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How to consolidate urban flows of goods without setting up an urban consolidation centre?

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Abstract

Urban consolidation centres (UCC's) are a popular measure in city logistics. They are usually introduced by local governments in order to reduce the number of motorized freight vehicles entering their cities. Practice has shown, however, that most of these UCC's are granted only a short lifespan because of their strong reliance on government subsidies. Still, striving to make the best possible use of truckload capacities is important when aiming to reduce the number of urban freight vehicles on the streets. Hence, a search for alternative consolidation strategies is necessary. The goal of this paper is threefold. First of all, it goes more deeply into the causes of the current lack of urban consolidation. Secondly, the existing literature and research on city logistics was explored for previous findings on urban consolidation. At last, a framework for classification of urban consolidation measures and initiatives was developed based on a survey of already adopted alternatives.

Keywords: Urban freight consolidation; urban consolidation centre; city logistics; urban logistics

1. Introduction

For more than twenty years now, initiating an urban consolidation centre (UCC) has been a popular measure in city logistics [1]. Because inner-city transportation activities are bundled, UCC's combine both high-quality deliveries and a mitigation of the negative effects of motorized goods vehicles entering cities. However, previous research on UCC's clearly shows that many of these freight platforms are

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granted only a short lifespan [2] [3]. First of all, because the cost of the additional transhipment often prevents them of being cost-effective. Therefore, they are dependent on governments willing to subsidize them because of their positive impact on congestion, emissions and the shopping climate. In addition, urban retailers do not always see their added value and therefore often opt out as soon they are expected to pay for the service [4] [5].

Nevertheless, the idea of consolidating goods from a destination perspective is valuable [6]. From the origin perspective, suppliers, carriers and large retailers already seek to consolidate freight as much as possible as it is cost-efficient for them. However, for cities, this cost-driven consolidation is not necessarily advantageous as trucks are still entering city-centres half-empty. After all, a truck might depart from the supplier's distribution centre fully loaded, but once the first delivery is carried out, it continues its journey half empty. And as a supplier's client-businesses are usually located in different cities, most freight vehicles entering a particular city are not used to their full capacity. In order to avoid the unnecessary nuisance caused to the users of the urban living environment by this inefficient mode of operation, a search for alternative, efficient and cost-effective consolidation concepts is needed.

The main purpose of this paper is to identify and classify feasible consolidation concepts aiming to make better use of the loading capacity of freight vehicles in order to reduce the number of vehicles entering urban areas. The paper consists of three main parts. The first section explains why it is beneficial and sustainable to bundle inner-city transportation activities to a larger extent than is currently the case. Next, in section two, the evolution of consolidation within urban logistics during the past fifteen years is sketched based on the results of several European research projects on urban freight measures, tools and initiatives. Finally, in section three, a general classification of consolidation-oriented tools is introduced together with a brief empirical analysis of already implemented examples.

2. Consolidating urban freight flows in order to reduce urban freight kilometres

Urban deliveries are carried out because people buy consumer goods at downtown retail stores. In response to that, retailers order new items from their suppliers to replenish their stock. At that point, supplier and retailer agree on the amount of goods to be delivered, the price (including transport) and the acceptable lead time. The supplier strives to provide the best possible service to his client and tries to fulfil their agreement to the best of his abilities by making sure the requested goods are delivered on time. Some suppliers carry out their deliveries on own-account and are therefore able to enter into direct consultation with the retailer on a mutually favourable delivery date and/or time within the agreed lead time. For the most part, however, suppliers make use of a professional carrier to pick up the goods and to take them to the shopkeeper's premises. Note that, in that case, supplier and carrier enter into an agreement of their own which, among other things, states how much time the carrier is granted to deliver the goods.

This mode of operation is common within urban logistics and is characterized by the lack of contractual obligations between retailer and carrier, also illustrated in Fig. 1. As a result, retailer and carrier are only little inclined to consult with each other on the most appropriate delivery date or time. This lack of direct consultation leads to particular inefficiencies which, for their part, cause a considerable amount of unnecessary freight kilometres [7]. First of all, there is the inefficient ordering behaviour of retailers. As carriers usually work by order of shippers and suppliers, the retailer is never directly faced with the consequential transport bill. This is reflected in his ordering behaviour since he often places his orders scattered in time, depending on when he has got time for it or when he thinks it fits to sales. Consequently, in most of the cases, suppliers receive small orders from their retailers instead of one bundled order. Secondly, suppliers and carriers are convinced that a short lead time is vital to a good customer service which means they do not save up deliveries but carry them out as fast as possible.

