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List of abbreviations

B2B = Business-to-Business

B2C = Business-to-Customer

BESTUFS = Best-Urban-Freight-Solutions

C2C = Customer-to-Customer

CEP = Courier-Express-and-Parcel-Deliveries

CIVITAS = City-Vitality-Sustainability

CO_2 = Carbon dioxide

CO_2e = Equivalent carbon dioxide

ICT = Information-and-Communication-Technology

ITS = Intelligent-Transport-System

JDS = Joint-Delivery-Systems

NO_x = Generic term for nitric oxide and nitrogen dioxide

OECD = Organization-for-Economic-Co-operation-and-Development

PM_{10} = Atmospheric particulate matter smaller than about 10 micrometres

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1. Introduction

A few years ago, it was published that the online platform ‘Amazon’ wants to use small drones in order to deliver their parcels to the customers. This would imply that the parcels are handed out to the customers by air with flight devices which are not directly steered by any person but computationally. Moreover, according to plan the shipping of the parcel would start at the business location of ‘Amazon’ and thereafter heading directly towards the door of the customer’s house (Kontio, 2013).

If this scenario came true that would mean a tremendous change within logistics services and activities. Next to adapting the whole supply chain of a company, this scenario would also mean a huge change for common parcel delivery service companies. Additionally, there would be a major change taking place within the overall transportation system within urban areas, if the described situation became true in some point in time.

Obviously, there are huge concerns if such a scenario can be realised or not. However, this is not of interest for this paper. Rather, the topic of this paper is to get familiar with city logistics, relevant issues to that and how possible future scenarios of city logistics can be realised. More in detail, the research question of this paper is the following:

“What is city logistics, and which determinants are important in order to make projects being successful?”

Potentially, the ‘Amazon’ drone can mean a solution approach in e.g. lowering the congestion level within urban areas. It can be seen that in many European cities the congestion level is increasing from year to year (Beeger, 2015). Thus, congestion represents a main concern of city logistics. However, at this stage the drone scenario seems rather to be science-fiction than being realistic. Therefore, the projects described in this paper concentrate on scenarios which can be handled at this point in time.

To give some overview on this paper, the structure will briefly be described: The following section deals with the relevance and the motivation towards the topic. Furthermore, terms will be defined and the overall problem setting is represented. In chapter 3 there is a literature review describing initiatives, problems and solution strategies as well as models dealing with concepts of city logistics. Chapter 4 reveals all the relevant stakeholders of city logistics, which goals they have, what similarities they share and what conflicts arise. The subsequent section deals with the changes and the developments going on in cities. Chapter 6 gives an overview of what trends can be derived

from the preceding parts, while in chapter 7 there are pilot projects and relevant determinants described. Eventually, there is a conclusion at the end in which the results of the paper are briefly summarized.

2. Primary framework

This section gives a more detailed introduction into the topic and consists of a general motivation towards the topic, a definition part and a part describing the general problem setting.

2.1 Motivation towards the topic

City logistics, also known under the name urban freight transportation, is a very broad and meaningful topic. The reason for this is that freight transportation within urban areas is involved in a huge number of activities. Because of the many activities involved the topic city logistics is very relevant and therefore very interesting and meaningful to do research in.

Furthermore, transportation in general is a very important field of human activity. This can be underlined by the fact that almost every day many persons benefit from techniques, which are routed in the field of transportation logistics. In obvious cases, this can be seen if a person wants to go from place A to place B and has the opportunity to take the metro, bus, car etc. Transportation logistics is also involved when it comes to the daily nutrition of a person, as all the food, which can be bought at a supermarket, has to be transported somehow to the stores. Thus, effective transportation chains have to be created in order to equip the supermarkets with all the items, which are needed. Those examples underline the importance of the field of transportation logistics.

In addition, numerical results can show the relevance of investigating the field of transportation logistics: The annual costs of excess travel in the United States adds up to approximately 45 billion US-dollars per year and the costs of the turnover of goods transportation in Europe adds up to approximately 168 billion US-dollars per year (King & Mast, 1997). Furthermore, general transportation represents up to 15%, 9%, and 15%

of national expenditures in the United Kingdom, France, and Denmark, respectively (Crainic & Laporte, 1997; Larsen, 1999).

The research of De Backer et al. (1997) has shown that distribution costs can amount to approximately half of the total logistics costs. In addition Chopra & Meindl underline that distribution-related costs make up roughly 20% of the overall manufacturing costs (Chopra & Meindl, 2009). A further statistics from the US Department of Transportation (2014) reveals that in the year 2012 approximately 67% of all the goods' transportation in the US was done by vehicle. All those numbers show the relevance of the topic transportation, which leads to the importance of investigating transportation logistics within urban areas as well.

A quote from Crainic & Laporte (1997) further underlines the importance of freight transportation: "Freight transportation lies at the heart of our economic life: In industrialized countries, it accounts for a significant share of the gross national product, in developing countries, it is the essential ingredient of sustainable development" The other dimension which makes the topic city logistics interesting and meaningful is the development of urban areas. Factors like gentrification, urbanization and a thinking-green-attitude play a major role here, to mention some key aspects (Glaeser, et al., 2001; Florida, 2002; United Nations, 2008). In fact estimations say that since the years 2007 the world-wide urban population has been larger than the world-wide rural population (Crainic, et al., 2007).

2.2 Definition

As already mentioned, city logistics is also known as urban freight transportation or urban freight movement. The topic includes the whole concept of a functioning transportation system within cities or urban areas, respectively. This includes being able to overcome problems which arise due to transportation logistics, be it commercial travels or private travels, within a city, like e.g. congestion, pollution or noise (Crainic, et al., 2004).

According to Taniguchi et al. (2001) city logistics is defined as "the process for totally optimising the logistics and transport activities by private companies with support of advanced information systems in urban areas considering the traffic environment, the traffic congestion, the traffic safety and the energy savings within the framework of a market economy". In a nutshell this means finding the optimal solution for the goods

and vehicle flow within urban areas, considering the entire nuisance resulting from the operations.

Due to an increasing amount of vehicles being on the roads within urban areas, the nuisances like congestion, pollution and noise are getting worse and worse. Nowadays this leads to a rising public awareness of the topic. Consequently, there is the request towards policy makers and businesses to do something and deal with the topic in order to maintain or even improve city inhabitants' quality of life. As a result, there is a need to get a better understanding and knowledge of the topic, which should be shared amongst the different players in the market in order to be able to handle it effectively. Furthermore, there is a need to more closely analyse and control the freight movement within cities (Kohler, 2001; Larraneta, et al., 1999; Morris, et al., 1999; Taniguchi, et al., 2001).

Normally when speaking about city logistics the main emphasis lies on large, congested areas. Moreover, the issues which are more closely described in the following part apply to the whole city territory. It should also be mentioned that each of the issues and possible solutions approaches can vary within different cities and even within different city districts. Thus, if not described especially, when dealing with the city, the very core and dense centre of the city is meant (Crainic, et al., 2004).

To overcome the negative impacts of freight transportation within cities the concept of city logistics has set several goals which include for instance reducing congestion and increasing mobility; reducing pollution and noise; contribute towards reaching the Kyoto environmental targets; improving city inhabitants' living conditions; as well as avoiding to penalize the commercial activities within city centres (Kohler, 1997; Crainic, et al., 2004; Taniguchi, et al., 2001).

2.3 Problem setting

As both space and capacity are limited in combination with the appearance of congestion within cities, the topic of urban freight movement becomes even more demanding. The issue of congested streets comes together with the restricted space and capacity of streets within a city and may even result out of those factors. Furthermore, it seems that congestion within dense urban areas is becoming worse and is growing in importance, also with respect to urban freight transportation.

A research of von Eichel (2004), which concentrates on major German cities, shows that there is a trend towards a higher usage of cars when it comes to private passenger travelling, whereas the usage of public transport is decreasing. The results of von Eichel's research may lead to the case that more and more vehicles are using and filling the streets of a city, which underlines the arising problem of congestion.

In turn, congested streets make it hard for a freight transport system to work efficiently and effective. This is because the process of planning exact departure and arrival times of transportation vehicles becomes harder to predict if streets are congested. This also leads to higher costs involved, yet another point leading to a lower efficiency of the system.

Another issue related to city logistics is that often freight movement is perceived as a disturbing activity from the view of a city's inhabitants (OECD, 2003). Hence, often the opinion about transportation vehicles is that they lead to air pollution, disturbing noise and to more congested streets. Based on this one might think that freight movement results in a lower quality of life within cities.

However, what is missing from the latter viewpoint is that freight movement leads to an improved quality of life too: Only with a well-functioning transportation logistics system stores like e.g. supermarkets can be equipped with needed goods and commodities. Thus, there a two sides of the coin, which shows the dilemma of city logistics as well: One the one hand freight movement within urban areas benefits a huge number of city-based activities, thereby leading to an improvement of inhabitants' quality of life. On the other hand fright movement leads to nuisance like pollution, noise and congestion, thereby decreasing inhabitants' quality of life (Crainic, et al., 2004; Taniguchi, 2014). This reveals that there exists a trade-off between the advantages and disadvantages linked to the movement of freight within urban areas.

A further major problem of urban freight transportation is that on average the load of a commercial vehicle is low and in many cases the vehicles drive around with no load at all (Morris, et al., 1999). According to Crainic et al. (2004) one of the reasons for low or even empty truck loads is that the in-bound and out-bound freight flows within urban areas are not balanced, as well as a random organization of distribution decisions and shipments. The latter point means that businesses often order items when needed, meaning there is not much consolidation or systematic collection of orders. This way "it is common, for example, to witness several trucks stopping one after another in front of a grocery or general store to discharge a few items" (Crainic, et al., 2004).

One more issue is that often decision makers of city authorities were not prone to put a lot of emphasis on the topic of freight transportation for a long time, even though it is very relevant to many people. This lead to the fact that the related issues were neither well understood at the city level, nor quantified (Crainic, et al., 2004). According to Crainic et al. (2004) the reason for this was the attitude of public authorities that freight transportation is a private business. As a result public authorities did not feel responsible for operating or giving advices to private businesses. This attitude, however, has changed by now and city authorities are willing to put more effort into the topic of city logistics (Crainic, et al., 2004; Lindholm, 2012; Taniguchi, 2014).

All of this shows that city logistics is of great relevance and very meaningful. Therefore, research in this topic is very relevant and it might be interesting to see how city logistics will evolve over the years and what scenarios there might exist in the future. This, in turn, might add a lot of value to different kind of players which are involved in the topic of urban freight movement.

3. Literature review

When searching for literature regarding city logistics or urban freight transportation, respectively, it can be seen that the amount of publications is huge. Early research in the field of city logistics has for instance been done by Jansen & Oldenburger (1991) or Ruske (1994). To provide a comprehensible overview of the plethora of publications the literature review part will be divided into the following three sub categories: Campaigns & initiatives, problems & solution strategies, as well as models.

3.1 Campaigns & initiatives

This section contains both marketing campaigns as well as initiatives from businesses and public authorities. On the one hand marketing campaigns are meant to get a better understanding of the topic and to promote the topic in order to get as many as possible stakeholders involved. This, in turn, is important so that actions can be taken which tackle the issues related to urban freight transportation.

On the other hand initiatives try to build a foundation in order that the several stakeholders involved can come up with useful and effective co-operations. This too is crucial to take actions with the aim of tackling issues related to urban freight movement.

An example for marketing campaigns is the work of Schrampf et al. (2013). In this paper the authors concentrate on the urban area of Vienna and give an impression of what different kinds of elements, items and perceptions are part of the topic urban freight movement. For instance the authors give an overview of which players and groups of people are involved in the demand of logistics and the supply of logistics, respectively.

Amongst others there are consumers, retail markets, gastronomy businesses, production facilities, construction sites and different kinds of service businesses involved to the demand of logistics. When it comes to the supply of logistics there are e.g. parcel services, truck companies, chain store logistics, disposal procedure logistics, and other kinds of logistic services involved (Schrampf, et al., 2013).

In addition, the authors show which performance processes are part of the topic urban freight movement. This includes the concepts of delivery services, specific systems and circles, reverse logistics and disposal services. Furthermore, the authors give an overview and concrete application examples of instruments that can be used in order to get a well-functioning system of smart urban logistics. Those instruments include logistical approaches, technological approaches, co-operation approaches and governmental approaches. Moreover, there are specific conditions and side factors described in the paper, like e.g. the influence of the energy market, labour market, safety regulations, innovation processes, the role of ecological efficiency etc. (Schrampf, et al., 2013).

Examples for initiatives are the City-Vitality-Sustainability (CIVITAS) initiative and the Best-Urban-Freight-Solutions (BESTUFS) initiative. The CIVITAS initiative is a large program to support sustainable urban mobility and is co-funded by the European Commission (van Rooijen & Quak, 2014).

Van Rooijen & Quak (2014) describe the concept of CIVITAS in more detail. The CIVITAS initiative was founded in the year 2002 and its aim is to make a change possible towards sustainable urban mobility through the following points: Promoting and implementing sustainable, clean and (energy) efficient urban transport measures; implementing integrated packages of technology and policy measures; building up critical mass and markets for innovation; overcome barriers for implementation of innovative

and ambitious measures and policies by experimental testing combined with targeted research (van Rooijen & Quak, 2014; CIVITAS, 2013).

Moreover, the authors describe that the CIVITAS initiative in fact came up with measures which can increase a sustainable urban mobility for cities participating in the program. Additionally, the results show that due to the participation in the program city authorities are influenced in the direction of sustainability (van Rooijen & Quak, 2014).

The BESTUFS initiative is a thematic network established and sponsored by the European Commission too. Amongst others the BESTUFS program is described more in detail in the work of Russo & Comi (2010) and in the handbook of BESTUFS (2007) in which regulation measures are addressed. Within this handbook of BESTUFS case studies of European cities are described which provide details of measures implemented and their resulting effects.

