewees pointed out that there is a strong need for spare parts and service partners that can carry out maintenance work. However, CEPs have been struggling to find partners that both can produce LEFVs in larger numbers while, at the same time, provide a network of local service partners across different countries. As a result, the companies stated that they have to deal with different manufacturers which enhances the coordination complexity and limits the possibility of creating cost savings by scaling the cooperation. In the end this impacts the overall cost for the LEFV fleets and its cost performance.

Customers

Another group of stakeholders are the customers that are at the receiving end of last-mile deliveries in cities. Even though they don't actively participate in the process of delivering they can have an interest in the way parcels are being delivered or transported. As highlighted by one interviewee in Sweden, the general public is curious about the LEFVs that drive around the city. Customers have also started to ask if they are able to determine whether their parcels are being delivered by "green vehicles" or not. Though, the customers are not able to make that kind of choice for their deliveries yet as emphasized in the statements below.

> "Customers cannot choose or know if delivery is happening in 'the green way'"
>
> "We are not in the place right now that we can say that its (the parcel) going to be delivered or picked up by green vehicle in Stockholm or any other city because we need to have the flexibility to optimize the routes."

The reason can be found in the optimization of logistics companies as they cannot guarantee by which kind of vehicle goods are being picked up as they need the flexibility to optimize the routes and deploy vehicles with the best utilization rate.

Competitors

A driver for the optimization is the competition among the logistics companies that operate last-mile deliveries in urban areas. These companies represent another entity in the network of city-logistics stakeholders. Due to the contest for market share, there has been a fight for delivery prices per parcel and the maximization of the very low margins in the business. As a result of that, CEPs are neither sharing information nor infrastructure with each other. Though, as already mentioned before, without any coordination or cooperation it is difficult to improve cost-performance of LEFVs.

Pressure Groups

Finally, the last city logistic stakeholder can be described as pressure groups that demonstrate and campaign for environmentally sustainable business practices and thereby create an impact on CEPs. According to one interviewee from Germany, the external influence has influenced logistics companies to prioritize projects including LEFVs to create local, emission-free deliveries.

4.2 LEFV

LEFV Characteristics

To understand on which aspects CEP are judging LEFVs it is necessary to know for what kind of characteristics they are looking for in the vehicles and how the implementation of the vehicles impacts the operation. According to the interviewees the logistics companies value the range of LEFVs as well as their uptime. This means that they need to be able to cover longer distances without the need to recharge during the day and they must perform reliably with as little downtime as possible. Furthermore, CEPs look at the cost side of the vehicles and calculate their financial expenditure by the means of ownership (buy or lease) and service (service, maintenance, and spare parts). The final expenses are dependent on the type of LEFV that is being used in the end. While the companies are striving for a fleet of coherent types, the supply by manufacturers and the different characteristics of operation between cities can cause companies to use different types. FedEx, for instance, is using both two wheeled bikes with loading space in the front and trikes with larger loading boxes in the back.

LEFV Capacity

The space of these boxes or the capacity of LEFVs is another important factor that CEPs are taking into consideration for their operation. Depending on the loading capacity the delivery productivity changes. The logistic companies all stated that the more parcels can be moved by one bike at the same time, the more efficient the overall delivery process becomes and the better the performance will be. Also, it has been mentioned that the larger the capacity per LEFV is the lower the number of vehicles that is needed for the operation. Consequently, less drivers are needed, and the salary cost can be kept at a minimum. It was also pointed out that even though more capacity is always helpful there is not much room for increasing the loading spaces as otherwise the LEFVs could lose their status of light vehicles and would need to be registered.

Delivery Operations

Another considerable aspect that was emphasized in the interviews was the LEFVs impact on the delivery operation. It was a common understanding that CEPs have to include at least another step into their process chain as the parcels have to be prepacked for the LEFVs and need to be delivered to a depot from which the vehicles are starting their tours. Associated with that are the routes that are being planned and optimized by software. Besides the necessary stops they can also include the delivery prices per parcel into their optimization algorithm so that the best cost-performance can be achieved under the given circumstances. For the consideration of cost-performance and the productivity of LEFVs in general, it is helpful to consider not just one single vehicle but the entire fleet. This was especially emphasized from a Canada interviewee as it has been one major finding of a LEFV project to think in fleets rather than in single bikes. The fleet management contributes a lot to the number of parcels that are being delivered every day. It has been pointed out during the interviews that the application of LEFVs requires a comprehensive concept and the utilization of an optimized number of vehicles. Again, this number can be different dependent on the location the operation is taking place. Based on the mix of parcels and places of delivery in an area, one vehicle might deliver less than the other one but still contributes to the final revenue and cost, which need to be distributed among all vehicles in the final calculation. Additionally, it might be the case that some parcels cannot be transported by LEFVs, so the fleet of light vehicles needs to be complemented by another vehicle e.g. a van. This approach has been chosen in the Colibri project approach in Montreal and can also be spotted in other locations e.g., at DPD in Nürnberg, Germany.

Micro Hubs

Part of the comprehensive approaches are also the micro-hubs, that as mentioned before, can be seen as an essential part of the LEFV operation in the cities. As they represent the depot from which the vehicles are starting their routes, it also has to be included in the cost-calculation of last-mile deliveries of LEFVs. This has been also emphasized in the interviews in which the search for appropriate micro-hubs was described as a common recurring issue. It was stated that the venues have to fulfil different infrastructural requirements and also need to be located at a suiting location. Besides that, other hub-related topics were brought forward in the interviewing-process, e.g., the idea of satellite hubs in the city that could decrease the number of empty runs of LEFVs and therefore could improve the performance of the vehicles.

Operational Advantages of LEFVs

Besides the described considerations CEP have to make for the implementation and operation of LEFVs, two other major advantages are being recognized by the companies. First and foremost, the companies value the cut of greenhouse gas emissions that both can contribute to climate change and bad air quality in the cities (particulate matter). Furthermore, the interviewees have all highlighted that LEFVs offer significant performance advantages by helping them to overcome accessibility difficulties. For instance, it is very easy for LEFV drivers to find a parking spot close to the delivery address while common delivery vehicles like vans spend a lot of their operation time to search for the next best parking space. This means that LEFVs can cut a lot of journey times which benefits the efficiency. As part of that, drivers of these vehicles are also able to park right in front of the delivery addresses which decreases the amount of time that they usually spend walking between their car and the front doors, also no double parking and/or blocking sidewalks, as well as blocked holding bays are issues anymore. In addition to that, less time is needed for LEFVs to be locked or unlocked. Besides these time savings the vehicles offer further accessibility advantages as they do not fall under the legislative regulation of regular vehicles and therefore have higher usability freedoms than traditional vehicles. This creates the possibility to use LEFVs on bike lanes, as well as use one-way streets both ways for instance. By using these accessibility rights, LEFVs can minimize their length of journeys and decrease the time between stops.

4.3 Performance

Costs associated with the LEFV Vehicle

One of the main points identified throughout the interviews was the area of costs being connected to the topic of implementing and operating LEFVs, in most cases cargo bikes, within the urban areas. Costs could derive from different areas, depending on the perspective of which one would look at the topic. By comparing the combustion vehicle costs with the new cargo bike costs, it was generally mentioned throughout the interviews, that the operating cost of cargo bikes would be much lower than the ones of the combustion engine vehicles, as for instance electricity is generally cheaper than Diesel fuel, maintenance and servicing costs on bikes would be less than on combustion engine vehicles. On the contrary, one interviewee from Germany mentioned that in the end the overall cost could not be of that much difference, if one would compare a cargo bike to a smaller delivery vehicle like a VW Caddy. Bikes in this scenario have a higher maintenance cycle than regular vehicles due to the high usage, which often bikes are not made for and therefore lack durability. The cost advantage could very much depend on the country in which cargo bikes are implemented, as it was also mentioned from our interviewee in Finland that vehicle costs for combustion engines were much higher due to emission taxes set by the government, which made it more attractive to look for alternative modes of transport from a vehicle cost perspective. One alternative method was mentioned by our interviewee from the Netherlands, as she mentioned that leasing the bikes could also be a very viable option for an operating company, as with this method, the operating costs could be externalized, and more flexibility would be created.

Costs associated with the LEFV Driver

The driver cost perspective was also identified as a factor. Here, it was also visible that it may depend on the country, how much of an impact the cost has in this area. It was mentioned that due to the smaller capacity of cargo bikes it could very well mean that the company would have to hire more bike riders to compensate for that, which would result in more labor costs. Still, the companies would try to keep the salary the same, as the new drivers would still be asked to have a license and qualification for the job. An alternative opinion was mentioned by one interviewee from Germany, who stated that he expected the personnel costs to decline by approximately 25%. The reason for that being would be that for drivers of larger vans and trucks a special license and qualification would be needed, while the supply of new workers in this area would steadily decline, making the few available employees much more expensive. One

benefit of having bikes as distribution vehicles would be that people could be hired without licenses and qualifications needed before, which would create some benefits for the operators on the driver cost perspective.