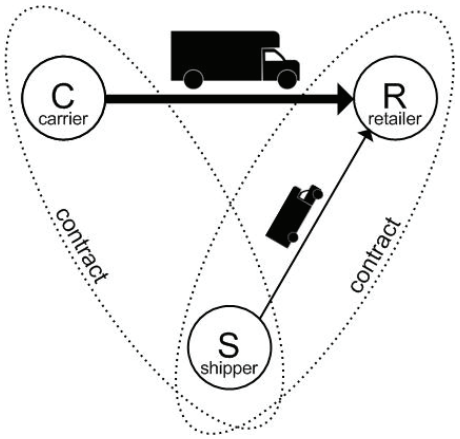

Fig. 1. The common mode of operation within urban logistics characterized by the lack of contractual obligations between retailer and carrier

Consequently, the flood of small orders results in many small deliveries. This approach also dominates our streets: many small delivery trucks and vans delivering small packages often several times a week at the same premises.

Irrespective of the size of individual deliveries, carriers aspire to use their freight vehicles as efficient as possible by sending off their vehicles fully loaded and aiming at as little empty or half empty kilometres as possible. Consequently, many urban delivery trips are round trips with several delivery addresses which are planned as efficiently as possible. As most carriers operate on a regional or even national level, not all addresses are located in one city. It means that freight vehicles usually enter the first city on the round trip fully loaded, but are only partially loaded when entering the second or third city. At the urban level, these empty or half empty kilometres are inefficient thus causing unnecessary hindrance and pollution. That is why, from a destination perspective, the adverse effects of urban deliveries would be reduced if flows of goods headed for the city were consolidated more efficiently.

3. Observations on the importance of urban consolidation concepts in the field of city logistics

During the last 20 years, many approaches and solutions to deal with urban freight problems have been proposed and tested. To date, however, little explicit attention has been paid to the concept of urban consolidation. This is clearly shown in the existing classifications of urban freight measures and initiatives since they never refer to consolidation concepts as a separate type or category. Fist of all, because some classification only categorize restrictive policy measures, e.g. the classification of Browne *et al*. [8] which distinguishes nine different kinds of measures which either imply restrictions for specific freight vehicles based on their fuel consumption, emissions, axle-pressure, height, width, length, weight, loading capacity or determine when and where freight vehicles are allowed to drive or to park to get unloaded.

In addition to these restrictive policy measures, authorities can also choose to pursue a more stimulating policy. Munuzuri *et al*. [9] distinguish four different groups of actions for policy-makers to mitigate the adverse effects of urban freight transport on the urban environment:

- Actions related to the public infrastructure; e.g. the creation of transfer points, such as city terminals, or the promotion of a shift to more environmental friendly modes; like the use of (shuttle) trains or an underground system.
- Actions related to land use management; e.g. creation of parking facilities, such as the provision of load zones.
- Actions related to access conditions; this category includes policy restrictions regarding to space, such as road pricing and vehicle restrictions, and regarding to time, such as time-windows and a ban on night deliveries.
- Actions related to traffic management; e.g. reconsidering the scope of regulations, such as harmonisation of regulations with other local authorities.

The first category mentions the example of city terminals, which are logistics facilities where freight destined for a particular urban region is consolidated. It does not mean however, that all measures aimed at consolidating urban freight flows belong to this first category. For example, restrictions on the load factor of freight vehicles entering the city rather belong to the third category. Other consolidation oriented measures, for example encouraging carriers to cooperate in each other's delivery area, do not belong to any category. This is due to the fact that this break down into categories is not based on the final goal of the suggested actions but on their area of influence. The same goes for most other classifications within urban freight logistics. Russo and Comi [10], for example, also made a classification based on the area of influence of city logistics measures which slightly deviates from the one of Munuzuri *et al*. [9]:

- Measures related to material infrastructure:
  - Linear, if they refer to links of the urban/metropolitan transport network
  - Surface (and/or nodal), if they refer to areas that can be reserved for freight operations
- Measures related to immaterial infrastructure (telematics) or Intelligent Transportation Systems
- Measures related to equipment
  - Measures on loading units
  - Measures on transport units
- Measures related to governance of the traffic network

Quak [11] for his part relies on the degree to which actions and initiatives affect their context to construct a framework to identify basic dimensions and classification for urban freight transport. He distinguishes two categories each with two subcategories:

- Class A: Improvements within the context
  - Category A1: Policy initiatives
  - Category A2: Company driven initiatives
- Class B: Improvements by changing the context
  - Category B1: Physical infrastructure initiatives
  - Category B2: Transport reorganising initiatives

Within his framework, Quak identifies 12 different types of initiatives based on 106 examples from the literature on improving sustainability in urban areas. Within the scope of consolidation of urban freight, two types of initiatives merit particular notice, each in a different category: Carrier cooperation initiatives in category A2 and Consolidation centre initiatives in category B1.