One goal of the BESTUFS initiative is to give some guidance for the several players who are involved when it comes to freight transportation within urban areas, considering measures which can be implemented in order to improve the flow of goods and in order to reduce the environmental nuisance caused by the operations of urban freight movement (BESTUFS, 2007).

In that context three main categories of measures have been identified: Goods' vehicle access and loading approaches in urban areas (e.g. efficient use of infrastructure; guidance on measures for goods' vehicle access and loading in urban areas, technology in urban freight movement), principal issues involved in last mile solutions (e.g. home shopping via e-commerce) as well as principal issues associated with urban consolidation and distribution centres (Russo & Comi, 2010).

Another example of an initiative is the City Ports program. It was established in the year 2005 and concentrates on European cities as well, in which tools and policies for urban freight transportation are investigated (City Ports, 2005). Detailed information on this initiative can be found in Russo & Comi (2010) as well as in the report from City Ports (2005).

Within the City Ports initiative a general method was produced in order to address the issues of urban freight transportation in a comprehensive framework in which policies are defined after local analyses. Other goals of this initiative are the ranking of critical issues, to come up with designs and evaluations of specific solutions and the involvement of as many players involved in the urban freight movement as possible (Russo & Comi, 2010; City Ports, 2005).

Within this context of the City Ports program there are basically two questions involved: 'What is regulated' and 'how to regulate'. 'What is regulated' refers for instance to the general infrastructure, logistics platforms, operative platforms as well as vehicles and transportation efficiency. 'How to regulate', on the other hand, refers to ordering the measures according to some kind of intervening policies, like e.g. restrictive measure, pricing measure, permissive measure, incentive measures etc. (Russo & Comi, 2010; City Ports, 2005).

3.2 Problems & solution strategies

Before describing some strategies in more detail, first some problems which can be found in existing literature and which are related to the topic of urban freight movement will be discussed. In turn, it might then be possible to tackle these problems with the described strategies in order to possibly solve the arising problems linked to freight transportation within urban areas.

A paper dealing with the problems related to urban freight movement is that of Lindholm (2010): The author focuses on the perspective of local authorities on sustainable urban freight transportation with the goal to contribute towards a better understanding in what way the movement of freight affects the urban environment. Additionally, she tries to find out what effect the awareness and knowledge within local authorities has on the situation of urban freight movement. The emphasis of the research lies on three main aspects: The sustainability concept, knowledge and awareness, as well as barriers and drivers (Lindholm, 2010).

Problems related to urban freight transportation are mentioned as well: Lindholm has found that "freight transport has a minor role in transport planning procedures in most cities, although freight transport operations represent a substantial proportion of emissions" (Lindholm, 2010). This means that city authorities underestimate the issues of urban freight transportation especially with respect to environmental aspects. A further result of the research is that the awareness and knowledge in the field of urban freight transportation is generally low which results in a low level of interest towards the topic and makes further outcomes of certain actions hard to predict (Lindholm, 2010).

One of the suggestions of Lindholm is that the issues related to urban freight transportation should gain a higher priority on the agenda of local city authorities and the

knowledge within the field of city logistics should be improved in order to tackle the before mentioned problems. A further strategy suggested by the author is to improve and get a higher level of co-operation and communication as these two factors are very essential. This should play a role not only within local authorities and businesses, but also between the different players involved in the urban freight movement, like e.g. between private businesses and governmental authorities (Lindholm, 2010).

Similar results can be found in other papers as well. For instance in the research of Muñuzuri et al. (2012), Taniguchi (2014), van Rooijen & Quak (2014), Browne et al. (2012) and Witkowski & Kiba-Janiak (2014). All of those papers show as a resulting strategy to improve and get towards a higher level of co-operation and communication between the different players. This shows as a consequence that these strategy aspects are very crucial in order to tackle the issues related to the transportation of freight within urban areas. Thus more information needs to be shared between the different players involved in urban freight movement.

Muñuzuri et al. (2012) also describe another problem: Local city authorities often try to apply a general solution approach to different types of issues and different types of cities. However, as shown by Lindholm (2010) too, there is no unique solution which solves all the problems easily with one approach. Rather, each situation needs to be analysed and evaluated separately and as a result several actions or a series of actions are needed in order to tackle the issues. In (Lindholm, 2012) the author describes that "city logistic schemes implemented in a large city are not always suitable for a smaller city and maybe not even for another city of the same size". Therefore, Muñuzuri et al. (2012) claim in their paper that "different types of urban distribution require different types of regulations".

There are further strategies in order to tackle the issues arising from urban freight movement that are described in Muñuzuri et al. (2012): These include for instance a better use of data gathering processes and a better use, as well as a better and further development of simulation tools. Furthermore, the authors suggest making use of a thorough economic analysis of urban freight transportation, which includes not only direct costs, like e.g. operation, infrastructure and management costs, but also all kind of indirect costs, like e.g. pollution or noise. (Muñuzuri, et al., 2012).

Moreover, Muñuzuri et al. (2012) claim that the management of on-street load and unload facilities should be improved. This includes for instance providing specific streets with loading zones, allowing double parking for brief deliveries or allowing

night deliveries in specific areas. That planning should however not be made randomly but especially shaped towards the situation where the streets and areas are located. Furthermore, the authors say "the key is to analyse the needs of the transport sector, provide enough infrastructure and regulatory capacity, and then enforce their correct use and application" (Muñuzuri, et al., 2012).

In addition, Muñuzuri et al. (2012) describe that the demand of street capacity could be decreased by e.g. establishing appropriate off-street loading and unloading facilities which might help finding solutions for arising problems. This idea is described in Pivo et al. (2002) too. Furthermore, other actions could try to concentrate on the supply of street capacity, meaning to increase this supply by e.g. "its dynamic allocation to freight distribution in those places and intervals where other priority uses are slack" (Muñuzuri, et al., 2012).

Another aspect described by Muñuzuri et al. is to make use of the internet when it comes to a more sophisticated use of load zones. That way, web-based applications could be used to reserve space in a load zone in advance. This might help in making freight flows more efficient when the loading zone is actually free and ready to use when the delivery vehicle is arriving. This idea of web-based application systems is described in the paper of Stickel & Furmans (2005) too.

To overcome the issues related to the freight movement within urban areas Taniguchi (2014) generally claims to make use of innovative technologies of information-and-communication-technology (ICT) as well as intelligent-transport-system (ITS) at a higher intensity. Furthermore, Taniguchi (2014) states that a change in mindsets of logistics managers as well as public-private partnerships promote city logistics to come up with good strategies in order to solve problems related to urban freight movement.

The research paper of Quak (2012) deals with problems related to freight transportation within urban areas and strategies to overcome these problems as well. In his paper the author states that local authorities have the opinion of carriers that they are not innovative and that they are not taking part in co-operations in order to improve their city logistics operations. However, as described by Quak the problem is that the actions from carriers are just not recognized and acknowledged by local authorities. Moreover, according to the author there exist three solution directions of how to make freight transportation within urban areas more efficient and more sustainable. These three solution directions are policy measures, technological improvements and logistical innovations (Quak, 2012).

Further the author Quak describes that the three solution directions should be combined in a good mixture and not be considered separately in order to truly improve the movement of freight within urban areas. “This implies actions from public and private actors that are coherent and complementary: An overall urban freight transport strategy that considers the variety of objectives of the different stakeholders” (Quak, 2012). This statement highlights the strategy of communication and co-operation too, which was amongst others claimed by Lindholm (2010) and Witkowski & Kiba-Janiak (2014).

Another research paper of Muñuzuri et al. (2005) deals with solution approaches for the issues of urban freight movement and puts those solution approaches into different categories. In their paper the authors state that they investigate general approaches that can be used by local authorities in any general medium-large city.

The categories in which the solution approaches are put in are as follows: Solutions related to public infrastructure, solutions related to land use management, solutions related to access conditions, solutions related to traffic management, as well as solutions related to enforcement and promotion (Muñuzuri, et al., 2005). Specific tools and actions of those solution categories are summarized in Table 1.

Table 1: Classification of urban freight solutions for application by local authorities

Local administration solutions for urban freight		
Public infrastructure	Transfer points	City terminals Outskirts logistic centers Logistic improvement of terminals Use of rail or ship terminals Use of public parking lots
	Modal shift	Use of the train or underground system Shuttle train
Land use management	Parking	Load zone provision Parking space planning Hub areas Use of other reserved spaces
	Building regulations	Load/unload interfaces Use of private parking lots Mini-warehouse
Access conditions	Spatial restrictions	Access according to weight and volume Access to pedestrain zones Street blocking allowance Closing the center to private traffic Road pricing
	Time restrictions	Adequate rotation in load zones Night deliveries Double-parking short time restrictions Access time windows
Traffic management	Scope of regulations	Carrier classification Freight zone classification Harmonization of regulations Street classification
	Information	On-line load zone reservations

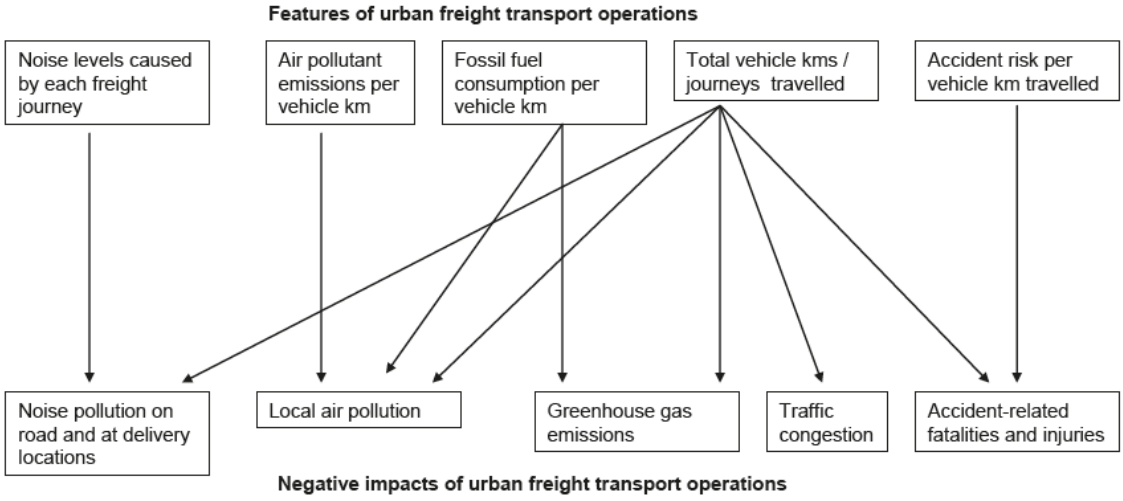
Source: (Muñuzuri, et al., 2005)

Referring to Table 1, Muñuzuri et al. (2005) describe, however, that not all of those actions and tools may be equally suitable or may be uniformly since it might depend on the city which action works and which does not. In addition, the authors claim that a combination of those solutions should be the aim rather than only concentrating on single solutions. The reason for this is that "some of these specific solutions benefit a certain group of stakeholders, but affect negatively those others" (Muñuzuri, et al., 2005).

Muñuzuri et al. further point out that the expected results of the solutions shown in Table 1 might not lead to an improvement of the whole situation as many of those solutions imply some constraints on the free movement of vehicles which might, in turn, lead to a damage of economic activities. Therefore, the authors state that "the best approach might be for the local administration to leave things the way they are, which is always one of the available options for a policy maker" (Muñuzuri, et al., 2005).

The research paper of Browne at al. (2012) contains some kind of summary of relationships between features and negative impacts of urban freight transportation. These features can be used as a basis for possible solution strategies regarding problems arising from urban freight movement. Those possible solution approaches are meant to be applicable by policy makers, thus also applicable by local authorities. The relationship of features and negative impacts can be seen in Graph 1. Thus, Graph 1 represents "options available to policy makers in their efforts to reduce the negative impacts of urban freight transport" (Browne, et al., 2012).

Graph 1: Relationship between features and negative impacts of urban freight transport



Source: (Browne, et al., 2012)

The outcomes shown in Graph 1 can be linked to the outcomes shown in Table 2. In this table Browne et al. (2012) give a summary of what concrete strategies could be implied by policy makers in order to reduce the negative impacts caused by urban freight movement being shown in Graph 1. Hence, Table 2 summarizes available strategy approaches to overcome negative impacts caused by freight transportation within urban areas.

Table 2: Features leading to negative impacts and associated strategies

Features of urban freight transport leading to negative impacts	Initiatives that can result in reduced impacts	Lowest govt level at which initiative typically implemented
Total vehicle kms / journeys by road in urban area	Load consolidation	Urban
	Ordering and delivery frequency	Urban
	Modal shift	National / urban
	Fuel taxes	National
	Location of activities (Land use)	Urban
	Congestion charge	Urban
	Parking regulations/On street loading spaces	Urban
	Real time traffic information	Urban
Fossil fuel consumption per vehicle km	Driver behaviour	Urban
	Vehicle engine design	International / national
	Vehicle design (Aerodynamics)	International / national
	Additions of biofuels to petroleum mix	National
	Matching vehicles to loads	Urban
	Use of vehicles powered by non-fossil fuels (inc bicycles)	National / urban
	Use of bicycles	Urban
Local pollutant emissions per vehicle km	Vehicle engine emissions standards (Euro standards plus other initiatives)	International
	Use of traps and filters	National
	Low emissions zones	Urban
Noise levels caused by each freight journey	Driver behaviour	Urban
	Vehicle design	International / national
	Ability to switch off built in reversing signals etc.	Urban
	Design of vehicle reception areas	Urban
	Loading time restrictions	Urban
Accident risk per vehicle km	Driver behaviour	Urban
	Vehicle design (wing mirrors)	Urban
	Cyclists wearing fluorescent clothing	Urban

Source: (Browne, et al., 2012)

3.3 Models

There exists different kind of research about models that can be used and are related to the topic of city logistics. This includes both quantitative as well as qualitative models. Ideas of quantitative models, being technical and mathematical in nature, can be found in the research papers of Crainic et al. (2004; 2007) and Muñuzuri et al. (2011) to name some examples.