Costs associated to Infrastructure

One major cost factor, which every interviewee agreed upon, was the increasing infrastructure costs associated with the implementation of cargo bikes in urban areas. Adding bikes as smaller delivery vehicles with a smaller sphere of action would mean that new points of transshipments would need to be installed within the city and therefore much closer to the customers, so that the bikes would be able to adequately operate. This would not only mean that new processes would be installed in the delivery process, but mostly that a location within the city center would be needed to be found, that actually fits the needs of the operators. These so-called "micro-hubs" or "micro-depots" could potentially increase the cost significantly, as the locations within cities are generally more expensive to rent, as on interview partner from the Netherlands mentioned for example:

> "[…] if we have to rent another micro-depot in the city center that increases the cost and that is quite a big chunk. Real estate in the city center is not cheap. […] infrastructure is the biggest cost driver that can set off other cost benefits."

This would be true for a specific facility as well as for a modified parking garage. Another cost driving factor in this case would also be the specific demands this location would have to meet, as the whole facility should be on ground level, enough storage should be given, garages for the bikes should be present and accessibility for bigger trucks to transship the parcel should also be available. Another possibility would be a movable micro-hub, as used by UPS for instance. This would mean that a large truck container would be placed within the urban area for the duration of the delivery window, so that the cargo bikes can use the container as a micro-hub to resupply themselves on their delivery routes. An issue here would be the dependance on the city authorities, as they would determine the place, time and rental cost for the duration of placing the container within the city, which could create a volatile cost relationship with the city, in case no long-term contract for this solution would be agreed upon. In general, it was

stated that the cost of implementation of cargo bikes within the last mile would very much depend on the city and could therefore differ from city to city.

LEFV Productivity

It was stated in the interviews, that in a general setting the bikes would most likely have a slightly better productivity within urban areas than regular vans or cars. Just electrifying vans and cars or using hydrogen powered vehicles for the delivery would not help to increase the productivity of the vehicles, as the size of the vehicles and most of the regulations and restrictions would not change. One of the German interviewees stated:

> "[…] if I use small, electrified vehicles, I don't have a big advantage from that in Germany […] I only have the possibility to either stand in the same traffic jam as everybody else or I have to evade to other paths"

So, derived from that, one major factor for more productivity is the accessibility advantage mentioned already earlier in this chapter. Coupled with that, another deciding factor for the productivity of cargo bikes in parcel deliveries was identified though, as it was generally stated that the customer density also plays a deciding factor on how productive a bike can be. The routes for bikes are mainly decided upon depending on the customer density in the planned sphere of action of the bike or generally on a stops per kilometer basis. Is the density of stops perceived as high enough a bike is seen as the better option to use, due to its accessibility advantages over a vans or car. Therefore, the customer-, receiver- and parcel-mix, as well as the location of the micro-hub all play an important role on assessing the overall productivity of a cargo bike. One possible limiting factor besides the customer density was mentioned by our interviewees from countries with stronger and longer winter seasons. Winter weather and snow could limit the productivity of bikes by up to 20%, as it was estimated by our interviewee from Finland, while for the days with much snowfall vans would have to be used as backups, although this was only needed for a couple days throughout the winter. Another interview partner from Canada also mentioned that there was no significant change visible between the seasons, except that during the winter more maintenance was needed and the bikes, as well as the drivers had to be specially equipped for the cold temperature and unsteady road conditions.

5. Theoretical Framework - adapting the Performance Prism

The importance of performance management, that has been emphasized during the interviews, was previously also outlined in the literature review. In that various takes on performance management and measurement were introduced and assessed. Beyond that the literature review exposed some of the strengths and weaknesses of the different approaches to this topic that are currently existing. Overall, there are many different frameworks or methods to choose from to measure or manage performance. The number of these approaches reflect the observation made by Najmi, Etebari and Emami (2012) who stated that performance management has received a lot of attention by both academic and business communities in recent years. To select a fitting approach for a certain purpose, the characteristics of the frameworks need to be considered. This thesis' purpose, besides drawing a comprehensive picture of how performance of LEFVs is perceived by CEPs, is to investigate how the performance of LEFVs can be improved by meeting the demands of city logistics and its stakeholders. For that reason, an application of the Performance Prism framework would be appropriate.

The Performance Prism was introduced by Neely and Adams in 2000. It presents a holistic framework approach to performance measurement and aims to overcome weaknesses of other performance frameworks by combining their strengths (Neely, Adams and Kennerley, 2002). The underlying idea of it is that the organization, that is applying the framework, must meet the requirements of its stakeholders to manage and measure performance in the best possible way. For this reason, it is well suited for those types of companies that are working in an environment with a diverse field of stakeholders and for those that prioritize creating value for its stakeholders (Najmi, Etebari and Emami, 2012). Overall, the framework consists of five interrelated performance perspectives that each focus on dealing with a certain question, which the organization, that is applying the prism, must answer:

1. Stakeholder satisfaction – Who are the organizations stakeholders and what are their need or wants to create value?
2. Stakeholder contribution – What kind of contribution does the organization needs from its stakeholders?
3. Strategies – What kind of strategy should be implemented by the organization to meet the stakeholders needs while fulfilling its own requirements?

4. Processes – Which processes does the organization need to put the strategies into practice?
5. Capabilities – What capabilities (people, practices, technologies, infrastructures) does the organization need to run the processes? (Neely, Adam and Kennerley, 2002).

The key is that the perspectives and their respective questions follow a certain hierarchy which means that an organization, that is applying this framework needs to follow the outlined chronological order. Once the questions and perspectives have been processed thoroughly, the performance management of the organization can be improved.

The achievement of this is also the objective of CEP companies that are operating LEFVs. Since they are part of the city logistics domain, they are dealing with complex stakeholder relationships daily. This makes the performance prism a good fit for their performance improvements efforts. Beyond that there are many other reasons why this methodical approach would be well suited for the analysis of this thesis' context.

One reason for the application of the performance prism is the idea that companies should improve and plan for success by looking into the future rather than in the past. This idea, which is considered important in regard to the issues of climate change and political set emission goals, was originally introduced in the Balance Scorecard (BSC) framework of Kaplan and Norton (1992). Instead of considering only financial KPIs from the past, they also included non-financial data as well as information and perspective of some stakeholders to measure and improve business performance. Yet, the performance prism of Neely, Adams and Crowe (2001) was chosen for the analysis over the BSC as it more emphasizes and acknowledges the importance of all stakeholders and their reciprocal relationships with a company. As it was pointed out by Cardenas et al. (2017) the interactions and relationships of and with theses stakeholders are the main focus of city logistics in general. The performance prism incorporates that. It focuses on these relationships by contemplating what the stakeholders want from the company and how they can contribute to the company's business in return. Only by considering these aspects and by adjusting its strategies as well as processes accordingly, a company can develop the right measures for its performance and thereby improve its interrelationships. Another reason for an application of the performance prism is that it supports the qualitative

research approach of the thesis as itself can be regarded as a qualitative framework. In addition to that, its utilization matches the preliminary findings about the high level of influence that stakeholders have on CEP companies operating in urban areas.

In consideration of this thesis' findings and the topic of performance management in general, the performance prism leaves out a few aspects that can be considered as important nowadays. While the framework focusses on improving the relationships of a company with its stakeholders, it still neglects the importance of Corporate Social Responsibility (CSR). This concept includes the triple bottom line of sustainability (Elkington, 1998; Sureshchandar and Leisten, 2005; Yadav, Sushil and Sagar, 2013), which has been identified as relevant in the context of this thesis. As it has been mentioned in the introduction, the literature review as well as in the interviews, sustainability aspects can be identified as one of the main driving forces for changes in urban freight transport and the implementation of LEFVs. It was also identified, that implementing sustainability in a company can have positive impacts on the company's overall performance, as it can create a better market position, positive publicity and image and lower risks (Wagner, 2007). Because of that the framework will be adapted accordingly for this thesis, by incorporating the triple bottom line of sustainability.

The modified version of the performance prism framework is shown Figure 4. It includes the first three perspectives of the prism (Stakeholder Satisfaction, the Stakeholder Contribution and the Strategies), while the two last ones (Processes and Capabilities) are being neglected. The reason for this is that the identification of needs and contributions, which are representing the reciprocal relationship of the CEP operator and its stakeholders, is the theoretical groundwork of the framework. Therefore, it has to be included in the adapted version. The same holds for the strategies, which can be seen as one of the man contributions of this thesis. They are focused on the general future success of LEFV operations in the entire city logistics domain and are therefore seen as important. In contrast to that, Processes and Capabilities are viewed as too specific. Even though they contribute to the strategies, they can be very different from company to company. This means that the definition of them as part of this thesis would unlikely be applicable on the different carriers in the industry. Instead of these two facets, the sustainability aspects will be incorporated by adding the three P's (People, Planet, Profit) of the triple bottom line to the framework (Elkington, 1998; Funk, 2003; Länsiluoto and Järvenpää, 2008). The sustainability factors function as reviewing or checking mechanism for the strategies, which emphasizes a stronger focus on the long-term success of the strategies created.