The fact that the various classifications do not directly refer to consolidation concepts does not mean that it is an insignificant concept. After all, some variants have been put into practice frequently. This is demonstrated by the results of four successive European research programs listing, categorizing and analyzing a big part of the city logistics measures implemented in the different European cities. The first

list of measures was given by COST 321 [12] which identified 56 theoretically feasible measures which were divided into eight categories:

- Logistical measures (1)
- Modal choice (2)
- Price of transport (3)
- Infrastructure and physical planning (4)
- Traffic management (5)
- Technical measures concerning the vehicle (6)
- Measures concerning the way of driving (7)
- Other measures (8)

Again, these categories do not refer to the goal which is pursued, but to the method of intervention. As consolidating can be done in different ways, none of these categories directly refers to consolidation of urban freight. Of the 56 identified measures, 13 are, at least to some extent, consolidation oriented (See Table 1). These 13 measures are classified into the first four categories. Column 2 of Table 1 shows to which category the consolidation oriented measure belongs. However, when considering the method used to consolidate, four alternative categories should be distinguished. First of all, the greater part of the measures regards a genuine additional transfer ('AT') point near the city centre. Secondly, four other measures aim at developing or promoting common delivery ('CD') points. Finally, two measures aim at changing the behaviour of carriers ('BC') and another two the behaviour of retailers and/or shippers ('BRS').

Table 1. Consolidation oriented measures within COST 321

Consolidation oriented measure within COST 321	COST 321 category	Own category
Shared use of storage space by retailers	1	CD
Promotion of storage facilities in inner urban areas	1	CD
Outsourcing of freight transport	1	BRS
Transport co-ordination and co-operation of retailers *	1	BRS
Goods distribution centres *	1	AT
Consolidation by means of "urban" containers *	1	CD
Development of lock chambers common to a group of receivers	1	CD
Regional rail network in combination with urban DC *	2	AT
Truck ownership licenses for urban distribution *	3	BC
Road pricing in cities *	3	BC
Optimisation of distribution systems including transport centres *	4	AT
Extension of transhipment facilities	4	AT
To revive railway or fluvial central urban sites as urban distribution centres	4	AT

Within the COST 321 project, all measures were assessed by a group of experts on their relative potential. The ones which were considered to be the most promising are indicated with * in Table 1. These results clearly show that more than half of the consolidation oriented measures were considered to be potentially beneficial, although, at that time, only goods distribution centres had been put into practice frequently. Beside the judgement of this group of experts, the countries participating in the COST 321 Action studied the effects of some of the measures. They distinguished three groups. The first group are measures with consistently favourable effects. None of the consolidation oriented measures was part of

this group. The second group are the measures with contrasted effects. Also none of the consolidation oriented measures was part of this group. The last group, measures with moderate effects, had the following consolidation oriented measures in it:

- Transport co-ordination and co-operation of retailers
- Goods distribution centre
- Consolidation by means of urban containers
- Tour planning
- Goods distribution centres with co-operation of carriers
- Road pricing in cities
- Optimisation of distribution systems

The fact that these measures were only granted moderate effects does not mean that they should be categorised as generally unworthy of implementation. This classification simply indicates that they are of subordinate importance in relation to the city as a whole because generally they only cover a particular part of the entire traffic situation or of the total urban area. Besides this assessment of theoretical city logistics measures, COST 321 also listed actually realized projects throughout Europe. This list shows that, back then, no consolidation concepts other than a UCC were put into practice.

Following the COST 321 results, Best Urban Freight Solutions (BESTUFS) was established in 2000. This thematic network was set up for four years and lead to a follow-up initiative, BESTUFS II, also for a period of four years. The goal of BESTUFS was to identify, describe and disseminate best practices, success criteria and bottlenecks with respect to City Logistics Solutions. Based on case studies, BESTUFS and BESTUFSII developed two Best Practice Guides on Urban Freight Transport. These guides discuss 6 strategies, measures or activities contributing to smooth urban goods transport and beneficial for all actors involved: (i) Goods vehicle access and loading approaches in urban areas, (ii) Last mile solutions, (iii) Urban consolidation centres, (iv) Road pricing, (v) Public private partnerships (PPP) in urban freight transport and (vi) Intelligent transport systems (ITS). The traditional consolidation measure, a UCC, is treated comprehensively and documented extensively. The other five do not aim at consolidation directly, but both Road pricing and Intelligent transport systems might, to some extent, also result in more efficient bundling of urban freight flows. Road pricing measures in urban freight transport are all measures imposing direct fees for the use of urban roads that might be able to influence the urban freight transport systems [1]. It is assumed that road pricing would result in a more conscious use of the urban road infrastructure, leading to smaller volumes entering the city or fewer ‘empty kilometres’. Intelligent transport systems for urban goods transport include among others the combination of electronic equipment and devices for traffic management, infrastructure control and signalling using innovative or smart technologies. They have a broad field of application, but one of the possibilities is an electronic freight exchanges system for urban freight transport (or virtual freight distribution centre). However, BESTUFS does not focus on the consolidation potential of these measures in its Best Practice Guides.

