Reverse last mile within the furniture sector

An exploratory study of innovative transportation methods

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Ingrid Nilsson and Ingrid Arvidsson

Abstract

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Background: Circular business models enables a new life for a product which has reached it end of use. By using circular business models and closing the loop of the supply chain, little raw material needs to be extracted which has significant positive environmental effects and enables a secure supply to resources in the future. A key enabler for circular business models is the collection and transportation of products at the customers' homes, a logistics activity called *reverse last mile*. This thesis focuses on furniture as a specific type of product.

Purpose: The purpose of this thesis is to identify and evaluate a number of concepts of how to conduct the transportation in a reverse last mile system for a furniture company and to identify opportunities, challenges and cost drivers that are related to them respectively.

Method: The method used is an exploratory multiple-case study where 15 interviews in total have been conducted. A thorough literature review and three expert interviews forms the basis and context of the study. Three companies working with existing transportation solutions of reverse last mile and seven companies or concepts working with innovative transportation solutions were interviewed. This thesis has been a complete elaboration between the two authors. Each author has been involved in every part of the process and contributed equally.

Conclusions: The conclusions obtained showed that existing solutions of reverse last mile can look different. There are opportunities for a furniture company to develop new methods applicable for a reverse flow of goods. A compilation of the parameters used in the analysis of innovative transportation solutions shows that cargo bikes with a large loading capacity is the most feasible transportation mode for reverse last mile operations in large city areas when transporting furniture. The main challenges with reverse last mile are the multi-parameter problem which it forms, the need of consolidation and collaboration, feasibility of transportation modes and risks and uncertainties related to it. The multi-parameter problem is mainly caused by the many differences between forward and reverse logistics, which adds up to delayed and uncertain information in the reverse supply chain.

Keywords: Reverse last mile, Reverse logistics collection, Closed-Loop supply chain, City logistics, Innovation of transportation modes.

Sammanfattning

Cirkulära affärsmodeller möjliggör ett nytt liv för uttjänta produkter. Genom att återanvända produkter i en sådan modell behöver en mindre mängd råmaterial extraheras jämfört med en traditionell affärsmodell. Återanvändningen har signifikanta positiva miljömässiga effekter och möjliggör säker tillgång till resurser i framtiden. Genom att på ett effektivt sätt att hämta upp och transportera möbler, från kundens hem till ett uppsamlingsställe, kan cirkulära affärsmodeller möjliggöras. Denna aktivitet inom logistiken kallas för *reverse last mile*, eller översatt *omvänd sista mil*. Forskningen bakom reverse last mile är begränsad och ämnet är relativt ungt. Intresset för cirkulära och hållbara affärsmodeller har ökat de senaste årtiondena, varför det är viktigt att bidra med mer forskning inom ämnet. Syftet med detta examensarbete är att identifiera och utvärdera en rad olika metoder över hur aktiviteter inom reverse last mile kan genomföras, samt att identifiera möjligheter, utmaningar och kostnadsdrivare kopplat till metoderna och aktiviteterna inom reverse last mile.

Metoden som har använts är en explorativ multipel casestudie. Totalt har 15 intervjuer gjorts. Som bas och kontext till studien gjordes först en genomgående litteraturstudie och därefter tre expertintervjuer. Tre företag som arbetar med existerande lösningar för reverse last mile intervjuades samt sju innovativa koncept/transportmetoder undersöktes, det genom intervjuer och empirisk data. De innovativa casen analyserades därefter utifrån olika parametrar som identifierats som betydande för reverse last mile. Detta examensarbete är resultatet av ett samarbete mellan författarna. Båda författarna har varit med i alla delar i processen och bidragit till lika delar.

Resultatet visar att existerande lösningar för reverse last mile mest sannolikt inte är optimala för dess syfte. Forward and reverse last mile kombineras ofta i ett och samma flöde, vilket i sig inte är ett problem men det rekommenderas inte av tidigare forskning. De innovativa transportlösningarna har analyserats utefter ett antal valda parametrar som har tagits fram av litteraturstudien. En sammanställning av de olika parametrarna visar att lastcyklar med stor lastkapacitet är det mest lämpliga transportsättet för transporter inom reverse last mile i urbana miljöer där befolkningsdensiteten är hög. Dock står några utmaningar i vägen för detta transportsätts möjligheter att nå framgång. De huvudsakliga utmaningarna med reverse last mile är multiparameterproblemet som reverse last mile är en del av, behovet av konsolidering och samarbete mellan aktörer, lämpligheten för olika transportsätt att agera inom reverse last mile samt risker och oklarheter som relaterar till reverese last mile. Multiparameterproblemet orsakas huvudsakligen av de många skillnader som finns mellan forward och reverse logistics, vilket bidrar till otillräcklig information inom reverse last mile.

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Chapter 1

Introduction

1.1 Background

Due to a rising global population, the availability of many nonrenewable resources cannot keep up with the demand. The capacity of land, forests and water are being strained past their limits. In order to provide the resources humanity uses and to absorb the waste, humanity uses the equivalent of 1.7 Earths. This ecological overshoot has been going on since 1970s and the annual demand of the resources, exceeds the amount the Earth can regenerate (Global Footprint Network, 2019). In addition, today we create more than 11 billion ton of waste every year globally. Only 25 % of the waste is recovered and returned to production (Lancy & Rutqvist, 2015). The usual way of running a business creates a growing imbalance between resource supply and demand, described by Lancy and Rutqvist (2015).

To meet the global imbalance of resources, there is a need for a growth model which delivers greater resource productivity than the original linear business model (Lancy & Rutqvist, 2015). In a sustainable business, the supply chain is extended in order to include by-products and to consider the entire life cycle of the product, creating a circular model (Linton, Klassen, & Jayaraman, 2007). By transforming into a circular business model, a company can gain both monetary and non-monetary value although it will take both time and effort. In a scenario where European businesses applies circular models, theoretically EUR 1,8 trillion could be unlocked for Europe's economy (Ellen MacArthur Foundation, 2019). In order to achieve a circular economy, there are many challenges that need to overcome. One of these challenges is to find new business models which can continue to add value for companies. IKEA is one company looking into transforming their complete business into a circular model. One aspect of this development includes their ongoing investigation of all parts in their supply chain.

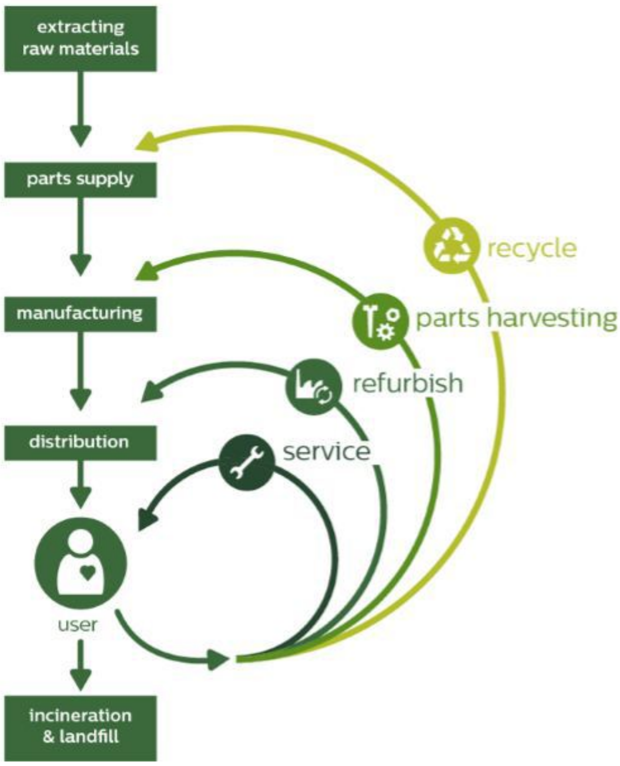

Figure 1.1: An illustration of a closed-loop supply chain and its activities. Source: Ellen MacArthur Foundation (2019)

In a circular business model, the value of discarded products can be captured and companies can make the life of the product as long as possible by e.g. refurbishment or upgrades. The concept of taking care of products which are no longer desired is referred to as *closing the supply chain* (Flapper, van Nunen, & Wassenhove, 2005). A closed-loop supply chain is also defined as a combination of a *forward* and *reverse supply chain* (Govindan, Soleimani, &

Kannan, 2015). Smart management of these closed-loop supply chains means that the most value of products are captured. The activities included in a closed-loop supply chain are product acquisition; obtaining the product from the customer, reverse logistics; transporting the product and warehousing of it, inspection, re- and marketing; selling the product once more (Blackburn, V. Daniel R. Guide, Souza, & Wassenhove, 2004). Figure 1.1 illustrates a typical closed-loop supply chain and its activities.

In order for it to be possible to complete the circle, there is a need for a system which transports the product from the customers' homes, back into the supply chain of the company. To manage the pick up of products at customers homes in a effective way and at low cost, new innovations are required. The transport from customers to a collection center is in this thesis referred to as reverse last mile. This thesis is conducted in collaboration with IKEA and aims to investigate innovative transportation solutions that furniture companies as well as other companies can use in a reverse last mile set-up.

1.2 Company description

IKEA is a large Swedish home furnishing company that was founded by Ingvar Kamprad in 1943. IKEA started as a small mail order company and is today a global company that has 355 stores in 29 countries (as of August 31, 2017) and employ 149.000 co-workers globally (IKEA, 2017). During 2017, IKEA had 817 million store visits and 460 million shopping center visits. IKEA has 9500 products across its range and every year the range is renewed with 2500 products that are designed by in-house and contracted designers (IKEA Range and Supply, 2017). The business idea of IKEA is "to offer a wide range of well-designed, functional home furnishing products at prices so low that as many people as possible will be able to afford them" (IKEA, 2019).

1.2.1 IKEA commitments

IKEA's vision is "to create a better everyday life for the many people". In their sustainability strategy, IKEA (2018) describes their commitments for the future. Sustainability plays a significant role of IKEA's business and is expressed as meeting the need of people today without compromising on the need of future generations. Today, IKEA's business model is based on the traditional linear model but IKEA's goal is to turn it into a circular model where only recycled or renewable resources are used and transported back into the supply chain of IKEA. By doing this, IKEA would be able to secure the resources for the future of the IKEA business. The ambitions for 2030 is to inspire and make people to take better decisions by offering knowledge, ideas and new affordable solutions. By designing products by circular design principles, the lifetime of the products and material would be longer. IKEA wants their products to be seen as raw material for the future; possible to be used for new products after its end-of-use. In order to reach the vision, IKEA wants to involve customers and other partners to be a part of the solution by finding a way to fix, share, donate and sell renewed products.

Figure 1.2: The linear business model. Source: Circular IKEA, Inter IKEA Group (2018).

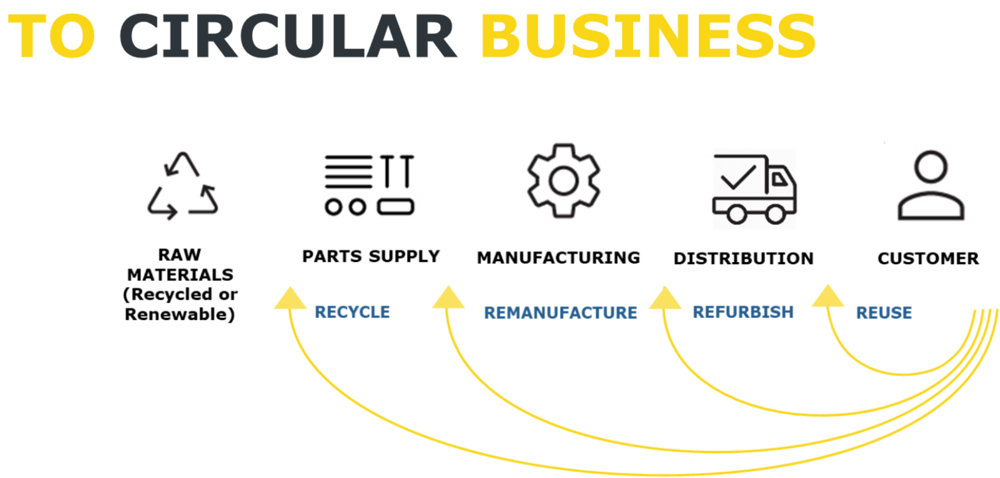

Figure 1.3: The circular business model. Source: Circular IKEA, Inter IKEA Group (2018).

1.3 Problem description

Due to heavy extraction of raw materials in manufacturing companies, the resource scarcity is a growing global problem. IKEA wants to contribute to the solution of it by taking a leading position in circularity. More concrete, IKEA wants to set up a circular business model where the used products is reintroduced into IKEA's supply chain. This change is illustrated by 1.2 transforming to 1.3, where the latter can be compared to that of a typical closed-loop supply chain, figure 1.1. By closing the loop and implementing a closed-loop supply chain, products ending up on the landfill would be counteracted, it would lengthen the lifetime of the products and secure resources for the future.

To take back products that have reached its end-of-use, IKEA wants to find new innovative methods of how to collect the products at the customers' homes and transport the goods to a collection point. In order to set up a reverse last mile method, IKEA want to investigate innovative transportation solutions that can be used for this purpose and be performed at a low cost. Taking back used products is in line with IKEA's commitments and vision of becoming a circular business. The focus will be to find innovative transportation methods that can be used by many different furniture companies. The solutions aims to fit for a diversified range of different sizes and values of goods.

The subject of reverse logistics has not yet been implemented on a large scale, why comparable solutions are non-existing or expensive. It is also little research conducted on the topic. In addition, reverse last mile is also higly affected of the development of city logistics and its future challenges. Many urban areas today are suffering from heavy traffic and pollution due to the need of both personal and commercial transportation (Daniel Boudoin & Gardat, 2013). The solutions should be sustainable and not contribute to increased congestion, noise and pollution in urban areas. New emerging technologies and new business models are interesting areas to investigate further. This thesis will thus contribute to the research of both reverse logistics and of city logistics. It aims to set up suitable suggestions of reverse last mile methods for mainly bulky products, but also for non bulky products, why companies such as IKEA who is interested in closing their loop also can make use of the findings.

1.4 Research purpose and questions

The purpose is to identify and evaluate a number of concepts of how to conduct the transportation in a reverse last mile system for a furniture company and to identify opportunities, challenges and cost drivers that are related to them respectively.

The research questions are:

RQ1: *How can existing transportation solutions of reverse last mile be applicable in a set-up for a furniture company?*

RQ2: *How feasible are new innovative transportation solutions and technologies for a reverse last mile set-up?*

RQ3: *What monetary drivers are present when operating within reverse last mile solutions?*

RQ4: *What are the challenges with reverse last mile?*

1.5 Focus and delimitations

The focus of this master thesis will be to investigate new innovative transportation solutions for the reverse last mile of a furniture company's supply chain and to evaluate these. More specific, this master thesis will focus on the first part of the reverse logistics, the part where the products will be collected and transported from the customers' homes and reintroduced into the supply chain. The thesis includes pick up at customers' homes or at other places where few (one or two) products are picked up. Therefore, e.g. a second hand that has furniture they cannot sell is also defined as a customer and a possible pick up point. The products that intends to be included in this thesis are products that can be defined as non-bulky products and bulky products. The definition of a bulky product is explained later more in detail. The area of study will be reverse last mile, see the box in figure 1.4.

The thesis is limited to focus on solutions for larger cities where the customer density is high as this is where implementation of reverse last mile is most likely to happen in the future. Since the master thesis is limited to a time and resource constraint, this thesis needs to be delimited further. The delimitations has been determined in consultation with the supervisors at Inter IKEA Group and Lund University. This thesis will not take the

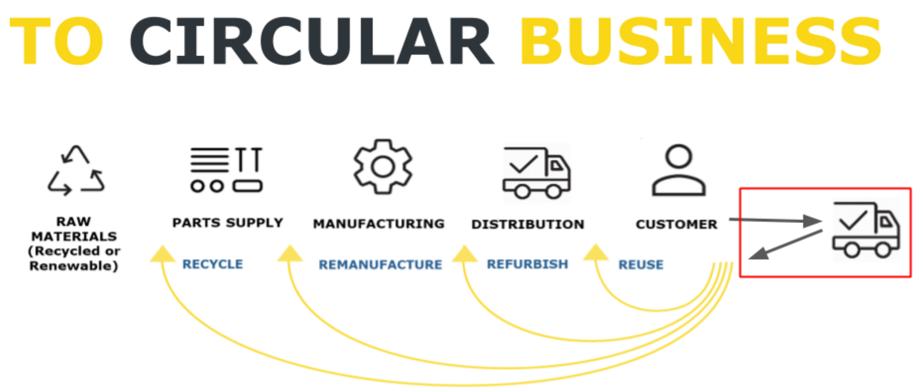

Figure 1.4: IKEA's circular supply chain with focus of the thesis. Source: Own edition of a figure from Circular IKEA, Inter IKEA Group (2018)

customer's point of view into consideration e.g. incentives for customers to ask for a take back. Furthermore, it will not include the handling decisions e.g. refurbishment or recycling of the products when it has reached back to the supply chain. The question whether how to manage and set up the information system through the supply chain will not be considered throughout the thesis. Two assumptions made are (1) that all products collected will be brought to one, common inspection center and (2) this inspection center is located within a distance which is possible to reach by an electric cargo bike from all collection points. Due to the complexity of the case and the high grade of influence between different factors, the delimitations will be mentioned throughout the report as a factor to take into consideration, but not investigated further.

Further on in this report, the concept consisting of collection of products and transportation between the customers' homes and the next node in the supply chain of the company will be defined as *reverse last mile*. The term reverse last mile is used within the furniture branch and is therefore preferred to use. The concept can also be called "reverse logistics collection", although to prevent confusion, reverse last mile will be used in this report.

1.6 Target group

The main target group is the Circular Supply Chain function at IKEA. As a current transformation of the business model, this thesis will also be of interest to anyone working at IKEA. Due to the growing interest of reverse logistics, this thesis will also be of interest for researchers within logistics, sustainability or business transformation and for other companies which has a interest in circular business models.

1.7 Report structure

Following this introduction chapter, chapter 2 will go through different research methods and research approaches. The selected method and approach is further described and motivated. Finally, a report execution where the three phases that the thesis will undertake is described.

Chapter 3 consists of a literature review. The literature review is divided into five chapters: Reverse and closed-loop supply chain, Reverse logistics, Reverse last mile, City logistics and Innovations within city logistics. These chapters aims to cover the relevant research areas needed in order to conduct the thesis. The literature review is summarized in section 3.6 and in section 3.7 the research framework follows.

Chapter 4 contains the empirical findings, which in turn consists of both findings from literature and from case studies. The case studies are divided into two sections; cases of existing solutions of reverse last mile and cases of innovative solutions of reverse last mile.

In chapter 5, the data collected from expert interviews is found. The experts are introduced and their interview answers are presented.

Chapter 6 consists of the analysis of the empirical findings. The analysis in turn is divided into four different sections; Cross-case analysis of existing cases, Single-case analysis and Cross-case analysis of innovative cases and Challenges for reverse last mile. The analysis compares the empirical findings with those from literature and expert interviews, as well as with each other in cross-case analysis.

Chapter 7 concludes the thesis and here the conclusions can be found. In addition, contribution to theory, limitations and suggested further research is presented.

Chapter 2

Methodology

This chapter describes the research methodology which will be used in the study and the research phases which the project will undergo.

2.1 Research design

The research purpose and questions are presented in the previous chapter and is what forms the basis of this thesis' problem statement. This section describes how the problem statement will be possible to conduct research on; the research design.

When designing a research project there are five possible research methods; an experiment, survey, archival analysis, history and case study (Yin, 2014). According to Yin (2014) there are three conditions which guides you to what method to use for a research project. As presented in table 2.1, these three conditions are: (1) the form of research question, (2) the extent of control a researcher has over actual behavioral events and (3) if it focus on contemporary events or not

In this study, the purpose focuses on contemporary events and the researchers can not control the environment in which the study takes place. The purpose is formulated as a question of ”How?”, as well as several of the research questions, as seen in section 1.4. The conclusion of applying this thesis to table 2.1, is that the case study method is feasible and should

Table 2.1: Relevant situations for different research methods. Source: Yin (2014)

Method	(1) Form of Research Question	(2) Requires Control of Behavioral Events	(3) Focuses on Contemporary Events
Experiment	How, Why?	Yes	Yes
Survey	Who, What, Where, How Many, How Much?	No	Yes
Archival Analysis	Who, What, Where, How Many, How Much?	No	Yes/No
History	How, Why?	No	No
Case Study	How, Why?	No	Yes

therefore be used. In addition, case study methods is particularly good when developing new theory (Voss, Tsikriktsis, & Frohlich, 2002), such as in this study.

The *unit of analysis* is the core of research questions and purpose, and what has formed the basis for research design. In this study, the unit of analysis is formulated as *possible transportation modes for reverse last mile*. The unit of analysis is the case to be studied and therefore determines sources of evidence and type of data to collect (Yin, 2014), why the suggested research design follows.

In order to answer the research questions, several cases will be studied in this thesis. The unit of analysis is the same for all cases studied; possible transportation modes for reverse last mile. This design is known as a multiple-case study (Yin, 2014). By conducting a multiple-case study, theoretical and literal replication can be obtained by choosing cases which are believed to replicate the same but also contrasting results. Thus, the robustness of the multiple-case study is larger than a if single case study should be chosen (Yin, 2014). An illustration of a multiple-case study is shown in figure 2.1. The context and cases of this specific study is decribed further in later sections of this chapter.

Further categorization of research can be done with regards to type of research which aims to be executed. The categories possible are exploration, theory building (descriptive research purpose), theory testing and theory expansion (Voss et al., 2002) (also known as explanatory research purpose). The type of research is dependent on existing research within the subject (McCutcheon & Meredith, 1993). A description of the categories is found in table 2.2.

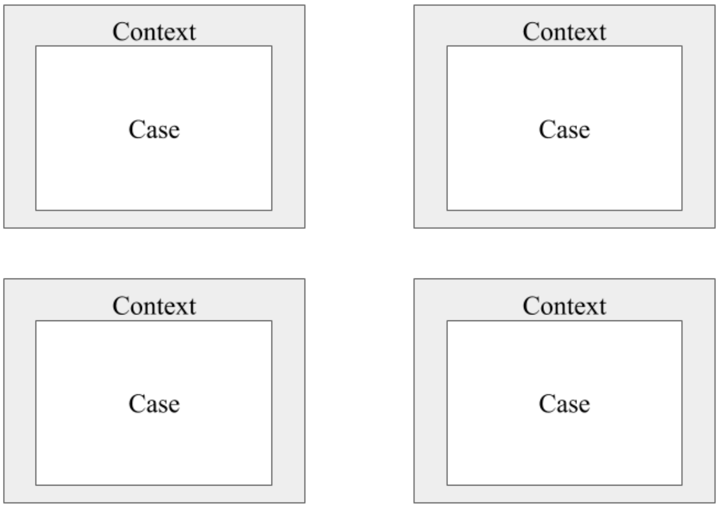

Figure 2.1: An illustration of a multiple-case design. Adapted from: Yin (2014)

Table 2.2: Description of different types of research purposes. Source: Yin (2014) and McCutcheon and Meredith (1993)

Exploration	Descriptive	Explanatory
Little previous research is to be found and no conceptual framework exists	Some theory exists and research aims to describe it further	A rich theoretical background is developed and research can test hypothesis

With regards to existing theory, the purpose and questions in this study does not stem from a rich body of research. Instead, there is no previous research which can form a basis to formulate a hypothesis for reverse last mile or similar. Exploratory research is suggested for early research of a subject (Voss et al., 2002; Steinberg, 2004) such as this study subject. Hence, the study is of exploratory nature. Suggested research designs for an exploratory study is literature review, surveying relevant people and case study (Steinberg, 2004), where this study consists of a case study with the other two as data collection methods.

2.2 Data collection methods

To answer the research questions with the chosen research design, several different data collection methods are used. The decisions regarding collection methods is based on the unit of analysis, the multiple-case study design as well as the exploratory nature of research. The methods used are a literature review, a study of comparable cases by conduction of interviews and written material and extraction of IKEA internal data. The methods are all explained in greater detail below.

2.2.1 Literature review

In a case study, theory development is very important (Yin, 2014) why a thorough literature study will be conducted. The use of literature is two-sided in this study; both to understand and review relevant theory and research and to further investigate possible solutions which already exists for reverse logistics collection, meaning to answer *RQ1*, *RQ2* and *RQ4*. The search is therefore divided into two parts; (1) basis of theory and (2) search of innovative transportation solutions. To fulfill the purpose of answering the research questions, a literature framework consisting of six different areas was first used, see table 2.3. The different areas used was also used as searching keywords.

Table 2.3: First stage of literature framework

Directly related literature	Related areas
Reverse supply chain	Waste collection
Reverse logistics	Omnichannel
Reverse logistics collection	Last mile delivery

Table 2.4: Second stage of literature framework

Directly related literature	Related areas
Reverse supply chain	City logistics
Reverse logistics	Innovation Technology
Reverse logistics collection	Last mile delivery

When conducting literature search 1 table 2.3 was used. However, it was found that Related areas was better grouped into different sections; *City Logistics*, *Innovation Technology* and *Last Mile Delivery*. After the first stage of literature framework research, *Waste Collection* and *Omnichannel* were areas that were considered to have lower importance for the research and therefore these were not investigated further into. The concept of city logistics covers the interesting areas of waste management and omnichannel logistics, as well as relevant city infrastructure changes. The updated literature framework is found in table 2.4. The used keywords while searching were *City Logistics, Urban transportation methods, Innovative city transportation, reverse logistics and collection, last mile delivery*, which led the to the new areas in the updated literature framework in table 2.4.

The literature search consists of finding literature related to these given topics. By studying Directly related literature as in column 1 of table 2.4, a deep understanding of the subject and recent research is obtained. Possible solutions of reverse logistics will also be found when studying these areas. The *Related areas* in column 2 are chosen because of the high dependency of well-functioning reverse logistics and quickly emerging research in both subjects. The differences between objectives and product characteristics of the businesses operating in *Related areas* and furniture companies is thought to result in innovative ideas of reverse logistics solutions.

All sources of literature have been critically reviewed with regards to reliability. Multiple sources have been used to validate statements made in the literature review. Scientific papers found by search on Web of Science are the main literature source. Web of Science is an online database which contains a large number of scientific journals and published research and conference papers.

2.2.2 Comparable cases

The study of comparable cases is conducted in order to answer *RQ1*, *RQ2* and *RQ3*. The cases will be collected from several different sources to fulfill this purpose. More specific, specific cases are selected to answer each of the questions respectively and are divided into two different groups; cases of existing solutions of reverse last mile and cases of innovative solutions and technology of reverse last mile. In short, they are referred to as existing cases and innovative cases further on in the report. The tables 2.5 and 2.6 presented below represents the first selection of cases. These were all contacted and asked whether they wanted to participate in the study or not.

In order to answer *RQ1*, the suggested cases of *existing solutions* found in table 2.5 was attempted to be studied.

Table 2.5: Suggestion of existing cases

Business area	Company
Companies operating in reverse last mile; other large manufacturing companies	Siemens
	Dell
	Electrolux
3PL companies	Bring
	DHL
	Postnord

In order to answer *RQ2* and *RQ3*, the suggested cases of *innovative transportation solutions* found in table 2.6 was attempted to be studied.

Table 2.6: Suggestion of innovative cases

Business area	Company
Companies operating in reverse last mile; other large manufacturing companies	Waste collection and moving companies
	Second hand collection companies; Sellpy, Blocket
	Startups and one-man companies
3PL companies	Crowd logistics solutions
	DHL
	Companies with innovative transportation solutions; Amazon, Alibaba
	Autonomous vehicles
Smart city initiatives	

The selection of suggestion of cases is done by the common importance of well-functioning reverse last mile. Several different aspects of reverse last mile are important to study in order to answer the research questions; both operating conditions of today and trends and possibilities of tomorrow, which forms the distinction between existing cases and innovative cases. Selection of cases should be based on either situations, on polar types in order to disconfirm patterns between cases or on high experience levels (Koulikoff-Souviron &

Harrison, 2005). These parameters have been used in order to determine the suggested selection of cases. The areas' importance of reverse logistics collection is driven by different objectives respectively and relevant time frames for development is different as well. These differences make the cases cover a broad range of businesses and this is thought to enable answering the research questions.

The final selection among the suggestions is based on the theoretical frame of reference in reverse logistics, of its possibility to answer the research questions and in collaboration with the supervisors. Whether the suggested cases wanted to participate in the study or not was also an important parameter. The final selection of cases will be studied both by written material and by conducting interviews at the selected entities. The tables 2.7 and 2.8 below represents the final selection of cases.

In order to answer *RQ1*, the cases of *existing solutions* found in table 2.7 is studied.

Table 2.7: Existing cases and their primary data sources

Company	Interviews	Secondary data
Sellpy	X	
Berendsen	X	
Bring	X	

In order to answer *RQ2* and *RQ3*, the cases of *innovative transportation solutions* found in table 2.8 is studied.

Table 2.8: Innovative cases and their primary data sources

Company	Interviews	Secondary data
Movebybike	X	
Pling transport	X	
Tiptapp	X	
Udelv	X	
Micro depot	X	X
Taxi solution		X
Logtrade	X	

The primary data sources used in each case are also presented in table 2.7 and 2.8, either interviews or secondary data consisting of previously written case studies. Interviews is a suitable method for the data collection, since it is recommended when the objective is to develop a deep understanding of a subject or to discover new dimensions (Blomkvist & Hallin, 2015). Three types of interviews exists; structured, unstructured and semi structured interviews. The content of an *unstructured interview* is not determined on beforehand, but instead only has a title and some prepared questions which will be discussed (Blomkvist & Hallin, 2015). The *structured interview* is when the interviewee only fills out a form together with the interviewer. This type results in quantitative data. The *semi-structured interview* is in between the two former types and organized around a subject with questions or themes prepared in an interview guide (Blomkvist & Hallin, 2015). This will be the used interview method in this study for the case interviews. By conducting semi-structured interviews, new ideas and concepts will be encouraged and at the same time will the focus of the interview be clear.