All performance measurements, that are chosen because of the strategies, will then also work as an indicator of how well the sustainability efforts are being put into practice. A further addition made to the adapted framework is the *Environment* in which the unit of analysis, the LEFVs of CEP companies, are operating in. The clear definition and specification of the environment helps to more narrowly address specific characteristics of the stakeholders that are operating in it. Following that, the strategies can be developed to fit better to the actual issues at hand, and each stakeholders' objectives can be defined and estimated more accurately (Folan, Browne and Jagdev, 2007).

Conclusive, it can be said that the modified performance prism uses a top-down approach with the goal to develop Performance Measures that help the company (CEP operator) that it is applying it. It facilitates a transformation of a complex reality, which includes various stakeholder relationships and sustainability issues, into a limited set of indicators. The operators thereby break down the complex structure into simple measures which can be used to track the overall success of its actions (bottom up) (Lebas, 1995 ; Folan, Browne and Jagdev, 2007).

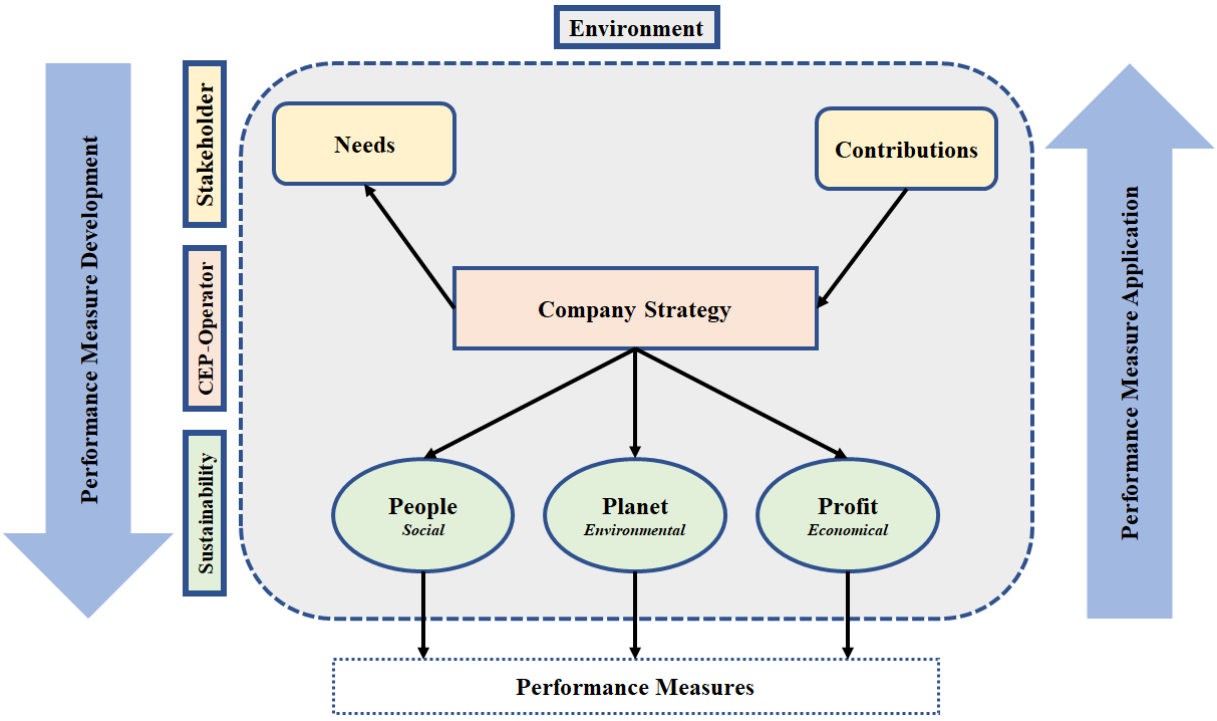


Figure 4: Adapted Performance Prism Framework for CEP-operators (self-made, 2021)

6. Analysis

This chapter will be used to bring together both gathered primary and secondary information to create one comprehensive analytical overview of the thesis's research results. For that, the analysis will follow the three-part structure that has been used throughout the thesis. In the first part of the analysis (6.1) the findings of the literature review in regard to urban freight and stakeholders will be compared to ones of the conducted interviews. All relevant stakeholders of urban freight and the parcel delivery sector will be presented and categorized based on their importance or relevance for the performance of LEFV operations. Following that, the second part (6.2) will summarize the advantages and disadvantages of LEFVs that have been identified throughout the literature review and the interviews. In addition, a sufficient overview of the vehicle's success-defining factors will be presented to the reader, with the objective of highlighting the needs of CEPs to operate LEFVs in a successful manner. This knowledge will then be taken up in the third part (6.3) of the analysis, which will be used to develop strategies to increase the overall business performance of LEFVs in urban areas. To do that, an adjusted version of the performance prism will be used. This framework, which will help to identify the wants and needs of the most important stakeholders, will also adapt the concept of the triple bottom line. In this way a sustainability focus can be incorporated in any business decision made.

6.1 Relevant Urban Freight Stakeholders

The main objective of this section is the identification and analysis of all stakeholders that, from the perspective of LEFV-operating CEPS, play a relevant role in the urban freight environment. To conduct this analysis, the information that has been obtained by reviewing the literature review will be compared with the one that has been gathered in the interviewing process. With that, previously made research results from the literature can be verified through the experiences of professionals in the field of parcel deliveries, while also enabling the possibility to add new information that were not considered at first but could be deemed important as well. Important to note is, that while the focus on stakeholders was more general in the literature review, the interviews provided more in-depth information and personal opinions. The input of the interviewees, who are working for some of the largest CEP-companies in various cities, allow to create a bigger thematic picture with different country specific perspectives. By using the described approach, the general opinion in the literature is respected and the perspectives of

directly affected operators are added. This creates a better understanding on which stakeholders should be considered more important.

For the determination of the overall importance of each stakeholder in the context of this thesis three different aspects will be decisive:

- The analyzed stakeholder is an external stakeholder.
- The analyzed stakeholder has received great attention in the literature.
- The analyzed stakeholder has received great attention in the interview.

If all three of these aspects can be fulfilled, the stakeholder is perceived as stakeholder with high importance. Two fulfilled criteria mean that the stakeholder is viewed as one with a medium importance. If only one aspect applies, the stakeholder is of low importance to the overall research.

The criteria are based on the problematization and research question of this thesis. Both internal and external stakeholder can have an impact on the performance of LEFVs. However, while the internal stakeholders are easier to manage, the external stakeholders are more difficult to be dealt with. This is because internal stakeholders share the same interest as their own company. In contrast to that external stakeholders are motivating their actions with their own interest. Therefore, external stakeholders are more important to this research. The emphasis on the stakeholders in the literature and in the interviews also gives a good indication of their importance. In case both researchers (theoretical background) and managers (practical background) pay a lot of attention to one stakeholder, it can be deemed as crucial to LEFV operation in city logistics. Once this attention level is not given for either literature or interviews, the overall importance is decreasing.

In the following paragraphs the information about the stakeholders will be analyzed and evaluated according to the outlined determination criteria. For this, the list of relevant stakeholders in urban freight transport, that was shown in the literature review, will be used.

City Authorities

One main point the interviewees agreed upon, which was also identified within the literature review, was that local authorities often recognized urban freight transport as a relevant topic for

cities, but also regularly lacked acknowledgement of their influence on urban freight, not seeing it as their responsibility to take action. Additionally, a lack of general knowledge and expertise was often identified on the authority's side, which complicates the decision- and policy-making even further and is shown by not including urban freight issues in for instance urban land planning. City Authorities overall have a strong influence through implementing policies, rules, regulations and infrastructure in urban areas and therefore stand out as the potentially most important stakeholders for CEP-operators to consider in city logistics operations and urban freight

Carriers / Other CEP Services

Other CEP companies represent the competition to an operator of LEFVs in the last mile and can for this reason be regarded as external stakeholders. CEP operators are focusing on a continuous optimization of operational speed, cost efficiencies, and processes to work as profitable as possible in a very competitive market. In the literature a lot of emphasis was placed on the lack of data sharing among the carriers or the lack of joint efforts to improve the sustainability of city logistics. Similar views could be derived from the interviewees that pointed out the sensitivity of their own data and the unavailability of data from competitors for the purpose of external benchmarking. Due to strong focus of both literature and interviews on the carriers, they can be regarded as stakeholders with a high importance to the performance of LEFVs.

Customers

Even though customers and their level of satisfaction has been pointed out as really important to the interviewed managers, they are less influential on the performance level of LEFVs. Accordingly, the main emphasis on this type of external stakeholders could be found in the literature, in which the changing consumer behaviors were described in more detail. Also, it was pointed out that customers are mostly taking the logistics services for granted and that they are not interested in paying extra fees for an improved level of service. Following the mentioned details of the analysis it can be concluded that customers, in the context of LEFV operation, are only of medium importance.

City residents

City residents present the sample of people living in urban areas that are not part of logistic activities, meaning that they do not receive parcels. As they don't actively participate in urban freight transport, they only become relevant to the topic in the context of external costs (emissions, noise, congestions). Neither in the literature nor in the interview the residents received a lot of attention. Therefore, they are of low importance to the research topic.

Tourists / Visitors

For tourists, the same statements and findings can be applied for as for the city residents. This type of external stakeholders has not received any attention in literature or interviews and can be characterized as stakeholder with a low level of importance.