In the research of Crainic et al. (2004) the authors concentrate on a model that is based on the idea of intermodal logistic platforms. An intermodal logistic platform, also referred to as city distribution centre, links the city to outside regions and countries. The idea is that these platforms receive large trucks and smaller vehicles that are dedicated towards local distribution. Additionally, the intermodal platforms should be easily accessible and are therefore often stand-alone facilities situated close to ring-highways or alternatively situated within or close to air or rail terminals (Crainic, et al., 2004). It has further been shown that intermodal platforms can represent an important step towards a better organization of city logistics (Kohler, 1997; Taniguchi, et al., 2001; van Duin, 1997).

The model of Crainic et al. (2004; 2007) concentrates on the idea of using intermodal platforms and consists of satellites which are mini platforms. In these platforms freight arriving from various external points can be transferred and consolidated into vehicles being environmental friendly. These vehicles are referred to as city-freighters and are adapted for dense zones within a city. In addition, ITS technologies can be used for real-time control and co-ordination of operations and vehicles (Crainic, et al., 2004).

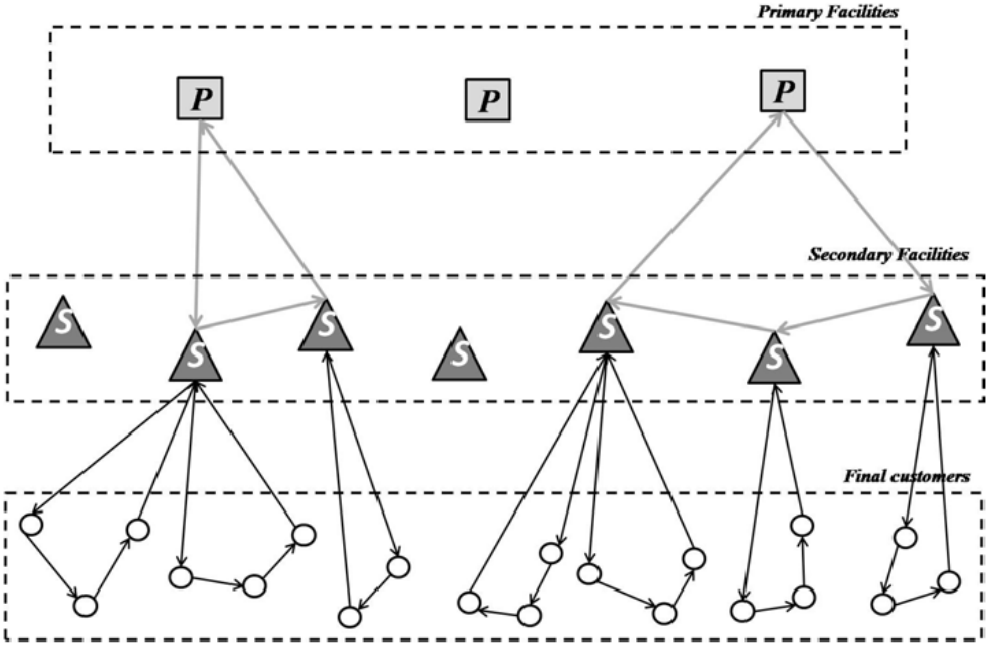
Moreover, this model is based on the problem setting called two-echelon routing problem. This is a mixed integer programming setting that has the aim to define the location as well as the number of capacitated facilities, define the size of two different vehicle fleets and define the related routes. Because of these unknown variables the setting can be categorized as two-echelon location routing problem (Cuda, et al., 2015).

Next to two-echelon location routing problems there are also two-echelon vehicle routing problems. Unlike the latter, location routing problems typically include both strategic and tactical planning decisions, whereas vehicle routing problems usually only include tactical planning decisions (Cuda, et al., 2015). Within this context, strategic planning decisions "include decisions concerning the infrastructure of the network, typically the number and the location of the facilities" (Cuda, et al., 2015). On the other

hand, tactical planning decisions "include the routing of freight through the network and the allocation of customers to the intermediate facilities" (Cuda, et al., 2015).

In Graph 2 Boccia et al. (2011) show the idea of a basic two-echelon location routing problem, which includes the primary facilities, i.e. production plants, the secondary facilities, i.e. satellite platforms, as well as the final customers. As can be seen, all of these groups are linked to each other and the freight flows from the production plants via the satellites to the final customers. This flow also works vice versa, meaning from the customers via the satellites to the production plant. This could for instance be the case if a customer sends back an item.

Graph 2: Possible solution instance of a two-echelon location routing problem



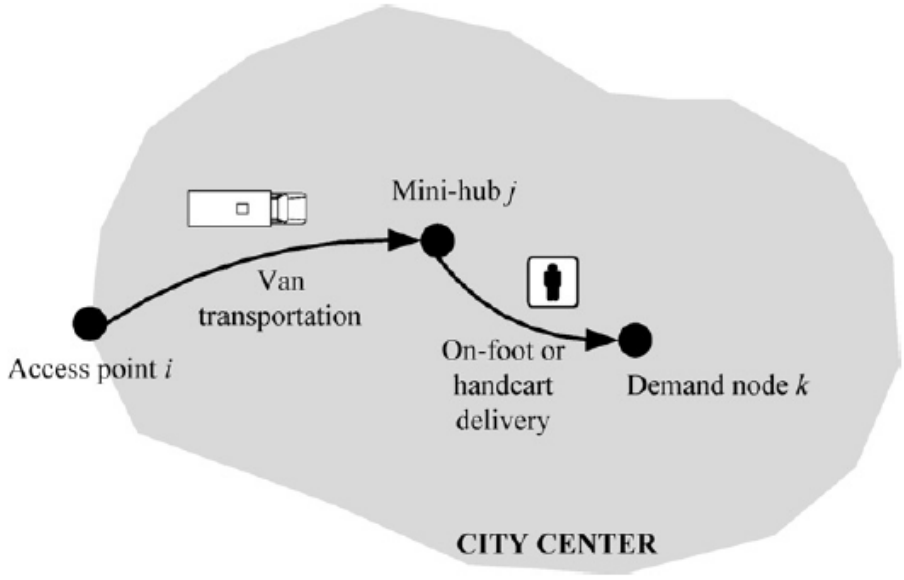
Source: (Boccia, et al., 2011)

Built upon the aforementioned model, the one of Muñuzuri et al. (2011) is a location model in which the optimal location of mini-hubs is determined. The basic idea of mini-hubs is comparable to the idea of intermodal logistic and satellite platforms discussed in the above paragraphs. Within the system of mini-hubs delivery vehicles can park and unload their freight, while the final delivery is to be completed by foot. More in detail, "these mini-hubs are specific streets or areas where delivery vehicles are allowed to park, regardless of the access time window, in order to complete the final deliveries on

foot or using a handcart“ (Muñuzuri, et al., 2011). A graphical representation of the idea of a mini-hub system can be seen in Graph 3. Graph 4 represents the mathematical formulation of the mini-hub location problem.

With the system of mini-hubs there are advantages and disadvantages which arise and are described by Muñuzuri et al. (2011). On the one hand, the system results in longer displacements from the parked vehicle to the final destination, representing longer delivery time. On the other hand, however, the system allows the vehicles to avoid time window restrictions by “making a single long stop in the mini-hub instead of driving around the city centre from one destination to another” (Muñuzuri, et al., 2011). This can represent a contribution towards making planning and organizing freight deliveries more easily.

Graph 3: Representation of freight distribution through a system of mini-hubs



Source: (Muñuzuri, et al., 2011)

Moreover, according to Muñuzuri et al. (2011) there is a difference between the systems of mini-hubs and city distribution centres. The authors stress that city distribution centres are transhipment points close to the city centre where delivery vehicles unload their freight and transfer them to city-freighters, while mini-hubs are just specific sections of curb at which the delivery vehicles stop to make the final delivery. Further-

more, the city-freighters need to be managed with sophisticated operation and planning tools, which is more costly compared to the final delivery by foot or handcart in the case of mini-hubs (Muñuzuri, et al., 2011).

Referring to the mathematical formulation of the mini-hub location problem of Graph 4, the objective function represents carrying the freight from the access point to the final demand node at minimum costs. The costs involved "is the sum of the overall costs of the transportation by truck or van between accesses and mini-hubs, and the overall costs of distribution on foot between mini-hubs and final destination nodes" (Muñuzuri, et al., 2011).

Equations (1) – (11) of Graph 4 represent the constraints of the location model. "(1) and (2) establish that the connection between access, mini-hub and destination node can only be established if the access is linked to the mini-hub and the mini-hub is linked to the destination node; (3) establishes that node *j* has to contain a mini-hub in order to allow the mentioned connection; (4) sets the overall number of mini-hubs to locate in the city centre; (5) forces that every destination node *k* must be assigned to only one mini-hub; (6) forces the fraction of vehicles entering the centre through access *i* must equal the known a_i values; (7) ensures that only the nodes in *H* can be considered access nodes; and (8) – (11) define the possible value ranges for the variables" (Muñuzuri, et al., 2011).

Muñuzuri et al. (2011) further describe that their model only considers freight flow that is asymmetric, meaning freight only flows in one direction, which is access – mini-hub – destination. Additionally, only costs linked to the covered distance are included in the model and there is no distinction between goods or commodities transported. Furthermore, the authors applied four hypotheses in order to simplify the mini-hub location problem. These are: No consideration of capacity restriction; single allocation; the number of mini-hubs to locate is known in advance; route considerations are not included. For more information on these hypotheses and the model the reader is referred to (Muñuzuri, et al., 2011).

Graph 4: Mathematical formulation of mini-hub location problem

$$\text{Minimize} \sum_{i=1}^{n}\sum_{j=1}^{n} c_{ijh} h_{ij} + \sum_{j=1}^{n}\sum_{k=1}^{n} \delta_k d_{jk} w_{jk}$$

$$\text{Subject to}: \; h_{ij} \geq x_{ijk} \quad \forall i, j, k = 1 \ldots n \tag{1}$$

$$w_{ij} \geq x_{ijk} \quad \forall i, j, k = 1 \ldots n \tag{2}$$

$$y_j \geq x_{ijk} \quad \forall i, j, k = 1 \ldots n \tag{3}$$

$$\sum_{j=1}^{n} y_i = p \tag{4}$$

$$\sum_{i=1}^{n}\sum_{j=1}^{n} x_{ijk} = 1 \quad \forall k = 1 \ldots n \tag{5}$$

$$\sum_{i=1}^{n}\sum_{k=1}^{n} \delta_k x_{ijk} = \alpha_i \sum_{k=1}^{n} \delta_k \quad \forall i = 1 \ldots n \tag{6}$$

$$x_{ijk} = 0 \quad \forall i \notin H, j, k = 1 \ldots n \tag{7}$$

$$x_{ijk} \in \{0, 1\} \quad \forall i, j, k = 1 \ldots n \tag{8}$$

$$y_j \in \{0, 1\} \quad \forall j = 1 \ldots n \tag{9}$$

$$h_j \in \{0, 1\} \quad \forall i, j = 1 \ldots n \tag{10}$$

$$w_{jk} \in \{0, 1\} \quad \forall j, k = 1 \ldots n \tag{11}$$

where:

i = access nodes in the downtown area.
j = potential mini-hub locations (all the network nodes).
k = destination nodes in the downtown area (all the network nodes).
p = number of mini-hubs to locate.
y_j = 1 if a mini-hub is placed in location j, 0 otherwise.
x_{ijk} = 1 of node k is assigned to mini-hub j and this one is assigned to access i, 0 otherwise.
h_{ij} = 1 if any x_{ijk} = 1 exists for any k, 0 otherwise.
w_{jk} = 1 if any x_{ijk} = 1 exists for any i, 0 otherwise.
c_{ij} = cost per distance unit for van transportation between access i and mini-hub j.
d_{jk} = cost per distance unit of walking between mini-hub j and destination node k.
δ_k = commercial density of destination node k.
α_i = fraction of the total vehicle flow that enters the city center through access i.
H = set of nodes defined as accesses to the city center.

Source . (Muñuzuri, et al., 2011)

Another model of Senarclens de Grancy & Reimann (2014) is based on the vehicle routing problem with time windows and multiple service workers. The idea of the model is that transportation vehicles park and cluster nearby customers at known parking locations, from where the final delivery to the customer takes place by foot. To make the service times and operations more efficient additional service workers are assigned to each vehicle. The objective function, calculating the total cost *C*, for this model can be seen in Graph 5. Referring to the model of Muñuzuri et al., the clustering parking locations can be regarded as mini-hubs.