The interviews was written down in text format during the interviews and afterwards, summaries of the interviews were made. The written interviews were sent back to the interviewees and they had the opportunity to correct the written information.

Secondary data in the case studies consists of case studies already conducted, found in literature and on websites.

2.2.3 Expert interviews

As suggested when conducting an exploratory study, surveying experts in the subject of reverse logistics will be used as a method. These interviews will also be of a semi-structured nature. The interviews will be conducted in order to answer *RQ1*, *RQ2* and *RQ4*. As shown in figure 2.1, a multiple-case study consists of both cases and context. Expert interviews will be a data collection method in order to understand the context of the cases. The experts are therefore selected based on their experience of reverse last mile, city logistics and interest in future trends of these areas.

2.3 Analyzing the multiple-case study

In order to answer the research questions, it is essential to analyze the data. There exists several different possible analysis methods. Yin (2014) suggests pattern matching, explanation building, time-series analysis, logic models, and cross-case synthesis as analyzing techniques. More specific methods suitable for qualitative data are data coding processes, described by Ellram (1996). Coding processes are ways to break down and categorize the data, done in a sequence. They start with open coding, followed by axial coding and selective coding, further explained below. McCutcheon and Meredith (1993) describes case analysis methods as building on two basic techniques; data reduction and logical analysis. Data reduction is done due to the rich amount of data which often is collected in case research. In the logical analysis, the researcher aims to find logical connections between the data connected. Data analysis in case studies are argued to be difficult by Yin (2014), as no straight-forward analysis methods exists. It is therefore important to adhere to analysis principles by Rowley (2002, p. 24) to make sure the analysis is well conducted; make use of all evidence, consider all rival interpretations, address the most significant aspect of the case study and draw on the authors previous knowledge in the subject, but in an unbiased and objective manner. As the data is collected from multiple cases, different analyses needs to be conducted. First, analysis is done on each individual case and thereafter analysis between cases and cross-case synthesis conducted.

In this thesis, the basic techniques by McCutcheon and Meredith (1993) forms the foundation of the analysis. Specific method used is coding, as suggested by Ellram (1996). Matrices that categorized the conditions at each site, as suggested by McCutcheon and Meredith (1993), were used throughout the analysis. These techniques were also used when conducting the literature review. More details on the analyses below.

2.3.1 Single-case analysis

In the single case, open coding is done first. This in order to break down, understand and conceptualize the data. Categories are searched for. This is an iterative process, which continuously reviews the categories and raw data. Matrices were used in order to display the data and understand the important categories of data in each case. After this process, axial coding follows. This is done in order to find subcategories in the groupings and further get insights about the data. Axial coding is done both in an inductive and deductive, as well as an iterative process, much like the rest of the thesis work.

The innovative cases will be summed up individually in the form of a SWOT-analysis. A SWOT-analysis is a strategic planning technique that identifies strengths, weaknesses, opportunities and threats for the chosen business or project. Both internal and external factors are included, as well as the current and future market.

2.3.2 Cross-case analysis

The single-case analyses are followed by cross-case analysis. Search of cross-case patterns is an important step in case research and is essential for generalizability of the case study (Voss et al., 2002). Here the result from open and axial coding was used and selective coding followed. The matrix of single-case analysis were used in this analysis as well. Selective coding considers a higher, more holistic, level of analysis than that of axial coding. The central category of analysis is selected and further compared to other categories. Selective coding is closely related to that of pattern matching, a technique suggested by Yin (2014) to be one of the best in case analysis.

2.4 Research approach

Theory can play a different role in a study depending on type of logic used (Karlsson, 2016). The type of logic is characterized by the relation between empirical findings and theory. Golicic, Davis, and McCarthy (2005) explains the two main types of approaches:

- *Inductive* - The qualitative path. Based on an identified phenomenon, an empirical study is conducted and theory is then used to understand the results.

- *Deductive* - The quantitative path. Theory forms a basis to hypotheses, which are then tested against an empirical study.

Figure 2.2 illustrates the different approaches.

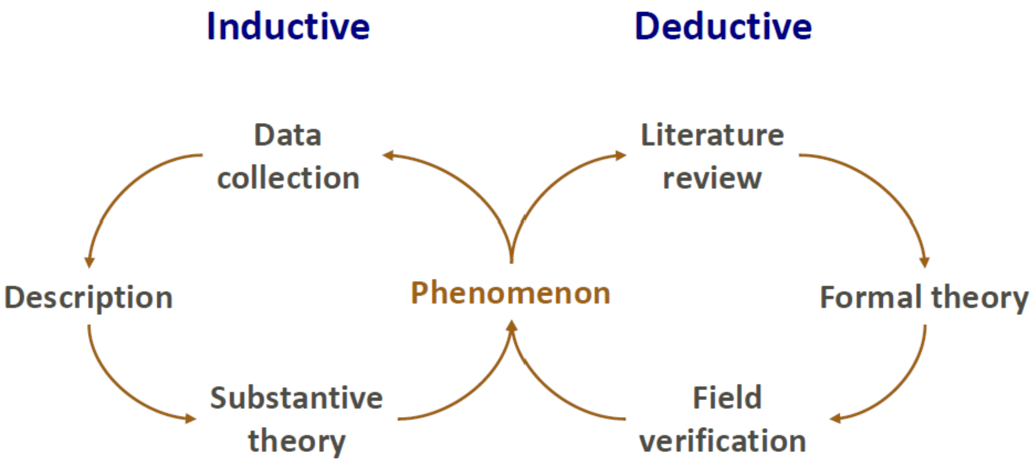

Figure 2.2: The inductive and deductive logic process. Source: Woodruff (2003), adapted by Olhager (2019)

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Golicic et al. (2005) suggests a balanced approach between these two types, also known as an *abductive* approach (Blomkvist & Hallin, 2015). By starting with an inductive approach, an intitial understanding of the subject is obtained. The deductive approach can then be used to test formal theory. The circles in 2.2 are followed back and forth in the research process (Golicic et al., 2005). This approach is suggested by Golicic et al. (2005) for research of supply chain phenomena. Supply chain phenomena are often found in a complex operating nature, and the young research fields to which many of the phenomena are part also adds to a need for an initial deep understanding of the phenomena. These two arguments are valid for the research phenomena of reverse logistics as well, why a balanced abductive approach will be used in the conduction of this study.

2.5 Scientific quality

Two ways to determine the scientific quality of a work is to measure its *validity* and *reliability*. In short, validity concerns whether the right thing is studied and reliability whether it is studied in the right way (Blomkvist & Hallin, 2015). This means that to obtain validity, correct operational measures for the concepts being studied should be identified and to obtain reliability, the study should be possible to conduct again with the same results (Yin, 2014).

Validity and reliability can both be increased by *triangulation* (Yin, 2014). Triangulation can be illustrated by a triangle, where one corner represents the issue being studied and the two others different data sources. In this study, triangulation is done both by the use of different data sources and of different data collection methods. By reading literature from different sources and conducting interviews at several different entities, triangulation is obtained. The choice of multiple case-study is also a way of triangulation. By conducting both case studies and a literature review and expert interviews, triangulation is used. By sending back the written information from the interviews to the interviewed person, credibility is further assured. Reliability is further increased in this study by the use of case study protocol. The protocol used is found in appendix A.

2.6 Explanation of commonly used concepts

Traditional transportation modes: Are transportation modes that are the most common way of transporting goods on roads in modern time. These transportation modes are large semi-trucks with various sizes that are run by non-renewable fuel. Traditional transportation modes have a negative effect on the environment as they contribute to congestion, pollution and noise.

Bulky goods: The exact definition of bulky goods differs between institutions. In this thesis, bulky goods is a heavy product with large volume that occasionally demands two persons to carry it. A bulky good can for example be a sofa, kitchen or a bed.

2.7 Research Execution

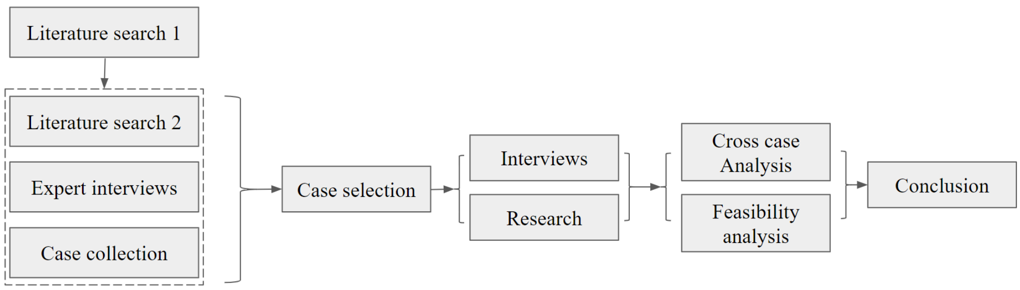

Figure 2.3: Illustration of the research execution. Source: Own illustration

Figure 2.3 illustrates the previous sections by combining the research design with the relationships between the parts it contains. The research execution is based on the suggested multiple-case study procedure by Yin (2014), where theory development forms a basis for selection of cases and design of case study protocol. Figure 2.3 illustrates that the first literature search (1) is executed in order to get a thorough understanding and for it to be possible to move on to the next step in the research, as also described in section 2.2.1 when presenting the literature review. The second literature search (2) is conducted as a second step together with expert interviews and case collection. These activities included in the dashed line rectangle is done together in order to as a next step select cases. The later steps in the execution is conducted as a final step a conclusion is obtained. Report writing will be done in parallel to all tasks. To further elaborate on the procedure, the research is divided in four different phases, illustrated in figure 2.4.

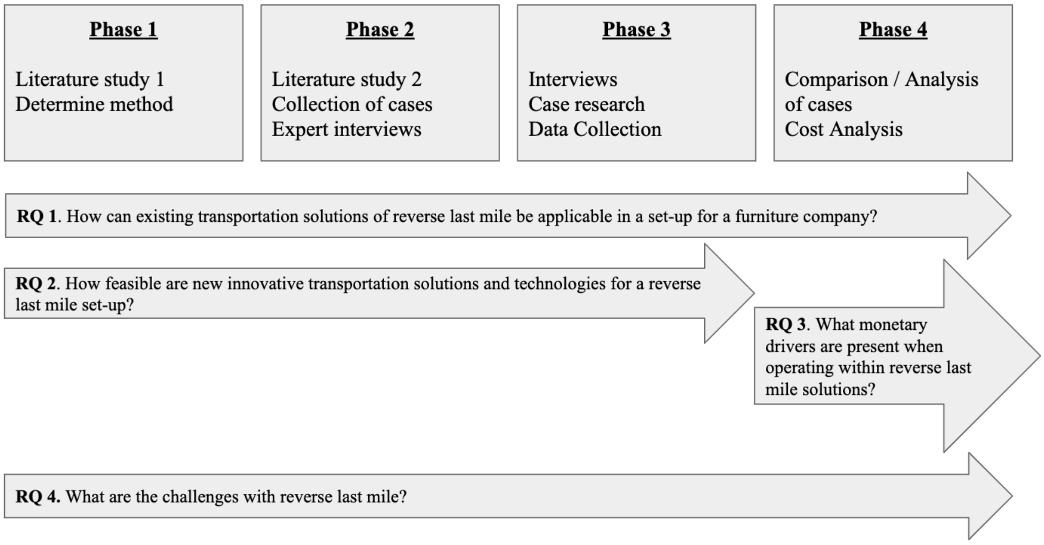

Figure 2.4: The four phases of the thesis and the Research Questions connected to these. Source: Own illustration

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Phase 1: Phase one consists of building a foundation for the thesis by the first literature review. During this phase the research questions and the appropriate research method is determined. The research method used is a exploratory case study method. The research will take both an inductive and deductive approach, as the thesis demands both existing information and collection of data. Relevant literature is searched for and thereafter placed in a framework (see table 2.3)

Phase 2: The second phase consists of data collection. The data is collected from the updated literature framework (see figure 2.4) and focus on innovative transportation solutions, from different case studies and expert interviews. This phase is finished by case selection and forms the basis for case study in phase 3.

Phase 3: As the possible cases has been examined and resulted in a final case selection, the third phase consists of conducting the multiple case studies. This is done by interviews and research, as described in section 2.2.2. As described by Yin (2014), each case will in this phase result in an individual case report.

Phase 4: When the multiple cases has been studied, the fourth phase consisting of analyzing the results can be conducted. The analysis is executed by a comparison of the possible solutions and its' abilities to be applied to furniture companies. Here, cross-case conclusions can be drawn. The conclusion contains a structured answer to the research questions of the report.

Chapter 3

Literature Review

This chapter describes the concepts of reverse supply chain, reverse logistics and reverse last mile as well as relevant theory related to city logistics and last mile delivery. A research framework based on the review is also presented.

3.1 Reverse and closed-loop supply chain

3.1.1 Definition

A traditional supply chain is defined as several entities involved in the process of bringing a product or service from a source such as raw material to its customer (Mentzer et al., 2001). This can also be described as a forward flow of goods or services and is often illustrated as a linear value chain. However, during the last decades there has been an increased interest of the opposite, reverse flow of goods (Pokharel & Mutha, 2009; Govindan et al., 2015; Lambert, Riopel, & Abdul-Kader, 2011).

Reverse supply chain management concerns this reverse flow of material or products from a customer back to a company, more specific the series of activities conducted in order to retrieve a product back from a customer and recover its value or dispose it (Prahinski & Kocabasoglu, 2006; Batista et al., 2018; Guide & Wassenhove, 2002). The whole, connected supply chain of both the forward and reverse flows of material, products and/or services is called the *closed-loop supply chain* (Gurtu, Searcy, & Jaber, 2015; Batista et al., 2018). The management of a closed-loop supply chain is defined as "the design, control, and operation of a system to maximize value creation over the entire life cycle of a product with dynamic recovery of value from different types and volumes of returns over time" (Guide & Wassenhove, 2009).

A closed-loop supply chain concerns a supply chain's own products, as in relation to the open-loop supply chain where the reverse flow can be handled by any third-party company and is not brought back to the original producer (Batista et al., 2018; Flapper et al., 2005). Figure 3.1 illustrates the difference between the two, where the closed-loop is shown in the upper part of the figure with material flows back into the supply chain and the open-loop with material flows into other supply chains in the bottom of the figure. When the perspective of the supply chain is widened to include both open-loop and closed-loop flows, the combination of the two is called *circular supply chain*, and is illustrated by the whole illustration of figure 3.1.

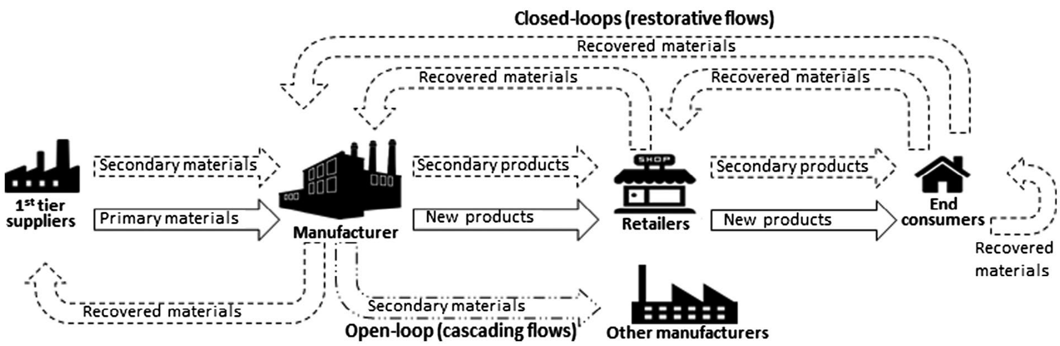


Figure 3.1: A model of a circular supply chain. Source: Batista et al. (2018)

3.1.2 Drivers and barriers

As previously stated, the subject of closed-loop supply chains has gained more interest over the past decades, both in research and in practice. A lot of different drivers and barriers of implementing a reverse supply chain has been lifted in the literature. Govindan and Bouzon (2018) has as a result of a literature study stated what drives and hinders implementation of reverse supply chain activities. They presented regulatory pressure, green consumerism and economic viability as main drivers and lack of personnel technical skills, initial capital and low involvement of top management as main barriers of implementation. Other drivers presented in literature are the value in used products, economic and regulatory drivers and consumer pressure (Brito & Dekker, 2003; Srivastava, 2008). By taking back products at its end-of-use, companies will prevent pollution to happen as well as lower the environmental burden (Lambert et al., 2011). In addition to this, remanufacturing of products can be made more environmentally efficient than the production of new products (Pokharel & Mutha, 2009). In modern supply chains, management of reverse flows has become a key competence (Brito & Dekker, 2003) and sustainable philosophies take a greater part in business strategies (Genchev, Richey, & Gabler, 2011).

3.1.3 Activities

In a closed-loop supply chain several activities are conducted. Apart from forward activities, a closed-loop supply chain also conducts five key activities; product acquisition, reverse logistics, inspection and disposition, reconditioning and distribution and sales (Blackburn et al., 2004). The activities of a closed-loop supply chain are illustrated in figure 3.2; where forward activities are colored white, reverse activities light gray and disposition alternatives dark gray.

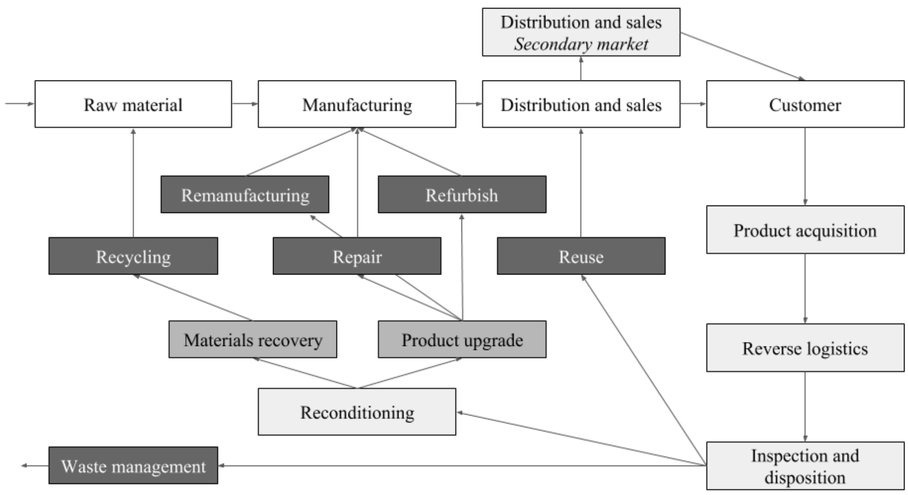


Figure 3.2: A closed-loop supply chain with its activities. Source: Adapted from Prahinski and Kocabasoglu (2006) and Guide and Wassenhove (2002)

- **Product acquisition** is the process of retrieving the product from the customer (Prahinski & Kocabasoglu, 2006; Guide & Wassenhove, 2002). The acquisition can be done by three different procedures; either by product returns, by a market-driven reverse supply chain or by products which are discarded as waste (D. Rogers & Tibben-Lembke, 2001).

- **Reverse logistics** is the next activity in the sequence of activities in a closed-loop supply chain. Reverse logistics involves all the activities required for retrieval of products (Tibben-Lembke & Rogers, 1999) and therefore deals with transportation, production planning and inventory management (Gupta, 2013; Prahinski & Kocabasoglu, 2006). It will be further explained in the next section of this thesis; 3.2.

- The customer may return a product for a known or unknown reason and the quality of the products differ greatly (D. Rogers & Tibben-Lembke, 2001). Because of this, **inspection and disposition** is necessary in order to examine the quality of a product and to restore it to its maximum value (D. Rogers, Melamed, & Lembke, 2012). The disposition options are illustrated in figure 3.2 and they are:

  - Direct reuse, meaning that it can be resold directly to another customer

  - Product upgrade, which includes the alternatives repair, refurbish or remanufacturing

  - Materials recovery which means recycling of material or recovery of specific parts

  - Waste management, i.e. landfill

- If a product is determined to have a need for a product upgrade or recovery of materials, the next activity for this product is **reconditioning**. The reconditioning option is product specific and can be either of the options pointed in the figure.

- The last activity of the reverse flow of a closed-loop supply chain is **distribution and sales**. This is illustrated in figure 3.2 by a parallel, secondary market. Other options are available, such as using the same channel as for new products or to sell the product to a specialty broker (Prahinski & Kocabasoglu, 2006). How to sell secondary products is not an easy decision; damage to brand equity is a concern raised by suppliers (D. Rogers et al., 2012).

The authors want to make a disclaimer regarding the expressions of the concept of reverse flows used, here and forward in the thesis. The terms ”reverse supply chain”, ”reverse logistics”, ”circular supply chain” and ”sustainable supply chain” among others are used interchangeably in literature and business (Gurtu et al., 2015), why other articles' definitions of e.g. activities can appear confusing.

3.2 Reverse logistics

Tibben-Lembke and Rogers (1999, p. 2) has defined reverse logistics as *“the process of planning, implementing and controlling the efficient and cost effective flow of raw material, in-process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing value proper disposal”*. Reverse logistics is, as previously stated, one of the activities conducted in a closed-loop supply chain. Companies all over the world in many various industries have included reverse logistic as a strategic part of their businesses and the interest of collection and recycling of products among researchers and companies is growing (Brito & Dekker, 2003; Srivastava, 2008; Pokharel & Mutha, 2009).

Reverse logistics can be divided into different activities; transportation, distribution, warehousing and inventory management (Prahinski & Kocabasoglu, 2006; Guide & Wassenhove, 2002). In order to succeed with the implementation of the steps, it is important that the communication between the four steps work satisfactory (Stock, Speh, & Shear, 2006). Further theory on reverse logistics is found in the sections below.

3.2.1 Differences between forward and reverse logistics

As can be understood from the main differences between a forward and a reverse supply chain, there exists several differences between forward and reverse logistics as well. Reverse logistics has some unique requirements compared to forward logistics (Feng & Tian, 2008) and differs from the forward logistics as it is not a symmetric picture of forward logistics but a more reactive and supply driven system (Srivastava, 2008). Reverse logistics is characterized by the volume, timing and quality of returns, as well as by the complexity of product, testing and remanufacturing (Srivastava, 2008). These conditions are often unknown. In addition, the mix of returned products is unknown too (Das & Chowdhury, 2012). The unknown state of characteristics makes up for a high degree of uncertainty in many different areas of reverse logistics operations (Srivastava, 2008; Fleischmann et al., 1997). The uncertainty makes forward logistics models in many cases not applicable for reverse logistics (Fleischmann et al., 1997). Processes needed for reverse logistics might look very different from those of forward logistics (Srivastava, 2008). Due to uncertainty regarding product returns, tasks as planning can easily increase in complexity and become complicated (Genchev et al., 2011; Guide & Wassenhove, 2002).

In order to formalize the reverse process, the specific elements of a reverse logistic program needs to be identified. This is also important in order to be able to measure and identify areas of improvement for the reverse logistic program (Genchev et al., 2011). The characteristics of reverse logistics also implies a lot of different risks associated with the activities. The operation and cost related parameters, decisions of disposition and cost of coordination are some specific risks which are mentioned (Srivastava, 2008).

In table 3.1 a comparison between forward and reverse logistics is shown. All differences stated adds up to the uncertainty of reverse logistics operations. The biggest difference between forward and reverse logistics is the number of origin and destination points, where forward logistics operates in a ”one-to-many” network structure while reverse logistics instead works in a ”many-to-few” network structure (Tibben-Lembke & Rogers, 2002; Fleischmann et al., 1997; Gupta, 2013). As example, in reverse logistics the products needs to be collected from many locations and the products will differ in size.

Table 3.1: Main differences between forward and reverse logistics. Source: Tibben-Lembke and Rogers (2002)

Forward logistics	Reverse logistics
Forecasting relatively straightforward	Forecasting more difficult
One-to-many transportation	Many-to-one transportation
Product quality uniform	Product quality not uniform
Destination clear	Destination not clear
Disposition options clear	Disposition options not clear
Costs are closely monitored by accounting systems	Costs less directly visible
Inventory management consistent	Inventory management not consistent
Marketing methods well-known	Marketing complicated by several factors

3.2.2 Financial implications

Lambert et al. (2011) states that reverse logistics is one of the most overlooked opportunities to facilitate return profits to a company and many companies are criticized for not working enough with reverse logistics. Reverse logistics itself, and many factors related to it, can contribute to increased profits to the company by improved customer service and as a competitive advantage (Brito & Dekker, 2003; Stock et al., 2006). Revenue streams enabled by a reverse supply chain can be divided into three categories; through sales of used items, of recovered items and added sales of virgin items (Larsen & Jacobsen, 2016). However, Horvath, Autry, and Wilcox (2005) states that reverse logistics can periodically generate negative cash flows and that these are hard to predict. Srivastava (2008) points out the importance for companies of knowing the financial impact that reverse logistic has. The financial implications of reverse logistics has despite the importance received a scarce amount of research (Horvath et al., 2005).

The initiation of the reverse logistics system is where the customer reach out and request a return approval. In order to succeed with the reverse logistics process, it is crucial to involve its customers in the process (Genchev et al., 2011). Effective product returns leads to more satisfied customers. In turn, more satisfied customers has a positive impact on revenue as customers tend to repeat purchases with the same company when the customer is satisfied with the delivered value (Stock et al., 2006). Factors of economic benefits can be divided into direct gains and indirect gains. The direct gains concludes input materials, cost, reduction, value added recovery and the indirect gains concludes anticipating/impending legislation, market protection, green image and improved customer/supplier relationship (Brito & Dekker, 2003). In reverse logistics, the uncertainty in product returns is very high and this complicates the inventory management and can thus lead to increased inventory holding costs (Guide & Wassenhove, 2002). According to Tibben-Lembke and Rogers (1999), the economic impact of reverse logistics vary depending on the industry and the firms channel choice.

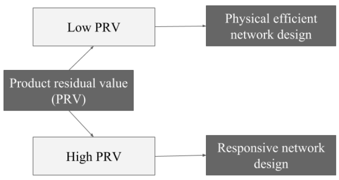
3.2.3 Reverse logistics network design

A key driver and pre-requisite for successful repair and refurbishment as well as to provide economic benefits is an effective and efficient reverse logistics network (Srivastava, 2008). Except from the actual network formalization, the collection of products, pricing, use, resale and remanufacturing needs to be covered in a reverse logistics system (Pokharel & Mutha, 2009). According to Fleischmann et al. (1997) there are several factors to take into consideration when setting up a reverse logistics system:

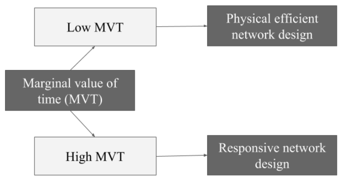
- Who are the actors in the reverse distribution channel?
- Which functions have to be carried out in the reverse logistic channel and where?
- What is the relation between the forward and the reverse logistic channel?

Network design is argued to be the most important area of reverse logistics (Srivastava & Srivastava, 2006). Within network design, facility location and vehicle routing are problems which literature has focused on addressing (Prahinski & Kocabasoglu, 2006). Location and configuration of facilities both affect and are affected by estimated returns (Srivastava & Srivastava, 2006). Other parameters which affect distribution decision are product characteristics, transportation costs, return volumes and strategic importance of reverse logistics within the company (Gooley, 2002). One necessary decision to make is whether to combine the forward and reverse flow of goods, or to separate them (Prahinski & Kocabasoglu, 2006). There is a big difference in handling forward or reverse flow of goods with regards to requirements of the distribution centre, such as equipment needed and facility layout (Gooley, 2002). A centralized returns centre is therefore argued to be beneficial compared to a combined flow of goods (Gooley, 2002; D. Rogers & Tibben-Lembke, 2001). The following question is then how many returns centres which is suitable; in a centralized structure each activity is conducted at a few locations, whereas in a decentralized structure the same activities is conducted at several locations in parallel (Gobbi, 2011)

Another aspect of concern when designing a network is the speed by which the network should conduct its activities. A known model for forward supply chains is originated by Fisher (1997), where the supply chain can be designed either as a physically efficient process, with the aim of supply predictable demand at lowest possible cost, or as a market responsive process, with the aim of responding quickly to changes in market demand. The different supply chain designs are suitable for different types of products respectively; functional products with low percentage contribution to profit margin should be handled by physically efficient processes, and innovative products with a high contribution should be handled by market responsive processes. This in order to balance costs versus customer satisfaction and to have a competitive supply chain. The translation of characteristics of new product types to that of used ones can be done by using product residual value (PRV); the value which the product has when acquiring it from a customer (Gobbi, 2011). Products with high residual value should be handled by a responsive reverse network design and products with low with a cost efficient design (Gobbi, 2011). The decision is illustrated in figure 3.3a. Marginal value of time (MVT) is another possible translation of product characteristics, meaning the speed at which a product loses its value with regards to time (Blackburn et al., 2004). Products with high MVT shoud be handled by a responsive chain, and low MVT products by an efficient chain (Blackburn et al., 2004). The choice is illustrated in figure 3.3b.