Subcontractors

Subcontractors can be characterized as internal stakeholders as they are being mandated by the CEP companies with whom they have contracts with. The importance of subcontractors was emphasized in both literature and interviews. It was mentioned that subcontractors can take over various activities from the CEPs (e.g., recruiting). They can also be responsible for the coordination of entire city logistics projects. With these capabilities they allow the contracting companies to have a higher level of flexibility in their business activities. However, the subcontractors themselves are less likely to be flexible in their operation. It was stated that they are reluctant in investing in new assets like LEFVs, as these vehicles are not requested from the majority of potential contractors. Overall, based on the evaluation criteria, subcontractors are only regarded as stakeholders of medium importance.

Drivers

For this analysis drivers of LEFVs have been added to the list of relevant stakeholders. The reason for this is that they have received a lot of attention from the CEPs as it was highlighted in the interviews that the performance differences between drivers of electric assisted cargo bikes can be quite significant. The attributes that are required from a LEFV driver differ from the ones of the classical delivery-van operator so it can be the case in some companies that a valid driver's license is not required to operate a LEFV. As drivers are internal stakeholders the

overall importance can be determined as medium for this research, even though there has been a strong focus on them in both literature and interviews.

Pressure Groups

Another stakeholder that has been added to the list of relevant stakeholders are pressure groups like Fridays For Future or Greenpeace. As it was confirmed by some of the interviewed managers, these groups enforce the sustainability efforts of the companies in the transport sector. Still there has not been a lot of attention on these groups during the interviews. In the literature they play only a very subordinate role. Their impact on the operation of LEFVs can be regarded as low.

LEFV Manufacturers

Manufacturer of LEFVs received only a small amount of attention from research literature. The focus was primarily on the potential LEFV mass production which could lead to a decreasing cost of procurement for logistics companies. The CEP companies highlighted that the manufacturers play a very important role in the LEFV domain due to a high demand for vehicles and spare parts, which more often exceeds the supply. As a result, there is a lack of vehicles and spare parts which challenges the scaling of the operations or the maintenance works of the LEFVs. LEFV manufacturers are of medium importance to the research topic.

The comparison of information that were gathered in the literature review and the interviewing process showed that for most of the stakeholders there have been a coherence in the level of emphasis and information detail. Yet, it could be noted that the interviewees sometimes had a different focus than the research. The reason for this might be the daily operation that the interviewed managers are experiencing, which leads to a different judgement and prioritization of topics. To give an overview of all the named topics and challenges that have been described in both literature and interviews, all information has been summarized in Table 4. The table also includes the categorization of each stakeholder based on their importance for the operation of LEFVs at CEP companies. Following the determination of the categories it was concluded that city authorities and other carriers or direct competitors are the most relevant stakeholders. Their role as stakeholder will be examined in more detail in 6.3.

Stakeholder	Perspective of Literature Review and Interviewees	Stakeholder Type	Literature Emphasis	Interview Emphasis	Importance
Carrieres / Other CEP services	CEP operators are focussing on a continuous optimization of operational speed, cost efficiencies, and processes to work as profitable as possible in a very competitive market. They don't share data and information among each other which leades to a lack of data consitency and unexploited benefits that could be achieved by more communication or coordination. Even though they are focussing on the implementation of more sustainable vehicles, they cannot gurantee a fully "green delivery" to the customers yet. As operators, CEPs are important drivers of sustainable transport.	External	Yes	Yes	High
Local Authorities (City Authority, Politicians)	Local authorities are interested in improving the sustainability of urban freight transport but lack the acknowledgement of their own responsibility to create conditions in favour of that. In addition to that they generally have a lack of UFT expertise to help facilitate city logistics projects. Auhtorities are responsible for the compliance of emission policies and sustainability goals with the aim to regulate and decrease emissions. Their rules, regulations, and standards of vehicles classification can impact the operation of LEFVs.	External	Yes	Yes	High
Subcontractors	Subcontractors can carry out activities of CEP operators that include the delivery of parcels, the recuitment of employees or even the execution of city logistics project, which involves the communication and coordination with city authorities. While contracting them offers a level of flexibility to the contractors, subcontractors are trying to appeal to as many contractors as possible. This however decreases their own flexbility (e.g. low interest of investing in LEFVs).	Internal	Yes	Yes	Medium
Customers	Customer or receivers of logitics services take urban freight transported for granted and are not willing to pay more money for an improved service (e.g. delivery in a defined time-window). Due to changing consumer behaviours they have started to get interested in green deliveries.	External	Yes	No	Medium
Suppliers / Manufacturers	Companies that are manufacturing LEFVs need to fulfil the demand of CEPs for this type of vehicle. By increasing their production output, they can create economies of scales which can benefit the LEFV operators as procurement prices would decrease. Beyond that, the manufacturers are responsible for providing a reliable supply flow of spare parts.	External	No	Yes	Medium
Drivers	Drivers of LEFVs have received a lot of attention in urban freight transport. Their skill level can make a big difference in the performance of LEFVs (specifically electric cargo bikes). Though, the qualifications that are required of the drivers can differ from company to company (e.g. the need for a drivers license). The recruiting pool of potential drivers mainly consists of courier drivers.	Internal	Yes	Yes	Medium
Pressure Groups	Pressure groups that are advocating for more sustainability and more extensice actions agains climate change, have received a lot of media attention over the last years. Their dedication for this topic and the increasing interest and indorsement for their demands has led CEP companies to put more effort in their own strive for sustainable operations. Though, the direct impact on the operation of LEFVs can be regarded as quite low.	External	No	No	Low
Residents in Urban Areas	Similar to customers, residents of urban areas take logistics services for granted. However, as they don't order parcels they are not part of the delivery chain that ends with deliveries in the last-mile. Still, residents experience the downturns of increasing city logistics operations (e.g. increased noise level, emissions, congestion).	External	No	No	Low
Visitors / Tourists	Tourists or city visitors only play a subordinate role in parcel deliveries of urban freight and have not received attention in literature or interviews. As they spend a limited amount of time in the cities and don't receive any parcels, they are only affected by noise, emissions or traffic congestions.	External	No	No	Low

Table 4: Stakeholders and their importance for the LEFV operation (self-made, 2021)

6.2 LEFVs

The second part of the analysis will entirely focus on the LEFV and its characteristics. Examining this type of vehicle is important as it represents the main unit of analysis for this thesis and connects the various investigated aspects of the city logistics environment. Throughout the thesis, LEFVs have been mostly discussed regarding operational performance

aspects and the level of external effects they cause in comparison to the classic delivery vehicles like vans. These typical urban freight transport topics are highly relevant issues considering that in urban areas throughout the world, specifically in the context of growing urbanization, e-commerce, and online shopping. To analyze LEFVs as an alternative means of transport, with the potential to tackle the challenges that are arising from these developments, information has been obtained through a literature review and the interviews. While the focus of the literature review mostly lied on the definition of terminologies and the gathering of research results, the interviews with managers from different CEP operators were used to get an understanding of the operator's perspective on the LEFV. The possibility of comparing firsthand information of logistics operators with the qualitative data from scientific literature also allows to verify various statements from both sides and thereby helps to emphasize the validity of certain aspects. Similar to the previous section, all this information will now be combined to analyze the benefits and drawbacks that come with this type of vehicle. Beyond that, factors will be evaluated that can determine whether the implementation and operation of LEFVs will be successful or not.

Advantages

One major benefit that has been emphasized in literature and interviews was the accessibility advantages that the operation of LEFVs offers. The possibility to use roads, bike-lanes or pedestrian areas offers a level of flexibility that helps to optimize the routing of the vehicles and improve journey length and times. Furthermore, it is much easier for LEFVs to find parking spaces than for vans. This also benefits the productivity of the vehicles, which according to the interviewed managers can be higher than vans over the course of one day. Consequently, it can be summarized that as long as LEFVs are being operated in the right locations, the right environment, and with the right processes in places, they can replace vans 1 to 1. This finding was partly doubted in the literature but could now be confirmed by the interviewees. A different level of attention was also paid to the topic of internal cost of operating LEFVs. While the literature talked about the total cost of ownership, the interviewees could more in depth talk about the different cost factors like procurement or maintenance of LEFVs. It was noted that the internal cost of operating this type of vehicle is advantageous in comparison to the operation of vans. The same can be said about the external costs that are being caused by transport activities in urban areas. When it comes to the emission of greenhouse gases, the noise level or the contribution to traffic congestion, LEFVs perform much better than the common transport

vehicles. In regard to this finding literature and interviews showed a coherence in their remarks. Another benefit that comes with using LEFVs on the last mile of deliveries is the improved safety for pedestrians. All described findings for the advantages of LEFVs are summarized in Table 5.