The most recent European research project on urban mobility which also incorporates a section on urban logistics is CIVITAS [13]. The goal is to help cities to achieve a more sustainable, clean and energy efficient urban transport system by implementing and evaluating a number of measures. Within the category of urban logistics measures, CIVITAS distinguishes eight different themes:

- Clean vehicles / clean fleet
- Distribution scheme
- Fleet management & route planning
- Loading and uploading
- Loading Zone

- Public private co-operation
- Security
- Urban distribution centre

Again, there is a separate category for the traditional consolidation concept: the urban distribution centre. The other categories do not contain measures referring to or resulting in consolidation of urban freight flows.

4. Classifying urban consolidation measures and initiatives

The above survey clearly shows that both literature and research projects on city logistics measures do not treat urban consolidation as a stand-alone concept. This is partly due to the fact that the various classifications use the impact of a measure as the basis for classification rather than the goal which is pursued. The aim of consolidating urban freight flows is to reduce the number of freight vehicles entering the city by making better use of the load capacity of these vehicles. But because this can be done in different ways, these measures never fit into a single category of classification and are never treated as a whole. The most important reason for the lack of clustered attention, however, is that only a few consolidation concepts are currently considered to be a valuable alternative. When in 1998 COST 321 identified various feasible city logistics measures, still 13 out of 56 were consolidation oriented. Afterwards, although reducing the negative impact of urban freight operations gained in importance, most of these measures and initiatives were never explored any further. A third reason is the fact that local policy makers give preference to measures which can be generally applied rather than multiple small-scale and tailor-made initiatives. In addition, their kind of political power will sooner induce restrictive measures than stimulating initiatives. This also explains why, in contrast with other consolidation concepts, urban consolidation centres and, to a lesser degree, road pricing measures were further explored.

There are, however, recent developments justifying a heightened attention for urban consolidation other than through a UCC. First of all, a number of alternative concepts has been field-tested in an urban setting for the first time providing a better understanding of their possibilities. In addition, some other consolidation concepts which have proved to be valuable on a larger scale seem also promising in the field of urban logistics. Secondly, and more importantly, throughout the past 30 years, the UCC concept has been put to the test in several European cities and urban regions showing that it is far from always successful [2] [3]. Furthermore, it was found that the common restrictive urban logistics measure, establishing time-windows, is both economically and environmentally inefficient [11]. These are the right circumstances to set up a classification of urban consolidation measures, actions and initiatives of all kinds in order to gain an insight into their qualities and possibilities as consolidation tries to combine lesser nuisance with sustainable and efficient deliveries.

The first and most important distinction is based on the extent to which receivers and/or carriers have to change their internal processes in order to join in on a particular initiative or action. As already established earlier, the inefficient bundling from a city perspective is mainly due to the lack of cooperation and consultation between receiver and carrier. There are two possible ways to tackle these inefficiencies: get around them or deal with them internally. In the first case, the empty urban kilometres are avoided by adding an independent and additional transhipment point to the supply chain. Carriers no longer deliver directly to the receiver but, whether or not voluntarily, make use of a third party to do so. As this paper aims to look for consolidation concepts other than a traditional UCC, the distinction is mate between such a physical consolidation centre on the outskirts of the city centre in which the local government plays either a key or supporting role and alternative transhipment points which differ from it

to some extent. What both options have in common is that they aim to disturb the traditional order and delivery routine of both carrier and retailer as little as possible. These measures and initiatives are referred to as 'physical' as it involves a concrete additional transhipment operation.