(a) The impact of product residual value. Adapted from: Gobbi (2011)



(b) The impact of marginal value of time. Adapted from: Blackburn et al. (2004)

Figure 3.3: Choice of reverse logistics network design

Another aspect of network design is the actors involved, and whether activities should be conducted in-house or outsourced. Stock et al. (2006) states that using 3PL (Third party logistics) is a better choice if the company itself lacks the expertise, has limited funds and lacks experience. In addition, if the amount of product returns are low, using a 3PL can be the preferred alternative. Several reasons justifies the decision to leave the transportation to a 3PL. Outsourcing is a good alternative if the 3PL can do a better performance when it comes to doing the deliveries more quick and more precisely. The 3PL does often have expert knowledge in the area which lead to more effective and efficient deliveries, which in turn lead to lower costs and higher revenues from returned items (Stock et al., 2006).

According to Feng and Tian (2008), when choosing a 3PL, four factors should be taken into consideration: Product lifecycle position, organizational performance criteria (such as time, cost, flexibility and quality), reverse logistics process functions (collection, packaging, storage, sorting transitional processing and delivery) and lastly, organizational role of reverse logistics. Depending on where in the life cycle the product is, the most important performance criterion will differ. For a product in the introduction phase, the performance criterion time may be considered more relevant than cost. The organizational role of reverse logistics includes choosing whether the product is going through reclaim, recycle, remanufacture, reuse or tack-back (Feng & Tian, 2008).

3.3 Reverse last mile

Reverse last mile is the activity where the products are collected after its end-of-use and transported to the next node in the reverse supply chain. Reverse last mile can either take place through the original forward channel, through a separate reverse logistics channel or through a combined channel (Fleischmann et al., 1997; Prahinski & Kocabasoglu, 2006), just as other reverse logistics activities. The different channels possible are illustrated in figure 3.4. Usually, the reverse flows are supported either fully or partially by other participants than who are present in the forward flow, such as junk-men or brokers (Prahinski & Kocabasoglu, 2006). More specific, collection methods which are addressed by literature are by collection centers owned by the manufacturer, by third party logistics or by use of retailers (Das & Chowdhury, 2012). The choice of collection method depends on a number of different factors, such as complexity of products, reason for return and which areas involved (Lambert et al., 2011).

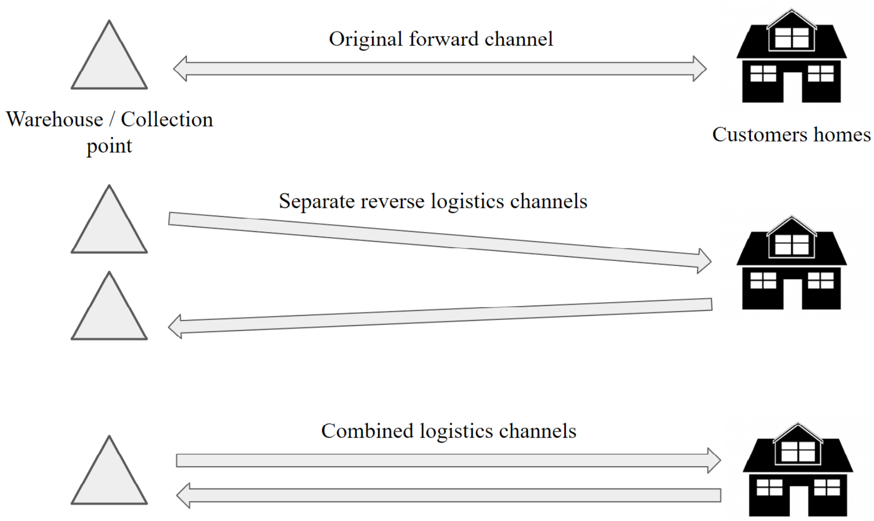


Figure 3.4: Original forward channel, separate logistics channel and the combined channel. Source: Own illustration of description from Fleischmann et al. (1997) and Prahinski and Kocabasoglu (2006)

When modelling choice of collection method with dependency on volume, the decision depends on the cost structure and collection quantity decisions. If economies of scale is possible by either high investment costs of remanufacturing or reverse logistics costs, collection by retailer is optimal with regards to costs. If diseconomies of scale exists, collection by manufacturer is optimal instead (Atasu, Toktay, & Wassenhove, 2013). Savaskan, Bhattacharaya, and Wassenhove (2004) modelled the same collection methods but with marginal cost of collecting independent of economies of scale. Instead collection rate was used as dependent variable. In this model, collection by retailer optimized total supply chain profits. However, according to Tibben-Lembke and Rogers (1999) the exact transportation and logistics cost is difficult to determine as many companies does not know the cost of these.

3.3.1 Last mile delivery

Last mile covers the final part of the transport in the supply chain, where the delivering vehicle stops to off-load the product to its final storing spot. Last mile delivery is the opposite of reverse last mile delivery, and vice versa. The deliveries relates to the microdistribution within the boundaries of a city or an urban area. The term ”last mile” does not mean an exact mile; the term was borrowed from telecommunications networks. The activity differs significantly depending on the geographical area (Cardenas et al., 2017). Traditional last mile deliveries are, as of today, very often conducted by use of a fossil fuel driven van. This type of delivery method is referenced to when the notion ’traditional transportation methods’ is used, as presented regarding commonly used concepts.

Tiwapat, Pornsing, and Jomthong (2018) presents five main modes of how last mile can be conducted: reception box, collection point, post office, attended home delivery and unattended home delivery, where the two last modes are most suitable for bulky products, due to size restrictions. The technology development pace is fast and modes of last mile delivery will increase in the future, leading to increased options to the customers (Tiwapat et al., 2018).

Multi-drop routing problems as well as accessibility to specific areas that does not have relevant logistics infrastructure (such as city centers) are the main characteristics for last mile delivery. Variables such as distance, time, costs or number of vehicles are important when modelling last mile problems. Environmental variables are normally byproducts of logistics optimization (Cardenas et al., 2017).

3.4 City logistics

3.4.1 Definition and development of city logistics

City logistics as expression refers to the planning, optimization and control of movement of goods in urban areas. It recognizes that transporting goods can have both a positive and negative impact on lives of people in these areas (Savelsbergh & Woensel, 2016; Burkhal, Larsen, & Ropke, 2012; Anand, van Duin, Quak, & Tavasszy, 2015). Transportation within cities often causes externalities such as noise and air pollution and congestion which leads to an unhealthy and damaging environment (Schoemaker, Allen, Hushbeck, & Monigl, 2006; Figliozzi, 2010; Savelsbergh & Woensel, 2016). As population of urban areas has increased and is expected to continue increasing, the challenges will be even greater in the future and city logistics as a topic has gained more interest as for both researchers, governments and companies (Savelsbergh & Woensel, 2016; Burkhal et al., 2012; Anand et al., 2015; Crainic, Ricciardi, & Storchi, 2009).

An empirical study conducted by Figliozzi (2010) shows that urban distribution of goods stands for 6 - 18 % of the total urban travel. Well-functioning city logistics is an important source of employment and generates wealth in a city (Cardenas et al., 2017). City logistics enables profits for companies but on the long run the benefits can be insignificant, as the mentioned negative externalities of freight transport are increasing (Cardenas et al., 2017). According to Schoemaker et al. (2006) the urban transportation stand in relation for 21 % of the CO2 emissions. To deal with this, there is a trend of increased public regulations, such as parking restrictions, limited access to certain areas, time windows and truck size restriction in cities (Cardenas et al., 2017). The regulations and the increased interest of urban logistics has led to a need of improving the efficiency of the goods transport in urban areas (Cardenas et al., 2017).

Cardenas et al. (2017) presents a framework of the urban logistics functional scope (see figure 3.5). This framework means to describe the different strategic levels within city logistics. The focus is at interrelationships and stakeholders' interactions at macro level. At the meso level, the focus lies in distribution of the goods and network design which aims to contribute to a holistic view to the problems. Last mile deliveries and collection focus on the actual operations that belong to urban goods transportation. Innovative transportation solutions that can be applicable for reverse last mile on the micro level is what will be studied in this research project.

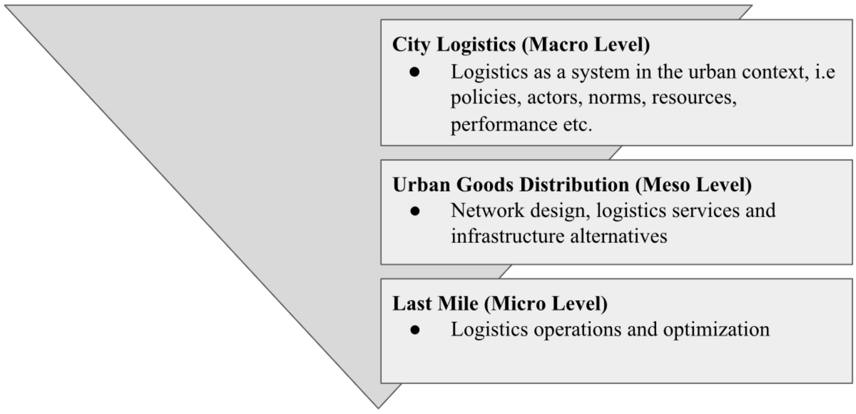


Figure 3.5: Urban logistics' functional scope. Source: Cardenas et al. (2017)

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The many stakeholders involved in city logistics makes it a complex issue (Gammelgaard, 2015). To mention some of the stakeholders, residents and visitors of the urban area, retailers, shippers and transportation companies are examples (Gammelgaard, 2015). City logistics challenges the stakeholders' relation to freight transportation and requires collaboration and innovative partnerships (Crainic et al., 2009). Restrictions on the system such as congestion, narrow streets, physical obstacles and a costly environment further adds to the complexity of city logistics (Dablanc, 2006). This makes freight logistics ubitiquous and take many forms (Crainic & Montreuil, 2016). Most modelling attempts of city logistics only includes one or a few stakeholders and misses the important result of interactions between stakeholders (Anand et al., 2015). There exists few formal models (Crainic et al., 2009) and real life successes of city logistics are few (Gammelgaard, 2015). Actual implementation of city logistics up until today in European cities has not been sufficient to meet the new demands (Dablanc, 2006).

New innovations are required in order to fight the challenges of city logistics and transform from the current logistics system to a sustainable system (Ranieri, Digiesi, Silvestri, & Roccotelli, 2018). New and emerging techniques can drive these innovations. Examples mentioned by Savelsbergh and Woensel (2016) are digital connectivity, alternative fuels of vehicles, autonomous vehicles and unmanned aerial vehicles. Examples by Ranieri et al. (2018) are Information and Communication Technologies (ICT), Industry 4.0 and new transport vehicles, as well as Internet of Things (Tiwapat et al., 2018). Throughout Europe today, manufactures are developing innovative electric vans, trucks and tricycles that aims to be used in urban transportation areas (Leonard, Browne, Allen, Zunder, & Aditjandra, 2014). New freight delivery vehicles are required to be small, low-emission and flexible to use in an urban city centre in order to be effective (Slabinac, 2015).

3.5 Technology innovation and diffusion of innovations

Generally, the success of innovation diffusion depends on factors such as early adopters and the spread of information (Heinrich, Schulz, & Geis, 2016). The success behind an innovation is a complicated story and there are many strategies of how to succeed. Fischer (2017) points out that except from focusing the technical development of an innovation, it is important to increase the possibilities for action and establish smart forms of cooperation within urban logistics. The diffusion of innovations (see figure 3.6) is a theory that explains how, why and at what rate the innovation and new technology ideas are spread. The theory was presented by Everett Rogers in 1962. Figure 3.6 shows the categorization of the adopters, formed as a normal distribution, where each category stands for a percentage that has adopted the innovation. The curve is only valid for successful innovations. The theory is based on four elements that influence the spread of a new idea: the innovation, communication channels, time and social system. Rogers defines diffusion as a process that spreads information through certain channels, over a time to a social system (E. M. Rogers, 1995). Information sharing is important during all phases of the innovation diffusion process. When it comes to buying and investment decisions among private users, the effect of information sharing is a important factor that is being studied (Heinrich et al., 2016).

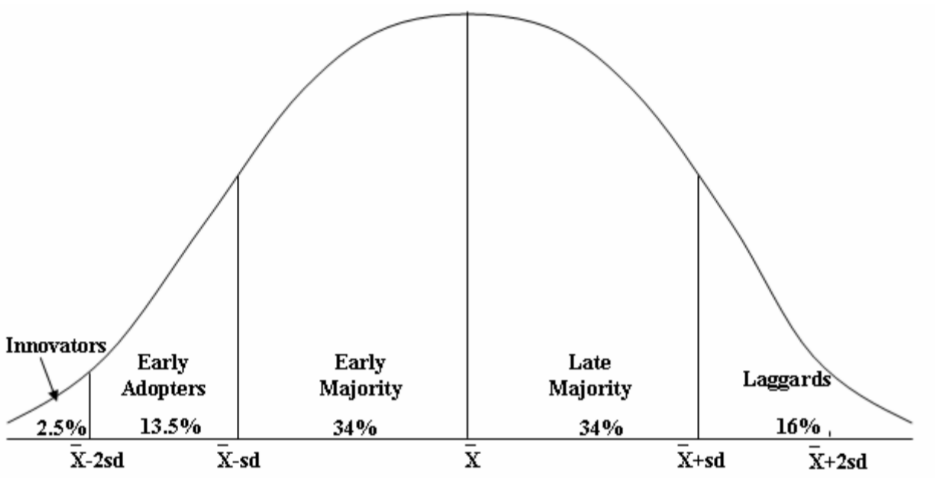

Figure 3.6: Categorization of adopters of a successful innovation. Source: E. M. Rogers (1995)

The success factor of new innovative transport systems are being hindered by habits, infrastructure and rigidities. Due to this, new transportation innovations face many obstacles during its journey but can also accelerate quickly when the barriers are overcome (Heinrich et al., 2016).

3.6 Summary of literature review

Reverse supply chain management concerns the reverse flow of material or products from a customer back to a company; more specific the series of activities conducted in order to retrieve a product back from a customer and recover its value or dispose it (Prahinski & Kocabasoglu, 2006; Batista et al., 2018; Guide & Wassenhove, 2002). The whole, connected supply chain of both these forward and reverse flows of material, products and/or services is called the *closed-loop supply chain* (Gurtu et al., 2015; Batista et al., 2018). Management of a closed-loop supply chain is then defined as “the design, control, and operation of a system to maximize value creation over the entire life cycle of a product with dynamic recovery of value from different types and volumes of returns over time” (Guide & Wassenhove, 2009).

Reverse logistics is one of the activities conducted in a closed-loop supply chain. Companies all over the world in many various industries have included reverse logistic as a strategic part of their businesses and the interest of collection and recycling of products among researchers and companies is growing (Brito & Dekker, 2003; Srivastava, 2008; Pokharel & Mutha, 2009). Tibben-Lembke and Rogers (1999, p. 2) has defined reverse logistics as *"Reverse logistics is the process of planning, implementing and controlling the efficient and cost effective flow of raw material, in-process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing value proper disposal"*.

Reverse logistics can be divided into different activities; transportation, distribution, warehousing and inventory management (Prahinski & Kocabasoglu, 2006; Guide & Wassenhove, 2002). This thesis focus on transportation, more specific the collection of goods and on finding innovative methods of how to collect and take back products.

City logistics as expression refers to the planning, optimization and control of movement of goods in urban areas. It recognizes that transporting goods can have both a positive and negative impact on lives of people in these areas (Savelsbergh & Woensel, 2016; Burkhal et al., 2012; Anand et al., 2015). Transportation within cities often causes noise and air pollution and congestion which leads to an unhealthy and damaging environment (Schoemaker et al., 2006; Figliozzi, 2010; Savelsbergh & Woensel, 2016). As population of urban areas has increased and is expected to continue increasing, the challenges will be even greater in the future and city logistics as a topic has gained more interest as for both researchers, governments and companies (Savelsbergh & Woensel, 2016; Burkhal et al., 2012; Anand et al., 2015; Crainic et al., 2009). In order to fight the challenges of city logistics and enable a transformation from the current system to a sustainable system, new innovations are required (Ranieri et al., 2018).

Innovation of technology plays an important role when investigating future technology and transportation modes. Whether an innovation will success or not, depends on early adopters and the spread of information (Heinrich et al., 2016).

3.7 Research Framework

All areas discussed in the literature review relates to reverse last mile. Thus, by putting reverse last mile in the center of investigation, all areas have a connection point between them. These connections are illustrated in figure 3.7. An area not discussed in the literature review but added to the framework is the furniture business, which instead comes from the context of the case in a furniture company. The areas and their connections with reverse last mile is what forms the research framework for the further investigation. When investigating all the four areas, a result regarding discussion for reverse last mile can be obtained as well, as the research framework centers around it.

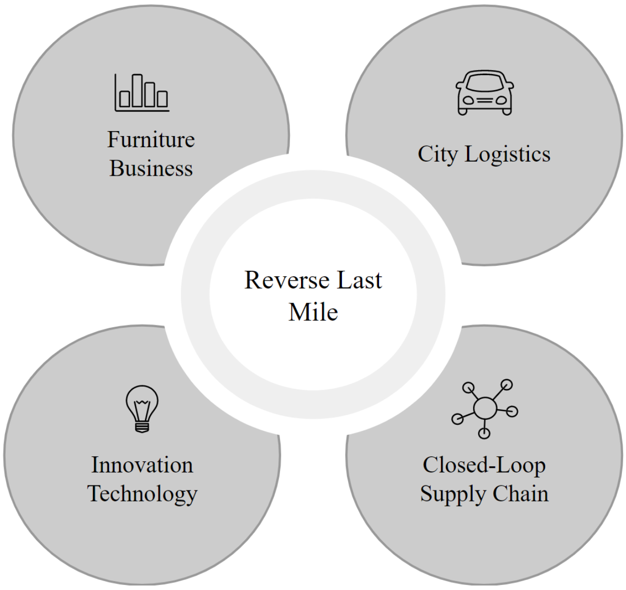

Figure 3.7: The research framework based on literature review. Source: Own illustration
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Chapter 4

Empirical Findings

This chapter describes the empirical findings, which in turn are divided into four different sections; innovations from literature, case studies of existing solutions of reverse last mile, case studies of innovative transportation solutions of reverse last mile and enabling innovations.

4.1 Innovations from literature

As described in section 2.7, the literature review has consisted of different phases of reading. The second phase of literature search in this study focused on innovative transportation solutions in city logistics. Innovations which can be used for reverse last mile are not discussed explicitly in the literature studied. Instead, one branch of innovations in city logistics relates to urban transportation and is assumed to be possible to use for reverse last mile transportation as well. These innovations are described in the sections below.

4.1.1 Cargo cycles

One commonly cited suggestion of transformation in urban transportation is that from fossil-fuel driven trucks to cargo cycles (Oliveira, Bandeira, Goes, Gonçalves, & D'Agosto, 2017).

Cargo cycles as expression can refer to several different types of vehicles (Schliwa et al., 2015). Figure 4.1 illustrates the differences.

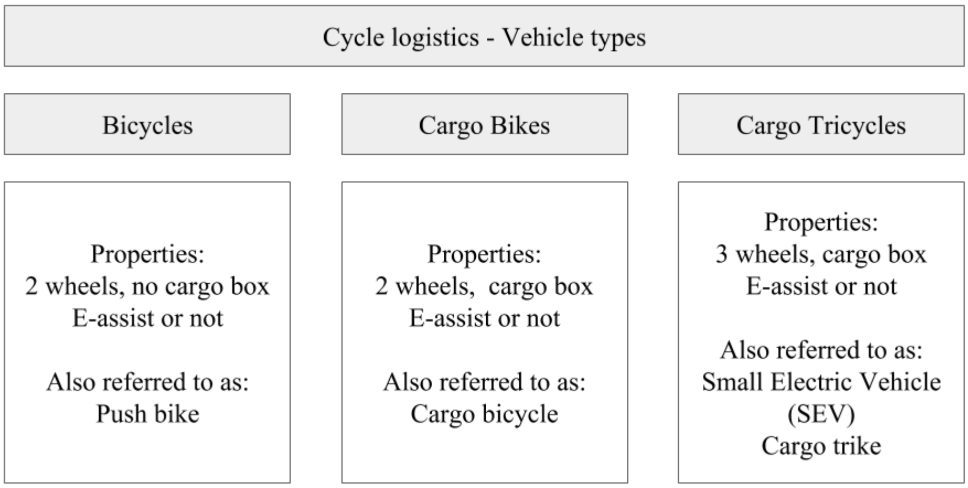


Figure 4.1: Vehicle types of cargo cycles. Source: Schliwa et al. (2015)

The benefits of cargo cycles in city logistics are many. It allows for a reduction of energy consumption, delivery time and traffic congestion, as well as greenhouse gas emissions, air pollutants and noise emissions (Heinrich et al., 2016; Oliveira et al., 2017; Ranieri et al., 2018). Other benefits are exclusion of parking problems and time window for deliveries (Wrighton & Reiter, 2014; Ranieri et al., 2018).

Cycle logistics is suitable for many types of deliveries; small weight packages such as online purchases and take-away food, mail services and furniture (Slabinac, 2015) and also stated explicitly to be suitable for reverse last mile (Wrighton & Reiter, 2014). The capacity of a cargo bike differs between studies and also between the cycle types and is estimated between 50 and 250 kg (Oliveira et al., 2017).

According to Wrighton and Reiter (2014) 51 % of all the motorized private and commercial trips related to goods transport in EU cities can be shifted to bicycles. A goods transportation that can be handled with a cargo bike is defined as (1) a distance shorter than 7 kilometers (2) less than 200 kg of weight and (3) not a part of a complex chain which involves motorized transportation (Wrighton & Reiter, 2014). Transportation by bike is because of its benefits a promising solution in order to improve city logistics (Heinrich et al., 2016; Sadhu, Tiwari, & Jain, 2014). It is, however, not widely accepted by customers today as a suitable delivery method. The main barrier of implementation is reported to be the market domination of small- and medium-sized companies as opposed to big courier companies (Schliwa et al., 2015; Oliveira et al., 2017). Customers do not want to sign contracts with these companies, and the business opportunity lies with implementation of cycle logistics in big courier companies. Another aspect of importance when considering cycle logistics is the characteristics of the city, where a dense populated city with old, historical centers has the greatest potential for a bike transportation shift (Schliwa et al., 2015).

4.1.2 Lightweight vehicles

Another innovation which attempts to meet the demands of new vehicles is called lightweight vehicles. Different types of vehicles fits under this umbrella term. One is electric small vehicles, such as mopeds and motorbikes (Ranieri et al., 2018). Another invention is V-Feather, which is a vehicle composed of building models which can be of various types and sizes. These modules can be dropped off or picked up at different locations (Slabinac, 2015). A photo of V-Feather is shown in figure 4.2. A third innovation is Deliver, a vehicle intended for large-scale production as a next-generation vehicle (Slabinac, 2015). This vehicle is shown in figure 4.3.

Figure 4.2: V-Feather vehicle. Source: European Commission (2014)

Figure 4.3: Deliver vehicle. Source: Technologic Vehicles (2014)

The light weight and smaller size of these vehicles reduces pollution and makes them agile and flexible to use in the urban setting (Ranieri et al., 2018).

4.1.3 Autonomous cars

Autonomous vehicles allows to be steered without human interaction. They instead operate by using computerized systems to detect and collect information about the environment, identify paths and hazards, as well as control functions such as acceleration and steering, to navigate the vehicle accordingly (Hulse, Xie, & Galea, 2018). Automation can be executed on different levels, from semi-automated to fully automated (Ranieri et al., 2018). They can be used for freight transport, either as assistance to a delivery person or substitute the delivery person, this in turn either by delivery to a reception box or as a self-driving shipment repository (Slabinac, 2015). The benefits of use of autonomous cars are improved road safety, reduced congestion by more efficient use of vehicles and infrastructure and increased accessibility for e.g. elderly (Fagnant & Kockelman, 2015). This means lower transportation costs, more efficient public transportation, increased urban road capacity and reduced pollution (Medina-Tapia & Robusté, 2018). Automated cars are being developed by several different car companies as of today and are possibly sold by 2020 or 2021 (Chan, 2017).

The development of autonomous cars are enabled by more sophisticated sensor technology and real-time communication between applications; key technologies also related to Internet of Things. The base of these technologies makes risk of cyber-attacks and hacking a concern of autonomous vehicles (Hopkins & Hawking, 2018). Security is one barrier of implementation; liability, perceptions and privacy are other (Fagnant & Kockelman, 2015).

4.1.4 Other autonomous vehicles

An innovation for future transportation, which has even been discussed in media, is drones. They have attracted attention because of the possibilities of more efficient home deliveries in urban areas (Tiwapat et al., 2018). Amazon is one company which has launched a pilot project for deliveries with drones (Amazon, n.d.), another is 7-Eleven (Williams, 2017). Advantages with drones are its possibility to be operated without a pilot, avoidance of congestion, speed compared to trucks and low transportation cost per km (Ha, Deville, Pham, & Hà, 2018). However, travel distance and parcel size is limited (Ha et al., 2018) and the legal aspects are complicated. The laws and regulations of today is not sufficient in order to cover drone flights (Luppicini & So, 2016). Kunze (2016) claims that the security and safety concerns hinders the implementation of drone deliveries in Europe.

Drones are also possible to combine with other delivery methods. One way to combine the advantages of drones with those of trucks is to use them together, a concept which is called Drone-Delivery using Autonomous Mobility (DDAM) (Yoo & Chankov, 2018). It is illustrated in figure 4.4. The first step is that the drone picks up the delivery from a delivery center, after which the drone flies to autonomous vehicle and the drone connects to the cars' roof. The car then drives and when it is close enough, the drone disconnects, flies to a delivery destination and lastly drops off package (Yoo & Chankov, 2018).

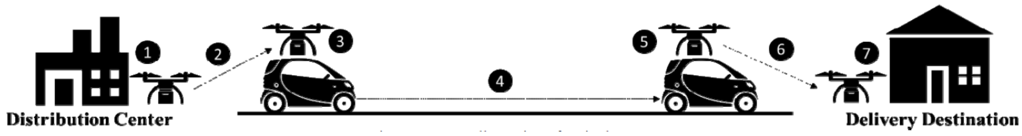


Figure 4.4: Illustration of DDAM. Source: Yoo and Chankov (2018)

Ground drone-robots are also being tested for the application of home deliveries (Ranieri et al., 2018). Slabinac (2015) refers to them as self-driving parcels. It has previously been used for intra-logistics, and goes by many different names (Kunze, 2016). They can be designed both as fast moving, street based vehicles (sometimes referred to as autonomous delivery vehicle (ADV)) and slow moving sidewalk based vehicles. There are several different projects which tests the concept of small, ground drones. Possibilities to co-use public transport is cited by Kunze (2016) to be a key asset of ground drones, whereas solutions for automatic off- and onloading is a key problem. In addition, security and safety issues still exist.

4.1.5 Crowdsourcing logistics functions

The concept of crowdsourcing is based on individuals who possesses resources such as financial, intellectual or material which can be used to perform traditional business activities, this enabled by using mobile applications and web based platforms (Carbone, Rouquet, & Roussat, 2017). The motivation for drivers to participate in a crowd logistic system is value propositions that includes monetary compensation and health benefits. Since set-ups of crowd logistics is a rather new phenomenon, novelty is also an important factor to attract drivers (Paloheimo, Lettenmeier, & Waris, 2016). Carbone et al. (2017) defines crowd logistics as "initiatives that tap into the logistical resources of the crowd to perform logistics services". Another definition is a ridesharing service model for same-day deliveries of goods (Castillo, Bell, Rose, & Rodrigues, 2018). Crowd logistics is characterized by small scale operations with economic benefits for the people involved.

Crowd logistics is a concept which is a part of a global societal evolution and is thus very affected by the development of other crowd solution such as crowd founding, crowdsourcing etc (Carbone et al., 2017). Crowd logistics is a part of the rising sharing economy which has trust as its main pillar. If the trust would be undermined, the crowd logistics and other crowd solutions could be seriously affected (Carbone et al., 2017; Rai, Verlinde, Merekx, & Macharis, 2017). The occupancy in the active running cars has been falling the recent years and this opens up for the opportunity to transport goods, as the capacity in the vehicles exists. Using all the loading capacity would lead to both economical, environmental and societal benefits (Rai et al., 2017).

According to Carbone et al. (2017) the concept of crowdsourcing within logistics can be divided into four different types; crowd storage, crowd local delivery, crowd freight shipping and crowd freight forwarding. Crowd local delivery is the type that is applicable for furniture and odd size parcels in a city environment and the type is characterized by local short distances. The crowd is responsible for pickup, transportation and delivery. This method uses individual's cars, vans, scooters, bicycles, public transport and even walking as transportation modes. An application in mobile phones is often used to manage the information sharing and payment transaction. The crowd local delivery system is often used in larger cities where thousands of people are moving every day. The crowd and the application enables fast deliveries at a low cost, as well as the delivery of consumer goods. In order to have a successful crowd local delivery system, the network needs to include a dense local network of delivery aids.

Crowd logistics generates several benefits which contributes to sustainability in urban areas. A successful crowd logistics business model provides overall sustainability and service to customers, offers flexible work opportunities and increase the efficiency of vehicle usage (Rai et al., 2017). Crowd logistics can have a great impact of environmental sustainability and Paloheimo et al. (2016) claims that crowd logistics is the most effective way to a reduction of resource use in the transport sector in the short term. However, the sustainability potential of crowd logistics is only viable if the crowd exploits existing car trips. When drivers instead dedicates trips to delivering parcels, the emissions and costs are higher than the baseline alternative of truck delivery (Gatta, Marcucci, Nigro, Patella, & Serafini, 2018).