Graph 5: Objective function of vehicle routing problem with time windows and multiple service workers

$$C(t, s, d) = t \cdot c_t + s \cdot c_s + d \cdot c_d$$

where

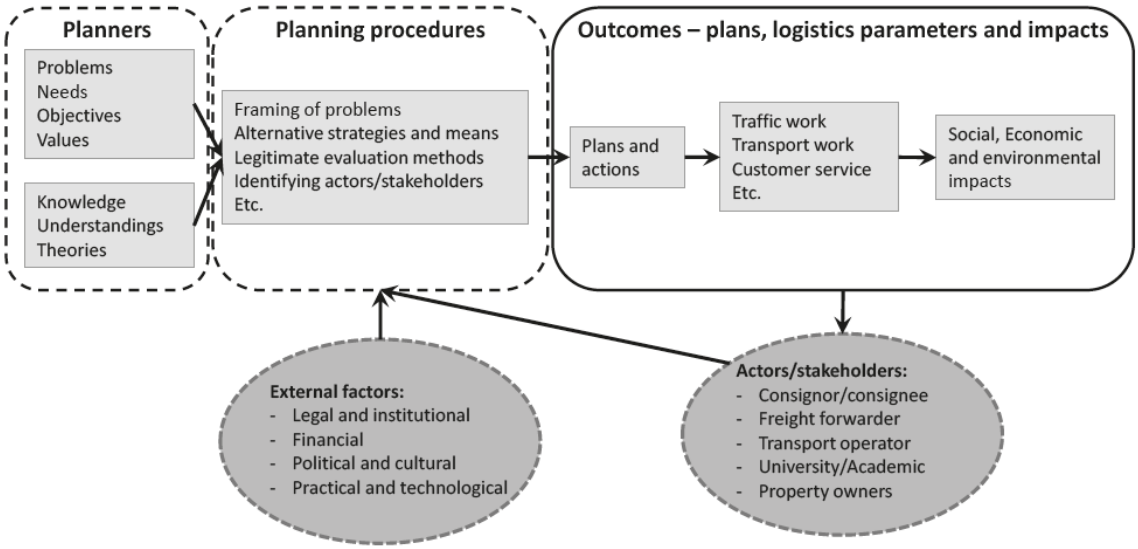
t	number of trucks
s	number of service workers
d	total distance driven by all trucks
c_t	fixed cost per truck
c_s	fixed cost per service worker
c_d	cost per distance unit

Source: (Senarclens de Grancy & Reimann, 2014)

Such models using intermediate platforms like city distribution centres, where freight is consolidated, are also referred to as joint-delivery-systems (JDS). In the research paper of Taniguchi (2014) the author describes that "the purpose of JDS is to increase the efficiency of urban goods distribution by consolidating goods of competitive freight carriers as well as reducing the negative environmental impacts, alleviating congestion, improving safety and security conditions in urban areas" (Taniguchi, 2014).

Next to technical, quantitative models, there exist qualitative ones as well. An example for this can be seen in the paper of Lindholm (2012) in which the author presents a process planning model. This is meant to be a practical tool for the planning process of local authorities' decision makers. The basic idea of the model can be seen in Graph 6.

Graph 6: Representation of process planning model



Source: (Lindholm, 2012)

The model presented in Graph 6 shows that there are many actions and actors involved when it comes to the topic of city logistics. Overall as stated by Lindholm (2012), the model describes the process from identifying the problems related to urban freight transportation towards the final outcomes of actions performed. Furthermore, all the actions are in some way linked and influenced by each other. Planners refer to local authority decision makers, who perform the planning procedures too. Moreover, the author stresses that "the stakeholder is an important factor in both the planning procedure as an input reference group, but is also an important group to consider since the consequences of the planned activities and the outcomes directly affect this group" (Lindholm, 2012).

Some more sophisticated quantitative as well as qualitative models related to city logistics can for instance be found in the research papers of Russo & Comi (2011), Comi & Rosati (2013) and Tamagawa et al. (2010). In the paper of Russo & Comi (2011) the authors describe a systematic model for assessing city logistics measures ex-ante. This model has the aim to simulate the choices made by decision makers involved in urban freight transportation and how the policies and resulting measures can influence the choice of the decision makers. The model of Comi & Rosati (2013) is called city logistics analysis and simulation support system. This model is meant to help in the identification of critical stages and to simulate scenarios of city logistics. Within the

paper of Tamagawa et al. (2010) the authors present a multi-agent model with which city logistics strategies and measures can be evaluated.

4. Stakeholders

This chapter deals with the different kind of stakeholders involved in urban freight transportation. Moreover, it will be discussed what view each stakeholder has on the topic city logistics and what each group of stakeholders expects to result from city logistics.

Basically there exist four major groups of players involved in urban freight transportation, which are the shippers, freight carriers, administrators and the residents. All of these stakeholders play an important role when it comes to the topic city logistics and are described by Taniguchi (2014) too. Another group of stakeholders who should be considered are the customers. They are mentioned separately here, as they are basically part of the residents. However, they partly have different goals compared to the other roles of a city's residents as can be seen in the referring sub-sections.

4.1 Shippers

Next to the end-consumers, the shippers are one of the initiators of freight movement as they basically start the whole process of freight movement by putting the order of moving goods or commodities from a specific origin towards a specific destination in hand of the freight carriers. Shippers can include production facilities, service facilities, sales and distribution businesses as well as public institutions to name some examples (Schrampf, et al., 2013).

Because the shippers are responsible for initiating the process of freight movement, it is crucial to integrate this group of stakeholders into the decision making process of new city logistics concepts. Thus policy makers as well as other kind of decision makers have to consider the goals and needs of shippers when considering actions related to urban freight transportation, since the shippers represent the role of initiating actors of freight movement (Schrampf, et al., 2013).

One of the main goals of shippers is to move their goods or commodities as fast and as cheap as possible from its origin towards its destination of a customer in such a way that the customers are eventually satisfied. The customers of shippers can include other companies, like e.g. other production plants or wholesalers, and end consumers.

Overall, shippers are actually not directly involved in congestion, noise or environmental issues, at least not in the first stage of the process. Consequently, this may lead to the fact that they feel not responsible for solving those kinds of issues. This highlights the need for decision makers, like local authorities, to communicate and coordinate with the shippers to overcome the nuisance related to urban freight transportation, which is claimed for instance by Lindholm (2010) or Witkowski & Kiba-Janiak (2014) as well.

4.2 Freight carriers

The freight carriers are responsible for the actual process of transport by moving the freight. Thus, freight carriers deliver items from its origin to the shippers' customers. On the other hand, the shippers represent the contractual partner of the freight carriers as the shippers put their order in hand of the freight carriers. Freight carriers include parcel delivery companies and transportation logistics companies, like e.g. truck transportation companies or rail transportation companies (Schrampf, et al., 2013).

Like in the case with shippers, it is important to integrate this group of stakeholders into the decision making process of new city logistics concepts. Therefore, as mentioned before, policy makers as well as other kind of decision makers have to consider the goals and needs of freight carriers when considering actions related to urban freight transportation. This is because the freight carriers represent the actors which are responsible for the actual process of transportation (Schrampf, et al., 2013). In addition, freight carriers are directly affected by actions taken by decision makers of e.g. local authorities, thereby underlining the need to take the freight carriers' goals and needs into account (Quak, 2012).

The aim of the freight carriers is to make the transportation process as efficient and effective as possible. This implies delivering the freight as fast as possible to make the delivery on time as claimed by the shipper. Additionally, this includes handling the transportation process at lowest cost possible, which could be reached by e.g. using as little vehicles as possible or using efficient vehicles with little fuel consumption. An-

other example that helps freight carriers to be as efficient as possible is to avoid congestion, since this results in a delay of on time delivery and thereby can result in rising costs too (Schrampf, et al., 2013; Russo & Comi, 2011).

The latter point shows that the freight carriers are directly affected by some nuisance being caused by urban freight transportation. In this case it is the example of congestion affecting the operations of this kind of stakeholders. Therefore, freight carriers should have the interest of being innovative to improve operations and reduce congestion as a result of urban freight movement. In fact, to some extent existing literature shows that freight carriers in some areas are highly innovative and try to apply new technologies in order to overcome nuisance issues like congestion (Taniguchi, 2014; Quak, 2012; Schrampf, et al., 2013).

Furthermore as already mentioned, freight carriers are directly affected by actions taken from decision makers. In that way they are for instance affected by regulatory actions like time window restrictions. The aim of time window restrictions "is assumed to be the avoidance of the collision of interests between different groups of stakeholders, namely freight carriers and the owners of cars who drive them to work or go shopping in the restricted areas" (Muñuzuri, et al., 2005).

However, since such actions have an influence on freight carriers' operations, they can mean a threat towards the effectiveness of transportation operations (Russo & Comi, 2011). Hence as in the case with the shippers, there is a need for communication and co-operation of actions between different stakeholders like freight carriers and local authorities (Lindholm, 2010; Witkowski & Kiba-Janiak, 2014).

4.3 Administrators

The administrators are a group who try to integrate and act on behalf of the different kinds of stakeholders involved in urban freight transportation. Thus the administrators try to find compromises in order to satisfy the different players involved in the movement of freight within urban areas. The administrators basically exists out of governmental and public institutions, including policy makers, local authorities etc. (Schrampf, et al., 2013). Often this group is just referred to as policy makers or local authorities.

The main goal of the administrators is to regulate city logistics in such a way that every actor involved is satisfied. However, there are always actions involved that benefit some specific group and can be harmful to another at the same time. The aim is thus

to find a good compromise. Further goals are to make city logistics being sustainable and to help overcome the nuisance issues related to urban freight movement in order to make cities a liveable place. Another aim is to offer sufficient infrastructure for effective and efficient transport operations. (Schrampf, et al., 2013; Taniguchi, 2014; Russo & Comi, 2011).

It should be highlighted that the group of administrators have a huge power as they can come up with laws and restrictions influencing other stakeholders. Because of that power the policy makers have to consider their actions in very detail, as the resulting impacts can be huge. An example for such actions is the case of time window restriction. Such restrictions can have a direct influence on transportation operations.

Furthermore, it is important for the administrators that they understand the goals and needs of the different kinds of stakeholders involved in urban freight transportation. This is not only the case because the administrators have a huge power, but also because they actually can influence all of the involved actors with specific actions. However, in reality the policy makers do not fully understand the positions and viewpoints of all the other stakeholders (Quak, 2012).

As a result of the latter point, local authorities in some cities have the opinion that the freight carriers put too little effort into innovation processes in order to improve the operations with respect to nuisance like congestion, noise and environmental issues. However, the problem is that those local authorities do not recognize and understand specific actions of the other players thoroughly, as already mentioned. According to Quak (2012) the reason for this is the different viewpoint on city logistics issues: Public authorities limit their scope to the city only, whereas carriers have a broader viewpoint by operating regionally or even nationally.

The aforementioned fact can lead to conflicts between the administrators on the one hand side and the other stakeholders involved in urban freight transportation on the other hand. Obviously, such conflicts are not helpful in order to come up with effective and efficient city logistics concepts. Therefore, those conflicts can harm the aim to overcome the nuisance issues related to urban freight movement. This underlines once more that a well-functioning communication and co-operation should exist between all the involved stakeholders (Lindholm, 2010; Witkowski & Kiba-Janiak, 2014). In fact, this might help so that conflicts do not arise in the first place (Muñuzuri, et al., 2005).

4.4 Residents

The residents of a city represent an important group of stakeholders. They are living in the city and are representing a city's inhabitants. According to Muñuzuri et al. (2012) they even represent the largest group of stakeholders. Furthermore, this group of stakeholders is rather complex and diversified. The reason for this is that the residents can act as many different players. In that sense residents can for instance act as pedestrians walking around the city, passengers travelling by car, public transport or bicycle, employees going to work in- or outside the city, consumers going for shopping in the city, or simply a person who is living in an accommodation within a city and likes to spend his or her leisure time in parks etc. (Schrampf, et al., 2013; Russo & Comi, 2011).

As can be seen the list of different roles a resident of a city can take on is huge and could be easily extended. The resident acting as a consumer is in some way a special and important role amongst the others. The reason for this is that the goals of a consumer are partly different compared to the goals of the other roles of the residents. Because of that, this role will be discussed in more detail in a separate sub-section.

Basically the main goal of a city's residents is to reach and maintain a good quality of life, hence a liveable city. This goal applies to all of the different roles the residents can take on. This implies for instance having a good accessibility both within and also to regions outside the city, well-functioning infrastructure including good road and public transportation availability, as well as a good availability of shops and retailers like for instance pharmacy stores or supermarkets. Also, a liveable city implies a city being environmental friendly and sustainable, meaning that it offers enough space for trees or parks to name some examples (Schrampf, et al., 2013; Muñuzuri, et al., 2012).

A problem arising between a city's residents and the topic city logistics is that often the residents only recognize the process of urban freight transportation as disturbing factor (Muñuzuri, et al., 2012). Thus, the inhabitants of a city only recognize the nuisance arising from the movement of freight. Of course residents appreciate commercial activity within a city as well, by e.g. good availability of supermarkets. However, as described by Muñuzuri et al. (2012) the negative aspects arising from urban freight movement outweigh the positive aspects. On contrast, as already mentioned that does not apply for the residents' role of a consumer thoroughly, which is why that will be discussed in a separate sub-section following next.

One more problem, which may be the cause for the problem described in the paragraph above, is that a city's residents are directly affected by the entire nuisance arising

from the transportation of freight within urban areas. Thus all the negative impacts hit the inhabitants, be it congestion, pollution or noise. A reason for that are the different kinds of roles involved within the group of residents, so there always is at least one role which might be negatively affected by a specific nuisance arising from urban freight movement.

Because of both the size of this group of stakeholders, as well as the fact that the residents are negatively affected by the impacts of urban freight transportation, it is important that the policy makers and decision makers in general consider the aspects and needs of a city's inhabitants. Moreover, the residents have some substantial power as well. The reason for this is that in a democratic political system inhabitants can vote policy makers and can protest against actions, giving them some influence on the whole process. Thus in that case too, it is important that good communication channels are established between the different stakeholders (Lindholm, 2010; Witkowski & Kiba-Janiak, 2014).

4.5 Consumers

A group of stakeholders not yet described in detail are the consumers. They can be part of a city's residents. However, they partly have different goals and a different viewpoint on the topic city logistics compared to the other roles of residents. Furthermore, they are typically end-consumers. Next to end-consumers, there exist other consumers too. Such consumers can be other businesses, like e.g. clothing stores, which receive items from another wholesaler or retailer (Muñuzuri, et al., 2012).