Advantages of LEFVs	**Aspects**	**Coherence of literature and interview**
Productivity	▪ Slightly improved productivity	No
External Costs	▪ Reduction of noise and emissions ▪ Less traffic and congestion	Yes
Internal Costs	▪ Operating costs are lower ▪ Salary and maintenance cost can decline	No
Accessibility and Flexibility	▪ Flexible use of streets, bike lanes, one-way streets and pedestrian areas ▪ More arking opportunities and improved accessibility to target customers	Yes
Safety	▪ Enhanced safety for pedestrians	Yes

Table 5: Advantage of LEFVs (self-made, 2021)

Disadvantages

The productivity of LEFVs is closely tied to their load capacity. Even though the effectiveness of these vehicles can exceed the one of vans, they still are limited in the number and size of parcels they can transport on a single journey. These limitations prevent CEP companies from working more efficiently on the last mile. This issue has been identified in both literature and the interviews. For the analysis of other disadvantages, it was recognized that there are some differences in the focus of researchers and operators. Hence it could be noted that limited scalability of LEFVs in traffic does not play a role for the operators yet, as the number of vehicles still is quite low. This means that a congestion of bike lanes as described by Melo and Baptista (2017) is not foreseeable yet. Still, CEPs need to find the optimal number of LEFVs for their operation to maximize the utilization rate of each vehicle. In that sense they do have to consider the scalability of their operation. The other way around, there are topics that have received more attention from the operators than from researchers. One example is the challenge of adjusting established transshipment processes at the hubs of CEP companies. Other disadvantages that were outlined in the interviews were the dependency of the LEFV performance on weather conditions and advantageous infrastructure. These topics are also

addressed in the literature. However, as the logistics companies are faced with these issues on a daily basis, their emphasis on it is much larger. Bad weather conditions, particularly heavy snowfalls, exposes the vulnerability of light vehicles to outside influences. In extreme cases it can happen that LEFVs are not able to operate which could disrupt the entire operation of a CEP logistics provider. Another dependency, that mainly has been emphasized in the interviews, was the one of a profitable LEFV operation on advantageous infrastructure like micro hubs. These micro hubs are difficult to be established as the identification of affordable places that are suited for logistic operations represents a major challenge. However, as long as the hubs are still located on the outskirts of cities, the operation of LEFVs is less feasible. All described findings for the disadvantages of LEFVs are summarized in Table 6.

Disadvantages	**Aspects**	**Coherence of literature and interview**
Load capacity	▪ Limited loading capacity of LEFVs ▪ Limitations of parcel size and weight	Yes
Scalibility of operation	▪ Upscaling of LEFV operation could lead to congestion of bike lanes ▪ Congestion would decrease the effciency benefits of LEFVs	No
Adjustment of operational procedures	▪ Implementation of new processsteps and adjustment of current operation ▪ Transshipment needs to be done in close proximity of the delivery destination	No
Dependency on infrastructure and authorities	▪ Infrastructure in some cities and areas may not be sufficient for increase of LEFVs ▪ Cities need to support the idea of microhubs	No
Dependency on weeather conditions	▪ Strong winters with lots of snow can limit the productivity of LEFVs	No

Table 6: Disadvantage of LEFVs (self-made, 2021)

Success-Factors (SFs)

Certain conditions and needs were identified through this report that would be considered necessary to successfully implement LEFVs as a mode of transportation for parcel deliveries within urban areas. These conditions and needs will be summarized under the term success-factors. Throughout the literature review as well as the interviews two types (groups) of success-factors were identified, which will be explained in this section and which are shown in Table 7.

The first type are pre-conditions that must be evaluated and met before the implementation of LEFV starts. This means that the company that wants to implement LEFVs would have to

analyze the urban area and assess if it meets the company-specific conditions to have LEFVs implemented there. Two main SFs for this type are the operational environment and the parcel mix. The former describes the population density, the distances between potential stops and the vehicle restrictions within certain areas, while the ladder describes the number of shipments, specifically small, light and time-critical, are demanded in these areas. Both SFs should be considered at first and cannot be influenced by the company beforehand, which is why they fall under type 1 - pre-conditions.

The second type are the needs for success that a company must manage and achieve to effectively operate LEFVs in urban areas. The type 2 SFs become relevant after the area was assessed via the type 1 SFs and therefore determined as a potential LEFV area by the company. Therefore, they determine how effective a company is in its implementation of LEFVs. Also, type 2 SFs, opposed to type 1 SFs, can be directly influenced by the company. The three main type 2 SFs identified were the cost advantage, fleet management and the operation of micro-hubs. The first one is simply describing that for the implementation and operation of LEFVs to be considered successful the overall performance should be profitable in the long-term. The other two factors that influence the profitability are the efficient use of a fleet of LEFVs and the efficient and profitable operation of a micro-hub within the city. As the whole operation of LEFVs depends on the installment of a micro-hub, both of the first two type 2 SFs therefore also depend on the operational efficiency of the micro-hub operation in the first place. This is the reason why the micro-hub efficiency, specifically from a cost-perspective, is seen as the most important type-2 SF.

Needs for Success	**Criteria**	**Success Factor Type**
Operational Environment	▪ High network density and short distances between stops ▪ Busy areas with vehicle restrictions and realtivley low speed of cars	Type 1
Parcel Mix	▪ Small and light shipments, time critical shipments ▪ Flows with small numbers of shipments	Type 1
Operation of Micro-Hubs	▪ Identfication of micro hubs locations ▪ Operation of micro hubs ciritical for operation of LEFVs	Type 2
Fleet Management	▪ Evaluation of LEFV fleets rather than individual vehicles to determine cost-performance and productivity in general	Type 2
Cost Efficiency	▪ LEFVs need to be profitable ▪ Focus on costadvantages in maintenance, procurment, operation and external cost	Type 2

Table 7: Success-Factors for LEFVs (self-made, 2021)

6.3 Framework Application

From the stakeholder analysis in 6.1, a categorization of importance was also conducted as can be seen in Table 4 Through this categorization it was identified that specifically two stakeholders are considered of high importance to CEP-operators in the urban environment, namely, the city authorities and the competitors of the CEP-operator. In the analysis of 6.2 it was identified that for the successful implementation of LEFVs two types of success-factors (SFs) would need to be evaluated. In this part it is assumed that the type-1-SF assessment was already completed by the company and an area for potential implementation was identified. Therefore, the strategies created will try to focus on the main type-2-SF identified in 6.2., the micro-hubs and their operational as well as cost-performance.

Having the two main stakeholders for a CEP-operator, as well as the main need for success (micro-hubs) for the implementation and operation of LEFVs identified, the framework will be applied separately to both stakeholders. The application will be done from the perspective of a CEP-operator, which means that a potential company strategy for each stakeholder-relationship with the CEP-operator will be created. The goal is to potentially improve the operational- and cost-efficiency of micro-hubs in urban areas. The starting point of the assessment will always imply that neither the company itself nor the competitors in the market have managed to successfully operate a micro-hub within the inner city.

It is important to emphasize that both strategies presented are not connected and are considered as two separate proposals for the CEP-operator to implement a strategy, depending on the stakeholder it chooses. The structure of the framework application will follow the framework that was developed in the chapter 5 (Figure 4) of this thesis and will follow the chronological order which is visualized in Figure 5.

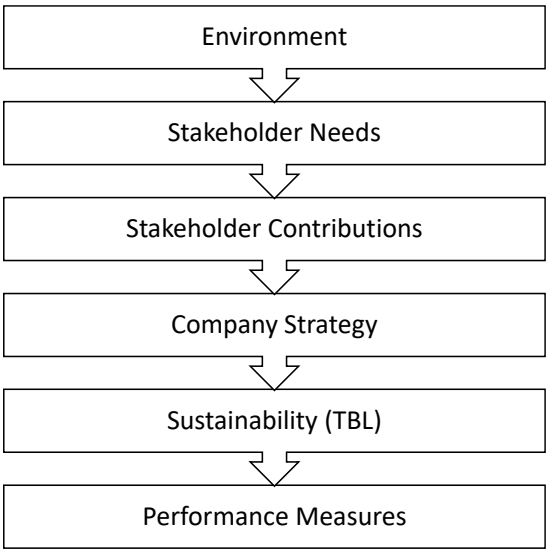


Figure 5: Framework Application Map (self-made, 2021)

6.3.1 Local Authorities

Environment

In this part the context of the stakeholder relationship will be described in short, which helps to better understand the relationship between the CEP-operator and the local authorities. As the assessment is done from the perspective of the CEP-operator the environment is set in the parcel delivery sector, specifically, as described throughout the report in urban areas with higher population densities, which often fits the description of downtowns and inner cities. Adding to that it will be assumed that LEFVs have not been successfully implemented yet, due to the type-2-SFs not being realized (6.2.), but that the general idea of implementation is seen positively by all stakeholders and realistic by the company (type-1-SFs). Therefore, the strategy created for the company in its relationship with the city authorities focuses on the main type-2-SF, the successful operation of micro-hubs in inner cities, which was determined as the underlying need for success in 6.2.

Stakeholder Needs

For the city authorities it was evaluated that they have the power to influence city logistics operations by defining legislation and regulations. It was also shown that, although recognizing urban freight as an economic driver, they often consider it as a disturbing factor, as urban freight contributes to the negative external effects described in the literature review and some of the interviews. The whole process of implementing LEFVs as alternative mode of transport within

urban areas therefore derives out of the notion of city authorities and regulators to reduce these external effects.