Although the many benefits of crowd logistics, there are many risks that needs to be considered (Carbone et al., 2017). When seeking delivery agents, the competition is not only stemming from other companies, but from drivers' own interests and needs. In addition, the availability of supply of vehicles is uncertain (Castillo et al., 2018). Crowd logistics offers opportunities that has not yet be considered to be included in supply chains. The commercial and financial results of the crowd logistics initiatives and that results regarding this has not been obtained. Crowd logistics therefore adds complexity to the context of logistics integration, and this will be a task for future research to tackle (Carbone et al., 2017).

4.1.6 Other innovations in city logistics

According to Cardenas et al. (2017) another, frequently used, method of improving reverse last mile is to use micro-consolidation platforms that are located close to the final destination. They function as a place where goods are kept and consolidated before last-mile transportation to e.g. retailers. This concept is called Urban Consolidation Centers (UCC) (Ranieri et al., 2018). In many European cities, new types of logistic facilities such as shared consolidation centers are being planned and constructed (Balma, Browneb, Leonardib, & Quaka, 2014). The development up until today has meant that space dedicated to logistics activities has shrunk, this due to high costs and unavailability of land (Dablanc, 2006). In order for it to be possible to reduce the size of vehicles as the innovations presented in previous sections, it becomes essential to use deconsolidation centers. This since suggested sustainable and efficient deliveries between cities is done in larger loads which needs to be decomposed (Oliveira et al., 2017). According to a report by Bouton et al. (2017), UCC is an innovation in city logistics which offers great potential in the transformation of city logistics.

Another innovation which has the possibility to impact the logistics system of today is a concept which has evolved from the technology of internet. The concept is called Physical Internet (PI) (Crainic & Montreuil, 2016). It is an open, multi-modal logistics network which uses the way the digital internet moves and manages standard data packages around the world (Crainic & Montreuil, 2016; Montreuil, 2018), first cited in 2011. The PI would move freight encapsulated in designated π-containers acting as globally standardized packaging; meaning all goods regardless of shape will be packaged into rectangular packages that can dock into other packages. The concept also involves the idea of shared transportation resources and creating and open logistics network (Montreuil, 2018). PI is believed to have the ability to tackle the problem of sustainability in logistics. More specific, fuel reduction, CO2-emission reduction and logistics cost will likely all decrease significantly with use of this collaboration concept. There are currently no well-developed model on how to transform from today's logistics network to that of the Physical Internet, and some criticism has been raised whether suitable business models can be developed with this concept (Stenberg & Norrman, 2017). A roadmap established by the European project European Technology Platform Alliance for Logistics Innovation through Collaboration in Europe (ALICE) of how to implement the PI concept by 2050 has been presented.

4.1.7 Relevance of innovations

Factors which can be used in order to evaluate efficiency of city logistics are vehicle types, horizontal collaboration and delivery method (Cardenas et al., 2017). According to a research done by Leonard et al. (2014) and again highlighted by Cardenas et al. (2017), the availability of facilities and light vehicles would improve the logistics performance in urban areas.

The relevance and possibility to apply to today's city infrastructure varies between the different innovations presented. Different authors and companies has tried to assess the future city logistics system, actors and vehicles. Kunze (2016) has presented a vision of logistics in Europe by 2030, where different transport alternatives which are possible to use for transport logistics are evaluated. In this vision, current transportation operators which will still be used are bikes, vans and trucks. Emerging transport logistics operators are also considered, and crowd logistics and ground drones are two methods of transportation which the author believes is likely to emerge by the year 2030. Ground drones are considered as one of the most promising new applications. Transports logistics operators which are regarded as more unlikely to be used by 2030 are drones.

Schröder et al. (2018) has written a report for McKinsey & Company, another organization which has evaluated opportunities for the future of city logistics and last mile transportation, using technology maturity as reference. The technology maturity of innovations for last mile delivery is presented in figure 4.5. As the figure illustrates, the technology maturity and thus also implementation readiness is different among the innovations discussed. The innovations with lowest technology maturity is some of the autonomous vehicles presented; fast moving ground-drones and regular drones. Other autonomous vehicles are according to Schröder et al. (2018) closer to be possible of launching, with semiautonomous solutions being present in the closest time horizon. Electric vehicles are possible to produce with scalability already today. A note by the authors of the report is the speed of technology development; a report 18 months earlier did not estimate the fast development of these technologies which has since then occurred. Because of the potential benefits of autonomous cars, Chan (2017), author of another report, argues that these cars has the possibility to enable a whole paradigm shift in transportation systems.

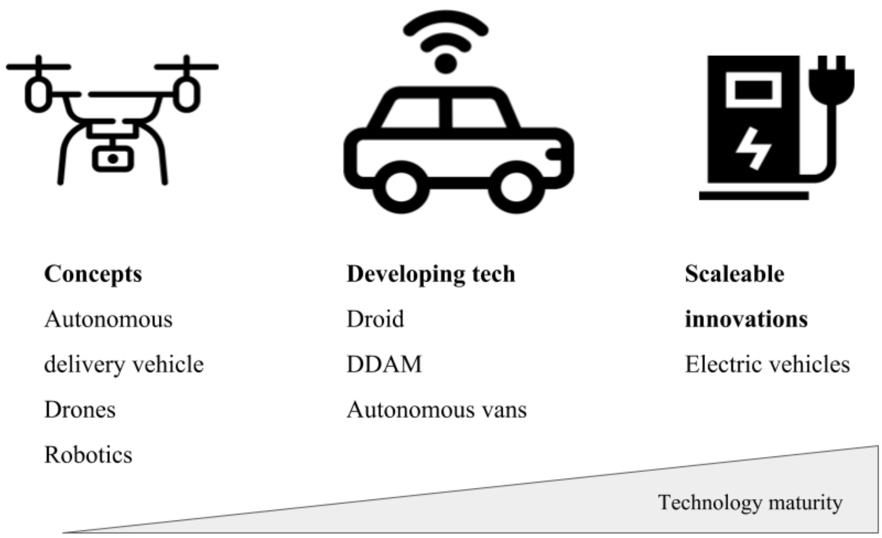


Figure 4.5: Maturity of technology for different vehicle innovations. Adapted from: Schröder et al. (2018)

Another report by McKinsey & Company by Bouton et al. (2017) has measured the potential impact of several different solutions which attempts to improve city logistics. The parameters measured were cost effectiveness, customer preference, environmental impact, technological maturity and infrastructure feasibility. A type of ground-drone; autonomous ground vehicle lockers, are presented as a particularly promising delivery method. These are similar to that of a self-driving delivery van and larger than droids which drives on the sidewalk. Droids and electric bikes are estimated to have a medium impact, and drones an even lower, marginal impact. Other innovations which can be used to improve urban deliveries are also discussed in the report, such as night-time deliveries. These are not related to modes of transportation and therefore not highlighted in this section.

4.2 Cases of existing transportation solutions of reverse last mile

The first section of comparable cases studied consists of existing solutions for reverse last mile, as explained in section 2.2.2. The case studies are based on interview data and company websites and documents. All interviews conducted are summarized in table 4.1.

Table 4.1: Interview information for case studies of existing solutions

Case company	Interview person	Title	Date
Sellpy	Interviewee 1	Logistics responsible	27 March 2019
Berendsen	Interviewee 2	Service and Distribution Manager	12 April 2019
Bring	Interviewee 3	Innovation and Product Manager	2 May 2019

4.2.1 Sellpy

All information in the section below, if nothing else stated, originates from the interview with Interviewee 1, see 4.1 for more information.

Sellpy is a Swedish online second hand company which was founded in 2014. Sellpy's business idea is to collect old clothes and products that people want to sell and pass on to someone else. Sellpy handles the pickup of products, the sorting and sells the products on an online platform. The person who wants to sell the products (here defined as the seller) orders a Sellpy-bag and puts the products in the bag and orders a pick up.

The person who chooses to sell their products with Sellpy gets a part of the profit. The share of the profit which goes to the seller is calculated by a pricing model. The seller gets 40 % of the price that the product is sold for and for products that are sold for over 500 SEK, the seller gets 90 %of the part of the price that is above 500 SEK. For example, for a product that is sold for 1000 SEK, 640 SEK goes to the seller. The seller gets 4 SEK if the product is sold for 35 SEK. Sellpy has an advertisement fee of 10 SEK for each product they try to sell. The products which cannot be sold are being donated to charity organization. The person who sells can decide whether their profit shall be transferred to their bank account or be donated to charity organization (Sellpy, 2019b).

The seller gets information regarding the products through their account at Sellpy and the seller can choose prices, edit advertisements and choose what to sell. Sellpy's requirements of the products is that they should not be damaged and they shall be clean. Sellpy sells products which they think they can sell for more than 50 SEK and the handling, sorting and advertising is made in Stockholm where the products are transported to. The price of the product is based on selling data from more than 1 000 000 products. The seller can get back a product whenever during the selling process. He or she will in case of a take back have to cover the freight cost him or herself (Sellpy, 2019a).

The pick-up of products is being done either by cargo bikes, car or by the 3PL company Shenker. The choice of method is done by Sellpy and is based on the area the seller lives. The mode of transportation depends on the density of people living in an area. The cargo bikes picks up the Sellpy-bags in the most central areas of a city. The bike collection is done by partnerships with Movebybike and Pling. In areas directly outside of the central area, the pick-up is being handled by a car. If the seller does not live within the area of direct pick-ups, meaning a low-density area, the bag can be handed to the closest Schenker agent. Schenker then handles the transportation of the goods. The bag can be placed outside the door or be handed over to the collector, but the convenience is that the seller does not need to be home for the pickup which simplifies both for the person that picks up and for the seller.

Sellpy's vision is to make it as available, simple and convenient as possible for their customers to consume circular and give their products a longer life. The service focuses on being a user friendly as possible and at the same time inspire and engage customers in questions regarding sustainable consumption. The customer who buys second hand product from Sellpy can see the amount of saved water for a product and savings in terms of carbon dioxide per clothing is going to be released during the spring 2019. The aim is to make it as simple as possible for the customer to make the most sustainable decisions (Sellpy, 2019c).

4.2.2 Berendsen

All information in the section below, if nothing else stated, originates from the interview with Interviewee 2, see 4.1 for more information.

Berendsen is a part of Elis which is an international leader within solutions for textiles, hygiene articles and facility service, operating in 28 countries in Europe and Latin America.

Berendsen leases a complete set of textiles for all different kinds of businesses. This can be cook clothing, towels, entrance carpets, bed and bath linen. Berendsen offers a complete solution in order to make textile handling as simple as possible for their customers, meaning that they offer pickups, washing, sorting and thereafter deliveries of fresh textiles. The used textiles are brought to a laundry service where they are being washed in a correct and safe way (Berendsen, 2019).

Berendsen has a circular approach to deliveries. The goods are being picked up at the same time as they are being delivered, why the capacity in the vehicles are always fully used. Berendsen only have corporate customers, which varies in size. The route is predefined and unless changes are made, the route will be the same every week. Berendsen has two distribution hubs for the area of southern part of Sweden, one in Kristianstad and one in Helsingborg. The washing activity is being performed in Arlöv and thereafter the goods are transported to the hubs, and later transported from the hubs to the customers. This washing center is one out of a total of 25 in all Sweden. They have 20 cars in their vehicle fleet operating in last mile distribution. This set-up enables Berendsen to spend more time with the customer.

The cost connected to the distribution is the personnel and the cost of the vehicle. Approximately two thirds of the cost stands for personnel and one third for the vehicles. The vehicles are leased and services of the vehicles are included in the price. The more the travel route can be optimized in terms of minimizing driven miles, the cost can be reduced. The first electrical car will soon be tested in Helsingborg city, due to the city's legal restrictions within city logistics. The whole vehicle fleet has until now been run on gas or diesel. The electrical vehicle will be used only in the city of Helsingborg. If this trial is successful, one more electrical vehicle will be implemented. Approximately 850 kg of goods is delivered every day, why cargo bikes would not be a possible mode of transportation. Public procurement puts high demand on Berendsen's services in terms of environmental standards, where each new contract shows an increase of restrictions. The new demand of customers drives Berendsen's environmental development forward.

The logistics part of the company was earlier handled by a haulage contractor, but the logistics is a big part of the business and because of the importance of being close to the customer, Berendsen chooses to run the logistics themselves. Berendsen focus on service and customer relationship and in order to have control over and a better opportunity to impact, it is a great advantage to have the logistics in-house.

For Berendsen, the greatest threat that would force them to change transportation mode is the legal aspects. The requirements on the market must correlate with the technology development of vehicles. Otherwise, the legal requirements will cause problems for the operating transportation companies. Berendsen are not facing significant problems with congestion in the geographical areas they cover. Parking spots causes problems sometimes, but very often there are load zones available.

4.2.3 Bring

All information in the section below, if nothing else stated, originates from the interview with Interviewee 3, see 4.1 for more information.

Bring is a Logistic company operating in the Nordics, transporting various goods for both large and small firms. Bring deals with packages, goods, temperature sensitive goods and can also offer storing solutions. Bring offers installing service of different products, such as washing machines and sofas. The market involves the Nordic countries, but Bring can help with connecting to other global logistic firms, if needed. Bring's main customers are contract customers.

The aim for 2025 is to only use renewable energy resources for the transportation fleet and properties. To achieve the goal, Bring works broadly with different climate smart solutions with focus on the car, fuel and the behavior of people.

Bring focus on deliver a high service level to their customers. The price depends on the service, whether if the product is delivered on the property line or if it is delivered and/or assembled in someone's home. They also take the packages with them and they can also offer to bring the old product with them when they deliver something. Bring also offers their customer to choose between many different time slots of when to have the delivery. Bring doesn't deliver without a confirmed delivery due to minimize missed deliveries. A newly launched solution in the biggest cities of Sweden called ”your hour” offers a more precise time slot on the day of delivery of one to two hours (depending on the service) and the delivery can also be tracked live. The primary result of ”your hour” shows that the customer satisfaction has increased significantly. Since the customer can see where the transportation mode is, this has also reduced the number of calls from customers.

Bring has identified different trends regarding small packages and bulky and heavy products. For smaller products, many new actors has introduced the market which had led to more pressured prices. City logistics is a difficult sector due to the infrastructure and the environment and for Bring, it is easier to deliver packages during the evening. A challenge for Bring is to more and more change their vehicle fleet to be run by renewable fuels. Bulky products are harder to transport with electric vehicles, and some products cannot be transported with renewable fuels and today, they are transporting heavy goods with HVO and bio diesel cars.

Bring offers pick up of products, both new and old products, although the total percentage of pickup of products is in general low, but the ratio depends on different segments. Bring wants to build better return solutions than they have today, and the reverse flow is not as fully developed as their forward solutions. The reverse flow is not mature yet, and involving the customers in the development is a key factor. Transporting bulky products is a hassle for many customers and Bring wants to solve this and build new services for their customers. Bring has a reverse flow for products that has reached its end of use which they transport to a recycling central. Depending on the product, this task has a various cost. Furniture are more costly to recycle and companies can't hand in furniture for free, at least in Sweden. Transporting used furniture includes the problem with packaging of the product, as the condition might demand it. Bring also request better track-ability for used furniture. A partnership between Bring and Second Hand firms was desirable for Bring, but many second hand firms couldn't handle the big volume of goods that would enter the second hand stores.

New transportation innovations that Bring looks more into is small autonomous droids that walks on the sidewalk and delivery small goods. Bring is testing digital lockers in homes as a pilot project. Digital lockers allows deliveries and pick-ups to be done even if the owner is not home, which is an enabler for efficient deliveries.

4.3 Cases of innovative transportation solutions and technologies

The second section of comparable cases studied consists of innovative transportation solutions for reverse last mile, as explained in section 2.2.2. The case studies are based on interview data, company websites and documents and secondary data case studies. The type of data used is stated in each case study. All interviews conducted are summarized in table 4.2.

Table 4.2: Interview information for case studies of innovative solutions

Case company	Interview person	Title	Date
Movebybike	Interviewee 4	CEO & Co-founder	5 April 2019
Tiptapp	Interviewee 5	Co-founder	10 April 2019
Samlastning i Sege Park	Interviewee 6	Project Leader	11 April 2019
Logtrade	Interviewee 7	Head of Information	16 April 2019
Pling Transportation	Interviewee 8	Chairman of the Board and Sales manager	17 April 2019
Udelv	Interviewee 9	Director of Business Development	23 April 2019

4.3.1 Movebybike

All information in the section below, if nothing else stated, originates from the interview with Interviewee 4, see table 4.2 for more information.

Movebybike is a Swedish company which offers transportation of bulky and non-bulky goods with cargo bikes in urban areas. The company was founded in 2012 by a father and son, Johan and Nils Wedin, who both are very passionate about bikes. Since then the company has faced both expansion of business and financial problems.

The cargo bikes has the possibility to move every item that exists in a home. Everything from a sofa to a kitchen can be transported with the cargo bikes and the only exception they present is a grand piano. Volume and to be able to transport large goods is a key for the cargo bikes. Their main customers today are private companies but the end customer can be both a company and a person. The biggest customer of Movebybike has been Linas matkasse, but recently they have experienced a new interest from retailers such as HM and iDeal. The demand of bike deliveries has increased significantly.

The first cargo bikes were developed by a moving firm, named *Bikes at Work* in the US. Today the bikes are developed by a company called STARKE which is a result from Movebybike starting developing their own bikes. The cargo bikes from STARKE are by now only prototypes but in a few months, the first batch of the own made cargo bikes will arrive and the business will start to run as planned. The capacity of bike production is restraining the business of Movebybike today. There is fewer bikes produced than what Movebybike would need to meet the demand of deliveries. This imbalance is the greatest challenge which Movebybike faces today.

A cargo bike can come closer to the end customer in an easier way than what a truck or a van can do. Interviewee 4 does not see any issues with operating within reverse last mile and picking up products and making this as a natural part of the route, compared to last mile deliveries which they are mainly conducting today. In order to fit deliveries to cargo bikes, Movebybike has hubs for consolidation and deconsolidation in the edges of the area where Movebybike operates. Trucks deliver to this hub and the goods is then reloaded onto cargo bikes which will handle the last mile delivery. In the same way, cargo bikes will pick up goods which are then consolidated at the hub and transported away by truck.

The relationship with the end customer is very important for Movebybike. Interviewee 4 explains that Movebybike wants to be the customer's own transport operator. Their strategy for the future is to conduct deliveries and pickups for many different companies, while still remaining their own brand. By being independent they are able to manage the customer relationship. The customer will be able to consolidate deliveries and influence when the goods will be delivered. If partnerships with other firms is going to happen, triangulation in terms of sharing information between the end customer, Movebybike and the partner must exist. As the e-commerce will increase, so will also the business of Movebybike. This has already been shown in the new interest from retailers.

Movebybike is involved in many research projects regarding optimizing and improving the route for cargo bikes. As of today, tools regarding optimizing the cargo bike route does not exists as there is no available mapping-data for bike routes available. To adapt cargo bikes to the city logistics, possible improvements regarding infrastructure needs to be identified.

Taking the capacity of goods that the bike can transport into consideration, the cost of transporting goods a few kilometers in urban areas with the cargo bike is significantly lower than transporting with traditional trucks. Cargo bikes transports can reach a very high efficiency and a very high accessibility. The bikes can make between 15 to 25 stops per hour, while the corresponding number of stops with a car would be approximately 10. The main setback with regards to costs of delivery by cargo bikes is the cost of the hub for consolidation and deconsolidation. The main driver of cost per delivery is the salary of delivery person.

When calculating the cost of a delivery, a template of 400 SEK per hour is used. This in order to mainly cover the salary and other costs.

Movebybike's main focus right now is to build up an organization and to procure a vehicle fleet. The company wants to expand and to operate on markets where they can make a difference for city logistics. For the future possible markets the parameters density of inhabitants and the topography of the area is important to consider.

4.3.2 Pling Transport

All information in the section below, if nothing else stated, originates from the interview with Interviewee 8, see table 4.2 for more information.

Pling Transport is a cargo bike transportation company which operates in Gothenburg since 2012. Three persons started the company as they wanted to try bike as a delivery mode in city areas. One of the persons was the founder of the cargo bikes Velove, and Pling was started in order to try to transport goods in a city with Velove's bikes. Pling is an economical association, owned by the employees in order to assure that the profit goes to the ones who is pedaling the bikes.

It all started with a restaurant customer, which needed help with "fika" and lunch. The customers has since then increased in number and Pling transports goods within different companies and sectors. They pick up bags from Sellpy, transport all post and papers for Gothenburg University, catering goods and deliverers flowers. Pling has done a few furniture transportation which has been successful. The only difficulty with transporting furniture is that it is time demanding, as the customer very often needs help with carrying it and has not been ready to load the furniture when Pling arrived.

Pling focuses on optimizing the routes and this task is to a large extent done manually. Pling wants to improve the handling of incoming- and outgoing goods in a better way by combining these and in that way optimize the capacity of the bikes. As of today, there is a need for a better fleet management system for bikes, but they have not yet found a suitable one. Pling rents a terminal where reloading is being made. In the future, Pling would like to find better solutions and locations for reloading of goods.

Pling has three Velove Armadillo and two Ecorides in their vehicle fleet. The standard container is $1m^3$ and the bigger container is $2m^3$ with maximum weight of 350 kg respectively 500 kg. Velove is the company developing the cargo bikes. The company was founded in 2015 and in order to improve the quality and develop the bikes they have been run by Pling, DHL Express, DB Shenker and Hermes. The constraint for the maximum weight includes driver, battery, bike and the goods. For Pling it is important to not disturb the city activities and in order to keep the city safe, they don't want to have too big containers as they would obscure the view and the risk falling increases the bigger the container is.

The competition is low on the geographical market Pling is operating on. The demand of sustainable transportation modes is increasing and Pling believes it will continue to do so in the future. They believe that new markets that they have not yet discovered will appear in the future and they are positive to collaboration and partnerships with other actors. They are particularly positive to partnerships with innovative companies that they share the same values regarding sustainability. When they get new customers they are ready to expand and take in external capital and eventually expand to new geographical markets. There is a certain waiting time when purchasing a new cargo bike but leasing is an option when you can get the bike directly. It takes some time to teach the new employees but since Pling has been growing steadily since they started, this has not been a problem.

Pling has divided the geographical market in which they operate, city of Gothenburg, into two zones, where zone one includes the central areas and zone two the outer areas. A benchmark regarding energy consumption has been made with an electrical truck. The result showed that the electrical truck used 15 times more energy than the cargo bike, and here the energy consumption during manufacturing the vehicles was not included. There is no study regarding the availability and efficiency in city areas, but with what they have experienced, the cargo bikes are superior the truck regarding both these parameters.

Pling values highly the customer relationship and they focus on delivering best possible service to achieve high customer satisfaction. The future strategy of the company is being revised and in the future, Pling wants to grow with strategic customers, get a wider customer range in order to enable co-loading.

The price of their pickup and delivery service depends on the time window the delivery wishes to be delivered within. The prices varies between the most expensive one which is one hour to the cheapest one on six hours or more. The price also depends on the size of the goods (volume and weight) and also in which zone the delivery or pickup is requested. Compared to traditional vans, the transportation of goods is generally a bit cheaper and overall, Pling's cost level follows the market well. The greatest part of their costs consists of salaries to employees and other cost drivers are the bikes, rent and spare parts. Pling do not invest a lot in marketing. As of today, Pling has 15 people employed, where a few works full time but the most of them works part time. Pling operates 6.30 – 23.00 and are taking approximately 150 deliveries per day. The deliveries has continuously increased ever since they started.

A threat for Pling's business could be an eventual price dump within last mile delivery. Today, the willingness to pay for last mile delivery is low. It would be hard to handle significant losses for Pling, compared to a larger company that has greater margins to handle this. Although, Pling forecasts a bright future for cargo bikes in city logistics.

4.3.3 Tiptapp

All information in the section below, if nothing else stated, originates from the interview with Interviewee 5, see table 4.2 for more information.

Tiptapp is a crowdsourcing solution present in Sweden which connects people who has the possibility to transport goods with people who needs to get goods transported. With Tiptapp, people can choose whether to give away products, either to a charity or to another person, ask for assistance to transport a product from place A to place B or ship products to a recycle central. Everything is managed through an application on the phone, including the financial transactions. The person who needs goods to be transported decides how much they is willing to pay for the service, and that is shown in an advertisement in the application together with other conditions and a picture of things that needs to be transported. If a person who does transports thinks it is a good deal, the task can be executed (Tiptapp, 2015).

The company was founded in 2015 by four co-founders. The first approach was to help with transport to recycling centrals. This offer has since then expanded into today's offer with both waste collection, transportation of goods and shopping services. The company now consists of 18 employees and have 200 000 users of the app in Stockholm.

Today the typical customer of Tiptapp is a private person who lacks free time and wants help to solve the challenges with personal logistics. The challenges can be both regarding the amount of time which a person has available for household duties as well as limitations with own means of moving goods. These persons are distributed between all ages and family situations. They typically do not own their own car. The products which are clunky and difficult to take with you on the subway is their most common type of product to ask for Tiptapp's service on. The most common specific product is sofas. A sofa typically costs 350 SEK to move from A to B. The busiest day for deliveries are Sundays.

The business model works as a transaction fee collected by Tiptapp. On each product which a user wants to move there is an associated suggested price. On this price which the deal is based on, the collector obtains 80% and Tiptapp the remaining 20% of the total sum.

Today, the customers are not used to the idea of another private persons to be able to deliver or pickup their goods. Customers' perceptions of transportation is believed to be the greatest hinder of expansion. Applications of shared economies are still relatively few, but when people has gotten used to the idea of e.g. renting out their homes the company AirBnB has grown to be enormous. The laws and regulations regarding taxes and payments are also a problem which Tiptapp faces. These are not adjusted to fit to platform where resources are shared, and this makes the work more troublesome. The regulations in other countries than Sweden they have found to be better adjusted to their business model. When these laws and regulations fit better to a sharing platform business, the real breakthrough is thought to occur.

To meet their customers in the future, their strategic direction of the company is to be present wherever the need of transportation occurs. The presence means that the application used today might not be where they meet the customers. New meeting points might be online websites or collaboration with different business partners, and these possible touchpoints are investigated today. The vision is to be the go-to service for movement of goods in and out of a household. They have not identified any direct competitors of their business, instead their offering is not found at any other company in Sweden. The closest competitor is that of messengers' cars.

In the future, Tiptapp's business model will probably still work the same way as of today. It is possible that extra services will be included. The payment model is thought to remain the same. The greatest threat to their business is if peoples' trust in each other is missing. When two private persons conduct business with each other as in Tiptapp's case, the building block of this business is trust. Tiptapp has built in some mechanisms in their app in order to increase the trust in each other. One of these mechanisms is a rating system of both the helpers and the services.

The geographical presence of the company is hoped to expand. A pilot has been conducted in London and a full launch is planned to be executed in a very close future. When this is done, they want to still expand to other cities. A lot of different cities are investigated in order to find future markets. It is important to grow the number of users beyond the critical mass, since the helpers and requesters then offer scalability for a delivery system which works fast and efficient, and which can consolidate deliveries.

4.3.4 Udelv

All information in the section below, if nothing else stated, originates from the interview with Interviewee 9, see table 4.2 for more information.

Udelv is the company behind the world's first autonomous driving car operating in last mile delivery. The company is located in Burlingame, California in the United States and was founded in 2017. The first autonomous cars was launched and driven on public roads in 2018. The car has 18 compartments and can take 18 deliveries at one time. Recently, the second generation car with updated robotics improved security, was launched. The latest version included 32 compartments and could do more deliveries per route. Udelv is currently focusing on the US market, but they see an increasing demand from other markets, such as Europe and Japan. Since the start the number of employees as grown steadily and they are continuously searching for engineers to employ.

As of today, Udelv has made 3.000 deliveries this year and they expect to have done 40.000 deliveries by the end of the year. The technology of autonomous driving cars exists, but the operations is in an early stage. Udelv focuses on testing, exploring and collecting data in order to define the right market to operate in and which products that fit the best for delivery by autonomous cars. The delivery of goods work very differently between different branches and the focus the last 1,5 years has been to understand these differences. The industries which has appeared to be most ready for delivery by self-driving vans are groceries and auto spare parts. The size of packages which can be transported can be adjusted for different types of deliveries. A restriction on size exists as the autonomous technology implies that the customer which handles the goods must be able to load or unload him or herself.

The potential market of returns is enormous. In order to operate in reverse logistics, autonomous cars needs to run a successful forward logistic operations. There are many uncertainties regarding reverse last mile. These uncertainties can mostly be solved by technology.

Globally, the legal issues whether it is legal to operate autonomous vehicles varies. In the United States, it depends on the state, but mostly autonomous vehicles does not face any legal issues. In order to succeed with, and to make reverse last mile pick-ups with autonomous cars happen, the customer behavior needs to change. The behavior also needs to change in baby steps which is a development that will take time. To make last mile delivery work sufficiently, the retailer experience and the customer experience needs to be right. Even changing current system to a new simple system will be challenging, and it gets more challenging the more people that needs to learn. When it comes to last mile delivery, the retailers are the one's loading the autonomous car with goods. In reverse last mile it is the customer doing these, why reverse last mile will demand more and visual tools must be invented.

Already today in the United States there is a lack of drivers within the logistic branch. Due to increased amounts of shipped goods the number of needed drivers will increase. The usage rate of autonomous vehicles in ten years is expected to be 80 % and in order not to miss out on business opportunities, retailers should already be considering to use autonomous cars as their delivery transportation mode. Not all products will be suitable for autonomous vehicles, why traditional transportation modes with a driver will still be needed for some more years in the future.

Approximately 65 % of the last mile cost today consists of the driver. This cost can be taken away for autonomous driving cars, although advanced technology will increase the cost. The final cost for autonomous cars can be reduced to 30 % of the cost compared to the traditional ways of transporting goods. A company using Udelv's delivering and pick up service is charged a service fee (a monthly payment) that depends on certain factors e.g. amount of vehicles.