The consumers represent another crucial group of stakeholders as they, similar to the group of shippers, act as an initial player of city logistics. By shaping the demand of specific goods and commodities, the consumers directly influence and start the initial process of freight movement. So the consumers' demand is responsible for what item needs to be present at a specific destination at a specific point in time, which can be seen as the initial starting process of freight movement. Thus, if there was no demand for a specific good, then there would not be a need to transport and deliver that item to a specific location either.

The aim of the consumers is the availability of a well-functioning system of commercial activities within a city. Thus, consumers being located within a city want to have the goods they demand available as fast, as cheap and as easily accessible as pos-

sible. Hence, the demanded items should be available in a good quality and at a reasonable price at the same time. This implies an effective and efficient transportation system within urban areas (Russo & Comi, 2011).

Regarding the difference between consumers and residents as mentioned before, unlike the residents group, for the consumers a good functioning system of commercial activity outweighs the negative aspects arising from urban freight transportation. Hence, what counts for the consumers is that goods and commodities are transported to a specific location within a specific period of time so that the demanded freight is available to them.

Within this group it is important for the other stakeholders involved in city logistics to understand the mindset of consumers. This is important to understand their goals and needs. In turn, this is crucial for the other stakeholders as the consumers act, similar to shippers, as initial players (Schrampf, et al., 2013).

To some extent, it might even be necessary to understand the consumers in order to change their mindsets. This might be important for all the involved stakeholders, but especially for the governmental administrators, in order to reach the goal of a sustainable process of urban freight transportation. This calls once more for a good communication and co-ordination of all the stakeholders involved in city logistics, in order to be able to solve the issues related to urban freight transportation (Lindholm, 2010; Witkowski & Kiba-Janiak, 2014).

4.6 Similarities & conflicts

This sub-section describes the similarities among the different stakeholders involved in city logistics. Next to that, it will be discussed what conflicts there exist between the stakeholders and the resulting implications towards reaching the goals related to city logistics. Regarding this Table 3 gives a summary of the basic interests of the involved stakeholders described above in the paper.

Table 3: Representation of stakeholders' interests

Stakeholders	Interests
Shippers	- Fast & cheap movement of goods from origin to destination in order to satisfy customers
Freight Carriers	- Efficient & effective transportation process - Avoiding congestion
Administrators	- Make city logistics being sustainable - Solve nuisance issues like congestion, pollution, noise - Make city being a liveable place - Regulate city logistics so that every involved actor is satisfied - Find good compromises of actions
Residents	- Good quality of life within city - Getting rid of nuisance issues like congestion, pollution, noise - Good accessibility within & outside the city - Well functioning infrastructure
Consumers	- Availability of commercial activity - Fast & cheap delivery of demanded items at good quality

From Table 3 it can be seen that there exist interests which are directly overlapping each other. These are mainly among the administrators and the residents. Both of these stakeholders share the interests of overcoming the nuisance issues arising from urban freight movement, like congestion, pollution and noise. Additionally, both of those stakeholders have the aim of making the city a liveable place, so to create a good quality of life for a city's inhabitants.

The just mentioned similarities between the administrators and the residents actually show that both of these stakeholders have to deal to a great extent with the social costs arising from the movement of freight within urban areas. Social costs represent the total costs towards the society overall. This includes both private costs as well as external costs (Burda & Wyplosz, 2009).

So with the situation of city logistics social costs represent the private costs of the transportation companies plus the external costs towards the society, meaning increased congestion, pollution and noise. The fact that both stakeholders of administrators and residents are strongly involved in the social costs might be a reason that both of these stakeholders have a large overlap of interest.

In addition, Table 3 shows that there exists an overlap between the stakeholders of administrators and freight carriers, namely avoiding and getting rid of congestion. Also,

there is an overlap between the shippers and the consumers that is a fast and cheap movement of items at a good quality.

Next to those direct and obvious overlaps in interests, there exist indirect similarities in interests too among the involved stakeholders. For example the interest of the shippers implies a well-functioning and efficient transportation system, which on the other hand is a direct interest of the freight carriers. Another example is that the freight carriers' interest of avoiding congestion within urban areas implies fewer nuisances towards a city's inhabitants, leading directly towards the residents' interest of a good quality of life within a city.

These examples show that somehow all the interests of the stakeholders involved in city logistics are linked and geared, which makes them depend on each other. The idea of depending interests of the involved stakeholders is described in the research paper of Anand et al. (2012) as well.

This also explains why a good communications as well as co-operation among the stakeholders is essential. Moreover, one might think: Why should the government spend money on something like city logistics which basically helps private businesses being more efficient and effective? The answer to this question is the same reason as described above: It is because of the linked and geared interest among the stakeholders involved in city logistics.

This way for instance an investment from the government that may lead to less congested city areas means a benefit for private transportation companies too, since the transportation vehicles avoid congestion, saving them time and resulting in less emissions the vehicle creates. Thus private transportation companies benefit through lower costs due to a higher effectiveness and efficiency as a result of the investment. In turn, the residents of a city benefit overall due to lower emissions and less congestion, leading to a higher sustainability of a city, which is also a goal of the public administrators. Therefore, all the involved stakeholders basically benefit from this example of a governmental investment, showing once more that the interests are linked and depend on each other.

However, there are conflicts among the stakeholders as well. This mainly applies to public authorities on the one hand, and private businesses on the other. The problem is that the different groups blame each other for not putting enough effort into new and innovative city logistics concepts. This way, local authorities in some cases blame private freight operators to not being innovative in order to come up with new city logistics

concepts. However, the problem is often that the public authorities often just do not understand what the private firms are doing, which may be a cause of a lacking communication and co-operation among the players (Quak, 2012).

The conflict of different stakeholders blaming each other is described by Dablanc (2007) as well. In her paper the author states that "changes [in the field of city logistics] are slow, and on the whole, it appears as though none of the stakeholders are willing to make fast progress: On the one hand side, city governments expect business to set up new logistic services fit to the emerging needs of the customers and retailers as well as beneficial to the environment; on the other side, logisticians are waiting for municipalities to initiate (and subsidize) new services before starting businesses which could prove poorly profitable and highly risky" (Dablanc, 2007).

All of this shows that a good communication and co-operation is essential in order to reach the goals related to city logistics, as it is claimed by e.g. Lindholm (2010) and Witkowski & Kiba-Janiak (2014) too. Furthermore, the conflicts existing among different stakeholders involved can mean a threat towards reaching the goals related to city logistics as well as co-operating together.

The latter point is shown by Holguín-Veras et al. (2014) as well. In their paper the authors state that "a beneficial policy that is accepted and embraced by all stakeholders is likely to be better, in the long term, than an ideal policy that is bitterly opposed by influential groups" (Holguín-Veras, et al., 2014).

5. Development of cities

In this section it will be described how, generally speaking, cities develop over time. Furthermore, it will be discussed what influence these developments might have on the topic of city logistics. More in detail, this section will be divided into the sub-sections urbanization of cities, governmental regulations, as well as the development of home deliveries within cities.

5.1 Urbanization

The term urbanization basically describes the amenities appearing within dense urban areas, which might be simply described as city areas too. Consequently, the appearance of amenities within cities might be the reason for the fact that more and more people are moving into urban areas. The following numbers highlight this fact: 50% of the world population has been concentrated in urban areas since the year 2010. This number will increase to 70% by the year 2050 (Taniguchi, et al., 2014). Based on these findings, more than two third of the world population will be living within urban areas within the next 35 years.

Next to these numbers there are some other estimations: According to the Organization-for-Economic-Co-operation-and-Development (OECD) the share of people living in cities has been 50% of the world population since the year 1950. Moreover, this number has increased to 77% by the year 2000 and the share of people living within cities is predicted to increase to 85% by the year 2020 (OECD, 2003).

These numbers highlight that cities or urban areas will play a major role in the upcoming years, as the majority of the world population is to be located within city areas. A further fact underlining this finding is the appearance of megacities. Megacities are typically cities with a population of more than 10 million inhabitants (Molina & Molina, 2004). According to Taniguchi et al. (2014) there has been a considerable growth regarding the appearance of megacities, which might be due to the amenities existing within these areas (Taniguchi, et al., 2014).

One of the substantial amenities within urban areas is a good quality of life. This is a major reason for the fact that an immense number of people are moving and living in city areas (Taniguchi, et al., 2014). Thus, people hope to accomplish this goal by moving into a city. The amenities of cities leading to a good quality of life from the residents' viewpoint are for instance high number of job offers, possible high incomes from the jobs, as well as access to culture and entertainment (Witkowski & Kiba-Janiak, 2012). Another amenity can be the availability of a good public transport infrastructure. However, some research findings show that the number of passengers using public transport has decreased for some cities over the preceding years, which might be due to a good individual transport infrastructure (Witkowski & Kiba-Janiak, 2012; von Eichel, 2004).

As a result of the amenities existing in city areas, accommodation prices within these areas have increased over the years. In the paper of Glaeser et al. (2005) the au-

thors state that over the past 30 years there has been a 72% appreciation in average housing prices within US metropolitan areas (Glaeser, et al., 2005). Increasing housing prices can be observed in city districts which initially seemed to be very unattractive too. Often these districts contain old and idle factory buildings, making these districts appear to be unattractive places. However due to the gentrification process, these districts are upgraded by young and creative subcultures, often called bohemians. As more and more people are then attracted by these people and places, these places become more attractive, leading eventually to higher accommodation prices (Florida, 2002).

Moreover, Glaeser at al. (2001) state that the quality of life gets more and more important in the future in order to determine the attractiveness of particular areas. The reason for this is that, according to Glaeser at al. (2001), some parts of the population tend to become richer and therefore are able to afford increased housing prices within city areas. In their paper the authors further describe that there exist a higher productivity within city areas, which is another reason for higher accommodation prices in these places (Glaeser, et al., 2001).

The trends of urban areas described above do not only hold for huge urban areas or large cities like megacities, but also hold for small cities, like medium-sized towns, and for a wide range of areas around the cities as described by van den Berg & Braun (1999). Therefore, the aforementioned trends have an impact on a considerable number of places word wide. Additionally, a finding of Dablanc (2007) might hold for a considerable number of places too: In her research paper Dablanc states that more and more logistic activities are disappearing from cities and there exist only few new promotions of modern logistic facilities (Dablanc, 2007). One of the reasons for the latter finding might be increased housing prices within these areas. That way it might be more profitable to rent out a specific place as accommodation instead of renting it to a firm who might not be willing to pay such a high price for its facility.

Overall, due to a rising population within city areas as well as a rising importance of attractiveness, the topic of city logistics is crucial for these places. This is because city logistics has a huge impact on many activities within city areas and therefore has an impact on the attractiveness of these areas too. The impact of city logistics can work in two directions: On the one hand, a well-functioning system of urban freight movement can directly increase the quality of live within urban areas. On the other hand, there are the issues related to urban freight movement like congestion, noise and pollution as mentioned before in the paper, leading to a decreased quality of live. Thus, to overcome

the negative effects of urban freight movement and to get the positive effects it is important to develop good city logistic concepts. In that sense it does not matter if they are large cities, like megacities, or medium-sized towns as this affects them all.

5.2 Regulations

This sub-section deals with the regulations put forward by governmental authorities, be it local or national authorities. It can be observed in city areas that nowadays many things are regulated. Furthermore, as the population within urban areas is growing to a large extent, there is in turn an increased need for extending regulatory actions from the government (Quak, 2012).

The reason for this is because authorities want to make and keep the urban areas as a liveable place and a place with a good quality of life. As these urban areas are growing, this task becomes more demanding. So within the topic of city logistics, authorities try to overcome the nuisance related to urban freight movement by coming up with regulations which are intended to reduce such nuisance (Quak, 2012).

To name some examples for regulatory actions with respect to city logistics, there exist for instance time window restrictions, low emission zones, or off-peak hour deliveries. As already mentioned before in the paper, the aim of time window restrictions "is assumed to be the avoidance of the collision of interests between different groups of stakeholders, namely freight carriers and the owners of cars who drive them to work or go shopping in the restricted areas" (Muñuzuri, et al., 2005).

Next, the goal of low emission zones is to "promote the operation of cleaner vehicles, and reduce the number of older, more polluting vehicles operating in central city areas" (Taniguchi, et al., 2014). Furthermore, the idea of off-peak deliveries is to use idle road and loading space. In that sense a transportation vehicle is intended to deliver its items at the destination at a time in which the road and the loading facility is not crowded and hence not congested, in order to make the operation more efficient.

These regulatory actions are indented to overcome the nuisance related to the movement of freight within urban areas. However, there are negative side effects coming together with regulatory actions too. The problem here is that regulations and restrictions can make other actions less efficient. In that sense regulations like time window restrictions or low emission zones can mean a less efficient transportation process

of freight carriers, since they might not operate in such a way being optimal to them as they are restricted by these regulations (Quak, 2012).

This point highlights the dilemma of regulatory actions. On the one hand regulations can help achieving the goals of city logistics and can help making urban areas a liveable place. However, on the other hand regulatory actions can mean a threat towards an optimal and efficient workflow of transportation processes. Therefore, it is important for authorities to not only consider the advantages arising from regulations, but also to consider the disadvantages and negative side effects. Hence, authorities have to carefully review their intended regulations and they should take the impacts on all stakeholders involved into account.

5.3 Home deliveries

Another issue is the topic of home deliveries. In times where the usage of the internet is growing at a large extent, the activities done via the internet grow as well. That also holds for shopping and ordering items online. As a result the need to transport goods or commodities to the homes of the consumers rises. Hence, there is a higher need for home deliveries.