The second option is to tackle the different causes of the fact that half empty freight vehicles are entering our cities. Today, the cargo of a particular truck or van often is destined for several delivery points in different cities meaning that the load rates are inadequate from a destination perspective. To raise these urban load rates, at least one of the stakeholders has to make changes to his internal procedures and processes, e.g. a retailer can cut back his weekly number of orders with a particular supplier in order to enlarge the size of the deliveries to his premises. Because of these internal adaptations, these kinds of actions are called 'behavioural'. Within this category of behavioural concepts, a second distinction has to be made between what we call 'horizontal' and 'vertical' concepts. The horizontal concepts aim at a particular stakeholder group within the supply chain, being carriers or receivers, the vertical ones aspire to ameliorate the vertical consultation between the different stakeholder groups. The framework for classification is shown in Fig. 2. Further details on these categories and the corresponding test cases are presented below.

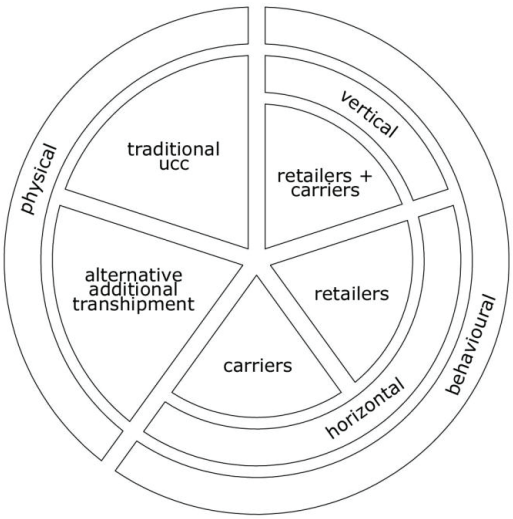

Fig. 2. Proposed classification for consolidation oriented measures

4.1. Traditional urban consolidation centre

Cities trying to encourage urban freight consolidation often set up or support an urban consolidation centre (UCC). Within the scope of a research project on UCC's, Browne *et al.* [2] defined a UCC as a logistics facility that is situated in relatively close proximity to the geographic area that it serves be that a city centre, an entire town or a specific site (e.g. shopping centre), from which consolidated deliveries are carried out within that area. A range of other value-added logistics and retail services can also be provided at the UCC. Logistics companies with deliveries scheduled for the urban area or site are able to transfer their loads at the UCC and thereby avoid entering the congested area. The UCC operator sorts and consolidates the loads from a number of logistics companies and delivers them, often on environmentally friendly vehicles, to an agreed delivery pattern.

Typical for this kind of measure is temporary or even structural governmental support to get and/or keep the centre operational because the additional trans-shipment costs should be compensated. This choice for support is understandable as intensive use of a UCC guarantees the best possible optimization of freight vehicle movements within the urban area because it can be adopted on a large scale both geographically and across branches of trade. Moreover, it enables governments to control the kind of vehicles entering their city, e.g. smaller vehicles which cause less hindrance when loading or unloading or environmentally friendly vehicles. There is a large number of field-tested UCC's which have been described comprehensively by Browne *et al.* [2], Karrer & Ruesch [1] and Van Duin [3]. These pilots and test cases show that many of these freight platforms are granted only a short life because the cost of an additional transhipment prevents them of being cost-effective [2] [3]. Therefore, they are often destined to disappear when governmental subsidies are lost. Furthermore, both carriers and receivers are not demanding an additional transhipment point, particularly when it is cost-raising. In general, receivers are reasonably pleased with the way they are delivered. After all, suppliers and carriers conform as much as possible to the needs of their receivers [14]. Also the interest of carriers to use urban freight facilities is often overrated when planning a UCC [11]. Nevertheless, a high participation of both receivers and carriers is essential as it determines the amount of goods being delivered to the UCC and therefore is one of the important factors of success [3].

4.2. Alternative additional transhipment point

Although it appears that far from all UCC's are a success, it does not mean that the idea of an additional transhipment point has to be sidelined completely. Because the main problem of traditional UCC's is that the break-even volume is rarely made, potentially successful alternatives should focus on traded volume. In Norfolk in 2007, an Urban Transhipment Centre was set up from an existing privately operated transhipment centre which already had a large amount of delivery points within the Norfolk urban region [15]. Although only four new customers were recruited, there is a high level of satisfaction with the service amongst existing customers. An analogous example is Utrecht, a moderate Dutch city of 311.000 inhabitants, which has no less than three urban consolidation centres. These centres actually are the existing distribution centres of three private carriers. All three of them do not have to comply with the time windows set by the Utrecht City Council in exchange for assuring high load rates and the use of environmental friendly vehicles [16].