The wants and needs of city authorities as a stakeholder in the context of urban freight can therefore be derived from the assessment through this thesis and estimated quite accurately. City authorities do understand the importance of urban freight for the survival and livability within the city, which means that they do not have an interest to get rid of it in general. Still, there are strong interests to decrease the external effects, such as reducing traffic and congestion, lowering the emission rates within urban areas, lowering the noise level, reducing illegal parking and obstruction of other infrastructure (e.g., sidewalks), increasing road safety in general. These points can therefore be considered as the wants and needs of city authorities in regard to urban freight.

Stakeholder Contributions

The main factor was already identified, which is the power of city authorities to define and implement legislation, through rules and regulations, that can create new circumstances for the actors (companies, private persons) affected by them. In the case of the CEP-operators the city authorities can therefore potentially contribute through legislation related to accessibility rights and infrastructure such as the road-network, expansion of the bike lanes network and its using rights, definition of loading spaces and holding bays within urban areas, etc. Also, accessibility to real estate and the future inclusion of CEP-operators in urban freight planning processes could be seen as relevant contributions from the stakeholder towards the companies.

Company Strategy: Use of a mobile-micro-hub (MMH) within urban area

In this strategy the function of the micro-hub would be taken over by a regular container on a truck trailer. This approach of using a truck trailer as a micro-hub is already partly established and used by one of the CEP-operators that were interviewed for this thesis. The strategy would include the establishment of designated parking/loading zones within the urban area, which would be provided to the CEP-operator by the city. These zones could be utilized by the operators to temporarily park their containers. Functioning as a micro-hub for the duration of the planned deliveries, they would contain parcels/pre-packed LEFV-containers as well as the LEFVs themselves. The LEFV would use this container to resupply itself after completing each route of deliveries, which means that the defined position of the container should be close to

the center of the delivery operations. This would help to decrease the length of the routes. In the best-case scenario, the parking zone would be located in a place that would allow the LEFVs to operate in a predefined radius.

This strategy would potentially be an interesting method for the CEP-operator, as no additional real estate would have to be obtained or rented within the city center, which could potentially decrease the costs of operation for a transshipment point within the city center. Also, the parking/loading zones would only be utilized for a certain duration each day, which could potentially cut the fees even further. Another factor would be an increase in flexibility for the operator, who would be able to change the location of the MMH, depending on the customer density anticipated for the shipments loaded for the day of operation. This would have the effect that the transshipment point could always be moved as close to the end customer as possible, creating opportunities for a faster delivery and more precise delivery times to customers. It should be noted that the flexibility of the MMH location would very much depend on the availability and number of designated parking/loading zones within the city, the more zones are available, the more flexible an operator could position the MMH.

For this strategy to be implemented and successfully executed the CEP-operators and city authorities would have to closely cooperate. The potential improvement in cost-efficiency would be heavily dependent on the parking fees the city would charge the operators for temporarily utilizing the designated zones. A prerequisite for the strategy would be the identification of potential parking zones as well as their approval by the city authorities. This strategy would therefore mean that the city authorities could have a strong influence on the success of the operation, its flexibility and profitability, as the CEP-operators would be quite dependent on the authority's willingness to cooperate. On the other hand, the authorities would have a strong interest in implementing new solutions as mentioned before within the *Stakeholder Needs* section. Helping CEP-operators to establish LEFVs as a mode of transport within urban areas could help authorities to decrease several negative external effects of urban freight, such as noise, emission, congestion, etc. They could use their "expertise" to determine the parking/loading zones within the urban area, looking to identify unused and underutilized spaces such as already existing holding bays, unused tramlines or bus stops and other unused land within inner cities. Another argument for this strategy would be that the city could create a new income stream through the parking fees it charges, which could be reinvested in further improving sustainability projects within the urban areas.

Sustainability and Performance Measures

As mentioned in the framework description, the concept of sustainability would also be incorporated via the Triple Bottom Line (TBL), so that the sustainability effects of the strategy would also be considered right away. The Performance Measures (Indicators) could then be applied to measure and track the success and progress of the strategy. The strategy of implementing MMH could potentially have positive effects on all three aspects of the TBL. From an economic perspective (*Profit*) the use of MMH could help the company to increase its cost-performance for using and implementing LEFVs, by lowering the operational costs of a micro-hub. The environmental perspective (*Planet*) would benefit from having LEFVs successfully implemented and established as delivery service, which would significantly help decrease the overall emissions caused by urban freight in a growing market segment. The social perspective (*People*) would on the one side have positive impacts for the residents, as the air quality would be improved, noise and traffic could be reduced and therefore safety would be increased. On the other side there could be one negative aspect caused by this strategy, as the MMH would be located in public areas throughout the city, which could negatively impact the cityscape and also be seen as obstructive by some. The performance measures would have to be decided by both the companies as well as the authorities together. For the company, the economic performance measures would be of higher relevance, as the whole operation would need to be profitable for them. The authorities could track the environmental performance of the strategy by measuring the reduced emissions, as well as keeping track of the LEFV-quota of all parcels delivered, which would indicate how many parcel deliveries were made by a LEFV. Table 8 summarizes the framework application for the stakeholder city authority.

CITY AUTHORITITES	
Needs	**Contributions**
Keep logistical supply alive Decrease emissions, congestion, noise Increase safety, livability (quality of life)	Create legislation making MMH possible Charge appropriate parking fees, Helping operators determine holding zones

CEP-OPERATOR
Strategy
Use MMH as transshipment points within urban area, so that LEFVs can be utilized and implemented

SUSTAINABILITY		
People	**Planet**	**Profit**
Positive : Emissions, noise and traffic is lowered, improving quality of life. Green Services can be offered regularly *Negative* : MMH could be seen as a negative impact on city life (cityscape) and block certain areas	*Positive* : Emissions could be lowered by having emission free deliveries and less traffic generated	*Positive* : Cost-performance could be enhanced on the operator's side. Total costs of operation could be decreased as well.

PERFORMANCE MEASURES		
People	**Planet**	**Profit**
Number of MMH used within urban area. Density of MMH used	CO2 Emissions saved LEFV-quota of total parcels delivered	Total Cost of Operation Cost per package delivered Cost per Stop

Table 8: Framework application for Mobile-Micro-Hub Strategy (self-made, 2021)

6.3.2 Competitors

Environment

The environment that has been defined in 6.3.1 can also be used for the application of the framework in the context of the CEP-operators relationship with its competitors. It can be characterized as the part of the parcel delivery industry that is taking place in urban areas with

higher population densities. For the environment it can be assumed that the previously defined type-1 success factors are complied, while the type-2 success factors still need to be achieved.

In this part the context of the stakeholder relationship will be described in short, which helps to better understand the relationship between the CEP-operator and the local authorities. As the assessment is done from the perspective of the CEP-operator the environment will take place in the parcel delivery sector, specifically, as described throughout the report in urban areas with higher population densities, which often fits the description of downtowns and inner cities. Adding to that it will be assumed that LEFVs have not been successfully implemented yet, due to the type-2-SFs not being realized (6.2.), but that the general idea of implementation is seen positively by all stakeholders and realistic by the company (type-1-SFs). Therefore, the strategy created for the company in its relationship with the city authorities focuses on the main type-2-SF, the successful operation of micro-hubs in inner cities, which was determined as the underlying need for success in 6.2.

Stakeholder Needs

The competitors of the CEP-operator stand out among the diverse field of stakeholders. Since they are pursuing the same business idea, their characteristics, operational procedures, interests as well as their wants and needs are very similar to the ones of the organization in the focus of this analysis. Some of these needs were outlined in the interviews, as the interviewees spoke about different aspects that would contribute to their satisfaction. Above all, they emphasized on the importance of a profitable operation. The drive for increasing the profitability and its impact on decision making elucidated the dependency on the financial performance of the companies. Part of that is the focus of CEP-operators to increase market shares and strive for new business opportunities. These goals can also be classified as need of these companies as they contribute to their overall success and help to gain competitive advantage, which in turn can lead to higher profits.

Stakeholder Contribution

The above-described similarities of the CEP-operators and the organization in the focus of the analysis also apply for the part of the stakeholder contribution. In general, the determination of contributions of the CEPs to each other's business is rather challenging, as it was identified throughout the thesis that no real cooperation is taking place between the operators and that no

data or information is shared between them as well. Even though this means that there is no active contribution among them, they still passively bring something to the table of which their competitors can benefit from. In their constant strive for competitive advantage, CEP-operators try to come up with innovative solutions in their operation to become more efficient. Since innovations and new operational procedures are very often being adopted by the competitors, CEP-operators contribute to the development of the industry. Accordingly, it can be said that contribution to the competition, by trying to innovate and improve, can be identified as the main stakeholder contribution.