The shopping and ordering of goods via the internet, also referred to as e-commerce, is growing at a large rate as can for example be seen in the work of Visser et al. (2014). It should however be mentioned that, unlike internet shopping, e-commerce covers "any commercial transaction between organizations and persons in society" (Visser, et al., 2014). On the other hand, internet shopping only "refers to the purchase of goods or services by consumers by the internet" (Visser, et al., 2014).

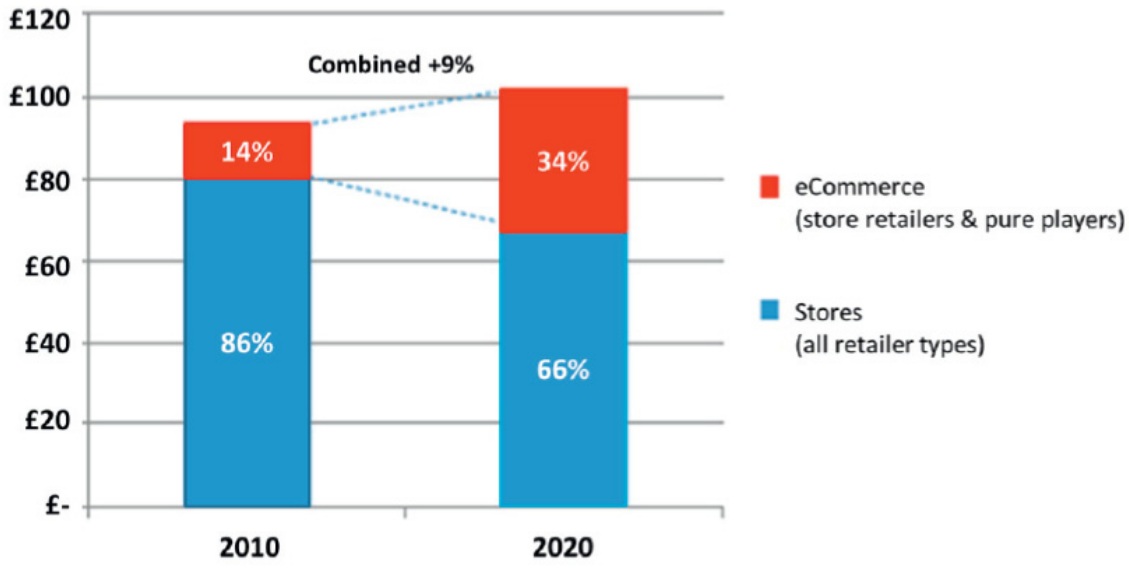
This way, e-commerce for instance includes the booking of a timeslot for a counselling interview with an agent of logistic services, whereas internet shopping only includes the booking of the service itself.

Visser et al. further describe in their paper that it not only has increased, but also that internet shopping might substitute traditional shopping. According to this idea a growing share of people are ordering their demanded goods via the internet, instead of going out of the house in order to go to a shop within the city. Based on a study within the Netherlands, up to one third of the shops in countries like the Netherlands will be closed by the year 2020 due to an increased usage of internet shopping (Visser, et al., 2014).

However according to Visser et al. (2014), not only the traditional business-to-customer market (B2C) and the business-to-business (B2B) market are growing, but also the customer-to-customer market (C2C), which is represented by e.g. internet platform like 'ebay'. Numerical results show that internet shopping accounts for roughly 4% of total global retail sales, with an increasing tendency in future years (Cushman & Wakefield, 2013). Another figure shows that between the years 2007 and 2012 there has been a growth in the global online retail market of around 15%, while the growth of total retail was only about 1% over the same time span (Visser, et al., 2014).

A further growth figure with respect to e-commerce can be seen in Graph 7, showing the forecast of sales by stores and e-commerce between the years 2010 to 2020. The scale on the y-axis is in billion UK pounds. As can be seen from the graph, combining stores and e-commerce sales there will be an increase of 9% of total sales. However, in the year 2010 the sales by e-commerce only substantiates for a relatively small proportion with 14%. Thus, the majority of sales are done by stores in the year 2010. On the other hand, in the year 2020 the share of sales by e-commerce more than doubles towards 34%, while the proportion of sales by stores shrinks to 66%.

Graph 7: Forecast of sales by stores and e-commerce [in billion UK pounds]



Source: (Javelin Group, 2011)

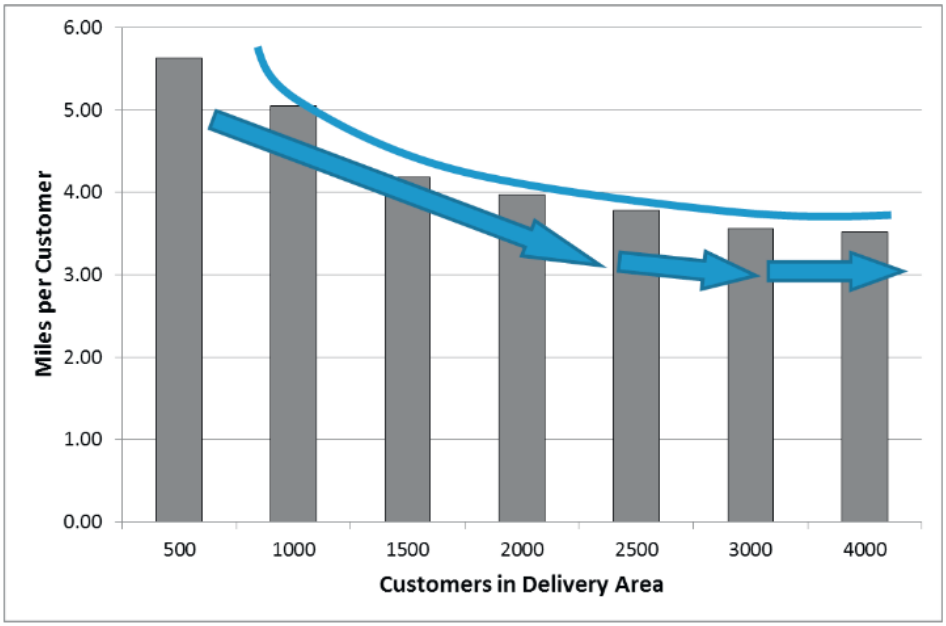
An issue related to internet shopping is that the ordered items have to be delivered to the consumers. Often, businesses being active in internet shopping do not even own a physical store within a city. Therefore, the ordered goods have to be delivered to specific pickup points or to the homes of the consumers (Visser, et al., 2014). A research on the Netherlands shows that from the ordered items via the internet 78% - 87% of these were delivered to the consumers' home (Weltevreden & Rotem-Mindali, 2009). This underlines that pickup points play a rather minor role towards this topic.

A problem with regard to home deliveries is that sometimes the receivers are not at home. Therefore, the freight carrier has to visit the home of the consumer several times, thereby causing unnecessary trips (Visser, et al., 2014). Another issue related to home deliveries is that consumers can send back their ordered goods if they do not like them or if they arrive damaged, thereby again leading to a higher number of trips for the carrier. These issues result in lower efficiency of the whole transportation process and lead to an increased level of nuisance related to the movement of freight within urban areas.

Obviously, if a freight carrier has to visit the same place several times, this causes unnecessary trips resulting in higher traffic on the road. Next to this negative effect arising from home deliveries, there might be a positive side effect of home deliveries too, as mentioned in the paper of Visser et al. (2014). The positive side effect is that traffic on the road could be substituted. Thus the basic idea is the following: If a consumer orders via the internet and gets the goods delivered at home, the consumer does not have to use a car in order to go to the city centre for buying the goods. Visser et al. (2014), however, modify that eventually this substitution effect might not work out in reality as, according to their study, home deliveries do not have a significant effect on car traffic.

Another point mentioned by Visser et al. (2014) is that home deliveries might get more efficient the more people are living within a specific range of distance. Thus, for a more dense area a fright carrier can visit more people within a specific range of distance, leading to a higher efficiency of the operation. This fact is underlined by Graph 8, showing that the average distance per stop, measured in miles per customer, follows a negative growth rate at a diminishing scale. Hence, at first the reduction in miles per customer is quite high with dense customer areas. However, the reduction in average distance per stop reduces less, the denser the area is.

Graph 8: Impact of customer density on average distance per stop [in miles per customer]



Source: (Visser, et al., 2014)

Another topic, which can be linked to the issues of home deliveries, is the demographic change of a city's inhabitants. It can be seen that next to cities becoming larger, the population is becoming older (Taniguchi, et al., 2014). As elderly people are becoming more restricted to some extent in their mobility, more items like food, medicine, clothes etc. have to be carried to their homes. So at a specific point in time elderly people might just not be in the shape anymore to go out for shopping at a large extent, making internet shopping attractive for this group of people. Thus, elderly people potentially further increase the rate of home deliveries. Hence, as there will be more elderly people in the future, the growth of home deliveries will be increasing even more (Taniguchi, et al., 2014).

Overall, it can be seen that home deliveries will play a major role in the upcoming years within city areas. As the population of urban areas is more and more increasing and as there will be a higher rate of elderly people, there will be a large growth rate of home deliveries as well. As was described before, a growing rate of home deliveries can raise the nuisance related to the movement of freight, like congestion, pollution or noise. The reason for this is that home deliveries might lead to more (inefficient) trips than actually needed.

This section revealed that the development of cities with the topics urbanization of cities, governmental regulations as well as the development of home deliveries within cities, pose additional challenges in future years. Thus, decision makers as well as basically all the other involved stakeholders of urban freight movement have to carefully consider and come up with good city logistics concepts in order to be able to master these challenges.

6. Trends derived

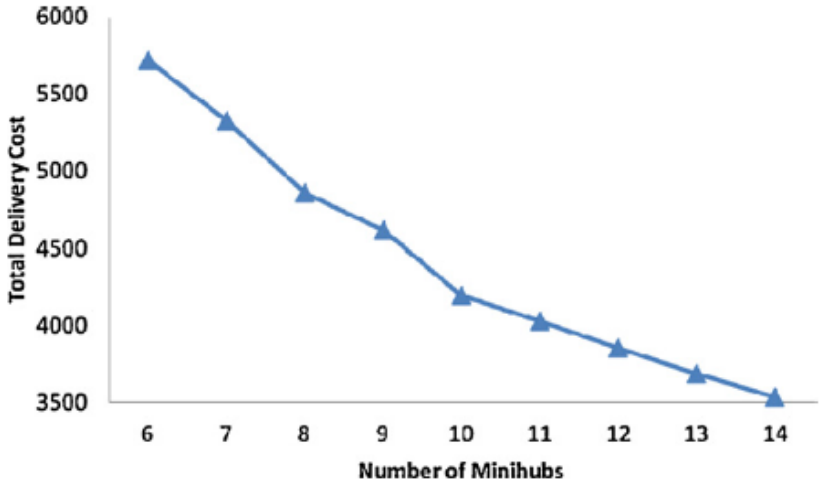
This chapter discusses the trends which can be derived from the preceding sections of this paper. Therefore, this chapter can be regarded as a concluding summary of what can be expected in future years with a high likelihood from the topic city logistics.

As was shown in the development of cities part, due to urbanization and gentrification patterns, space within city areas becomes more valuable. Consequently, for firms it becomes more costly to afford space for shops or facilities. This leads to the fact that there will be fewer facilities of firms as well as fewer shops within city areas. With respect to shops, the just described situation might not hold for all kind of shops as huge, global player businesses might still be able to afford the high prices, but it might at least hold for smaller, regional shops which continually will disappear from dense city centres due to the high prices.

Furthermore, as a result of the increasingly valuable space there will be less space dedicated for parking activities around dense city centres. This can especially mean a problem form the point of view of the transportation sector. The reason for this is that transportation vehicles have then fewer possibilities and therefore more restrictions in order to dispose their deliveries. In turn, this leads to the fact that a system of satellite platforms or mini-hubs, as for example described in the models of Muñuzuri et al. (2011) and Crainic et al. (2004; 2007), will attract more attention. Hence, there might be more of such intermodal platforms within a specific range of distance of the dense city centres, in order for the transportation vehicles to avoid driving to city areas where there exist hardly any parking spaces. It is also likely that the last part of the delivery, the so called last mile delivery, is done for instance by foot or specific devices like handcarts or dedicated cargo vehicles.

In fact regarding the mini-hubs Muñuzuri et al. (2011) show that with a growing number of these hubs total delivery costs decrease. This can be seen in Graph 9, which is based on a research on the city centre of the Spanish city Seville and on a system where the last mile delivery is done by foot. Muñuzuri et al. (2011) explain that this tendency illustrated is to be expected since with a higher number of mini-hubs smaller distances have to be covered on foot. In turn, according to the authors the cost per distance unit by foot is 3.8 times more expensive than the cost per distance unit by vehicle in the case of Spain. However, it is described that "this does not mean that the number of mini-hubs needs to be as large as possible, since the limit would be a situation where all the existing nodes would be considered mini-hubs and no on-foot displacements would be necessary" (Muñuzuri, et al., 2011). Rather, as the authors describe, the decision on the number of mini-hub is a political decision taken by the local authorities where they weigh up the amenities and drawbacks related to this.

Graph 9: Representation of total delivery cost with respect to number of mini-hubs [in €]



Source: (Muñuzuri, et al., 2011)

As further described in the development of cities part, the urbanization pattern will lead to the point that cities become larger, thus the population within urban areas increases. In combination with a shrinking number of passengers using public transport, this leads to an increased number of vehicles on the road and consequently to more

crowded streets. This, in turn, increases the nuisance like congestion, noise and pollution.

Moreover, the consumer group of stakeholders will become more important and may be the most relevant group of stakeholders in the upcoming years. The reason for this is that the population within urban areas is increasing, thus there will be more consumers too, as well as the fact of being an initiator of freight movement. Hence, there will be a growing number of consumers within urban areas shaping the market and development of city logistics by their demand. Because of that, it is important for decision makers to carefully consider the viewpoint and needs of the group of consumers.