Another alternative is to downscale the scope of the consolidation initiative and to focus on a particular delivery area. In France in 2001, a concept called 'Espace de Livraison de Proximité' (ELP) or 'Nearby Delivery Area' was tested in several cities and is still in place in Bordeaux, Paris, Dijon, Rouen and Lyon [17]. A similar area is dedicated to goods vehicles for the loading and unloading of goods destined for the nearby shops. It is often located in an underground car park where goods are unloaded from the incoming freight vehicles and then loaded onto electric tricycles for the final distribution leg. That way, both freight vehicle kilometres and the global time for delivery are reduced as goods destined for this particular district are unloaded at once. And more importantly, loading and unloading operations are facilitated without modifying current transport contracts, freight vehicle drivers have dedicated spaces at their disposal and the road occupancy of freight vehicles is reduced drastically. In 2006, 700.000 deliveries were carried out this way resulting in a total reduction of 660.000 km of diesel vehicle mileage. In 2003, the same concept was tested in Bordeaux proving that it is also advantageous when applied on an even more local neighbourhood or street scale [18]. The 2006 experiment in Rouen proves that mixing an ELP and cargocylces is very efficient, adaptable and cheap [19]. This concept bears quite a lot of resemblance to the traditional UCC, but deviates from it because it is completely privately operated and serves a particular (small scale) area.

Both linking an urban transhipment point to an existing privately operated distribution centre and the nearby delivery point concept are geographically oriented and therefore still closely related to the traditional urban consolidation centre. The third alternative transhipment point concept does not aim to bundle the deliveries to the various receivers in a particular urban area, but departs from the finding that all shops part of a particular franchise chain have the same offer on their shelves and are supplied by the same suppliers. Each of these suppliers delivers often small amounts of goods to every shop part of the chain. Intres is a Dutch service organisation uniting more than 1200 retailers. Through Intres, retailers can join in on completely elaborated franchise concepts. The organisation thought it would be cheaper and more convenient to its franchisees if deliveries for a particular shop were consolidated. In addition, this can also be favourable from a city perspective as deliveries to a particular shop are bundled into a single freight vehicle. Intres chose to test this concept on its Livera retail chain which consists of 136 franchise stores selling women's underwear, nightwear and swimwear [20] [21] [22]. The different suppliers of the Livera shops were asked to mutually collaborate in the transport sphere in order to diminish the number of journeys to a particular shop, but they turned out not to be prepared to do so. After calculating the savings when a single carrier would distribute all of the deliveries to the different Livera shops, Intres contracted one carrier and had all suppliers deliver their cargo for the Livera shops at his depot. During its testing phase, the concept brought profits to all stakeholders as the supplier pays less distribution costs, Intres is able to charge a percentage for its mediating role, the selected carrier works more efficiently and the retailers is interrupted less frequently. In addition, as fewer delivery vehicles call in at a particular shop in order to supply it, citizens, commuters and shoppers experience fewer nuisances because of it. Only to the carrier that was not chosen, the concept is less advantageous.

4.3. Adapted behaviour by receivers

As already stated earlier, there are other ways to consolidate urban freight flows more efficiently from a city perspective besides introducing an additional transhipment point to the supply chain. It can also be done by adjusting the conventional working methods of some of the stakeholders. Thorough analyses of the existing behavioural concepts which have gone beyond theory prove that the main stakeholders able to influence the number of urban freight vehicle movements are the carrier and the receiver. Furthermore, the existing examples also make clear that both of them are only inclined to participate in any kind of initiative if they think to personally benefit from it. In the case of the receiver, that appears to be a problem as the bare fact that the number of freight vehicles entering the city is reduced does not yield a financial profit. At the most, it leads to a more pleasant shopping climate for his customers and less interruptions by carriers delivering something. That is why concepts oriented towards the receiver would also have to be advantageous to them in other ways in order to receive bottom-up support.

The existing consolidation concepts aimed at receivers can be divided into two different categories. The first option is to encourage the receiver to make some adjustments to his procedures and processes. For example, the Dutch project on demand driven consolidation called 'Vraaggestuurd Bundelen' persuaded retailers to change their ordering behaviour [7]. Often retailers do not take into account that an order from their part puts a complete system into action. When an order reaches the supplier, he immediately engages a carrier to take the goods to the retailer, as he is convinced that fast deliveries are essential to a good customer service. He does not await a possible second or third order from the same receiver within the next few days which means that retailers who do not bundle their orders, unintentionally cause more trips to their premises than necessary as they do not always need the goods straight away. Another example of adapted behaviour is the Paris Consignity project which is a network of automated lockers for pick up and deliveries [19]. One of the major developments of Consignity is the supply of spare parts to a major elevator manufacturer for its maintenance service. Previously, every day

100 employees were circulating between the manufacturer's 5 spare parts warehouses located close to Paris and various intervention points at businesses and private buildings in the city centre. Numerous trips were made without optimization and much lost time due to congestion. The purpose of Consignity is to minimize the movements of the technicians by providing the spare parts they need closer to the buildings they operate in. Supplying the Consignity lockers is done at night by a single carrier.