4.3.5 Delivery from micro depots

One solution to the problem of growing congestion due to increased amounts of deliveries in urban areas is the micro-logistics approach. Micro-logistics as a concept refers to additional consolidation hubs located in or close to city centers, where consolidation of goods is done in order to conduct last mile deliveries with small vehicles. These vehicles are appropriate for congested city centers and can consist of small electric vehicles or cargo bikes. This solution has been tested at many different places in different set-ups, and Frankfurt is one of those. The City of Frankfurt am Main and UPS together with partners IHK Frankfurt am Main and House of Logistics and Mobility (HOLM) GmbH are working together to find innovative transportation solutions for city logistics. This is done by reinforcing existing economic incentives and thus enhance the effectiveness of sustainable logistics. In micro logistics, the goods are organized according to the different distribution channels of the customer and to transport the goods in a sustainable way, bikes have been identified as an appropriate mode of transportation (Eltis - The urban mobility observatory, 2019).

The concept with micro depots was first tested in Hamburg in February in 2012 by the company UPS. They placed four containers each weekday at central locations in Hamburg. The containers contained goods that were delivered either by three wheeled electrically-assisted cargo bicycles or by foot. On working days, this concept removed between 7 and 10 delivery vans from central Hamburg. This concept is being operated in many German cities. The City of Frankfurt and UPS installed a micro depot as an interim storage facility in the city center. Electrically cargo cruisers and hand trucks were used to deliver the goods to its final destination (Eltis - The urban mobility observatory, 2019).

The result of the micro depot project in Frankfurt shows that diesel fuel consumption has been reduced by 32 liters and carbon dioxide emissions by 85 kg per day, due to using three fewer delivery vehicles in the delivery operations. Annually, calculated with 300 operation days, this would lead to a yearly reduction of carbon dioxide emissions of 25,5 tons. In addition to this, the project also reduced the noise emissions and improved the air quality in the city center (Eltis - The urban mobility observatory, 2019).

A project called “Design and operation of an electric courier cargo bike system” analyzes the Micro Depot concept with cargo bikes in two areas in Munich. The paper focuses on finding the optimal location for the micro depot, optimizing routes and estimating the time it takes to deliver the parcels but also the environmental effects. In congested urban cities in Western Europe, the usage of cargo bikes as a delivery method is appreciated by both the inhabitants and the person executing the bike delivery. To enable the concept of micro depots, providing space for micro depots is essential. The location allocation of the problem was solved mathematically. In the second step the solution was adapted to urban constraints such as accessibility. The third step consists of optimizing the routing problem and compare these to different container solutions. The mathematical optimization showed that the average distance between a delivery stop and its closest container was 490 meters in the first area and the second area this number was 410 meters. Due to urban restriction these spots could not be used, and after further analysis the optimal spot ended up to be 570 meters of average distance in the first area, and 840 meters in the second area (approximately). In the second area it was shown that even if the theoretical optimal container spot differed 350 meters from the practical placement, the average extra duration of the delivery routes was only 5 minutes. This result shows that even if the container spot ends up being less optimal, the resulting bike routes are still feasible. The project was very successful and by extending the project and using all available capacity of the containers, 20 ton in local CO2 emissions could be saved every year due to diesel trucks that can be removed (Niels, Hof, & Bogenberger, 2018).

Another example of a micro depot solution has been tested as a pilot study in the city of Malmö, Sweden. This project is called “Samlastning I Sege Park”, translated to “Consolidation of goods in Sege Park”. All information regarding this project originated from the interview with Interviewee 6, if nothing else stated. See table 4.2 for more information. This project consisted of a micro depot located in the edge of the area Sege Park. Here all goods which were to be delivered to some public services in the area were unloaded. The goods were then reloaded to electric bikes and small electric vehicles. The goal of this project was to have a sustainable delivery of goods to the area, where they took all three aspects of sustainability into consideration; social, economic and environmental sustainability.

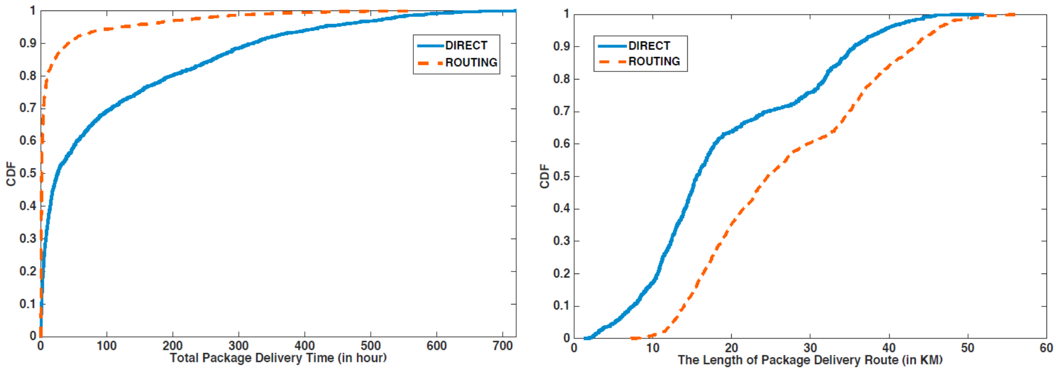
The project leader considered the project very successful. The impact of delivery by micro depot was evaluated by measuring the three sustainability pillars. The parameter which measured environmental impact was chosen to be saved carbon emission. This was estimated by calculating the amount of delivery vans which the project replaced. This parameter showed good results, as the deliveries conducted by the project were emission free. The social impact was harder to measure. Interviews with personnel at the different public services were conducted. These pointed at improved cognitive abilities of children as noise emissions decreased. The economic impact was measured with two different focuses; socio-economic impact and business economic impact. The socio-economic impact showed positive results, but the ability for it to be profitable for the business sector as well was the main drawback of the project. The solution with micro depot needed additional personnel compared to previous solutions, which represented the largest increase of costs. The project leader considered the location of the depot to be important in order to succeed. It should be possible to access it easily by truck in order to receive deliveries to the depot, often meaning outskirts of a city. At the same time, it should be close to the city center. These two factors combined results in an optimal location at the edge of a city center.

Using micro depots for last mile delivery has many strengths and great potential to be replicated on a larger scale, especially for middle sized cities and agglomerations. The project in Frankfurt am Main showed that the quality of logistics over last mile delivery was increased and made parcel delivery more sustainable and efficient. The business idea is consistent with the debate about driving bans in city centers. The operations regarding micro depots are environmentally sustainable and thanks to better management and better organization of deliveries, the spatial planning and safety for residents was improved in both projects. The project in Frankfurt am Main showed that the operational costs for logistics operators was reduced, while the Malmö project faced increased costs instead. Despite the many benefits, there are also some challenges. Economies of scale on the vendor's side is required especially in the beginning of the operation when a certain economic investment is needed. To keep the micro depot fully operational, it is important to guarantee a constant flow of goods. A challenge is to effectively manage the coordination between different stakeholders. This may be an entry barrier if the logistic operators, associations of retailers and the local administration have different point of views. The project leader in Malmö considered a successful cooperation between the public and private sector to be the key factor of success for micro depot deliveries.

4.3.6 Using Taxis in a reverse flow

A suggested solution by Pan et al. (2015) for reverse flow of goods is to combine taxi journeys with pickup of product returns. Two main reasons for choosing taxi cars are presented; their constant mobility covers most delivery paths and they are possible to trace by GPS in order to monitor the movement of goods. Two strategies of pickups are investigated in the study; direct or routing. The direct strategy means that the package should be delivered by one car trip only. The routing strategy identifies 'hotlines' of taxi journeys, meaning the most frequent taxi routes, and identifies an optimal route based on delivery by these lines. This strategy allows for transshipment between taxis.

The study was conducted by access to a database of taxi GPS traces which is simulated in the Chinese city Hangzhou. A collection network is drawn based on shops in the city to act as collection facilities. Based on the historical GPS data, the taxi hotlines are identified. The simulation horizon is decided to be limited to one month. Results of simulations are shown in figure 4.6 with respect to delivery times and distances. In figure 4.6a it is illustrated that the delivery time for direct pickups are longer, as a result of only using already existing taxi journeys. The distance for routing pickups is shown in figure 4.6b and is longer since the routing path may be longer than the direct path.



(a) Delivery times

(b) Distance covered per delivery

Figure 4.6: Cumulative distribution functions from results of simulations for direct and routing strategy. Source: Pan et al. (2015)

The authors believe that this crowdsourcing solution with use of taxi cars, since it makes use of available capacity without changing original routes, is more sustainable than other crowdsourcing methods, making the extra carbon footprint almost non-existing. The opportunity to taxi drivers to make extra money makes the concept social-friendly as well. The solution has to the extent of the authors of this report's knowledge not been tested as a real application. However, since it has been investigated using real data of city geographic and taxi routes it is very close to an actual application, and the results should be similar to those obtained by direct application.

4.3.7 Logtrade - Internet of Logistics

All information in the section below, if nothing else stated, originates from the interview with Interviewee 7, see table 4.2 for more information.

Logtrade is a digital logistics system that can handle buying, booking and managing transports with carriers. The system can easily be connected to the ERP system and can handle all administrative tasks in real time. Many features can be added to the system if needed. The company was founded around 20 years ago. Today, in collaboration with Ericsson, Logtrade is also developing and creating features for a system called *Internet of Logistics*.

Internet of Logistics is an open global communication standard for transportation and logistics data. It was initiated by Ericsson and is managed and developed by inter alia International Air Transport Association (IATA) and around 50 other stakeholders under Digital Cargo Forum (DCF). It was during the development of the 5G-standard as Ericsson realized that all direct and indirect service providers in trade, logistics and cargo transportation industry worked in silo structures, thus creating a huge interoperability-problem. Everybody present in the supply chain was only to various degrees digitized and they had different ways of exchanging data, which made communication between transportation- and logistics-branches and logistics companies difficult.

Because of the silo structures there was a need for a digital platform model of secure and controlled logistics data interactivity – based on an open standard. Not only did the traditional companies within logistics work in isolated structures – the definition of what could be a transportation capacity or warehouse was according to Logtrade too narrow: No matter if you are a private person on a bike or in a car, or a logistics company, you should be able to tap into the system and offer your services to move an object from point A to point B, or to offer your ”place” as a hub or warehouse. Logtrade emphasizes that the issues transcends the traditional boundaries of logistics. So while Ericsson saw that the whole logistics branch needed a complete ”make-over”, LogTrade saw that the definition of ”whole logistics industry” was insufficient.

Internet of Logistics opens up for a better flow of data from source to factory, from factory to consumer and from consumer to recycling – thus possibly enabling and facilitating a circular economy. Internet of Logistics is both the name of the semantic data model standard and the concepts inherent ambition to create a world wide web for supply chain.

To enable smarter actions from the actors in the supply chain, logistic data must be exchanged on a virtual platform-based infrastructure for data exchange. Logtrade has used the Connected Logistics Chain (CLC) before Internet of Logistics was developed, which is a structure which connects shippers, carriers and places to each other. Today, Logtrade allows for these operators to be coordinated by using the Internet of Logistics standard to describe a product and the participators. The system is putting the actual product in the center. The product is given an URI and an identity and can thus control its own way in a logistics flow. Logtrade's platform can be used both as a large, shared network and as a local, company specific network. The platform and standards are still in a development phase.

Internet of Logistics is an ongoing project with many applicable areas. Right now it is only a platform for collaboration and the power of the tool depends of what it will be used for. The costs related to use of the platform is therefore unclear. As of today, the payment model works as a monthly fee payed be the participants. The cost of a delivery is thought to be an agreement between the actors to be applied for each delivery or pickup. Logtrade then facilitates the transaction. At the heart of its value, LogTrade and Internet of Logistics reduce the correlation between being (for example) an efficient carrier and having to make heavy investments in digitizing once private internal logistics-infrastructure. Also, because it enables every moving object and every physical place to tap into the system, more capacity is created without any new production. This leads to higher fill rates and more sustainable delivery solutions, locally and globally.

4.4 Enabling Innovations

4.4.1 Repack

When the product has reached its end-of-life and is ready to be transported back into the supply chain there is a need to pack it and protect it with packaging. Repack offers a sustainable solution to this purpose. Repacks business model is to offer reusable packages and their core business is to design reusable packaging for industrial purposes. The purchased product is packed and transported in a Repack to the customer. The customer can fold the Repack and post it on the closest postbox and the repack is send back to the company who controls it and assures that it can be used again. Repack does also offer solutions for large products, such as Sofas. Repack and the concept would also fit for the reverse last mile and the bulky goods could be packed into it and transported. The material of Repack is waterproof, although the seams are not (Repack, 2019).

4.4.2 Glue Smart Lock

Glue Smart Lock is an innovation that enables deliveries to enter inside one's home, even when the resident isn't home. In this way the deliver and the customer never needs to meet, which is an enabler for deliveries as well as pickups. The door can be opened by the resident with an application on the mobile phone. The mobile phone is used as a key and with this system you can open the door for family, friends and food deliveries that can be place immediately in the fridge, without giving out the key. The phone gives push notifications about who enters the door and who leaves (Glue, 2019).

Chapter 5

Expert Interviews

This chapter describes the empirical findings of the conducted expert interviews. The areas investigated are challenges and trends in city logistics and possible future transportation modes.

One of the data collection methods used in this study is expert interviews. All interviews conducted are summarized in table 5.1.

Table 5.1: Interview information for expert interviews

Expert number	Title	Date
Expert 1	Team Leader Strategy Creation and Innovation at Volvo Cars	3 April 2019
Expert 2	Contact person at Urban Freight Platform	25 March 2019
Expert 3	Professor Emeritus at Lund University	27 March 2019

5.1 Expert Interview 1

5.1.1 Background

Expert 1 is the Team Leader Strategy Creation and Innovation at Volvo Cars. The expert focus on product development and specifically with electronics and software. This area includes autonomous vehicles and future mobility in urban areas. The expert investigates different mobility systems and prerequisites on a strategic level with a long term time horizon. The car industry is in a digital revolution and the branch entered this relatively late compared to other. In a fast changing environment with many competitors, it is especially important to act quickly, be innovative and be able to test ideas. The expert's role is to prepare Volvo for new innovations and new business models in order to see what can work in the future, why the expert has deep insight in trends and challenges for city logistics.

5.1.2 Challenges with city logistics

The expert focuses on transportation of people on a systematic level. There are some similar challenges and trends and two sectors, people and goods transportation, have a great influence on each other. The amount of transported goods and people are different depending on what time of the day it is. This causes challenges for how to optimize and manage this in the best possible way, both in a business and a sustainable perspective. Large amount of people and goods transportation during the same time causes pollution, congestion and noise and this wants to be avoided. As a result of this, many cities have introduced restrictions of how and when goods transportation are allowed to operate. The times when people movement happens the most is the same every day, normally mornings and late afternoon. The route the people does, is naturally not the same and this is the core challenge with transportation of people. The solution lies in investigating the reason for why we move people and goods around.

In order to proceed the city logistic development the car as a transportation mode and the infrastructure needs to cooperate. The car itself is facing a great challenge as we for 100 years has built up our society under the assumption that people can buy a car and get around in that way. That has changed and will change more as more modes of transportation will enter the market. To add complexity to the problem, cities differs in many ways and the prerequisites are different.

5.1.3 Identified trends within city logistics

Legalization regarding transportation restrictions in cities is becoming a more and more common phenomena. Cars are in a higher extent banned in central areas in order to improve the environment. Mixed mobility systems will most likely in the future exist in the outskirts of a city, and outside of that the individual mobility will still be the dominating way of transportation in the future. In order to have a well-functioning and profitable public transport system, the density of people must reach a certain density. A concept to overcome the transportation problem with people and goods is divide the transportation of goods and people. The point is to transport people morning and late afternoon, and outside if these hours, do transportation of goods. There are many concepts regarding these ideas.

5.1.4 The future of transportation

Automatization of vehicles is a concept that has increased in interest the last years. The automatization of vehicles demands changes in the infrastructure. When autonomous vehicles are ready to enter the market, one of the biggest challenges will be how to relate to different transportation modes. Having only one type of transportation mode in a city's vehicle fleet won't work for many different reasons. Society will have to manage having both manual and autonomous vehicles. The handling of the diverse vehicle fleet will be the greatest innovation in the future.

Autonomous droids does already exist on some markets, and they have already been banned from some specific hours due to disturbing passengers on sidewalks. The droids that exists today does not have enough volume to transport furniture, but theoretically it would be possible to have droids with larger volume. A problem that would occur is the pick-up activity of the furniture as this can't be handled automatically. Autonomous droids with a built-in pick up system is far away in the future.

5.1.5 Other

The car and many other modes of transportation are facing sustainability issues as the amount of energy that is used to transportation is too large. Producing products in a way that they can easily be reused or recycled is something that needs to be focused on.

Moreover, new business models can increase sustainability overall and it is getting more and more common. Leasing models and pooling concepts are two business models that Volvo has introduced.

5.2 Expert Interview 2

5.2.1 Background

Expert 2 is contact person for an initiative called Urban Freight Platform, a collaboration between Chalmers University of Technology, University of Gothenburg and Volvo Research Educational Foundations. This platform aims to facilitate research regarding urban freight which is aligned with sustainability goals and urban livability. He has a Ph.D. in transport engineering and works as a lecturer at Chalmers University of Technology.

5.2.2 Challenges with city logistics

One of the main challenges of future city logistics is described to be the volume and number of deliveries, which are only estimated to increase in the future. In Gothenburg alone there are 40 000 to 50 000 trips conducted each day with a total of 15 000 tons of goods. It can be easy to think that one solution only will solve the problems of deliveries in cities, but the volumes are too large. Instead a lot of different solutions will need to be implemented in the future.

There is a lot of different actors involved in city logistics; transport operators, shippers and receivers, local authorities, independent operators, real estate owners and local communities to name a few. The most obvious challenge for the future is the willingness of these actors to participate. It is important to understand that deliveries makes up for a whole system, meaning you can not only look at the impact if you change one of the entities but rather take a systems approach of the change. One vehicle alone will not make an impact if it is not accepted and used by the whole system. The system of deliveries also means that it is important to consider all actors which are affected when suggesting a change to the system. Their incentives and objectives need to be taken into consideration. One example is implementation of night time deliveries in two different cities; Huangzou in China and New York in the US. In China, the city introduced a restriction of deliveries by day and expected the night time deliveries to increase. However, the retailers did not change their expectation of when to receive goods and a lot of violations of the restriction took place. In the US, the program was more successful. The focus was to change the behavior of retailers in order for them to push the development. This was done by financial incentives for night time deliveries. As a result the receivers of goods started trust programs in order to let transporters have access to facilities for night time deliveries and many night time deliveries were conducted.

The complementary innovation which is needed for city logistics is therefore to change the behavior of customers. If they want to participate in a new, sustainable system, this system is more likely to happen. If the receiver is not willing to change restriction of deliveries, the transporters cannot do anything to change the way they are delivering. They need to meet the demand of their customers. Thus, the implications of different solutions for customers are important to consider.

5.2.3 Identified trends within city logistics

A common solution in Europe the last five years is urban consolidation centers. They have been successful in order to improve deliveries but not financially stable without city subsidiaries. Off-hour deliveries is another innovation which offers benefits for efficiency of the transport company and congestion in cities. Other innovations are electric bikes and small electric vehicles. Which solution that is suitable depends on what problem you are trying to solve – they all help with different things. The expert and his team have recently published a paper on what solutions which will fit where. The results tell that what transportation methods which are suitable to implement depends a lot on local conditions. It is also necessary to have different solutions.

Other identified possible transportation modes are autonomous vehicles, such as drones and delivery vans. Drones can be applicable for some types of deliveries; medical deliveries or sensitive products. Autonomous vehicles will be implemented as well, but it might take longer than what some experts have expected. In 5-10 years autonomous vans will not yet be used, instead most goods will be moved by trucks like today. One big barrier of implementation of autonomous vans is the monetary flows. To invest in autonomous technologies is expensive, and the greatest saving which can be done is that of the salary of the delivery person. However, when investigating how time is spent when delivering, 33% is spent driving but as much as 55% of time is spent on side activities of delivery. These activities can be calling customers, going to and from the customer's door, loading and unloading goods. All these activities need to be replaced simultaneously with that of driving, and this makes up for a too high investment as of today. The driver could be kept in an autonomous van in order to conduct the actual deliveries, but when the cost of salary is not excluded, the investment becomes too high as well.

5.2.4 The future of transportation

The solutions of future transportation are not easy to pinpoint. Trucks and traditional methods of transportation will probably still be used. Electric and low-emission vehicles have the possibility to conduct a sustainable collection and delivery of goods. A lot of different solutions need to be implemented – probably all of the suggestions above. However, they are all suitable for different types of goods, places and contexts.

The main challenge for the future is associated with customization of deliveries. E-commerce and residential deliveries are generating almost as many deliveries as B2B already. As long as people are not conscious of how their higher expectations on delivery time and location affect urban traffic and the environment, there is little hope that technology can decrease the negative impacts of urban freight.

5.3 Expert Interview 3

5.3.1 Background

The third expert is a professor emeritus in Engineering Logistics at Lund University. He holds a Ph.D. in Industrial Engineering from Stanford University, an M.Sc. in Electrical engineering from the Royal Institute of Technology in Stockholm and a MBA from the University of Stockholm. Expert 3 has also been professor of Logistics and Transport systems at Linköping University for 20 years and working with economics and future studies at the Swedish National Defense Research Institute for 5 years.

5.3.2 Challenges with city logistics

An enabler for last mile deliveries and reverse last mile pick-ups is to disconnect the deliverer with the customer. Delivery times is a critical factor and the cost will increase when the times for delivery must happen within a thin time frame. In order to succeed with the deliveries, the key is to disconnect the customer from the deliverer. This is a challenge for the transportation industry and innovative solutions to this is starting to appear on the market. Digital keys, delivery to the persons garage, car or outside the door are examples of this. The idea is based on separating the deliverer with the customer on a neutral and safe spot. Box-deliveries is a concept many companies are working with. The goods are delivered to a box and the person receiving the package can by identifying themselves open the box and access the package. These concepts for decoupling the customer from the deliverer could with some modification also be used for reverse logistics. Further upstream is normally the last mile deliverer decoupled from the forward logistics by a terminal, most often specific to the transport company. A common policy has been to set up brand neutral urban consolidation centers to consolidate the last mile shipments to costumers. These could be used for reverse logistics.

5.3.3 Identified trends within city logistics

When it comes to recycling and reuse of furniture, recycling centrals and second hands are working together in a greater extent today, at least in Sweden. Scalability can be achieved when the products are being brought to one common place. In some places, the municipal waste collection system picks up the bulky goods for free a few times and drives it to the recycle central but after a certain amount of times, it can be done for a fee.

The emptying a home after someone has passed away can be done by several types of firms. They take care of everything that exists in the home. The most expensive furniture are sold on an auction, products that are in a good shape are being sent to second hand stores and the rest is sent to recycling stations. Removal firms often have storing capacity which is an advantage when it comes to using full capacity of the transports from the moving firm. A partnership with moving firms could enable efficient take back service of products. There are actors that receives old furniture from moving firms, repair them with workforce that has a hard time to get other jobs. The furniture are then sold to second hand and there has been some success stories with this concept.

Autonomous vehicles such as drones in the air, droids at the sidewalk and autonomous cars are in a very interesting phase right now and startup companies operating with these are receiving a lot of financial support. The disadvantage with autonomous vehicles is that someone still has to do the on and off loading of products, they take up space, security and safety issues, and some cities require a remote pilot or a person walking with it. Due to this the advantage with autonomous vehicles when it comes to deliveries is not significantly large. If the technology allows the on and off loading to be autonomous in the future, it would make more sense to have autonomous vehicles in a delivery and pick up concept. Flying drones as a delivery method is precluded as it is expensive, adds noise and implies a risk of falling down. Drones transporting pallet size goods in tunnels requires large investments and does not exist in a large extent although it has been tested. The use of cargo bikes in city logistics, both of private persons and as a service to buy, is increasing and as a person is required for the driving, a person will also be there for the on and off loading.

5.3.4 The future of transportation

A key factor when it comes to efficient and optimized city logistics is to coordinate all kinds of transportation modes and movements in an area. Private persons, private companies and logistics firms could be included in a common information platform in order to optimize the transportation with respect to time and capacity in the best possible way. A common system that would connect transportation's and sell over capacity would have both economical, socioeconomic and environmental benefits. The system would demand data of the shipment volume, weight, sender, receiver and specific requirements in order to make it work. This is not done on a large scale today but it could happen in the future if the right incentives and policies are put in place. Such concepts go under the name of horizontal collaboration or physical internet and this is a highly relevant topic today. Physical internet is based on the idea that all transport resources are available for everyone.

A possible driving force behind the change is that the contracts and cost models for the infrastructure changes. If the cost model "Pay per Use" would be implemented on infrastructure this would mean that it would cost more for non-renewable fuel driven vehicles to operate on roads.

5.3.5 Other

The most convenient way of handling returns is to match the delivery of new products with removal of old ones. E.g., the deliverer takes the old product with them when the new product is delivered. This is the common practice for white goods as fridges. This is a simple way of making return of goods work although it demands that the person wanting to get rid of a product is the same person that buys something new and this is not always the case.

In some places in Australia and the US people put the old furniture on the street on a special day. Anyone can go and take the furniture if they want and the furniture that are left are being taken care of by the municipality. In some apartment buildings in Sweden a storage room in the cellar serve a similar function.

Designing products and furniture for reuse and for transportation would make the circular business model an easier task. A new convenient design of products is needed on order to disassemble and sorting the product, and to give it a new life. The amount of re-use and re-cycling depends on the regulatory requirements on the actors. Such regulations for packaging and electronics have been in use in most countries since long.

Chapter 6

Analysis

This chapter consists of the analysis of existing cases, presented in section 6.1, single-case analysis of innovative cases, presented in section 6.2 to 6.9, cross-case analysis of innovative cases, presented in section 6.10, and lastly the challenges of reverse last mile, presented in section 6.11. All sections aim to answer one or several of the research questions respectively. More specific, section 6.1 answers RQ1, section 6.2 to 6.10 answers RQ2 and RQ3 and section 6.11 answers the last RQ4.

The result of the analysis of all cases and of challenges is based on the research framework presented in section 3.7. In the analysis of *innovative cases*, specific parameters which relates to the different areas are used and extends the framework. The addition of parameters is illustrated in figure 6.1. The parameters are determined by analysis methods described in 2.3, where their ability to distinguish the feasibility of innovations is what formed the basis of the decision.

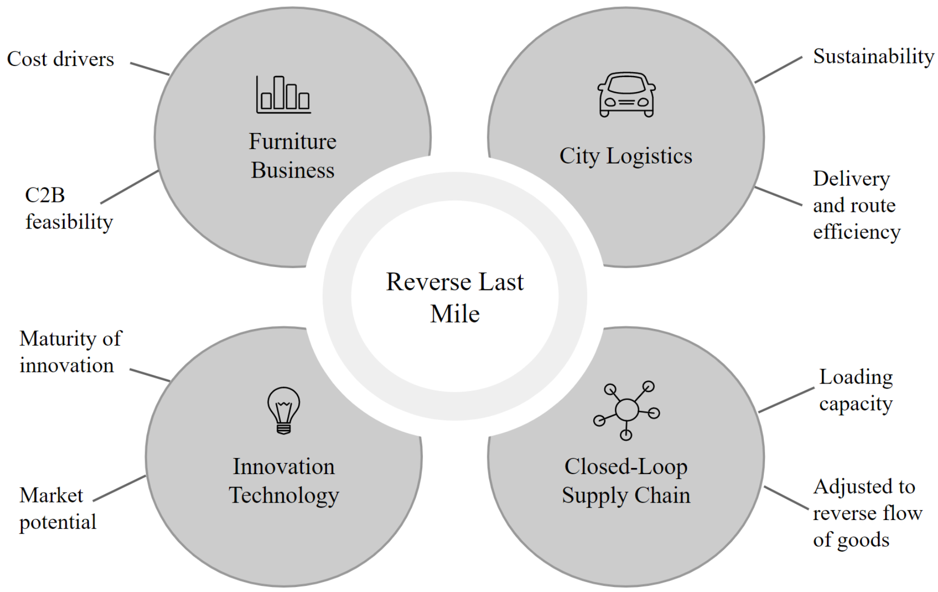


Figure 6.1: The research framework and its additional parameters. Source: Own illustration

A description and motivation of the parameters used in the analysis is found below:

Firstly, the area of Innovation technology discusses the feasibility of possible implementation of this solution as reverse last mile. The parameters chosen summarizes the ability of implementation and are:

- *Maturity of Innovation*: Means how developed and tested the innovation / concept is, and how ready it is to be used in a reverse supply chain.
- *Market potential*: Estimates the market potential today in order to estimate future development of the innovation or concept.

The second aspect of feasibility; Closed-loop supply chain feasibility, consists of how well the cases can handle the specific characteristics of reverse flow of goods and the ability to transport furniture. The parameters used summarizes this feasibility as they discuss the differences between forward and reverse flow of goods and what the capacity of pickups is. The parameters are:

- *Adjusted to reverse flow of goods*: A parameter which discusses the ability to handle characteristics of reverse last mile, more specific inability to forecast, many-to-one transportation and unknown product quality.

- *Loading Capacity*: The parameter aims to estimate and compare the size of the volume in the transportation mode or concept. Larger volume is to prefer, as the transportation mode must be able to transport large furniture.

Another feasibility of innovative cases which will be analyzed is that of city logistics and its future challenges. The main challenges for city logistics are environmental sustainability and need of increased efficiency, why the possibility for each case to meet these challenges are considered as analysis parameters. More specific, the parameters are:

- *City Logistics Sustainability*: City logistics sustainability refers to environmental sustainability and involves level of congestion, level of emissions and noise, caused by the transportation mode.