Additionally, there will be a growing number of elderly residents. This trend will substantiate the growth towards more home deliveries. An increased tendency of home deliveries will in sequence result in rising workflows on streets too. Thus, this trend will again lead to an increased nuisance of congestion, noise and pollution.

Furthermore as shown in the section discussing the different groups of stakeholders, the goal of a city's residents is to get environmental friendly and liveable cities. For example the residents ask for more green space like parks, where they can spend their leisure time. On the other hand, residents want a city with many amenities as well. This, however, also leads to higher freight movement as many amenities are linked in some way to the movement of freight. Thus, on the one hand residents want a liveable city with, if possible, no nuisance, but on the other hand they also ask for a high level of amenities which eventually results in actions leading to a higher nuisance.

Due to all these trends, there are many problems related to the topic of urban freight movement. However, to just cut down and decrease the movement of freight within urban areas is not a solution approach because the residents ask for amenities, which eventually are in some way linked to freight to be transported.

Overall, the conclusion which can be drawn is that urban freight movement on its own creates nuisance, and it is likely that the need to move freight will increase in upcoming years. On the other hand, it is expected from transportation operators to come up with actions to reduce the level of nuisance. All of this poses major challenges on the topic of city logistics and asks for good and efficient concepts by considering and taking all stakeholders involved into account.

7. Pilot projects

To give a more detailed illustration of future scenarios in city logistics, this section describes some pilot projects existing in this field. Furthermore, some of the specific and dedicated cargo vehicles, as mentioned in the previous chapter, will be described in more detail. Those cargo vehicles being part of the pilot projects and going to be discussed include the cargo bike as well as the cargo hopper. Moreover, it will be described which determinants are important in order for projects to be successful.

7.1 Cargo bike

Cargo bikes are specific kind of bicycles dedicated to transport freight. There are several types of cargo bikes. That way there exist cargo bikes with two, three or four wheels and some types are supported by an electric engine. Likewise the transportation volume and weight can differ substantially with a maximum weight amounting up to 500 kilogram (Riehle, 2012). However, most of the cargo bikes used by now have a weight limit ranging from 100 – 150 kilogram (Riehle, 2012). Additionally, as there are substantial differences, the purchasing prices differ as well. Graph 10 shows some examples and gives some more information on different types of cargo bikes.

Graph 10: Illustration of cargo bike examples

Type (Producer): Bullit (Larry vs. Harry, Denmark)
Weight bike: 24-32 kg
Max. transportation weight: 180 kg
Size loading area (l·h·w): 71-78.7 · 46.6 · 26.7-37.2 cm
Size bike (l·w): 245 · 59 cm
Electric engine: no
Purchase price: 1 953 – 2 821 €

Type (Producer): Christiania (Christiania Bikes, Denmark)
Weight bike: 35 kg
Max. transportation weight: 150 kg
Size loading area (l·h·w): 88 · 62 · 36-50 cm
Size bike (l·w): 208 · 85 cm
Electric engine: optionally
Purchase price: 1 289 – 4 250 €

Type (Producer): Cyclo Cargo (Cyclopolitain Vehicules, France)
Weight bike: 129 kg
Max. transportation weight: 250 kg
Volume loading area: 1.5 m³
Size bike (l·w): 265 · 100 cm
Electric engine: yes
Purchase price: ca. 7 000 €

Source: (Riehle, 2012)

The idea of cargo bikes is not entirely new as can be seen for instance in the work of Gruber et al. (2013): These kinds of bikes were already common for urban freight movement from the beginning of the last century until the 1950s and 1960s, a time where the rapid spread of automobiles began. Between the years 1980 – 1990 there was then a boom in using the bicycle as a mode of freight transport. In that time small and light-weight deliveries were carried by bicycle messengers within dense urban areas.

Once again, that boom was stopped by the digital revolution around the turn of the century. That way small sized items like e.g. documents, photographs or tickets no longer needed to be sent physically but could be sent for instance by email (Gruber, et al., 2013).

This changing history of using bikes as a means of freight transport shows that the process of urban freight movement does not stay constant over the years. As shown in the work of Riehle (2012) this is based on the fact that there is an ongoing development process with respect to urban freight movement. This development process depends, amongst others, on the changing surrounding conditions like the changing mindset towards sustainability of the population, political decisions as well as economical needs (Riehle, 2012).

As can be seen with the upcoming pilot projects to be described, it seems as there might be a rising use of using bikes as a means of transport again. A reason for a potential new boom of using cargo bikes lays in the advantages coming along with this mode of transport. These can be seen in Table 4, summarizing the advantages and disadvantages of using cargo bikes.

Table 4: Summary of advantages and disadvantages of using cargo bikes

The advantages offered by freight cycles for urban distribution work include:

- They require less kerbside loading space than a motor vehicle
- They are easier to manoeuvre in heavily congested situations than motor vehicles.
- In some cities they have dedicated lanes and can also use bus lanes (unlike motor vehicles)
- They can potentially access urban locations closed to motor vehicles at certain times of day
- They do not emit greenhouse gases and are producing very low noise levels
- They have lower purchase and running costs than motor vehicles
- They have smaller space requirements for overnight storage than vans and other goods vehicles
- They are not usually subject to on-street parking charges or parking fines
- Cyclists do not require driver licensing
- The public has a positive public perception of cycles especially as a result of them having a far lower environmental impact than motor vehicles
- They are likely to be safer in areas with high pedestrian activity than motorised goods vehicles
- City authorities are generally increasing the amount of transport infrastructure provided for cyclists

The disadvantages associated with freight cycles include:

- The limited payload weight and volume they offer for the carriage of goods compared with motor vehicles. This limits the type of goods they can carry and the type of supply chains they can be used in.
- They have lower travel speeds than motor vehicles in free-flow conditions - this can result in longer journey times when traffic conditions are good. This makes cycle delivery most advantageous in central or inner urban areas.
- Their lower speeds in free-flow conditions limit the distance over which they can feasibly make deliveries.
- Existing supply chains often involve distribution centres located on the edge of, or outside, the urban area. It can prove difficult to operate cycles for urban deliveries from such locations given the distances involved and the lower speed of cycles in outer urban areas.
- Supply chain reconfiguration can be necessary to facilitate urban deliveries by cycle – ideally this requires the implementation of a distribution centre located in the delivery catchment area. Such distribution centres bring additional costs, especially when located in areas in high land values therefore such centres need to be as small and "no frills" as possible.

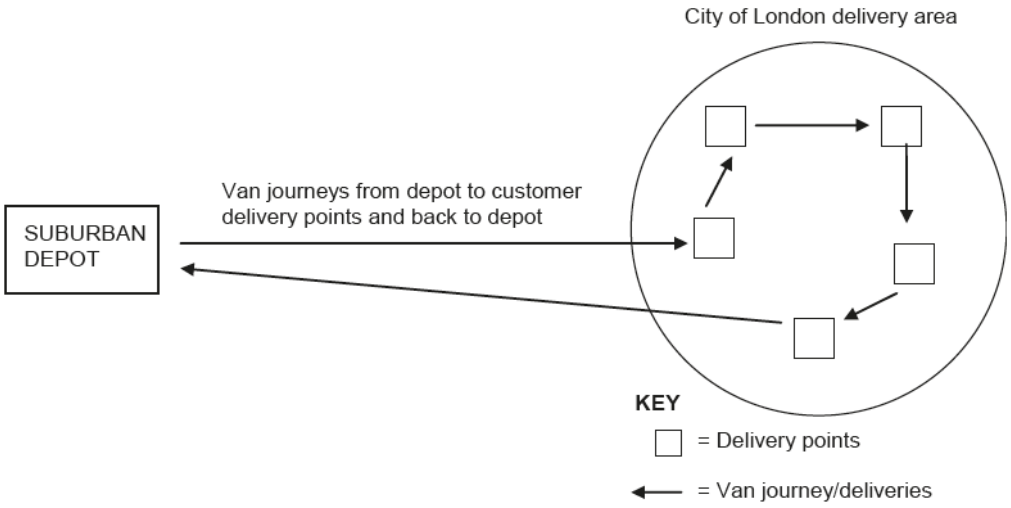
Source: (Leonardi, et al., 2012)

An example of a pilot project with respect to cargo bikes is the case of a stationery and office supplies company from London, which decided to replace their combustion engine vehicles with electrically assisted cargo bikes in order to make the deliveries to their customers. Next to cargo bikes, the company additionally used a so called urban micro-consolidation centre (Leonardi, et al., 2012).

Such a consolidation centre is a special form of a satellite platform. It contains the word 'micro' because of its small size of roughly 20 times 8 metres. This special kind of intermodal platform was used within the project as transhipment facility in order to transfer the parcels to be delivered from the suburban depot to the cargo bikes for the last mile delivery. In addition, the micro-consolidation centre was used as parking area to park the cargo bikes at night (Leonardi, et al., 2012).

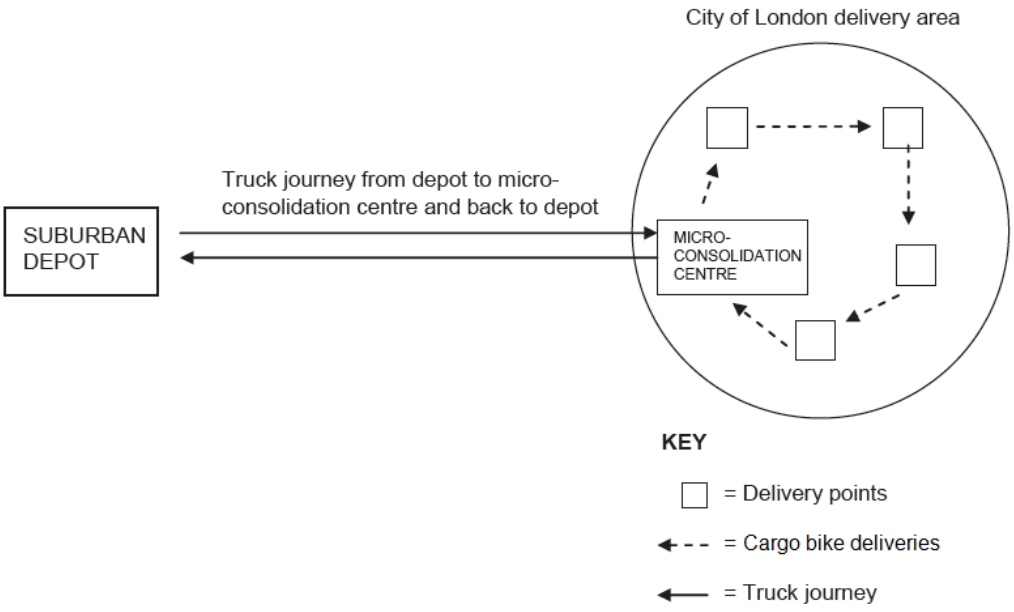
The difference with and without the micro-consolidation centre of the pilot project from London is illustrated within Graph 11 and Graph 12, respectively.

Graph 11: Delivery system by diesel vans before the start of the London pilot project



Source: (Leonardi, et al., 2012)

Graph 12: Delivery system by cargo bikes within the London pilot project



Source: (Leonardi, et al., 2012)

This pilot project from London took place between the years 2009 – 2010. Furthermore, the cargo bikes being used were similar to the type 'Cyclo Cargo' as shown in Graph 10. Besides using cargo bikes, electric vans were used as well within the project. Overall, the results of Leonardi et al. (2012) show that by replacing the combustion engine vehicles in combination with the urban micro-consolidation centre a reduction of 20% in the total distance driven by all vehicles per parcel delivered between the suburban depot and the final customer was achieved. Additionally, total CO_2e emissions per parcel delivered were 54% lower towards the end of the project than prior to that. Because of the success of this project the firm continued operating this process after the end of the trial (Leonardi, et al., 2012).

Also, this project "demonstrated that even in a supply chain in which goods are already highly consolidated there is still the potential to achieve further benefits in terms of further reductions in total distance travelled and greenhouse gas emissions through additional consolidation efforts and the use of clean electric vehicles" (Leonardi, et al., 2012).

There are similar trials in which courier-express-and-parcel-deliveries (CEP) companies try to replace combustion engine vehicles by cargo bikes. An example of this is the case of the CEP firm 'UPS', which introduced cargo bikes in combination with the idea of urban micro-consolation centres, as described before, in the German cities Hamburg and Cologne (Lockschen, 2013; Riehle, 2012). Unfortunately, up to this point in time no results were published for these projects. In (Riehle, 2012) further trials are described from e.g. the German cities Kassel and Munich or from the Belgian region Flandern. However, these trials are rather small in scale with companies operated often by only one person and deliveries up to 20 kilometres in distance. The overall results of this work show that cargo bikes can have a great contribution towards climate and environmental protection (Riehle, 2012).

Because of the positive effects by using cargo bikes within city areas, it is likely that there will be more firms in the upcoming years using such kind of vehicles for their deliveries. In the paper of Gruber et al. (2013) the authors describe that cargo bikes will be the future vehicles for delivering items within cities, which holds according to the authors at least for CEP companies. Similar conclusions can for instance be found in (Riehle, 2012).

7.2 Cargo hopper

Another type of environmental friendly vehicles used for pilot projects is the so called cargo hopper. This consists of an electric vehicle which is pulling several trailers, making it appear as an electric mini-train. The cargo hopper resulted out of a co-operation between the Dutch city Utrecht and the local transport business. This vehicle was introduced in the year 2007 and was operated by the transportation company 'Hoek Transport' (van Rooijen & Quak, 2014).