One step further is genuine consultation and even cooperation between different receivers. The same Dutch project on demand driven consolidation tried to have retailers which are delivered by the same supplier or carrier agreeing on a mutual delivery day or time which means that carriers do not have to take into account different retailer's preferences when planning their delivery tours [7]. Somewhat more far-reaching is the cooperation between different receivers on the Belgian industrial estate De Prijkels. This is not an 'urban' example, but might also have a future within a city context. The estate comprises 280 acres of land and houses 96 companies of which 90 are an SME [23] [24] [25] [26]. In 2002, in response to the many burglaries on the estate, five companies decided to engage a surveillance company together. Thanks to this concentration of forces, they were able to negotiate a long-term agreement at a very keen price. Because of this success, the founding companies decided to start cooperating in other areas too. They mapped the waste flows, negotiated common conditions with the company collecting garbage at the estate and mutually agreed on what day of the week they should be collecting it. Therefore, fewer kilometres are driven in order to collect the same amount of garbage. Furthermore, some companies on the estate also order their fuel oil and diesel together, try to purchase paper and office utensils in bulk or engage a single parcel delivery service provider to have all their parcels collected and delivered once a day. Also the already cited Livera example is based on cooperation between retailers.

Even another step further is the Swedish SMILE project which had the aim to develop a web-based food logistics system, linking 40-50 small food producers in the region with 5 purchasers in the city of Malmö [27]. The food producers do not individually hire transport to bring their produces to their client, but make use of a common food logistics system which is owned and operated by both the producers and the purchasers. Similar to the Livera example, a single carrier is hired to carry out al transport involved, but new to this is that receivers and suppliers closely work together in order to reduce travel distance of fresh food supply.

The previous four examples clearly show that there either has to be an immediate cause to start cooperating or a supervisor taking the lead. When stores are part of a retail chain, and in urban areas that is the case for almost 3 shops out of 5 [28], deliveries and orders are centrally managed and therefore already consolidated. However, this consolidation does not apply to the urban level as the different outlets usually are settled in different cities. Because local governments often are in demand to reduce the number of freight vehicles, they are forced to coordinate these kinds of cooperation. The above sited projects show that in some cases, when the number of retailers to align is not too high and/or when the mutual competition is not too severe, it can be done. Another example can be found in London where the government supports big urban receivers in developing a logistics plan. It is called a Delivery Servicing Plan and it should guarantee a consistent approach of the deliveries as it helps managing deliveries to reduce the number of trips, identifying where safe and legal loading can take place and commissioning delivery companies who can demonstrate their commitment to best practice [29]. An analogue system has been set up for urban construction sites [30].

4.4. Adapted behaviour by carriers

As opposed to receivers, carriers in urban settings do benefit directly from freight consolidation because every empty or half empty kilometre costs them. When a carrier has to call at several delivery points during a particular run, he prefers the distances between two successive delivery points to be as

short as possible because it saves him time and money. Therefore, carriers already plan their routes as efficient as possible, but they have to take into account the often scattered locations, the supply preferences of the receiver and various governmental regulations on urban deliveries. Some carriers developed innovative approaches to decrease the distances between the different delivery points in order to keep down the lid on costs which are at the same time beneficial for the urban environment. The first example is Centraal Boekhuis, a Dutch company specializing in the distribution of books in The Netherlands and Flanders, the Dutch-speaking part of Belgium [31]. It links 500 publishers and more than 1500 booksellers selling books in traditional bookstores and specialized retail chains, but also at supermarkets, gas stations, toy stores and museums. Centraal Boekhuis has got a fine-meshed distribution network at its disposal through its own transport company De Vervoerscentrale. From an efficiency point of view, Centraal Boekhuis chose to also use this network to distribute other goods which can easily be transported with books and which have to be delivered at stores already on their route or close to shops they are already delivering.