- *Delivery and route efficiency*: Delivery and route efficiency shows to what extent the concept/transportation mode can easily access delivery spots in the city, how easily it can park, and how it is being affected by time windows restrictions.

Furniture business feasibility is the last aspect of feasibility. In order to be a possible transport solution for reverse last mile for a furniture company, it is important that the company in question is possible to cooperate with. This importance is why furniture business feasibility is chosen as a last aspect of feasibility. The cost aspect is also included here. The parameters used are:

- *Cost drivers*: Describes what cost drivers that are present in a reverse last mile set-up.

- *C2B Feasibility*: Answers whether the cases are feasible for partnership and for C2B operations.

6.1 Cross-case analysis of existing transportation solutions of reverse last mile

This section aims to analyze and answer RQ1: How can existing solutions of reverse last mile be applicable in a set-up for a furniture manufacturing company?

The existing cases will be directly compared in terms of a cross-case analysis. Single-case analysis is not conducted since the findings showed that the applicability for furniture companies was low for all cases, and a direct comparison was decided to provide more value to the whole analysis. The analysis compares their reverse last mile solutions as of today by use of the research framework, both with each other and with literature. The applicability for furniture companies is then analyzed.

6.1.1 Innovation technology

A common aspect between the three studies of existing solutions are that transportation modes used in forward flows are used for reverse logistics activitiesas well. Sellpy uses the same types of pickups which are common for regular delivery of goods. Berendsen and Bring uses the same return transports. No specific reverse optimization methods or tools were used in either company. Srivastava (2008) suggests that processes needed for forward and reverse logistics are different, which is not shown by these three cases.

6.1.2 Closed-loop supply chain

The three cases of existing reverse last mile solutions represents three different ways of working with reverse logistics and reverse last mile. Firstly, all companies are part of different types of reverse supply chains. Berendsen operates with a closed-loop supply chain as they have closed their own loop. Sellpy, who focuses entirely on reverse flow of goods, are a part of an open-loop supply chain, where other clothing companies are the manufacturers. Bring as a transporting company, operates partially in the open-loop supply chain as well. The reverse supply chain activities are also different. Sellpy conducts many of the reverse activities found in 3.2, but offer no reconditioning activities. Berendsen instead focuses on the reconditioning activities, and conducts most of them as well. Bring has a service where they offer to pick up bulky products and transport it to the recycling center and thus only conduct a few of the activities. Hence, the reverse supply chains and reverse logistics activities of today can look different between different companies.

The reverse last mile decisions regarding network and transportation modes looks different between the three companies. The different decisions are supported by Gooley (2002), who states that product characteristics, transportation costs and return volumes affects the decision, all which differs between Sellpy, Berendsen and Bring. Sellpy operates with small packages, Berendsen with large products and Bring operates with both large and small products. Transportation costs are higher for Sellpy as all products will be transported to Stockholm. Return volumes are not stated specifically in the cases but as Berendsen distributes larger products with high return rate, they are probably faced with larger volumes. Bring also shows this distinction as they have chosen different transportation modes depending on distance and characteristics of goods that are being transported. They have in addition chosen different network designs. Sellpy uses 3PL and Berendsen does not. According to Stock et al. (2006), this could be based on that Sellpy lacks funds and experience to conduct reverse last mile activities in-house.

6.1.3 City logistics

One of Sellpy's transportation mode is cargo bikes which does not add to external environmental effect such as congestion, pollution and noise in the same way as a tradition delivery method does. Berendsen uses cars or smaller vans for delivery and pick-up and Bring uses a mixture of vehicles. The challenges of city logistics in the future might therefore not be met by the transportation mode decisions of these companies.

In summary, Sellpy, Berendsen and Bring have made reverse last mile decisions based on three different parameters; Sellpy uses population density as base of decisions, Berendsen uses existing transports as base and Bring uses type of goods. The predictability of returns and possibility to fill an entire truck are two major differences between the three. These parameters also forms the basis of whether to do the activities themselves or not for Sellpy and Berendsen. All vehicles used are not optimal for city logistics development.

6.1.4 Applicability for furniture business

For furniture companies, product characteristics, transportation costs and return volumes again look different from that of Sellpy and Berendsen but a similar to those of transport of bulky goods for Bring. The products are bulky such as for Berendsen, but the return volumes are probably lower as a piece of furniture is kept for a long time in a household. Depending on own access to funds and experience in a single furniture company, the reverse network design might look different between companies. Based on this comparison, both decision parameters of Sellpy and Berendsen can be used for a furniture company as well, to set up a reverse network.

As Bring, Sellpy and Berendsen use existing solutions of forward logistics, furniture companies can likely use the same methods as they are using for forward logistics as well. However, as either Sellpy or Berendsen have investigated other possible solutions to handle reverse last mile, it is possible that the use of existing methods is semi optimal. Bring operates with furniture in urban areas and they are well known with its challenges. They are aware of the increasing trend of reverse last mile operations and do investments in new innovative transportation methods.

It was difficult to find a company which focuses on and has a well-developed solution for reverse last mile, both in the studied cases and in the proposed cases. The existing solutions of reverse last mile are somewhat applicable for a furniture company, but there exists a lot of potential to develop new concepts and be a leader in innovation of reverse solutions.

6.2 Single-case analysis of innovative transportation solutions and technologies

This section aims to analyze and answer RQ2: How feasible are new innovative transportation solutions and technologies for a reverse last mile set-up?, as well as RQ3: What monetary drivers are present when operating within reverse last mile solutions?

6.3 Case 1: Movebybike

6.3.1 How a reverse last mile set-up can look like

Reverse last mile with Movebybike would be conducted simultaneous with the last mile operations. The bike would be able to pick up goods under the assumption that there is free loading capacity available. The pickup of goods would be ordered in the same way as for deliveries of goods and transported to Movebybike's hub for warehousing and consolidation.

6.3.2 Innovation technology

Bikes as a transportation mode is not a new innovation, but movement of goods with bikes are. The maturity for bike transportation is thus not dependent on the vehicle as such, but on the perceptions of it as a transportation mode. The customer perceptions of bikes as a suitable delivery vehicle is represented to be low by Schliwa et al. (2015).

Movebybike is an innovative startup, run with an entrepreneurial spirit. They have operated for a few years but the company has the last years taken another direction and their strategy is starting to clear out. Movebybike faces a higher demand of their services than they can meet. The competition regarding cargo bikes transporting companies is low, almost non-existing on the geographical area they operate on. As described in section 4.1.7 the future predictions for city logistics is that cargo bikes will be used as a transportation mode in the future. However, Schliwa et al. (2015); Oliveira et al. (2017) presents the big market opportunity for companies bigger than Movebybike, which might be a hindrance for further expansion.

Movebybike lacks vehicles, which is hindrance to run the business as wanted. This is an issue which they need to overcome in order to be successful in the future.

6.3.3 Closed-loop supply chain feasibility

Movebybike is today operating with both last mile and reverse last mile in a successful way. It is consistent with the study of Wrighton and Reiter (2014), who states cycle logistics as particularly suitable for reverse last mile. There exists several differences between forward and reverse logistics, and handling the characteristics of reverse logistics is needed in order to be well suited for reverse last mile. An overview of the differences is presented in table 3.1, where the first three is regarded as most relevant for reverse last mile options in this thesis. Firstly, it is difficult to forecast when a return of a product will be initiated. As Movebybike is run as a traditional delivery company, some forecasting is needed for their business in order to be efficient and for storage in the warehouse which therefore can be an issue. Many-to-one transportation network for reverse last mile works well for cargo bikes and forward and reverse flow of goods can be combined in the bikes. However, the loading capacity of a cargo bike does not allow for a lot of pieces of furniture to be loaded at once. More on this below. For pickups of goods, a benefit with a cargo bike is that they can get close to the pickup point. Lastly, the product quality is different among products in reverse last mile. The quality can to some extent be controlled by the driver of the bike at time of pickup.

Movebybike has done a few pickups of furniture but lacks the continuous large scale experience of operations in order to identify some of the risks and uncertainties with reverse last mile delivery, described by Srivastava (2008); Fleischmann et al. (1997).

Movebybike holds the loading capacity on their bikes to transport almost every item that exists in a home. The distance which the bike route is suitable for, is estimated to 7 km by Wrighton and Reiter (2014). Many cargo bikes has less capacity than a truck, although Movebybike's cargo bikes and trailer are designed to have almost the same capacity as a smaller van. Hence, when it comes to reverse flows and pick-ups, keeping track of the free capacity in the cargo bike is highly recommended, as well as sharing information regarding the size, volume and weight of the product that is being picked up. Due to the limited volume, flatpacks would be preferred to transport in cargo bikes, rather than fully assembled furniture. The cargo bikes are run by one person, and heavy furniture might require two persons to load the furniture, unless a helping lifting tool can be used.

Movebybike is requesting a system that optimizes and plans the route for a cargo bike but according to the company, such a system does not exist today. The software that are used for route planning today are based on specifications of a truck or van, and since cargo bikes have different characteristics, those software's are not satisfactory enough for cargo bikes.

6.3.4 City logistics feasibility

Cargo bikes compared to traditional delivery diesel trucks, brings with various sustainability advantages such as reduction of congestion, noise and emissions, as described in section 3.4.1. Sustainability in city logistics in this paper refers to the environmental aspect of sustainability. Further, as described by Cardenas et al. (2017), a good transportation mode in future city logistics should contribute to an efficient handling of goods and enable a larger amount of goods to be handled in the city. These factors Movebybike's cargo bikes allows for, as they enable time efficient deliveries and pickups. Movebybike states that they can do the deliveries more efficient than a traditional delivering truck. As described in section 4.1.1, time windows for deliveries, parking restrictions and other types of regulations are increasing for traditional delivery vehicles such as vans, mentioned especially by Cardenas et al. (2017). A benefit with cargo bikes is that these restrictions can be avoided by use of them for deliveries or pickups. Expert 1 states that adaptability for future changed infrastructure is required for transportation modes operating in a city. These requirements are met by Movebybike, as complex existing infrastructure is not needed for Movebybike in order to operate.

Cargo bikes are most suitable in central areas of a city and in urban areas where the distances are relatively short and the population density relatively high according to Wrighton and Reiter (2014) and Schliwa et al. (2015). On a global level, it is hard to draw conclusions regarding cargo bikes feasibility, due to variation regarding population density, topography, legal restrictions, infrastructure and distances of cities in the world. The suggested route length of 7 km for cargo bikes demands an increased amount of reloading hubs at strategic positions.

6.3.5 Furniture business feasibility

Due to the lack of bikes, it is problematic for them to run their operations as wished. Movebybike is facing increased number of requests from companies that wants to build partnerships with them and have their products delivered by bike, and Movebybike will most likely be ready for collaboration when the bikes are in place. The company can be used in a traditional business agreement of deliveries, why it is feasible for C2B operations.

The cost drivers for Movebybike for operating in last and reverse last mile delivery consists of salaries to employees, cost of a reloading hub and the cost of extra reloading. The biggest cost driver is the personnel. The vehicles are a one-time investment and the cost of usage is low. In order to be profitable, high delivery efficiency is required compared to traditional delivery methods in order to make up for the extra consolidation and deconsolidation needed.

6.3.6 SWOT Analysis

Strengths	Weakness
• Ready to implement reverse last mile operations • High loading capacity per bike • Lower cost than traditional methods • Higher delivery speed than traditional methods • Sustainable transportation modes	• Little experience of reverse last mile operations • Requires development of the network • Customers values bigger transportation companies higher • Difficulty to handle some differences between forward and reverse last mile
Opportunities	**Threats**
• Expandation possibilities • High interest from e-commerce actors • High feasibility for small packages • Could get advantages from legal changes • Advantageous future predictions for cargo bikes	• Capacity of bike production

Figure 6.2: A SWOT analysis of Movebybike

6.4 Case 2: Pling Transportations

Pling and Movebybike have very similar challenges, as they are both cargo bike transporters operating in last mile and reverse last mile deliveries. General challenges and analysis for cargo bikes has been described in earlier section and will not be repeated.

6.4.1 How a reverse last mile set-up can look like

Pling's set-up would be very similar to Movebybike's. The pickup of goods would be done on the same route as the deliveries of goods are being done, if the capacity allows it.

6.4.2 Innovation technology

Pling is a small but steady growing company with experience within the cargo bike last mile delivery operations. The company has a clear vision for the future and wants to expand to new markets. Pling is an innovative company and they are open to try new types of transports and to partnerships. They strongly believe that their market will expand and that new opportunities will appear during the upcoming years. As described in section 4.1.7 the future predictions for city logistics is that cargo bikes will be used as a transportation mode. The bikes can room both bulky and non bulky products but there is a certain size restriction.

6.4.3 Closed-loop supply chain feasibility

Pling's cargo bike can easily access the customers and are easy to park when the delivery is going to be made. The capacity of Pling's bikes is a bit smaller than Movebybike's, meaning that they can take fewer pieces of furniture in one load. Pling operates with a weight restriction, but the weight capacity is still higher than what Oliveira et al. (2017) has reported. They have operated successfully within reverse last mile, although lacks experience to a large extent, meaning that they have not been able to experience the risks and uncertainties described by Srivastava (2008); Fleischmann et al. (1997). Flatpacks would be more suitable for Pling as the bikes loading capacity is smaller than Movebybike's. In addition to this, flatpacks is preferred as they do have a small reloading area with little storing possibilities, as of today. Just like Movebybike, Pling is also in the need of a software which optimize the route for cargo bikes.

6.4.4 Infrastructure feasibility

The bikes Pling use is designed to fit the infrastructure and the city logistics. The bikes are designed to be low in order not to obscure the sight and in order to minimize the risk of falling over, although this has resulted in smaller loading capacity than Movebybike's. The bikes has been tested by several companies in order to improve the quality of those.

6.4.5 Furniture business feasibility

Pling as Movebybike has conducted reverse last mile transport previously. It is run as a traditional delivery company, why C2B feasibility is high. They have also conducted several successful partnerships and has good opportunities for this in the future as well.

The cost drivers for Pling is very similar to Movebybike's. The greatest cost driver is salary of the driver and the cost for delivering goods is slightly lower than delivery by truck.

6.4.6 SWOT Analysis

Strengths	Weakness
• Well functioning organisation • Progressive and opportunistic organisation • Ready to expand and implement reverse last mile operations	• Lower capacity in the bikes • Little experience of reverse last mile operations • Customers values bigger transportation companies higher • Difficulty to handle some differences between forward and reverse last mile
Opportunities	**Threats**
• Well aware of the increasing trend of cargo bikes as a delivery method • Identified an increasing market • Advantageous future predictions for cargo bikes	• Feasibility of bulky goods

Figure 6.3: A SWOT analysis of Pling

6.5 Case 3: Tiptapp

6.5.1 How a reverse last mile set-up can look like

Tiptapp's business model works well for both forward and reverse flow of goods. The reverse last mile would be initiated by a requester, requesting a pickup of a product to be delivered to a certain destination. A transporter would accept the request and organize the transport. All communication takes place between requester and transporter. The transport is facilitated by Tiptapp's application. Companies can be involved either as transporter or requester and then operate with the same conditions as a private person, or as a collector of goods at a drop off point.

6.5.2 Innovation technology

Tiptapp offers a crowd logistics service specified as crowd local delivery by Carbone et al. (2017), as their customers arranges short distance transportations. Tiptapp has developed the application where transporters and customers meet, which is often used in crowd local delivery. Literature discussing crowdsourcing is relatively young but it exists a lot of different research on the subject, as seen in section 4.1.5, which implies a high maturity of the innovation. Tiptapp themselves however, experiences some resistance from customers and a less mature product. The company itself now consists of 18 employees and has a well set-out strategic direction, why the development of the company has passed the stage of start-up. They are focusing on their current business model and are not focused on new innovations.

The numbers of users of the applications today can be compared to the number of inhabitants in Stockholm, as well as with estimated number of deliveries in a city per day. 200 000 users of Tiptapp accounts for approximately one fifth of the Stockholm population. Expert 2 reported approximately 40 − 50 000 deliveries in Gothenburg city, where many of these are not for private customers, and results from a city smaller than Stockholm. With these facts, a broad conclusion can be made; Tiptapp has unexplored market potential. Tiptapp experiences no competition, why they can take a large market share. It is important to note that it might not be possible to take a large market share of this total amount of deliveries, as these are not only conducted C2C. More discussion on this in section 6.5.5. Other cities are also possible for expansion, as they have already planned themselves.

6.5.3 Closed-loop supply chain feasibility

Tiptapp's system is built on matching random requests with random transports and the transports are conducted independent of each other. This makes the system insensitive to difficulty of forecasting reverse last mile pickups. Thus, the problem with difficulty of forecasting is to a large extent avoided with use of a crowdsourced solution. The independent transports also means that many-to-one transportation of reverse last mile is not an issue for Tiptapp's business. As the requester needs to describe the item which is being picked up, the product characteristics are also somewhat known prior to a pickup. Altogether, the differences with reverse last mile compared to last mile is handled by this crowdsourced solution. Tiptapp has been handling reverse last mile transports since the beginning of their business, why the risks connected to the uncertainties should be well known by the company.

Different types of transportation modes can be used depending on type of product and on transporter assets, why the loading capacity of a transportation differs between each transport. As the most commonly transported product is a sofa, most transporters have the capacity to handle one of these. As it is possible to assume that the most common mode of transportation which transporters own is a regular car with a restricted loading capacity to approximately 2 m length and 1 m width, the smaller the product which will be transported is, the more the possibilities of transports increase. Who should be present at loading can be determined by agreement of the requester and transporter, why any amount of people which are needed for loading can be present.

What decreases feasibility for both transporter and requester is lack of laws and regulations adjusted to crowd sourced solutions, as reported by both Tiptapp and discussion of risks by Carbone et al. (2017).

The average time to receive a transporter is 2 hours. The speed of pickup can therefore be high, but is also hard to know what to expect as an appropriate transporter needs to be available. The place for drop-off is assumed in this report to be at a fixed spot in a city center. If this place is not passed when conducting ordinary car trips, it might be hard to match a transporter with the final destination.

6.5.4 City logistics feasibility

Current issues with congestions and emissions might not be solved with use of crowdsourced solutions. Both improved and worsened sustainability of transports are discussed in literature by Rai et al. (2017); Paloheimo et al. (2016); Gatta et al. (2018). The result might be improved sustainability in the short term, but not in the long term. With regards to sustainability it is important that not dedicated transports are conducted with crowd logistics, but instead the idea of 'picking up on the way' is emphasized. If transporters use small, low-emission vehicles as suggested by Slabinac (2015) to improve city logistics, more negative environmental externalities than of today might be decreased.

As Tiptapp utilizes existing capacity in transportation, more efficient transports than of today can be obtained. Rai et al. (2017) also reports that occupancy in running cars has fallen over recent years, why capacity in cars exists. To what extent the improved utilization improves efficiency of goods transport enough for requirements of Cardenas et al. (2017) is difficult to estimate. The vehicles which are used are those which suits today's infrastructure. In addition, Tiptapp only plans to be present in big cities, favorable by literature for crowd logistics as well (Carbone et al., 2017). Restrictions on cars and other vehicles used today in cities such as parking permits and restricted access in the future, discussed by Cardenas et al. (2017), might therefore be an issue. As another issue, the infrastructure of the future is discussed by Expert 1 to possibly look different than of today. This will affect Tiptapp's business as the possible trips to utilize might look completely different.

Trust is reported to be the main pillar of Tiptapp's business, both by the case study and in literature (Carbone et al., 2017; Rai et al., 2017). As trust is hard to measure, it is hard to tell whether this is in place or not today. The comparison with AirBnB shows that trust has been found in other application of shared economy, why it should be possible to be built for these types of transports as well.

As the interests of transporter can conflict with request, the ease of transportation by crowdsourcing might not be as high as of other means of transportation, discussed also by Castillo et al. (2018). The risks related to uncertain supply of transporters makes the uncertainties of reverse logistics, table 3.1, increase even further.

6.5.5 Furniture business feasibility

Partnership, in terms of a company having a crowdsourcing company conducting their transportation, is a complex set-up as Crowdsourcing solutions is created for C2C; a private person picking up a product from a customer and delivering it to another customer. It is cumbersome to use platforms aimed for C2C as a business. For company collaborations it raises uncertainties how to use this platform. Either, the company can act as a regular customer or take over the responsibility of the product once it is dropped off. To delay the responsibility of the product demands that the customer knows where the product needs to be transported in order for company pickup. In addition, the drop off point must be somewhere where drivers can somehow ”pass by” in order to be in line with the crowdsourcing concept. Tiptapp are interested in partnerships. With such, the feasibility of C2B might be possible to increase.

The cost of having a crowd logistics solution as a company’s reverse last mile set-up is yet unknown. The main cost driver is that of the transporter, and how they values the transportation. The willingness to pay to get rid of a sofa is approximately 350 SEK on average, which indicates the value of having someone handling the transportation of a used large furniture for people who does not own a car or larger van. As a company user, another driver is the share of the transport which Tiptapp as a platform owner takes.

6.5.6 SWOT Analysis

Strengths	Weakness
• Experience within reverse last mile and furniture in particular • Activities driven by private actors • Takes advantage of existing capacity • Coordinates people's movements and the need of getting something moved	• Uncertainty regarding the influence on sustainability in urban environments • Difficult to operate C2B
Opportunities	**Threats**
• Little to no competition within the area of reverse last mile in crowd logistics solutions • Planning to expand	• Trust as its main pillar • Legal issues with C2C operations • Change of infrastructure in the future

Figure 6.4: A SWOT analysis of Tiptapp

6.6 Case 4: Udelv

6.6.1 How a reverse last mile set-up can look like

A private customer will initiate a pickup of goods. This customer will pack the product according to requirements of the vehicle, such as in a specific box with a label on. The Udelv vehicle arrives and the customer loads the van according to instructions from the van. It then drives off and drops it where ever was registered by the customer.

6.6.2 Innovation technology

Udelv is one of the first companies which has launched and runs an autonomous delivery van, which emphasizes the young technology of autonomous vehicles. The estimated time horizon for implementation of autonomous vans differs among the sources in this paper. Udelv is ready for launch since 2018, but Expert 2 suggests that full implementation will take longer than 10 years. Chan (2017) estimates that automated cars are sold around present time, and Schröder et al. (2018) discusses how the speed of technological development has been higher than estimated. Thus, it is difficult to discuss the potential development and customer readiness of Udelv's product. Schröder et al. (2018) estimates the maturity for autonomous vans to be semi high, which can summarize the discussion. Self-driving cars is a new type of vehicle present in city logistics. The possibilities of Udelv as an early developer of a vehicle is many as a paradigm shift to autonomous technologies is thought of by Udelv but also Chan (2017) and Schröder et al. (2018).

As the technology has been proven to function, the company has grown as well and they are further developing the capabilities of technology improvements. The company is still young but has passed the first stages of a start-up. The speed of innovation appears to be high at Udelv as they are developing their product shortly after company introduction.

They are currently only operating in the US, but experiences little competition from both US and the rest of the world why the potential for expansion is great.

6.6.3 Closed-loop supply chain feasibility

As a self-driving van operates on order of a digital system, agility can be built in the system and priorities according to certain parameters can be chosen. The inability to forecast reverse flow of goods will then be avoided, as the van can respond to a request as soon as it is received. The van can, with its system, deliver and pickup products independent of each other, why the forward and reverse flow of goods can be combined. Thus, the differences in forward and reverse logistics transportation networks can result in a many-to-many solution with high accuracy. The tracking of goods will be possible to a larger extent than manual services offer as it is necessary to scan products which are loaded into the van. The increased possibility to track in real time makes it possible to update forecasts and plan pickups and deliveries in real time as well. The tracking will also allow for information about the product and its quality and help overcome this difference between forward and reverse logistics. However, when operating with a reverse flow of goods, the responsibility of examination and control gets shifted from retailer to the retailer's customer. To teach customers how to handle the pickup and new tools will be a difficult task, and the feasibility with these flows will probably be lower than for those of deliveries.

Udelv's vans contains boxes that can room non bulky goods during the transportation. Even though these can be adjusted, it is only possible to a certain extent and the capacity is thus restricted. Human resources are needed during on and off-loading of heavy furniture which is not offered by Udelv as its van is self-driving, and the combination of these two factors indicates that Udelv's self-driving car is less feasible for furniture. Udelv therefore does not consider furniture as a type of delivery of pickup of prioritization, why it will likely not be more suitable in the future either.

6.6.4 City logistics feasibility

Udelv's product will be good for improvement of city logistics as congestions, emissions and noise pollution will decrease according to Fagnant and Kockelman (2015); Medina-Tapia and Robusté (2018). Self-driving vans allows for more efficient deliveries, why the expected increase of transported goods in city logistics can be handled in a sustainable way. The possibility to combine forward and reverse flows of goods in a good way also increase efficiency. The trend of restrictions on traditional vehicles will likely not affect self-driving vans and they will hence be possible to use in cities in the future as well.

Udelv does not recognize any of the barriers discussed in section 4.1.3 by Fagnant and Kockelman (2015) such as legal issues and privacy as having a large effect on their business, why the feasibility of current infrastructure systems appear well fitted for autonomous vans. However, they are only operating in parts of the US and when expanding the geographical scope, laws and regulations in other areas might be a bigger issue.

6.6.5 Furniture business feasibility

Due to the learning aspect for the crowd to load the van described earlier, the feasibility for C2B operations is lower than the B2C feasibility. Udelv aims to create partnership and be the last mile deliverer to a company. Due to geographical market restrictions, business partnership is only possible for the market in the United States, as of today.

Autonomous vans are argued to be expensive both by Expert 2 and 3. The development costs of Udelv are unknown, but they have not yet reached their goal of being less costly than ordinary delivery vans. Thus, the costs of autonomous technology might still be too expensive for companies to implement. The main cost driver is that of the technology development. New technology needed in companies which uses autonomous transportation is another cost. When the development has reached far enough and implementation is done, the costs of using autonomous vans will likely be significantly lower.

6.6.6 SWOT Analysis

Strengths	Weakness
• A new, often discussed technology • First operator on the market • Electric, environmentally friendly vehicles • No driver is needed	• As of today, not feasible for reverse last mile of bulky goods • Relatively high cost due to new technology
Opportunities	**Threats**
• Unexplored market • Early phase of the innovation • Unexplored feasibility • Has a large possible market for deliveries and pickups of goods	• Requires to teach a crowd about a new concept for autonomous vehicles in a reverse last mile network • Laws and regulations regarding self driving vehicles

Figure 6.5: A SWOT analysis of Udelv

6.7 Case 5: Delivery from micro depots

6.7.1 How a reverse last mile set-up can look like

The concept of delivery from micro depots consists of placing a container with deliveries and let the last mile delivery start from, and end at it. This minimizes the distance of the last mile and reverse last mile which makes cargo bikes even more suitable as a transportation mode. The reverse last mile would start with the cargo bikes picking up goods at the customers' homes and transporting it to the container. There it will be consolidated with other goods and picked up by a truck or similar.

6.7.2 Innovation technology

As described earlier, by Eltis - The urban mobility observatory (2019), Niels et al. (2018) and in the interview with Marcus Ljungqvist this type of project has been tested at many different places, mainly in Europe. Many reports has been written and the overall result shows that the concept has potential to become the general way of handling reverse last mile deliveries and pick-ups of products. Since the container is full of goods in the morning, there would be a lot of free capacity in the container when all the goods has been delivered. Even though there is potential, it has up until now only been tested in small scale. The delivery method is mainly suitable for cities where the distances are short and the population density is high.

6.7.3 Closed-loop supply chain feasibility

Forecasting and planning of the goods is extra important when it comes to micro depot as the capacity available for transport and storage is restricted. Trouble of forecasting makes a big challenge for micro depot solutions as the capacity of both bike and storage is limited. As for analysis of only cargo bikes, many-to-one transportation can also possibly be an issue. Micro depot solutions is mainly for last mile deliveries and the operation with reverse last mile is rather unknown, meaning that they have not been able to experience the risks and uncertainties described by Srivastava (2008); Fleischmann et al. (1997).

A micro depot solution adds another step in distribution of products, why it might not be considered profitable by companies using it for distribution and pickups. Another issue is ownership of costs, also discussed when considering urban consolidation centers. According to Bouton et al. (2017), these hold a great potential for improving city logistics, but as Expert 2 discusses, no one is willing to share the costs of such center. This needs to be established among companies before an implementation in order to be a competitive solution for distribution of goods.

6.7.4 City logistics feasibility

The analysis of cargo bikes regarding sustainability, efficient deliveries, able to access and parking in a city, legal restrictions and adaptability for changed infrastructure has been made in the case analysis with Movebybike. The result regarding cargo bikes is applicable to the micro depot solution as well since transportation by bikes is used here as well. Specific additional aspects for the micro depot will be presented here.

The micro depot solution requires a centrally placed container or similar, why many trips to and from a city center needs to be conducted for delivery and pickup. This increases emissions and congestions in comparison to only cargo bike transports which have consolidation platforms further away from the city center.

Micro depots are reported to have the greatest potential to improve city logistics by Bouton et al. (2017). Where to locate the container is a challenge the micro depot faces. The space in urban areas in European cities are very often highly utilized and finding an available spot can sometimes be difficult. The project Niels et al. (2018) showed that although the theoretical optimal location was not feasible, and the practical optimal location was hundreds of meters away, the concept would still be successful and the time spend per route would not be significantly larger.