In total this multi-trailer vehicle is 16 metres long and 1.25 metre in width, making it fit into the small street network of the inner city centre of Utrecht. Furthermore, it has a maximum speed of 25 kilometres per hour and has a maximum capacity, being equivalent to 5 – 8 vans. The cargo hopper delivers freight from an urban distribution centre into the city centre to shops and retailers, thus operating in a B2B context. Additionally, it is especially designed for the last mile delivery within the dense area of Utrecht (van Rooijen & Quak, 2014). A graphical illustration of the cargo hopper can be seen in Graph 13.

Graph 13: Illustration of the cargo hopper in Utrecht

Source: (Quak, 2012)

The results of this pilot project show that in Utrecht there was a decrease of 4,080 freight vehicle trips, corresponding to a saving of 88,332 kilometres driven by combustion engine vehicles. In turn, this lead to a reduction of 10 tonnes of CO_2 (-73% com-

pared to the time prior to the project), 5 kilogram of NO_x emission (-27%) and 1 kilogram of PM_{10} emission (-56%) (van Rooijen & Quak, 2014). Because of the successful results the operations with the cargo hopper further continued in Utrecht.

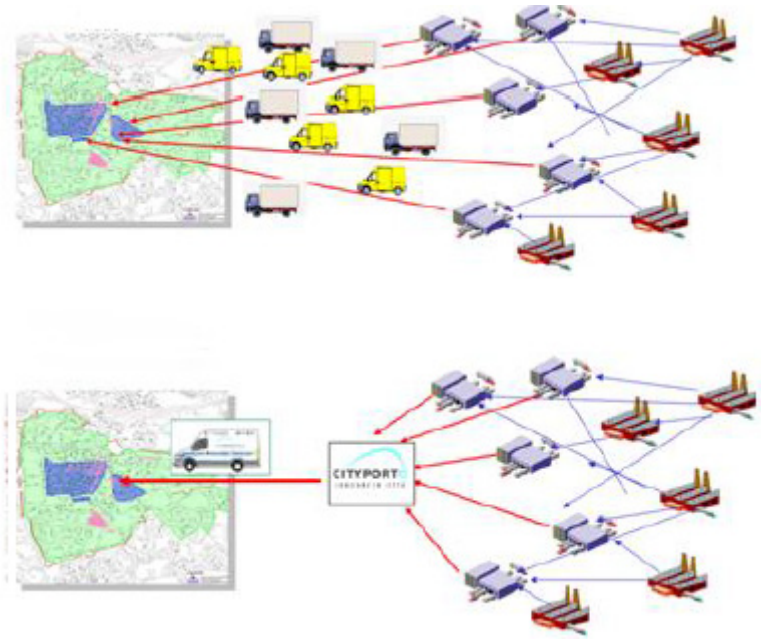
Similar trials with electric vehicles can be observed in the Dutch cities Nijmegen and Amsterdam. Moreover, it can be seen that all of these projects from this sub-section where subsidized by local governments (Quak, 2012). Thus, the operating firms did not have to bear all the involved costs by themselves, being one of the major reasons for the success of the projects as, generally speaking, the purchase price of such electric vehicles is very high.

Another project being subsidized by local governments combined with environmental friendly vans is the project called Cityporto taking place in the Italian city Padua. It uses the concept of an urban consolidation centre in combination with natural gas-powered vans. The project started in 2008 and is still running due to its success. Graph 14 illustrates the concept of Cityporto and shows the situation prior to it too. The main motivation to start this pilot was a high level of congestion and pollution in the inner city of Padua due to a high number of delivery vehicles in the narrow streets of Padua (Bestfact A, 2013).

During the years 2008 – 2010 the project revealed the following outcomes compared to the time prior to the pilot project when there were only diesel vans used for transportation: The introduction of Cityporto lead to a net travel distance saving of approximately 561,442 kilometres. Furthermore a reduction of 219 tonnes of CO_2, 369 kilogram of NO_x as well as 51 kilogram of PM_{10} emissions were observed during the above mentioned time span. In addition, there was a decrease in congestion level and the cost-benefit analysis demonstrated a beneficial outcome, even though no concrete numbers are published on this (Bestfact A, 2013).

Next to a well-functioning co-operation of the several stakeholders being involved, the location of the urban consolidation centre and a well-functioning IT system to monitor the operations are among the success factors for the Cityporto pilot (Bestfact A, 2013).

Graph 14: Representation of situation before and during Cityporto project



Source: (Bestfact A, 2013)

7.3 Determinants of successful projects

First of all, when dealing with this sub-section, it should be defined what successful projects are. In here this includes projects which are lasting for at least one year or which continued after the end of the trial. Additionally, projects are classified as successful when numerical results show positive effects, like for instance a reduction of kilometres driven, fewer vehicles to be used, a reduction in polluting emissions etc.

To give a better overview on successful pilot projects Table 5 summarizes some of these projects.

Table 5: Summary of successful pilot projects

Project Name	Location	Concept	Duration	Achievements
Bentobox & Urban Freight Labratory area [1]	Berlin, Germany	Urban micro-consolidation centre in combination with cargo bikes	2011 - still running	- reduced vehicle km - reduced congestion - reduced emissions - reduced costs and effort of data collection and evaluation
Brussels Consolidation Centre [2]	Brussels, Belgium	Consolidation centre in combination with electric & fuel powered vehicles	2014 - still running	- 50% reduction in distance travelled - 6.3% reduction in number of deliveries and pick ups - 13% reduction in NO_x - 7% reduction in CO_2 emission
Cargohopper Project Utrecht [3]	Utrecht, Netherlands	Consolidation centre in combination with electric vehicles	2007 - still running	- reduction of 4,080 freight vehicle trips - 73% reduction in CO_2 - 27% reduction in NO_x - 56% reduction in PM_{10} emission
Citylogistik Copenhagen [4]	Copenhagen, Denmark	Consolidation centre in combination with electric vehicles	2012 - still running	- reduced noise level - reduced congestion - reduced pollution - fewer daily deliveries
Cityporto [5]	Padua, Italy	Consolidation centre in combination with electric vehicles	2008 - still running	- 561,442 km reduction in distance travelled - 219 t reduction in CO_2 - 369 kg reduction in NO_x - 51 kg reduction in PM_{10} emission - reduction of congestion
Gothenburg City Logistics Initiative [6]	Gothenburg, Sweden	Consolidation centre in combination with electric vehicles	2012 - still running	- reduction in pollutants emissions - low noise level - reduced CO_2 emissions
The Green Link [7]	Paris, France	Consolidation centre in combination with cargo bikes & electric vans	2009 - still running	- 20% reduction in delivery costs - reduced distances and increased eficiency - reduced noise and pollution
UCC Trial London [8]	London, United Kingdom	Urban micro-consolidation centre in combination with cargo bikes & electric vans	2009 - still running	- 20% reduction in distance driven - 54% reduction in CO_{2e} emissions per parcel
UPS Cargo Bike Project [9]	Hambug, Germany Cologne, Germany	Urban micro-consolidation centre in combination with cargo bikes	1997 - still running	no results published
Urban Freight Distribution San Sebastián [10]	San Sebastián, Spain	Urban micro-consolidation centre in combination with cargo bikes	2008 - still running	- reduction of trucks operating in the city - reduced congestion - reduced pollution

Information from: [1] (Bestfact B, 2013), [2] (Institute for Sustainability A, 2015); [3] (van Rooijen & Quak, 2014); [4] (Bestfact B, 2014), [5] (Bestfact A, 2013), [6] (Bestfact A, 2014), [7] (Institute for Sustainability B, 2015); [8] (Leonardi, et al., 2012); [9] (Lockschen, 2013), [10] (Bestfact C, 2014)

From the pilot projects described in this chapter it can be seen that they have similar determinants in common. In turn, these play a key role for projects to be successful. It can be seen that these determinants include financial support by public authorities, well-

functioning communication and co-operation between different kinds of stakeholders, awareness of environmental issues and awareness of changing developments within dense urban areas (Institute for Sustainability A, 2015; Institute for Sustainability B, 2015; Leonardi, et al., 2012; Lockschen, 2013; van Rooijen & Quak, 2014; Bestfact A, 2014; Bestfact B, 2014; Bestfact C, 2014; Bestfact A, 2013).

For the sake of completeness, it should be mentioned that this list of determinants is by no means a comprehensive list. These determinants proofed to be successful according to the aforementioned projects. However it is likely that there are additional determinants, which cannot be derived from the description of the projects directly.

Moreover, it is important to consider the conditions under which successful trials were accomplished. That way, as described by Leonardi et al. (2014), it is important to look at the size of the company, if it is a typical case of a freight carrier or if it is a specialized market the firm is operating in. Hence, it might not always pay off to just copy a successful trial for any case. Furthermore, using vehicles like cargo bikes or cargo hoppers benefits towards the society from an environmental viewpoint, but this does not automatically result into financial benefits for the operating firm (Quak, et al., 2014).

Therefore, it is of major importance that the projects are successful from an economical viewpoint as well. As this might be difficult, mainly in the starting phase of a pilot project, it is crucial for initiators of such projects to get some help in form of subsidies.

Overall, this chapter described what successful pilot projects there exist and how future scenarios in city logistics may look like. Moreover, it is important for operating transportation firms to get support and subsidies from local governments as the firms cannot bear the entire costs, which can be huge, all alone. If there was no support, it might not be worth it for a transportation firm to introduce new concepts either. This can be due to the aforementioned fact that with such projects there come along benefits for the society, but these do not automatically result into financial benefits for the operating firm. Hence at least for the starting phase of a new concept, local governments should play a role in bringing the costs and benefits together, as claimed by van Duin et al. (2010) too.

Furthermore, as shown by Maes & Vanelslander (2012) for the society sustainability is a selling argument to come up with new concepts combined with environmental friendly vehicles. However, what really matters is the speed of the operations. Thus, what is of major importance for the freight carriers is an efficient workflow of opera-

tions. Only if this requirement can be met, concepts that are environmental friendly and lead to a higher degree of sustainability will proof to be successful as a whole.

8. Conclusion

This paper has provided an extensive overview on the topic city logistics and the related issues to this. The main problems include nuisance like congestion, noise and pollution. The goal of city logistics concepts is to overcome these issues and to put forward the advantages linked to urban freight transportation, such as efficient and effective freight flows.

Next to providing an overview over existing literature on the topic, the relevant stakeholders including their viewpoints and goals were presented. These are the shippers, freight carriers, administrators, residents and consumers. The outcome shows that basically all of the stakeholder's interests are linked to each other, either directly or indirectly. However, there also exist conflicts due to different viewpoints of the stakeholders.

Furthermore, some developments taking place within cities were revealed, like urbanization, regulations and a tendency towards more home deliveries. In addition, trends that can be derived were disclosed, including increasingly valuable space within urban areas, growing cities as well as a growing share of the elderly population. Next to these, there is a trend towards environmental friendly cities and an increased likelihood that more freight needs to be moved in upcoming years. This underlines the huge conflict that people want to overcome nuisance, however freight transportation itself creates nuisance. In turn, this asks for well-functioning city logistics concepts in order to overcome this conflict.

Moreover, pilot projects were presented, which work in combination with environmental friendly vehicles like cargo bikes or electric vans. These projects can be seen as possible future scenarios that can help to come up with effective city logistics concepts. Additionally, determinants of successful projects were discussed, involving financial support for the initiators of such projects, a well-functioning system of communication and co-operation between the stakeholders, awareness of environmental issues as well as awareness of changing developments within dense urban areas.

As can be seen within this research there have not been many studies about concrete pilot projects related to city logistics containing detailed numerical results. For further research it would thus be important to get a deeper insight into achieved results of corresponding pilot projects. In turn, these can then be used in order to apply more research within the topic of relevant determinants and conditions, in order to make city logistics concepts more efficient and effective in future years.

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Attachments

Abstract

The goal of this master thesis is to reveal the most important determinants for successful projects within the field of city logistics. Moreover, it provides an extensive overview on the topic city logistics and the related issues.

The most important works in the field are discussed in the literature review, followed by a stakeholder analysis. Furthermore, some developments currently taking place within cities are examined, including urbanization, regulations and the tendency towards more home deliveries.

Additionally, further trends are disclosed, such as increasingly valuable space within urban areas, growing cities as well as an expanding share of the elderly population. Furthermore this thesis discusses the trend towards environmental friendly cities and the increased likelihood that more freight needs to be moved in the future. Finally, several pilot projects are presented which help to determine important success factors.

Zusammenfassung

In dieser Masterarbeit geht es um die Beantwortung der Frage welche Faktoren eine wichtige Rolle spielen, um Projekte im Bereich City Logistics erfolgreich realisieren zu können. Zudem gibt diese Arbeit einen umfassenden Einblick in das Thema City Logistics mit all den dazugehörigen Problemen und Anforderungen.

Neben einer ausführlichen Literaturauswertung zum Thema, bietet diese Masterarbeit einen Überblick über all die involvierten Akteure samt deren Standpunkte und Ziele zum Thema City Logistics. Desweitern werden in Städten stattfindende Entwicklungen aufgezeigt, wie beispielsweise Urbanisierung, Regulierungen sowie die Tendenz zur erhöhten Anzahl von Lieferungen direkt nach Hause.

Zusätzlich werden Trends dargelegt, welche aus den anderen Kapiteln der Arbeit abgeleitet werden können. Dies beinhaltet zum Beispiel die Wertsteigerung von Flächen innerhalb städtischer Gebiete, stärker wachsende Städte, ein steigender Anteil von älteren Einwohnern, mehr Umweltbewusstsein in Städten sowie eine erhöhte Wahrscheinlichkeit, dass in den kommenden Jahren ein größeres zu transportierendes

Frachtaufkommen entstehen wird. Darüber hinaus werden Pilotprojekte im Bereich City Logistics vorgestellt, die auch als Basis dienen, um relevante Erfolgsfaktoren abzuleiten.

Lebenslauf

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