Company Strategy: Competitor Collaboration for the utilization of micro-hubs in urban area

To develop a strategy that enhances the performance and performance management of a company, by improving its relationship with its competitors, careful considerations have to be made. On the one hand, the needs and wants of the competitors must be fulfilled. On the other hand, the competitors also have to contribute to the reciprocal relationship. In the case of the organization that is being analyzed, this means that it needs to help improve the profitability of its competitors (stakeholder satisfaction) while also ensuring that the competition, which drives innovation, is continuing under regular circumstances (stakeholder contribution). Under the consideration of the thesis' findings and the predefined urban freight – parcel delivery environment, an increasing profitability of LEFV operating CEPs can be achieved by decreasing operational costs. To do that, either the efficiency of the operation has to be optimized or other incurring costs need to be decreased. In the thesis various suggestions were made about that. Efficiency can be enhanced by scaling the operation of LEFVs or by increasing cooperation among the competitors to learn and benefit from each other. Furthermore, micro-hubs have been identified as the most important strategic topic. The problem with the hubs is that, even though they optimize LEFV operation, they are often not economically affordable, which prevents companies from a successful implementation of LEFVs. Therefore, their costs need to be decreased to contribute to the goal of lower operational costs.

In consideration of all this information a strategy can be derived that helps to support the objectives of the competitors as well as the organization that is in the focus of the analysis. The idea is that the analyzed organization initiates the creation of some form of collaboration among the existing CEP-operators in a city. This collaboration can happen in different ways (e.g., alliances, mutual agreements or guarantees) and is aimed at coordinating the use of micro-hub spaces in a city. Important to note is that the collaboration only follows that one goal, which is

the sharing of spaces and costs for micro hubs. Any cooperation that goes beyond that (e.g., the sharing of transport capacity, joint operation) is not included in the consideration as this would perhaps disrupt the rules of competition. The concept is based on the underlying idea that the companies increase their efficiency by sharing micro-hub spaces as well as rental cost, and with that facilitate the establishment of a micro-hub satellite network. This type of network, that was mentioned by the interviewee in Canada, allows to upscale LEFV operation and decreases the number of empty runs. To illustrate the idea following scenario can be used as an example:

Operators A, B and C all operate LEFVs that are based in each of the companies' micro-hubs in the same city (Figure 6). From these micro-hubs the LEFVs can efficiently be operated in a radius of approximately 2 km (see chapter 3.2.2). The operators can utilize the entire space of the micro-hubs but also have to pay the full rent. Both rental cost as well as the radius limit the scalability of the operation and with that prevent the achievement of efficiencies and scalability.

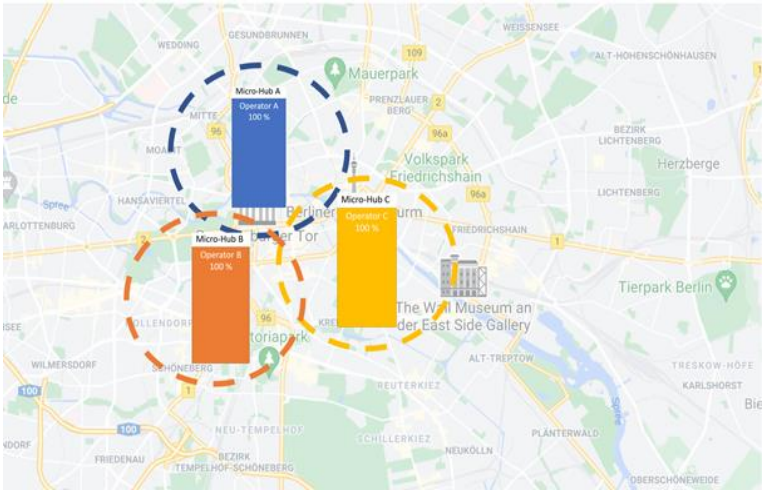


Figure 6: Independent utilization of micro-hubs (self-made, map from google-maps, 2021)

To improve their operations, companies A, B and C start to collaborate by sharing micro-hub spaces and rental cost accordingly (Figure 7). As the operators are now able to include two more hubs into their operation, they decrease the number of empty runs of their LEFVs which improves their efficiency and drives down cost. Besides that, they are also able to deliver to more places using the LEFVs which creates scalability and increases the revenue of the LEFV operation. The rental cost per operator remains the same, as the collaboration partners share them equally.

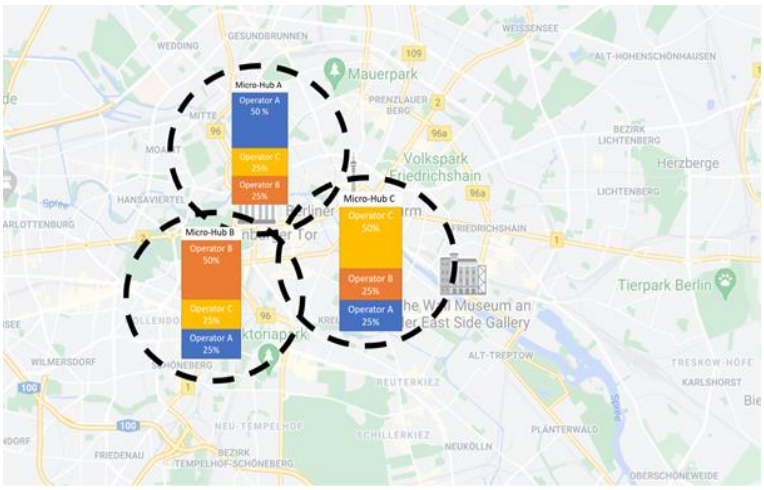


Figure 7: Shared utilization of micro-hubs (self-made, map from google-maps, 2021)

The idea of this scenario is based on the assumption that the micro hubs are not fully utilized in terms of parcel handling, which allows the companies to give away some of their handling space to their competitors. It also needs to be added that it is not a requirement for every one of the collaborating partners to already possess a micro-hub in the beginning of this scenario. Instead, they can also start the collaboration even before they operate a single hub and coordinate their efforts in finding well-suited locations together, which offers the possibility to even more optimized the idea behind this strategy.

The collaboration idea of the strategy would allow to improve the efficiency and scalability of the LEFV operation, while maintaining similar operational costs. Consequently, the operations profitability would increase, which means that the overall performance of LEFVs would have been improved. By that the wants and needs of the competitors would be satisfied and the analyzed organization would also have benefited. As the collaboration only includes the rental cost, the competition between the different operators would remain unchanged. Therefore, the stakeholder contribution would also be fulfilled. It needs to be mentioned though, that this type of strategy is more suited for larger cities with a widespread customer density as smaller cities probably not offer the possibility of many micro-hubs and the creation of a satellite network.

Sustainability and performance measures

The outlined strategy affects all three dimensions of the triple bottom line. With the implementation and upscaling of the LEFV operation caused by the collaboration, less particulate matter is being emitted, less noise is created by transport activities and the traffic

decreases which positively impacts people's lives. "Green" last-mile deliveries can be offered by more companies in more locations of urban areas (in particular metropolitan areas). With more hubs per CEP-operator, a higher level of flexibility can be achieved that might help to provide specified time-window deliveries. Due to the upscaled operation of the electric vehicles, less greenhouse gases are being emitted which benefits the environmental sustainability. Also, the CEP-operators profit from an improved cost-efficiency and more efficient LEFV utilization. The performance measures, that are also being outlined in the summary of the framework application in table 9, can be defined accordingly. Covering the social perspective, it can be measured how many people are receiving parcels that have been transported by LEFVs on the last mile. Also, the saving in CO2 could be measured to reflect positive effects on the environment. For the economic perspective, the CEP operators could measure the success of the strategy based on total operation cost, cost per stop or cost per delivered package. Table 9 summarizes the framework application for the stakeholder competitors.

COMPETITORS	
Needs	**Contributions**
Increase profitability Increase competitive advantage Increase market share	Competition between each other creates drive for innovations and the search for new competitive advantages

CEP-OPERATOR
Strategy
Competitor Collaboration for the utilization of micro-hubs in urban area

SUSTAINABILITY		
People	**Planet**	**Profit**
Positive : Emissions, noise and traffic is lowered, improving quality of life. Green Services can be offered regularly. Potential for time window deliveries, where customer can decide specific delivery time, as MH brings the transshipment closer to the customer.	*Positive* : Emissions could be lowered by having emission free deliveries and less traffic generated	*Positive* : Potential decrease of costs of operation for LEFVs. Total costs of operation could be decreased as well. Potential for more efficient load capacity and vehicle utilization through satellite hubs, decreasing empty runs.

PERFORMANCE MEASURES		
People	**Planet**	**Profit**
Number of green service customers Time window preferences, which could help increase performance	CO2 Emissions saved LEFV-quota of total parcels delivered	Total Cost of Operation Cost per package delivered Cost per Stop

Table 9: Framework application for micro-hub cooperation (self-made, 2021)

7. Conclusion

Main Findings

The purpose of this thesis was to identify how the performance of LEFVs used in the parcel delivery sector in urban areas could be improved overall. The analysis of this topic also included identifying and defining the stakeholders of urban freight as well as the vehicle in focus, while taking on the perspective of the CEP-operator. To identify possible performance improvements in this context a new framework was created and adapted from the Performance Prism framework.