6.7.5 Furniture business feasibility

The micro depot concept can be conducted by any actor who wants to operate in a last mile and reverse last mile set-up. Due to the risks and uncertainties, as well as the need of high and stable volume in order to make the concept profitable, it is recommended to be conducted by an actor that handles large amounts of deliveries, such as UPS. These firms are feasible for business partnerships, as well as C2B operations.

The cost regarding these concept showed different results in different projects. The project in Malmö showed slightly increased cost, while the project in Frankfurt and Hamburg showed decreased costs. The concept brings along another re-loading activity from the container to the cargo bikes, and this needs to be conducted with human resources. A result from the project Eltis - The urban mobility observatory (2019) was that planning and the usage of full capacity in order to achieve economies of scale is important to make it cost efficient. When it comes to reverse last mile, forecasting is harder than in forward logistics, why this concept would most likely imply very various utilization rate of capacity of the reverse flow. The cost drivers are that of space for the micro depot, employees for deconsolidation and consolidation and additional transport needed.

6.7.6 SWOT Analysis

Strengths	Weakness
• Thoroughly investigated and tested concept • Sustainable method and reduces noise and pollution in urban areas	• Difficulties how to locate the micro depot • Difficult to organize and manage • Demands high planning • Uncertainties regarding costs
Opportunities	**Threats**
• Big potential to expand • Fulfilling a need of sustainable delivery methods in urban high density areas	• Ownership of costs

Figure 6.6: A SWOT analysis of Micro Depot concept

6.8 Case 6: Using taxis in a reverse flow

6.8.1 How a reverse last mile set-up can look like

A pickup and delivery is registered by a requester at a platform which coordinates taxi routes and available capacity. Depending on what strategy is used, the package gets picked up when either an identical taxi trip is conducted or when a combined trip can be put together. The taxi driver or requester then handles the loading and the taxi driver or receiver handles unloading.

6.8.2 Innovation technology

As this is not a case study with a specific company present, it is difficult to discuss the capabilities in the same way as for the other case studies. The missing real case also implies that the maturity of the innovation and for a company which implements the idea is low. The market of crowdsourcing solutions has grown as is presented in the literature and case study of Tiptapp, which also means that there is a lot of market potential if a taxi delivery or pickup solution would be implemented.

A comment can be made on the capability of deliveries and pickups; the study does not discuss whether taxi drivers are able to or interested in conducting these. It could be that a collaboration is possible between taxi companies and companies which wishes to conduct deliveries, meaning that the will of the taxi driver can be neglected. The will of taxi drivers is a challenge, which if implementing the solution would need to be investigated.

6.8.3 Closed-loop supply chain feasibility

As the case only exists in theory, it is hard to tell how easy it will be to use in a reverse flow. It can be assumed that it will work as well for forward flow of goods as for reverse flow of goods, as the destination needs to match in both cases. The difficulty to forecast a reverse flow of goods will not affect the use of taxis as a transport, as the pickups are conducted independently and when there exists a match between a taxi route and a requested transport. Many-to-one transportation network will, if the destination of reverse last mile transports is well placed, be well fitted for taxi cars as they typically conduct trips one-to-many, meaning from e.g. city center to a suburb, and need to conduct many-to-one trips back to the origin. The destination and drop-off point therefore should be placed close to the origin of taxi trips to work well. The product quality will not be easier to control by use of taxi cars as the drivers will likely not be performing inspections or such. The case study specifically studies reverse flow of goods, but does not discuss the specific characteristics which are related to these transports. Thus, the awareness of the risks related to reverse last mile are not being discussed and could therefore possibly be high as they increase with the unknown conditions according to Srivastava (2008); Fleischmann et al. (1997).

The loading capacity is the main drawback of use of taxis for reverse last mile. It will most likely only be possible to use the trunk of the car, why it is ill fitted for furniture transports. If the furniture are disassembled the usability of taxis increase, or if flatpacks or help of e.g. Repack can be obtained. As the taxi drivers can help with loading, the actual loading is a smaller problem than that of capacity.

What is missing in the case is presence of a collaboration platform between taxi cars and those who wishes to conduct deliveries and pickups. Before this is developed, the service will be very cumbersome to use. Who should own such a platform is not discussed either.

It could as example be owned by a platform company such as Logtrade, by a crowdsourcing company such as Tiptapp or by a company who conducts deliveries and pickups such as Sellpy. A private car taxi can't take the largest pieces of furniture such as kitchens, sofas and beds, which is a drawback for the case.

6.8.4 City logistics feasibility

As deliveries by taxi cars only exploits already existing trips, this transportation has the possibility to conduct more sustainable deliveries than those by truck according to both the case study and Gatta et al. (2018). Sustainability of crowdsourcing in general is discussed in analysis of Tiptapp, why analysis specific to the taxi solution is presented here. The efficiency of deliveries and pickups can be increased as well, as it will use existing capacity and routes. Restrictions in cities usually does not apply for taxi cars, why they can be less affected by increase in regulations than a normal car. However, current infrastructure fits taxi cars. Delivery by taxis can therefore be less well fitted in the future, such as for other solutions which uses current vehicles and infrastructure, as is discussed about changes in the infrastructure. As the taxi delivery business model offers sustainability, flexible work opportunities and increases efficiency of vehicle usage, it has the possibility of being successful in city logistics according to Rai et al. (2017).

One thing which is discussed about crowdsourced logistics by Carbone et al. (2017); Castillo et al. (2018) is the increased uncertainty related to it, also presented in the Tiptapp analysis. When using taxi drivers as crowd transporters, it is possible that these risks decreases as the available taxi vehicles are easier to predict than those of private customers. As this case study is not tested in practice, the risks related to it are however still high. Trust is likely also a smaller issue when using taxi cars than private persons in crowdsourcing logistics, but this has not been proven.

6.8.5 Furniture business feasibility

As there is no present solution to use this today, the feasibility of partnerships is unknown and it is difficult to estimate how good the feasibility for C2B could be. As taxi companies can be used, it is probably higher than for crowdsourcing solutions involving private persons. This all depends on the design of a collaboration platform.

As the taxi routes are being conducted regardless of it being combined with a delivery, the main cost driver is that of salary for the taxi driver. The extra distance the pickup possibly requires will also generate costs.

6.8.6 SWOT Analysis

Strengths	Weakness
• A lot of available capacity • Cheaper than traditional deliveries • More sustainable than other crowdsourcing solutions	• Exists only in theory • Uncertainty regarding future existence of taxis as they work today
Opportunities	**Threats**
• Could build partnerships and possible increase profit • Development of collaboration platform to enable this solution	• As of today, a theoretical concept • Many unknown risks • Uncertainty regarding the interest from taxi firms to participate

Figure 6.7: A SWOT analysis of Taxis in a reverse flow

6.9 Case 7: Logtrade - Internet of Logistics

6.9.1 How a reverse last mile set-up can look like

A pickup of a product can be initiated either by the product itself after a given timeframe has passed or by a private customer who scans the product and adds information about pickup. The place where the product will be delivered to can either be pre-destined by the producer or added by the customer. The platform then calculates a transporter for the place which it is destined for, it arrives and picks it up and transports it to the given place.

6.9.2 Innovation technology

The platform based on Internet of Logistics is in a very early stage of development. Internet of Logistics is in line with the need of horizontal collaboration between transporters, explained by Expert 3. The future challenge for Internet of Logistics is to further develop the standard and decide how it should be used. Logtrade has been present in the logistics industry for approximately 20 years, which suggests that they have a lot of experience to put in a new system such as Internet of Logistics. As early developers of a system which can handle Internet of Logistics standards they are an innovative company. They have a lot of capacity and competence within the company to run the pilots currently conducted and to keep developing the product.

Physical Internet is closely related to Internet of Logistics and Logtrade's platform. PI is thought to be both a great way to handle the future challenges with logistics and to be hard to implement, by Stenberg and Norrman (2017). It could lie a lot of market potential in the business of the platform, but Logtrade then needs to ensure that it is profitable for all participating actors, otherwise the companies will not join the platform and the purpose fails.

A big challenge for Logtrade is the early development phase of their platform product. It will need a lot of piloting before it can be launched, as it changes the communication and collaboration between companies and how transports are being conducted today.

6.9.3 Closed-loop supply chain feasibility

Internet of Logistics would enable an agile system for transportation of goods. The agility enables an insensitivity of the differences between forward and reverse logistics, as the standard allows for easier communication between actors and of capacity. As the product characteristics will be saved in an URI, a lot of uncertainty regarding reverse logistics can be avoided. An example is the product quality, which can be controlled easily by storing data about the product use or time of purchase.

The system aims to optimize capacity in the transportation modes and would enable information sharing and connect the need of getting something transported with available loading capacity. As the volume and weight would be matched with available capacity, the system would fit for both flatpacks and assembled furniture and there is no restriction on volume. As of today, the risks related to reverse last mile, as described by Srivastava (2008); Fleischmann et al. (1997) has not been experienced, due to lack of operations within reverse last mile with Internet of Logistics. Some furniture requires two persons for on and off-loading and this must also be included as a parameter in the "matching system" by Internet of Logistics.

Internet of Logistics will most likely need a changed customer behaviour in order to be successful, as it will change the way transports are being set up. Heinrich et al. (2016) states habits as a big hindrance for innovation, why changed behaviour is probably important to overcome. As Internet of Things and Physical Internet are believed to accelerate innovations in city logistics according to Ranieri et al. (2018); Tiwapat et al. (2018), Logtrade's product is however more likely to be developed at a high speed.

6.9.4 City logistics feasibility

Sustainability in city logistics can be improved when Logtrades system is used as they hope to be possible. As the transport utilization will be higher, the resources will be used more efficiently and thus reduce the environmental externalities per transport. However, depending on both how the system is developed and on the actors which are part of it, the effects on city logistics might look completely different than those of the ideal goal. The efficiency of transports needed in future will however probably be obtained as the utilization is higher. The types of vehicles which are used on the platform is also unknown, why restrictions of traditional vehicles might or might not be avoided.

Logtrade's platform development and Internet of Logistics solves an issue which has been mentioned by several authors and experts in this thesis; there is a need for collaboration between actors in order to have a successful city logistics system in the future. It is stated by Crainic et al. (2009); Stenberg and Norrman (2017); Cardenas et al. (2017) and Expert 3 who believes that collaboration is a key factor. Cardenas et al. (2017) also points out the importance of having effective transports, something a system as Internet of Logistics would increase, as horizontal collaboration would be possible. Internet of Logistics aims for everyone, private persons and companies, to "tap in" to the system in order to make it efficient. How this would work out in practice is yet unknown. Another aspect discussed by Expert 2 is the need of several different modes of transportation in future logistics. This need is enabled by Internet of Logistics. Because of the factors above, the feasibility for infrastructure and city logistics is therefore high.

The transportation branch is traditional and integrating an innovative system as Internet of Logistics to this could be challenging and raises question how a business model can work, as described by Stenberg and Norrman (2017). This might be a hindrance for the market development of Internet of Logistics.

6.9.5 Furniture business feasibility

Logtrade would use Internet of Logistics in their platform, for which a company pays a service fee for. The more companies that use the system, the more effective it would get, and this indicates high feasibility for partnership. How feasible Internet of Logistics is for C2B depends of how the customer would initiate the transportation and of other requirements of the customer, which is not yet stated.

The cost drivers of the platform is unclear. As Logtrade believes all actors should agree on prices in between them, it is not certain whether the costs of transport will be higher, lower or the same compared to other agreements or transportation types. Logtrade only faces development costs as of today, but as the platform is more developed, this driver might change.

6.9.6 SWOT Analysis

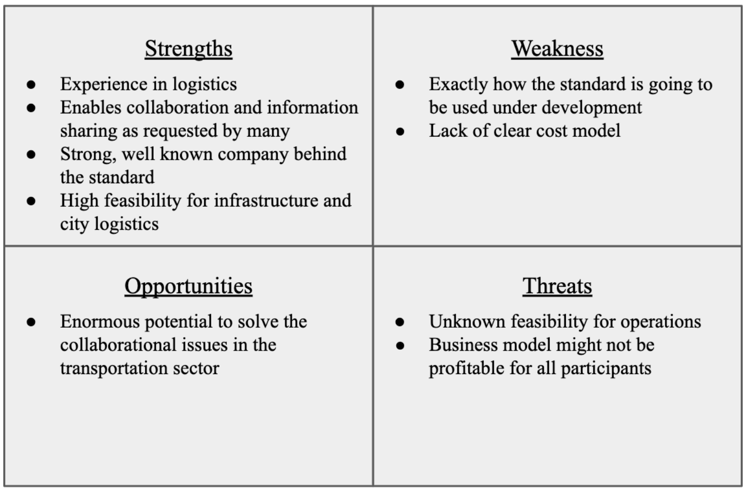


Figure 6.8: A SWOT analysis of Logtrade's platform based on Internet of Logistics

6.10 Cross-case analysis of innovative transportation solutions and technologies

This section aims to analyze and answer RQ2: How feasible are new innovative transportation solutions and technologies for a reverse last mile set-up?, as well as RQ3: What monetary drivers are present when operating within reverse last mile solutions?

6.10.1 Introduction of cross-case analysis

A cross-case analysis has been made in order to compare the different cases between each other. The objective is not to find out which innovation that is most suitable, but to compare the cases in order to answer *RQ2* and *RQ3*. The comparison is done based on the analysis presented in single-case analysis, with additional graphical illustration of certain parameters, as is presented in the beginning of this chapter. In all of the graphs, top right corner is to prefer as a position.

6.10.2 Innovation technology

The maturity of innovation in each case differs among the cases presented. Maturity of innovations has also been presented by literature, however not in a single comparison between all innovative transportation modes in this study why different sources for comparison is used. Firstly, bikes as a vehicle is not a new mode of transportation, but as of today bike deliveries are still considered a new type of delivery method. Customer perceptions regarding the usage of cargo bikes has been presented as low by literature, but the maturity of bike delivery in the case study has evolved over the last years. The maturity for bike delivery is therefore among the highest in this comparison. As for crowdsourcing solutions, the literature is ready for implementation with several different solutions suggested. Tiptapp experiences lower maturity of their applicationthan what literature does and believes that trust needs to improve in order to continue expansion of their business. Thus, the actual maturity of innovation is regarded as lower than that of cargo bikes by the authors. Self-driving vans represents a new technology, which both Udelv and literature agrees on. The speed of maturity was argued to be hard to estimate. Schröder et al. (2018) believes that the maturity of technology is semi high, consistent with the summarized conclusion of maturity of innovation. As for micro depots, it has been tested several times and does not use new technology as such. Instead, the acceptance of companies to use it as a delivery method is found to control the maturity of this solution. This appears to be low as the tests has not yet been fully implemented. Thus, the maturity of micro depots is regarded to be lower than that of cargo bikes. Delivery by taxis is a solution with even lower maturity as it has never been tested in practice. However, the lowest maturity is presented by Logtrade as their product still need a lot of piloting before it can be determined how it will work for companies using it.

The market potential of all cases presented is good as they represent an innovation in city logistics which could change city logistics as it is operated today. The total market which they could capture and current trends differs among the cases. Delivery bikes has a good market potential according to literature and has experienced growth in the case studies. These companies might however not face the greatest market potential, as Schliwa et al. (2015) presents the big courier companies' implementation of bike deliveries as that of greatest potential. The market potential for Tiptapp is also good as they have little competition and a lot of dicussion is found in literature, but they can miss a large share of the total deliveries as the business is not well suited for B2B. Udelv with a self-driving van is a company which can be a part of transforming city logistics and the current infrastructure, discussed both by experts and literature. With this possibility, the total market potential is great as they can take market shares from current transport modes as well. Micro depots on the other hand faces a challenge as it has been tested several times but is not yet considered a valid option for companies to use. The market potential for taxis is small as well, as it is not yet an option to consider for deliveries when only present in theory. For Logtrade, the market potential is higher as a lot of different sources asks for a coordination of resources. The fact that the product is not yet fully developed and the problems stated about successful business models with Physical Internet lower the market potential for the platform, but the estimation is based on a lot of uncertainties.

All the case studies faces different specific challenges. These vary among the cases, which is easy to understand as the selection of cases all operate in different parts of the world and with different modes of transportation. These challenges need to be overcome by each company respectively in order to be successful in the future.

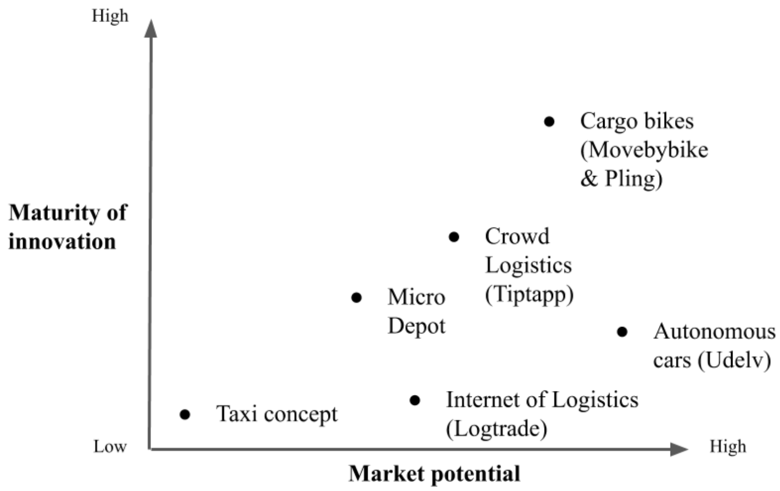


Figure 6.9: Cross-case analysis between *Maturity of Innovation* and *Market potential*

Figure 6.9 shows maturity of innovation versus market potential. It is an illustration of the analysis conducted above. High maturity and high market potential is to strive for, as the innovation can then soon be fully implemented.

6.10.3 Closed-loop supply chain feasibility

As there exists several differences between forward and reverse logistics, and the cases studied are mostly focused on forward logistics solutions, it is important to compare how well suited the solutions are for reverse last mile in particular. The focus on reverse logistics was low among all cases except Tiptapp and the taxi solution, as the rest focused on solving forward last mile deliveries. As the emphasis of reverse solutions is so low, the authors believes that it should exist opportunity for future innovations for reverse last mile which suits the reverse flow of goods and furniture better than these cases do. It was assumed earlier in this study that innovative transportation solutions for last mile could be used also in reverse last mile, and the discussion of the actual feasibility follows below.

Firstly, bikes are discussed to have some difficulty with forecasts as the routes need to be planned ahead. The capacity of the bike and hub is also affecting the ability to handle reverse logistics as they both have restrained capacity and cannot allow for a sudden large volume of reverse flow of goods. Movebybike allows greater capacity than Pling. Cargo bikes have the ability to get close to customers, which is good for loading furniture and they can also operate with agility. With the use of crowdsourcing, the independence between transports allows for a good ability to handle the differences between forward and reverse last mile. With autonomous vans, deliveries and pickups can be conducted simultaneously which makes it possible to execute reverse last mile with good efficiency. The autonomous technology is also well fitted to handle the differences between forward and reverse logistics, but the difficulty with loading of the van is a drawback with a self-driving vehicle. All other solutions can offer one person to help with loading the goods. The traceability offered by Udelv is the best among the cases. They however represents the case with least interest in furniture transports. Micro depots faces a lot of the same issues as bike deliveries, but with a larger constraint on capacity as the container only can handle a certain volume. The forecasting is thus a bigger issue. The taxi solution has independent transports just as Tiptapp, but can only handle a limited sized furniture piece. With use of Logtrade's platform, the system is agile and can be adjusted to different types of products. They also offer good traceability and information sharing about the product such as Udelv. The capacity is adjusted to what is needed for each products as all types of transports are thought to be available, so any type of furniture would be possible to transport.

Many of the methods in the cases are only suitable for largely populated cities. This thesis focuses on solutions for these specific cities why this is not an issue, but it is important to remember that bikes, crowdsourcing solutions and taxi delivery are all dependent on such a city for it to function well according to literature. Other issues which needs to be overcome for the best feasibility are legal issues for crowdsourcing, costs for micro depots, a collaboration platform for taxi deliveries and customer behaviour for Internet of Logistics. All these represents large obstacles, meaning bikes and autonomous vans has a more feasible solution for reverse last mile as of today.

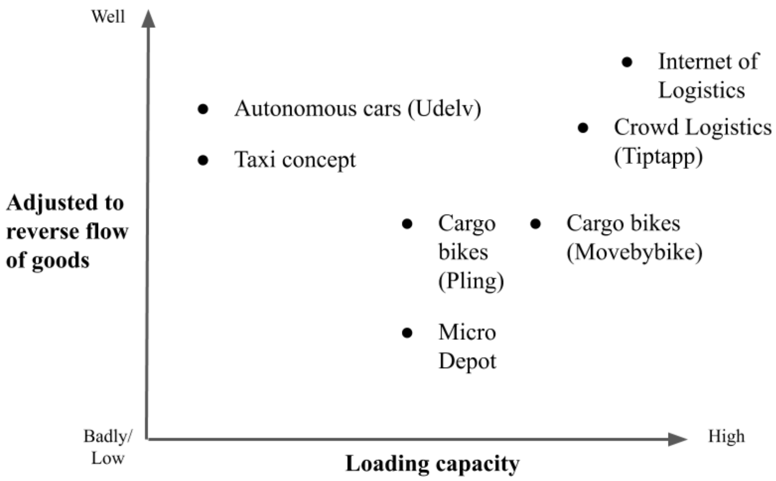


Figure 6.10: Cross-case analysis between *Adjusted to reverse flow of goods* and *Loading capacity*

Figure 6.10 shows how well the solutions are adjusted to reverse flow of goods versus loading capacity. Internet of Logistics is estimated to have the highest level of both parameters, as it theoretically would combine the products need of being transported with available volume in a transportation mode participating in the system. Autonomous cars and the taxi concept has been estimated to have the lowest loading capacity but this does depend on the vehicle. .

6.10.4 City logistics feasibility

Sustainability in city logistics differs among the cases studied. Cargo bikes produces no emissions or congestions, why the sustainability is high. As for crowdsourcing solutions, a definite answer of sustainability performance cannot be provided as literature is not coherent. When no dedicated trips are conducted, congestions will be improved but emissions will not. Thus, the sustainability parameter is not among the best by crowdsourcing. By self-driving vans, depending on the fuel source, sustainability with regards to emissions and congestion will be improved. As the fuel can lead to emissions, it is regarded as less sustainable than cargo bikes. Micro depots share the same sustainability results as cargo bikes with regards to the reverse last mile as such, but needs more transports in a city center to the depot, why the resulted sustainability of this solution is somewhat lower than that of cargo bikes. Taxis' effect on sustainability is similar to that of crowdsourcing solutions, with the exception that no dedicated trips are conducted and thus the sustainability result is higher than that of other crowdsourcing solutions. Logtrade's platform can use any types of transports, why the emissions and congestion can be everything between very high and very low.

Efficient deliveries and the ability to handle an increased amount of deliveries has been stated to be an important parameter for transportation modes in order for them to be successful in the future. Cargo bikes offer efficient deliveries as these can reach close to the customer. They are somewhat restricted by the distance to final destination in order to be more efficient than other solutions; approximately 7 km is what is suggested by literature, and another optimization tool is needed to obtain greater efficiency. The crowdsouring concepts, such as the Taxi delivery concept and Tiptapp, is only efficient if it is used in the right way, namely if the products are 'picked up on the way'. Dedicated transportation done by crowdsourcing concepts will most likely have a negative impact on efficiency. These concepts are therefore regarded as the lowest with regards to efficiency. The other solutions can all improve efficiency, but to different extent. Udelv have a high potential to do efficient deliveries, as it can combine reverse and forward last mile flows and are not affected by available parking space. Micro depots offer a highly efficient delivery, as they can both benefit from the properties of the cargo bikes and the proximity to on- and off-loading point, but are also restricted by distances such as for cargo bikes. Internet of Logistics is very likely to enable efficient deliveries, as the goal of the platform is to make better use of existing capacity.

Legal restrictions regarding transportation modes in urban areas are increasing and this is in order to improve city environment. The legal restrictions that affect trucks and cars in city areas, will favor cargo bikes as fewer cars means that is is easier for cargo bikes to access roads and final destinations. Legal restrictions will influence Tiptapp and the Taxi delivery concept depending on the vehicle that is used. Most likely, legal restrictions are not favoring the concepts, especially Tiptapp, as private vehicles are used. Udelv is not facing legal issues on the market they operate on today, but on a global level this can possibly be an issue as safety is a topic discussed together with autonomous driving vehicles. Internet of Logistics will itself not be directly affected by legal restrictions regarding city environment.

The infrastructure is likely to change according to the experts and the transportation modes must have high adaptability for infrastructure changes. The solutions which presents the highest adaptability is cargo bikes and self-driving vans, as the cargo bikes are small and can adapt to many types of infrastructure and the infrastructure changes are presented as to be adjusted to autonomous technology. Taxi cars and Tiptapp's business idea fits the infrastructure today, but changes of infrastructure in the future can possibly lower the feasibility. Internet of Logistics would not be affected in the same way as actual transportation modes, but must be aware of the changes and the trends, that can impact their business and the possible participants on the platform.

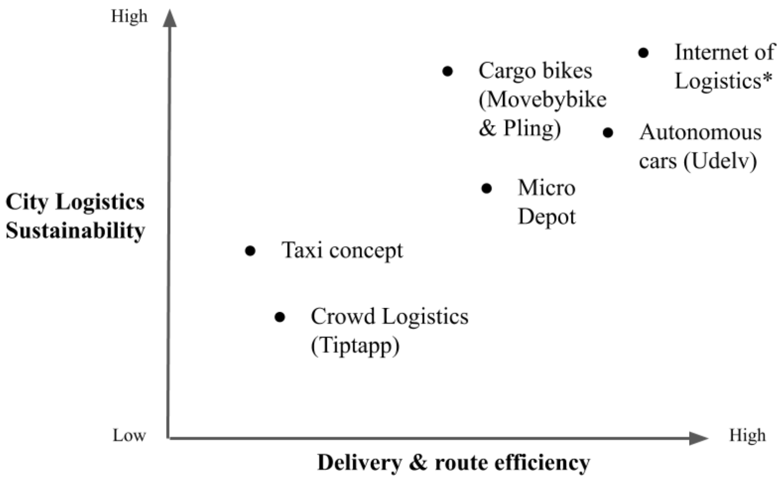


Figure 6.11: Cross-case analysis between *City Logistics Sustainability* and *Delivery and route efficiency*

Figure 6.11 shows city logistics sustainability versus delivery and route efficiency and illustrates the analysis of city logistics feasibility. Internet of Logistics cannot be compared under the same assumptions, as the innovation is not a transportation mode and the resulted sustainability and efficiency depends on the actors who participate in the platform. The estimation in the figure is based on the best case scenario for the platform.

6.10.5 Furniture business feasibility

The ability to transport C2B in reverse last mile is important as this is the relationship between the first activities of a reverse supply chain. C2B feasibility and business partnership is regarded as high for the cargo bike companies/concepts (Movebybike, Pling and Micro

Depot concept), as well as for Internet of Logistics. It is also high for Udelv, although only on the market in the United States as of today. The crowdsourcing solution Tiptapp is mainly for C2C or from customer to recycling centers operations, why the C2B feasibility is regarded as unknown. The taxi concept does only exists in the theory and therefor the feasibility for C2B is considered to be unknown.

The cost drivers differs between the cases. The cost for the vehicle is a one-time investment for the cargo bikes companies and variable costs consists of electricity and spare parts and of the salary of the driver. Innovation such as Udelvs autonomous driving car and Internet of Logistics has development costs as their main cost driver. The comparison is found in table 6.1.

Table 6.1 summarizes the result from *C2B feasibility* and *Cost drivers* for all examined cases. Reverse last mile transportation should be feasible for C2B operations as well as having cost drivers which sum up to a low cost per collected product.

Table 6.1: Summary of C2B feasibility and cost drivers

Case	C2B feasibility	Main cost drivers
Movebybike	Yes	Chauffeur, electricity, spare parts, the cargo bikes
Pling Transportation	Yes	Chauffeur, electricity, spare parts, the cargo bike
Tiptapp	No, focused on C2C	The costs are handled directly between the customer and the transporter. Tiptapp takes a percentage of the price
Udelv	Yes	Autonomous technology, vehicle
Micro Depots	Yes	Chauffeur, container, cargo bikes, electricity, spare parts
Taxi concept	Unknown	Chauffeur, drive of extra distance
Internet of Logistics	Yes	Development of the platform/standard

6.11 Challenges with reverse last mile

This section aims to analyze and answer RQ4: What are the challenges with reverse last mile?

6.11.1 Reverse last mile as a part of a multi-parameter problem

The differences between forward and reverse logistics are many, as described in section 3.2.1. Table 6.2 repeats the main differences. All these differences adds up to challenges for reverse logistics and reverse last mile. Many of the differences stem from difficulty of obtaining information which in turn leads to challenges. First, difficulty to forecast means that efficiency can be hard to obtain and business needs to be ad hoc. With unclear product quality, final destination and disposition, a lot of manual work is needed and information will be even further delayed in the supply chain. The transportation network will by many-to-one transportation look different than that of forward logistics. The differences stated means that reverse last mile is affected by a lot of different parameters.

Table 6.2: Main differences between forward and reverse logistics. Source: Tibben-Lembke and Rogers (2002)

Forward logistics	Reverse logistics
Forecasting relatively straightforward	Forecasting more difficult
One-to-many transportation	Many-to-one transportation
Product quality uniform	Product quality not uniform
Destination clear	Destination not clear
Disposition options clear	Disposition options not clear
Costs are closely monitored by accounting systems	Costs less directly visible
Inventory management consistent	Inventory management not consistent
Marketing methods well-known	Marketing complicated by several factors

In addition, reverse last mile is greatly affected by city logistics, which in turn faces several challenges in the future. These challenges are mentioned in section 3.4.1. Expert 2 emphasizes a systems approach when investigation effects of city logistics, why this whole system needs to be taken into consideration when developing reverse last mile as well. Altogether, reverse last mile faces a multi-parameter problem in order to be developed.

The general challenge with reverse last mile is that it does not exist an accepted way of transporting products as this is a new phenomenon. This especially with bulky products. Many authors has reported an increased interest of reverse flow of goods, but this has not been sufficient in order to develop such a reverse flow. As stated by Govindan and Bouzon (2018) the main drivers of implementation of reverse supply chain is regulatory pressure, green consumerism and economic viability. The main barriers of implementation was identified as lack of personnel technical skills, initial capital and low involvement of top management. The different areas of business which the drivers and barriers stems from also points at the fact that reverse logistics and reverse last mile is something which needs to take a lot of different parameters into consideration. Another aspect which adds to the parameters is how to design the network of reverse last mile with regards to both forward last mile and the actors who should participate. Internal capabilities, product characteristics, transportation costs and return volumes needs to be considered for these decisions as stated by Stock et al. (2006) and Gooley (2002).

Reverse last mile is increasing in popularity and companies and societies are starting to realize the importance of reverse supply chain (Brito & Dekker, 2003; Srivastava, 2008; Pokharel & Mutha, 2009). However, this interest is not found in the case studies conducted where no innovative company, except from Tiptapp and the taxi solution, reported that they focused on reverse flow of goods. Although, a majority of the companies were interested and wanted to participate in reverse last mile operations. To implement reverse last mile solutions in the future, an iterative process such as used for Niels et al. (2018) will likely need to be used. The implementation will therefore be somewhat time consuming. Due to the complexity of different markets and geographical differences, the results of how to run a reverse last mile system will most likely differ from different cities all over the world.

6.11.2 The importance of consolidation and collaboration

A common trend in cities is the consolidation of packages that is being made in reloading hubs. What is not yet decided, is who will take the cost of these hubs. The hubs itselves are having financial problems in order to run, and only hubs with additional extra services are profitable, stated by Expert 2 in 5.2.

Overall, collaboration within last mile and reverse last mile enables a more efficient and optimized last mile delivery and improves the environment in cities. There is a lack of collaboration between logistics transportation firms today, stated by Expert 1 in 5.1, but a system as Logtrade would through their system enable an interaction between different logistics firms, an interaction controlled by the package.

6.11.3 Feasibility of transportation modes

Due to the historical development of city logistics, infrastructure and transportation modes the feasibility varies between the analyzed cases. Due to its size, volume and weight, bulky products has always been a struggle to transport and there is a need for transportation modes and solutions that can handle this transportation, both the forward and reverse last mile. Furniture and bulky goods can sometimes have a shape that does not enable efficient packaging. IKEA's furniture are delivered in packages and the customer puts it together him- or herself. The characteristics of new products are hence different from that of returned products. If disassembly and efficient packaging was required for initiating the reverse flow the capacity of the transportation could be used in a more efficient way. Some transportation modes e.g. cargo bikes have a weight restriction, and although the volume can fit in the capacity the weight restriction would be constraining parameter. However, the upcoming activities in a reverse supply chain such as refurbishment or re-manufacturing might not be optimal if the product is disassembled. For reselling, a fully assembled furniture can be an advantage as some customers sees an additional value of getting the product fully assembled. This question requires more insight and analysis of optimizing and making the whole reverse supply chain efficient.

6.11.4 Risks and uncertainties regarding reverse last mile

As described by Srivastava (2008) the characteristics of a reverse logistics implies risks associated with the activities. The main risks described is cost related parameters, decisions of disposition and cost of coordination. Very few of the interviewed cases had reverse last mile as their core business, and therefore a clear cost picture could not be given, which confirms the theoretical research. The unknown state of characteristics such as timing, condition and volume makes up for a high degree of uncertainty in many different areas of reverse logistics operations, as described by (Srivastava, 2008; Fleischmann et al., 1997).

Reverse last mile is also affected by uncertainty from the activities previous to it, as product acquisition can be performed in different ways (D. Rogers & Tibben-Lembke, 2001).

The biggest difference between forward and reverse logistics, described by Tibben-Lembke and Rogers (2002); Fleischmann et al. (1997); Gupta (2013) and found in table 6.2, is that forward logistics operated in a “one-to many” network while reverse logistics operates in a “many-to-few” network structure. In many of the interviewed cases these two networks, the forward and the reverse last mile, has been combined, which is one of three ways of how to have a reverse last mile set-up, described by Fleischmann et al. (1997); Prahinski and Kocabasoglu (2006) in section 3.3. However, in many of the cases where the forward channel is combined with the reverse channel, the amount of forward delivered goods, stand for a much larger part of the activities than pick-ups of goods. The risks described by Srivastava (2008); Fleischmann et al. (1997) has not been experienced in a larger context, due to the small amount of pickups, and therefore the risks regarding reverse last mile is relatively unknown for the interviewed companies so far. Many of the interviewed cases were interested in operating within reverse last mile, and did it in a small scale. To mention one, Bring was aware of the increasing trends of reverse last mile and they want to expand and investigate further into the reverse last mile operations.

The barriers of implementation of reverse logistics is a challenge to reverse last mile as well. Initial capital and involvement of top management is important to conduct a successful reverse last mile based on main barriers by Govindan and Bouzon (2018).

Since many of the interviewed cases are not specialized in reverse last mile, there might be a lack of knowledge of how to handle these risk. The investigated cases had various transportation modes, and this will most likely lead to different opportunities to handle these risks. To mention an example, transportation modes with larger capacity could handle the uncertainty regarding volume better than smaller capacity would.

6.11.5 Costs of reverse last mile

The overall willing to pay for transportation is low and increased competition on the market puts pressure on the cost, according to Pling Transportation and Bring. The average willing to pay for a sofa’s transportation from a customer, stated by Tiptapp, is 350 SEK which indicates the willingness to pay for a transportation. Reverse last mile set-ups are often integrated with the forward last mile set-up, why the exact number of cost has been difficult to identify. General cost models has been identified where crowdsourcing solutions such as Tiptapp would be the less costly one of the investigated cases, for a collaborating company (such as IKEA).

The financial implications of reverse last mile are unknown, as discussed by Horvath et al. (2005), Tibben-Lembke and Rogers (1999) and table 6.2. The uncertainties in previous section are also closely correlated with uncertain costs. In the case studies conducted, the costs for reverse last mile cannot be explicitly stated. As such, another challenge with reverse last mile is to understand and determine the costs related to it and to estimate the cash flows.

6.11.6 Enabling factors for a functioning reverse last mile set-up

Several factors has been presented in order to enable an efficient reverse last mile set-up in this section. Some additional factors has also been identified from interviews with both experts and the case companies and by literature.

Expert 1 in section 5.3 states that an important enabler for forward and reverse last mile is to separate the deliverer and the customer. This could for be done by packaging the product and leave it outside the door or somewhere where its accessible for the deliverer. Solutions for this has been experienced in cases with both Bring, Tiptapp and Sellpy and other investigated cases offers solutions of how to separate these. Repack offers a package, which protects large bulky goods so they can be left outside while waiting for a pickup. This enabler touches an area that is not directly the focus on the project. Warehouse management and storing of goods both before and after the transportation needs to be in place in order for a reverse last mile to function. Customers can however still be involved in the process, such as determining delivery type or product quality. The customer involvement is crucial according to Genchev et al. (2011) in order to have a successful reverse logistics system.

The lack of supporting technology was experienced from a few of the interviewed companies. The cargo bikes companies requested a supporting optimization software that optimizes the route for a cargo bike. Bring wanted to develop and improve their reverse last mile operations and requested supporting technology and systems to operate within it.

As reverse last mile is closely connected to city logistics, it is important that a functioning reverse last mile set-up takes the challenges of city logistics into consideration. A reduction of negative environmental externalities per transport needs to be implemented in the future. An enabler presented by Slabinac (2015) is to operate with small vehicles, another is to use new and emerging techniques (Ranieri et al., 2018).

Chapter 7

Conclusion

This chapter contains the conclusion of this master thesis. First the research questions are answered. Lastly, future research topics within the area is suggested and followed by a discussion about contribution to theory.

7.1 Conclusions of Research Questions

The purpose of the study was to identify and evaluate a number of concepts of how to conduct the transportation in a reverse last mile system for a furniture company and to identify opportunities, challenges and cost drivers that are related to them respectively. In order to fulfill this purpose, a research framework with additional parameters was used. The research framework is based on the literature areas studied, and the parameters were chosen by coding of the empirical data. The framework is found in figure 7.1. By this framework, areas of examination add up to investigation of the topic of reverse last mile and thus fulfilling the purpose of the study.

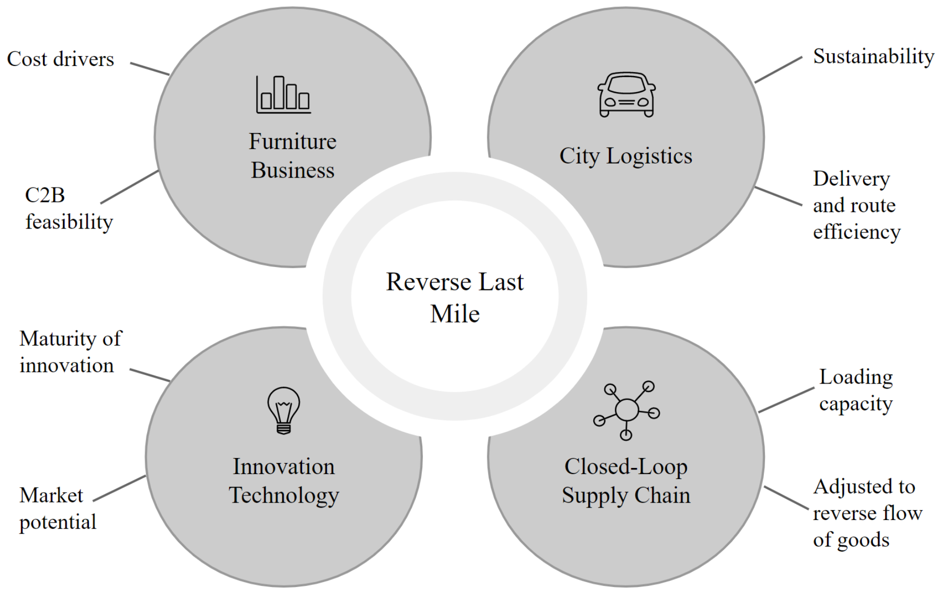


Figure 7.1: The research framework based on literature review. Source: Own illustration

Summarized answers of the specific research questions of the study follows.

7.1.1 RQ1: *How can existing transportation solutions of reversed last mile be applicable in a set-up for a furniture manufacturing company?*

Existing solutions of reverse last mile differs between companies studied, as they use different modes of transportation, the decision to outsource or conduct operations in-house is different and the design decision of reverse last mile is based on different parameters. The use of forward last mile methods is common between all studies. This use is not supported by literature, why there exists opportunity for a furniture company to conduct reverse last mile differently than these cases do. Suggestions by the authors are an increased focus on reverse last mile operations by the company in question, as the companies studied did not consider it an essential part of their business and this could possibly make a difference in developing a well fitted solution for reverse last mile.

7.1.2 RQ2: *How feasible are new innovative transportation solutions and technologies for a reverse last mile set-up?*

Feasibility was investigated by use of the research framework. The analyzed transportation solutions differs among the areas of research and parameters presented in figure 7.1 and thus in feasibility. The analysis showed a good feasibility for cargo bikes with regards to innovation technology, city logistics and furniture business as it has high maturity of innovation, market potential and possibility to handle the challenges for city logistics. It also has good possibility for C2B operations. What is less feasible for cargo bikes is the ability to handle a reverse flow of goods as it needs some forecasting and has restricted capacity in both the vehicle and consolidation hubs. Crowdsourcing with Tiptapp's application has good feasibility in the area of closed-loop supply chain, as the transports are conducted independently and the loading capacity is good. With regards to innovation technology it is somewhat mature and thus feasible, but city logistics and furniture business as areas are less applicable for crowdsourcing. Self-driving vans shows good feasibility in the areas of city logistics and closed-loop supply chain of the parameter adjusted to reverse flow of goods. Innovation technology is a little bit unclear as the studies found do not agree with each other. The main drawback is that of the capacity in the van which is too low to handle furniture. The feasibility of micro depot is similar to that of the cargo bike as these are used in micro depot solutions as well. The capacity is more restricted why the feasibility in the area of closed-loop supply chains is lower. The solution has also faced challenges with costs, why the innovation technology feasibility is low. Crowdsourcing with use of taxis shows good feasibility to handle reverse flow of goods. However, the loading capacity is low why the overall feasibility for closed-loop supply chains is low. The taxi solution also faces challenges with regards to city logistics, such as for Tiptapp's crowdsourcing solution. As it has not been tested in practice, feasibility in the area of innovation technology is also low. Lastly, Logtrade's platform based on Internet of Logistics can be highly feasible for city logistics, closed-loop supply chains and furniture business, but as the maturity of innovation and thus feasibility of technology innovation is so low, the result is followed by a lot of uncertainty. If the platform develops into what Logtrade's vision is, the good results can be obtained.

A compilation of the parameters and the research areas shows that cargo bikes with a large loading capacity is the most feasible transportation mode for reverse last mile operations in large city areas.

7.1.3 RQ3: *What monetary drivers are present when operating within reverse last mile solutions?*

The monetary drivers present when operating within reverse last mile are presented in table 7.1.

Table 7.1: Summary of cost drivers

Case	Main cost drivers
Movebybike	Chauffeur, electricity, spare parts, the cargo bikes
Pling Transportation	Chauffeur, electricity, spare parts, the cargo bike
Tiptapp	The costs are handled directly between the customer and the transporter. Tiptapp takes a percentage of the price
Udelv	Autonomous technology, vehicle
Micro Depots	Chauffeur, container, cargo bikes, electricity, spare parts
Taxi concept	Chauffeur, drive of extra distance
Internet of Logistics	Development of the platform/standard

7.1.4 RQ4: *What are the challenges with reverse last mile?*

The main challenges with reverse last mile are the multi-parameter problem which it forms, the need of consolidation and collaboration, feasibility of transportation modes and risks and uncertainties related to it. The multi-parameter problem is mainly caused by the many differences between forward and reverse logistics, which adds up to delayed and uncertain information in the reverse supply chain. Another challenge for reverse last mile is to identify existing costs for the reverse last mile set-up. Enabling factors for successful implementation of reverse last mile is to separate the pickup from the customer such that they can be conducted independent of each other and to consider the feasibility of pickup vehicles for city logistics.

7.2 Contribution to theory

The research framework used in this thesis connects the areas of closed-loop supply chains, city logistics, innovation technology and furniture business, as illustrated in the research framework. These connections in research has not been found in the literature studied, why this framework and the results of the study contributes to a branch in research in all these areas. This study can therefore act a as a first exploration of the inter-connections of these topics and as an elaboration of the existing theory respectively, as well as an early investigation of reverse last mile as research topic.

7.3 Future research

As the study is exploratory, a lot of different future research questions have been identified while continuing the work. As this thesis is based on qualitative data, quantitative data can be used and elaborate on the comparison between reverse last mile solutions with these existing and innovative cases. The quantitative data could consist of costs, loading capacity and characteristics of products to be picked up in order to quantitatively compare the transportation solutions. It could also be a study of the actual anticipated return volumes, either with IKEA as company or in the furniture or another business sector. A third study with use of quantitative data could be of a closed-loop supply chain as such, and whether it enables lower costs and better environmental sustainability or not. It is an assumption in the literature studied, but little has been found with quantitative data as basis.

Another possible qualitative study is possible business models for closed-loop supply chains for furniture. Such study could compare transportation modes with regards to their part of a closed-loop supply chain and its specific context. Another type of study could consist of analysis of possible collaborations and network solutions for reverse last mile or reverse logistics, as collaboration is requested by several sources in the study. A third possible is exploration of reverse last mile solutions but for another type of goods than furniture. E-commerce is expected to increase and mainly consists of smaller packages with other prerequisites for transportation than what pieces of furniture has.

7.4 Limitations

Due to the broad perspective of this project, certain limitations has been needed. When scanning the market for innovative last mile transportation methods and modes, the global market was scanned. Due to the size of this market, there is a risk that innovations that would fit better for the purpose was not identified. This thesis might be biased as the authors are from Sweden, explaining why most of the cases origins from the Swedish market. However, the interviewed cases found has connections to other markets (mostly the European) why the studied cases are considered to be valid.

The initial intentions was to conduct a cost analysis, but due to insufficient data collection of costs related to reverse last mile, this could not be conducted.

This project has been limited to focus on large cities with high density of people. Further investigation regarding exactly how large and exactly how high density of people has not been conducted. The exact numbers of this was regarded as less important for the purpose of the thesis, as this thesis has a qualitative approach.

Due to the lack of research within the area of transportation modes, this thesis has been dependent on information from companies. The topic *Reverse last mile* has a limited amount of research which has meant that the project has been tackled with many uncertainties regarding reverse last mile. The authors hope that this thesis can lay another puzzle piece in the work of reverse last mile development and contribute to the creation of a reverse supply chain.

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Appendix A

Case study protocol

A.1 A. Overview of the case study

Purpose The purpose is to identify and evaluate a number of concepts of how to conduct the transportation in a reverse last mile system for a furniture company and to identify opportunities, challenges and cost drivers that are related to them respectively.

Research questions
RQ1: How can existing transportation solutions of reverse last mile be applicable in a set-up for a furniture company?
RQ2: How feasible are new innovative transportation solutions and technologies for a reverse last mile set-up?
RQ3: What monetary drivers are present when operating within reverse last mile solutions?
RQ4: What are the challenges with reverse last mile?

Method The method that will be used in this research project is a multiple case study, as we will conduct interviews with relevant companies, startups and other entities e.g smart city initiatives that can give us valuable insights to our thesis. The study will be of exploratory nature, as the field of study is in its early stage. The analysis method used will be a cross-case analysis.

Theoretical framework Reverse supply chain management concerns this reverse flow of material or products from a customer back to a company, more specific the series of activities conducted in order to retrieve a product back from a customer and recover its value or dispose it (Prahinski & Kocabasoglu, 2006; Batista et al., 2018; Guide & Wassenhove, 2002). The whole, connected supply chain of both these forward and reverse flows of material, products and/or services is called the *closed-loop supply chain* (Gurtu et al., 2015; Batista et al., 2018). Management of a closed-loop supply chain is then defined as "the design, control, and operation of a system to maximize value creation over the entire life cycle of a product with dynamic recovery of value from different types and volumes of returns over time" (Guide & Wassenhove, 2009).

Reverse logistics is one of the activities conducted in a closed-loop supply chain. Companies all over the world in many various industries have included reverse logistic as a strategic part of their businesses and the interest of collection and recycling of products among researchers and companies is growing (Brito & Dekker, 2003; Srivastava, 2008; Pokharel & Mutha, 2009). Tibben-Lembke and Rogers (1999, p. 2) has defined reverse logistics as *"Reverse logistics is the process of planning, implementing and controlling the efficient and cost effective flow of raw material, in-process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing value proper disposal"*.

Reverse logistics can be divided into different activities; transportation, distribution, warehousing and inventory management (Prahinski & Kocabasoglu, 2006; Guide & Wassenhove, 2002). This thesis focus on transportation, more specific the collection of goods and on finding innovative method of how to collect and take back products.

City logistics as expression refers to the planning, optimization and control of movement of goods in urban areas. It recognizes that transporting goods can have both a positive and negative impact on lives of people in these areas (Savelsbergh & Woensel, 2016; Burkhal et al., 2012; Anand et al., 2015). Transportation within cities often causes noise and air pollution and congestion which leads to an unhealthy and damaging environment (Schoemaker et al., 2006; Figliozzi, 2010; Savelsbergh & Woensel, 2016). As population of urban areas has increased and is expected to continue increasing, the challenges will be even greater in the future and city logistics as a topic has gained more interest as for both researchers, governments and companies (Savelsbergh & Woensel, 2016; Burkhal et al., 2012; Anand et al., 2015; Crainic et al., 2009).

The area *Reverse Last Mile* is in a early phase of research and therefore innovation of technology plays an important role when investigating future technology and transportation modes. Whether an innovation will success or not, depends on early adopters and the spread of information (Heinrich et al., 2016). In order to fight the challenges of city logistics and enable a transformation from the current system to a sustainable system, new innovations are required (Ranieri et al., 2018).

All areas discussed in the literature review relates to reverse last mile. Thus, by putting reverse last mile in the center of investigation, all areas have a connection point between them. These connections are illustrated in figure A.1. An area not discussed in the literature review is the furniture business, which instead comes from the context of the case in a furniture company. The areas and their connections with reverse last mile is what forms the research framework for the further investigation. When investigating all the four areas, a result regarding discussion for reverse last mile can be obtained as well, as the research framework centers around it.

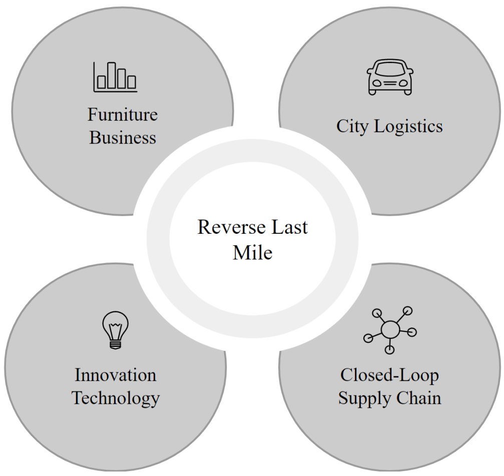

Figure A.1: The research framework based on literature review. Source: Own illustration

Case selection The selection of cases is done by the common importance of well-functioning reverse last mile . Several different aspects of reverse last mile is important to study in order to answer the questions; both operating conditions of today and trends and possibilities of tomorrow. The areas' importance of reverse last mile is driven by different objectives respectively and relevant time frames for development is different as well. These differences makes the cases cover a broad range of businesses and this is thought to enable answering the research questions. The final selection between the suggestions is then based on the theoretical frame of reference in reverse logistics, of its possibility to answer the research questions and in collaboration with the supervisors. The cases will be studied both by written cases and by conducting interviews at the selected entities.

A.2 B. Data collection procedures

Data collection plan In order to gain access to the cases wanted, email and phone contact will be used and the thesis research questions and the contacted person's part in it will be clearly presented. The main purpose, background, research questions and methods is presented in a one-pager which will be attached to emails.

The first approach in order to gain access to interviewees is to kindly ask them to be present in our thesis work and present an opportunity to get good publicity. If not successful, the second approach is to contact potential interviewees together with IKEA and present a potential business partner in the future, although the second approach was not needed to use.

The companies of interest will be asked to participate in an interview. This will be conducted in person or by Skype. Other sources of data which be asked for is their financial records and other documents, this in order to estimate the costs of the specific company's business model.

Expected preparation work The work done in prior to conducting case interviews is done in order to get the most out of interviews. They will be held on a day without other activities, this to be flexible in case of unanticipated events of the interviewee or others. Research by internet searches will be done in prior to interviews.

Names of contact persons: The contact persons are anonymized.

A.3 C. Data collection questions

The questions are divided between the different types of interviews. This since they serve different purposes in the study.

A.3.1 Expert Interviews

What is your background in logistics?

How do you see that circular supply chains has developed the past centuries? In literature and practice.

Which are the requirements of future transports?

What are examples of implementation of new transportation solutions for last mile delivery?

What are the greatest challenges regarding implementation of new innovative transportation solutions?

What other complementary innovations are needed for society and private companies in order to set up a reverse last mile system?

Which transportation solutions do you see as less likely to be implemented in the future?

How do you see that a sustainable collection of products can look like?

What main cost drivers do you see as the most important regarding these new transportation solutions?

Crowdsourcing solutions, what role will these solutions play in the future, according to your beliefs?

Are private companies in general playing an active role in the development of urban deliveries?

A.3.2 Companies - Existing Solutions

Examining Questions - Level 1:

What are the drivers for circular supply chain? What are the barriers for circular supply chain?

What is the solution of today?

What are the costs related to reverse last mile?

Will their demand of reverse last mile change in the future?

Has they realized any changes which need to happen in city logistics, reverse last mile? Both for the own company and for society.

What is the planned development of reverse last mile?

Asked Questions - Level 2:

What is your company position? What responsibilities do you have?

How does your circular supply chain look like today? Why does it look like that - what has been the drivers of the development?

Who are your main customers today? Which will they be in the future? What is the future strategy and business model of the company?

How does your reverse last mile work today?

How will it look in the future? Will the stakeholders, partners be the same?

Do you have any plans to change your reverse last mile method? If yes, why? If no, do you see any potential risks or opportunities which can lead to a forced change?

What are the costs related to reverse last mile?

A.3.3 Companies - Innovative

Examining Questions - Level 1:

Drivers of business model?

Potential of the application?

Barriers of implementation?

Scalability of production and business model?

Ways of running the business - partnerships, own delivery etc.

Asked questions - level 2: What is your company position? Responsibilities?

How was your company started?

Which products and/or transportation methods do you wish to replace with your product?

Who are your main customers today? Which will they be in the future? Private or corporate customers?

What is the future strategy and business model of the company? Which markets do you wish to reach? Are there any additional applicable markets, which you do not attempt to reach? What it the growth strategy of your company?

What are the main threats and barriers of your company?

For which products (regarding size, value) is the innovation suitable for?

In what ways is the innovation sustainable? Are there any supportive innovations, technologies or working partners needed for your business model to work?

What are the costs related to reverse last mile?

A.4 D. Guide for the Case Study Report

Outline of conducted expert interviews:

Outline of the conducted interviews over existing and innovative transportation methods:

Expert number	Title	Date
Expert 1	Team Leader Strategy Creation and Innovation at Volvo Cars	3 April 2019
Expert 2	Contact person at Urban Freight Platform	25 March 2019
Expert 3	Professor Emeritus at Lund University	27 March 2019

Table A.1: Interview information for expert interviews

Case company	Interview person	Title	Date
Sellpy	Interviewee 1	Logistics responsible	27 March 2019
Berendsen	Interviewee 2	Service and Distribution Manager	12 April 2019
Bring	Interviewee 3	Innovation and Product Manager	2 May 2019
Movebybike	Interviewee 4	CEO & Co-founder	5 April 2019
Tiptapp	Interviewee 5	Co-founder	10 April 2019
Samlastning i Sege Park	Interviewee 6	Project Leader	11 April 2019
Logtrade	Interviewee 7	Head of Information	16 April 2019
Pling Transportation	Interviewee 8	Chairman of the Board and Sales manager	17 April 2019
Udelv	Interviewee 9	Director of Business Development	23 April 2019

Table A.2: Interview information for case studies of innovative solutions

All information given will be qualitative data. The information given during interviews will be written down and a summary of the interviews will be written before they will be presented in this report. Empirical data will be extracted from reports and literature, which will be compiled in the report and mixed with the information obtained from the interviews. The literature review, interviews and and expert interviews constitutes the foundation of the analysis.

A.5 E. Additional Case and Interviews

The empirical research resulted in 14 interviews, where two case interviews turned out to be less applicable for the purpose and outside the limitations of the project. Although, valuable insights regarding crowd sourcing and crowd logistics was obtained from the interviews and will be presented here.

Case company	Interview person	Title	Date
PiggyBee	Interviewee 10	Co management partner	9 April 2019
Baghitch	Interviewee 11	Founder of Baghitch	12 April 2019

Table A.3: Interview information for case studies of existing solutions

A.5.0.1 PiggyBee

All information in the section below, if nothing else stated, originates from the interview with Interviewee 10, see A.3 for more information.

PiggyBee is a crowd sourced transportation solution founded in 2012 that connects people through a platform. The person who needs to have something transported can search online for a traveller and get in touch through a message system. Through messages the pricing and tip can be discussed. To secure the payment a secure payment module can be used to lock in the amount. After the drive and delivery the traveller is paid and gets a rating.

The crowd sourcing concept was not mature in peoples minds and it took some years for PiggyBee to start grow. They are growing organically and are now doubling their users every year. Their main transporters are travellers and backpackers.

PiggyBee offers a solution for products that needs to be transported a long distance, and very often needs to be taken through customs in different countries. They do not focus on last mile deliveries and to mention, last mile deliveries is one of their biggest issues and something they are trying to improve. Their main threat to their business is trust between the transporter and the customer, customs as well as legal issues

A.5.1 Baghitch

All information in the section below, if nothing else stated, originates from the interview with Interviewee 11, see A.3 for more information.

Baghitch is a crowd sourcing company that was founded in 2011/2012 by Interviewee 11. The founder experienced difficulties when transporting products he bought from the Swedish second hand service Blocket. Many cars had free capacity during the route and wanted to take advantage of this possibility by creating a service where individuals could act transportation mode. The first platform where individuals were connected was a facebook-group but later a digital platform that could manage financial transactions was invented.

The company got financial investments, but due to time-demanding procurement activities Interviewee 11 sold the company and today the company is run under the name Sendoo. The customers was mainly auktion firms and furniture dealers but due to a differentiated customer crowd, a clear type of customer was hard to define. Erik explained that Baghitch was too early for the market and the market was not mature enough to make the company grow. Many companies was very positive to crowdsourcing concepts, newspaper wrote articles but this was not enough for the company to be successful. In order to prove that the case would be successful, the geographical area would need to be scoped down significantly.

The cost of the transport was calculated with an algorithm and suggested to the driver. It was based on the length of the route as well as the traffic situation on the suggested road. If the price suggestion was given to the driver, getting through with transportation would be difficult.