The first main finding was the observation of the importance of stakeholders within urban areas and the field of urban freight. It was identified through the interviews that LEFVs can have certain operational advantages over the traditional delivery vehicles, but that overall, due to the certain restrictions for LEFVs, the possibility of increasing their operational performance is limited. Generally, a vehicle is only allowed to be considered a LEFV, if it meets certain criteria and conditions, such as precisely defined size dimensions, maximum total weight and capacity, as well as a maximum speed of the vehicle. These defining conditions for a LEFV therefore set a limit for possible operational performance increases, which means that the focus needs to shift to other factors that could potentially help to increase the overall performance of these vehicles. Here, it was identified that specifically in the area of urban freight and city logistics every operator has a complex set of stakeholders, that are more or less involved in its business. Therefore, finding ways to improve its stakeholder relationships can be a possible and most likely sustainable solution for operators to increase their performance of LEFVs used in urban areas.

The second main finding realized through the interviews was that for the success of the LEFV operation, the cost of operation and profitability was of high importance. The main driver for the costs for LEFVs was identified through the needed infrastructure changes that would have to take place to implement LEFVs in urban areas in the first place. These infrastructural changes would imply that the operators would need to install new transshipment processes in the delivery process of the last-mile and therefore a new transshipment location, a so-called micro-hub, would be needed in inner cities. These micro-hubs create new costs for the operation, which were not existent without LEFVs and therefore, the operational and cost-efficiency of these hubs must be considered as one of the main success-factors for the implementation of LEFVs in urban areas

The third main finding was that by analyzing the stakeholders of urban freight it was realized that the authorities, specifically in the context of urban freight the city authorities, are considered as the most important stakeholders for operators. The authorities therefore are considered as actors within urban freight, as they have a direct impact on the operation and the success of urban freight. Still, it was identified that although being considered as important active stakeholders, authorities have often tended to take on a passive role when it came to the topic of urban freight. This has led to a lack of expertise on the authority's side and a more and more uncoordinated approach by urban freight operators over time. City authorities therefore need to understand the importance of their role in urban freight and take on more responsibility to make urban freight more efficient and sustainable. They should actively use their political power not only to regulate but also to cooperate with the operators involved in urban freight to find common solutions that benefit both sides long-term and help to increase the livability of urban areas.

Additionally, three research questions had been formulated at the beginning of the thesis to help to better assess this topic. The first question focused on the stakeholders of urban freight, the second question focused on the specifications of the LEFV and the last question tried to find a solution for the performance increase of LEFVs.

RQ1: *How are stakeholders influencing the last-mile operations of LEFVs in urban areas?*

Through the work of this thesis several stakeholders of urban freight and specifically towards CEP-operators have been identified. It was shown and analyzed that the number of stakeholders involved in this area can be considered quite high and that the relationships of a single CEP-operator within city logistics can be quite complex. Overall, the analysis section of the thesis helped to categorize and identify the possibly most important stakeholders to the operators, which were rated with a high importance in 6.1. City authorities and the competitors were considered as the most important stakeholders through this assessment. Having identified that improving stakeholder relationships as the potentially best way to improve the overall performance of LEFVs in urban areas, it can be concluded that the focus of CEP-operators should be on these two stakeholders at first to achieve the best performance improvements possible.

RQ2: *What conditions can make the implementation of LEFVs in urban areas successful?*

Within the thesis the characteristics of the LEFVs were described, identified and presented in the analysis section of 6.2. It was shown that the vehicles have a certain set of advantages and disadvantages, which would have an effect not only on the operators, but also on other stakeholders within urban areas. Still, for these vehicles to generally be considered as an option certain success-factors (SF) were identified as well. These included two types of success-factors, where the type-1 SF described the pre-conditions needed for LEFVs to be implemented and type-2 SF described the actual focus-areas the operators can influence to make the implementation of LEFVs more realistic. The main type-2 SF identified was the importance of the micro-hub in the LEFV operation and the need for operators to find a way to make the operation of these hubs more efficient.

RQ3*:* *How can the performance of LEFVs in urban areas be improved?*

To potentially increase the performance of LEFVs the stakeholder relationship focus was chosen and the focus-area for improvements was the micro-hub, as mentioned already. To adequately combine these two criteria, the performance prism framework was chosen and adapted according to the needs that are considered as important for today's time, specifically the sustainability focus, as this respects the needs of everyone affected through the Triple-Bottom-Line. The framework helped to create two separate strategies that could be applied by a CEP-operator in connection to one of the two chosen stakeholders. These strategies showed that improving the relationships between the operator and its stakeholders can potentially help to improve the performance of the LEFVs in urban areas, without having to modify the operational performance of the vehicle itself. However, it should be considered that the framework and the application of it involves a certain amount of bias and subjectivity, as the determination of needs, contributions, strategies as well as the triple bottom line - measures are mostly based on the personal assumptions of the framework-users.

Implications and Future Recommendations

Overall, LEFVs are an alternative mode of transport that should and need to be more closely considered in the urban freight environment for the future of city logistics. Climate change is becoming a more relevant topic than ever and will most likely stay relevant for the coming years. At the same time urbanization is continuing to grow, while the e-commerce sector and online shopping keeps rising as well. Urban freight operators therefore have several challenges to overcome by meeting the growing demand on an overburdened infrastructure-system, while having to decrease its negative external effects and emissions. Therefore, LEFVs could help to fight several of the external effects of urban freight and have the potential to satisfy several stakeholders at once. Still, increasing the performance of these vehicles in the described circumstances is quite complex, but could be achieved by focusing on the following future recommendations derived from this thesis:

- There are limited opportunities to increase the operational performance of LEFVs, which means that stakeholder relationships and cooperation's need to be considered more closely
- City Authorities need to understand the importance of urban freight and get more actively involved in creating a better city logistics environment, which respects everyone involved
- Micro-Hubs are most likely at the center of attention when it comes to successful LEFV implementation and therefore need to play an important strategic role for finding improvements

The framework created in this thesis combines the issues at hand and shows a systematic qualitative approach in finding a solution for the underlying question of how the performance of LEFVs could be improved within urban areas. The developed framework differs from previous performance frameworks in this area, as for the first time it incorporates the concept of sustainability. Also, the framework gives the opportunity to specifically define and set the context of the operation in which the framework is being applied (see '*Environment'* in Figure 4). Thereby, the created performance measurements are not generally applied but specifically fit to a situation or a certain environment, in the case of this thesis the urban area combined with the use of LEFVs. Overall, the framework offers a way for a company to develop sustainability focused strategies to improve its business performance, while respecting its stakeholders' perspectives and interests.

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Appendix

Interview Questions

The following part outlines the predefined questions that were part of the interviewing process. As noted in the methodology section of this thesis, the interviews followed a semi structured approach which means that the questions below do not reflect the entirety of the questions that were asked throughout the various interviews. Instead, other questions were asked that more specifically followed-up on the answers that were given. Very often these questions focused on the company's relation with its stakeholders and the operation of micro-hubs, as these topics were identified as most relevant during the research process. Below short explanations are given to the specific predefined questions.

1. What is your company's core business?
2. What is your area of responsibility in your company?

The first two questions were chosen to establish a dialogue between the interviewers and the interviewee. Due to the focus on the interviewee and its company it was possible to get a broad understanding of interviewees skills and the operational focus of the respective company.

3. How would you define the term performance in the context of last-mile logistics in urban areas?
4. Which performance indicators do you perceive as the most valuable / important in last-mile logistics?
5. What impact do performance indicators have on your decision making?

Questions 3. to 5. focused on the interviewees, respectively the company's, idea of performance and the impact of it on the daily operation. As described in the literature review, people can have different perceptions of the term. For that reason, it was important to get hold of these perceptions. These questions helped to answer research question three (RQ3).

6. What are the reasons to use LEFVs in last mile logistics?
    a. Besides cost- and emission-factors, which indicators and/or measures are considered relevant for the implementation of LEFVs?

7. How does performance of LEFVs differ in comparison to vehicles using a combustion engine?
    a. Which new performance indicators were implemented for the use of LEFVs?
    b. Were new performance indicators for LEFVs developed / implemented or adapted?
8. How has the cost allocation of the operation changed due to the transition to LEFVs (e.g., share of personnel-, vehicle-, infrastructure cost, etc.)?
    a. How has the total cost of the last mile delivery process changed?
    b. How has the cost efficiency changed (cost/stop or cost/trip)?
9. Which methods do you use to measure the performance of LEFVs in last mile logistics (e.g., gathering and analysis of GPS data)?
    a. Has the approach of measuring performance changed in comparison to vans / other vehicles?
10. Which benchmarks do you use to evaluate performance of LEFVs?

Questions 6. to 10. focused on answering research question two (RQ2). These questions served to understand the interviewees / companies' perspectives on LEFVs and its performance aspects. The objective of these questions was to understand the underlying reasons of each company that motivated the implementation and operation of this vehicle type, especially from a performance perspective.

11. What are the current internal/external barriers preventing you from potentially improving the performance of LEFVs? /
    a. What are the current issues in the operation of LEFVs in the last mile?
12. What impact do other stakeholders have on the implementation and performance of LEFVs

The last two predefined questions were aimed at research question one (RG1). Due to a high stakeholder complexity in city logistics, the interrelations of them were identified as both important and relevant for the research. Whereas one question more openly asked for potential ways of improving the performance of LEFVs, the other question more specifically aimed at the stakeholders.