Another possibility for carriers to limit the distances between two delivery points is to concentrate on a limited geographical area, e.g. a particular city or region. However, to ensure a certain demand for his services, the carrier has to take some measures in order to be competitive. Duncker, a Dutch transport company, succeeds in this by specializing in a particular kind of transport, namely refrigerated transport [32]. Duncker only delivers the Amsterdam city centre and consolidates the refrigerated cargo at a distribution centre just outside the city. By analogy with the urban consolidation centre concept, the different suppliers deliver their goods at the Duncker warehouse. This example shows that, although this kind of concept usually is set up and (partially) funded by a local government, it can also be adopted and successfully applied by private companies. A more common approach to limit the working territory is to closely cooperate with carriers who operate in a different area. This approach is frequently used in international haulage but could also be adopted on a more regional level. Teamtrans, for example, is a collaboration of 13 Dutch carriers who divided the Dutch territory in 13 service areas based on postal codes [33]. Each of the carriers serves one of these areas operating from his central depot. Within that area, he does not only distribute goods for his own customers, but also for the 12 other carriers. At night, his cargo destined for a location outside his service area is transported to the depot of the carrier serving that area. This collaboration results in an efficient bundling of goods and a decrease in the number of kilometres driven to deliver the goods and has a positive impact on congestion as in the morning, when traffic is at its heaviest, the goods are already near their final destination.

Although the above examples lead to less freight vehicles on the urban roads, they still are private initiatives of which the initiator is not primarily concerned with the urban living environment but with the success of his company. However, they do illustrate that also in real terms carriers are able to reduce their urban trips whilst remaining competitive. Local governments cannot enforce similar systems, but can try to encourage them in order to reach their own goals for example by giving incentives for improving the load rates in city freight distribution. The city of Göteborg set up a pilot project in that sense designed as a voluntary scheme in co-operation with the transport industry [34]. Within this project, the criteria for entering the inner city zone for distribution vehicles was a combination of a 65% load factor, a limited time gap between stop time and running time and complying with the emission restrictions linked to the already existing Environmental Zone. The pilot involved 8 vehicles which were equipped with technology for the registration of the driven routes and the load rates. The participating carriers were given positive incentives to encourage them to respect the 65% load factor. The conclusions of the project were first of all that it is possible to discuss urban freight issues and to come to agreements with carriers and secondly that in order for a similar scheme to become successful at a large scale, it is necessary to combine incentives and restrictions. Besides Göteborg, not many other municipalities experimented with load factor raising incentives or regulations. There are, however, other concepts they could initiate that

originally were not developed for local freight traffic, for example cargo pooling [35] [36]. The concept departs from the idea that free space in a freight vehicle could be rented out to suppliers or carriers wishing to transport cargo to a destination on (or close by to) the route of the vehicle. In advance, the cargo is transported to a transhipment point which, in the case of urban freight transport, often would be the distribution centre of the carrier carrying out the transport. In practice, an internet platform could be set up to match free space with non allocated cargo.

4.5. Direct contact, consultation and/or collaboration between carriers and retailers

The four previous solutions for low urban freight load rates do not address the main cause of this problem, notably the lack of consultation between carriers and retailers. Remarkably, even amongst the selected test cases and examples of consolidation oriented city logistics measures, there are no examples of collaboration or at least consultation between these two stakeholders. However, a Belgian project by the Flanders Institute for Logistics (VIL) on off-peak deliveries shows that bringing all stakeholders together on the initiative of a neutral partner can make a difference [37]. The aim of the project was to shift freight movements to the off-peak hours in order to achieve a more reliable supply chain and cut costs as delays due to congestion would be avoided. This idea was field tested for the supply of the warehouses of a Belgian retailer. Until now, night deliveries were not possible because the warehouses of the retailer were closed between 10 pm and 6 am. In theory, it would be beneficial to all stakeholders (and specifically to the retailer and the carrier) to make use of these nightly hours. In practice however, the issue was never discussed because the retailer and the carrier do not have a contract between them. Within the scope of this project, all parties were brought around the table and made engagements on this issue. Now, since the testing project, 3 participating suppliers permanently partly deliver this retailer at night instead of during the day and that to everyone's satisfaction. Afterwards, the stakeholders pointed out that the biggest achievement of the project was facilitating contacts between receivers and carriers as they normally never mutually confer.

5. Conclusion

The threefold objective of this paper was (i) to substantiate the benefits of consolidation within the typical urban retail supply chain, (ii) to analyse the position of the various urban consolidation concepts within the literature and research on city logistics and (iii) to categorize the already adopted concepts in order to provide a starting point for further research into alternative freight flow bundling concepts. The first conclusion to be drawn is that the main cause for the inefficiencies at the urban level is the lack of direct consultation between carrier and receiver resulting in a flood of small orders and many small deliveries. Secondly, this paper clearly shows that within the existing literature and research on city logistics, urban consolidation was never treated as a stand-alone concept. Only urban consolidation centres have been examined in detail, the other concepts were, mainly during the initial period of city logistics research, treated superficially. Finally, analysis of the existing examples of urban (and other) consolidation lead to a classification of consolidation oriented measures and initiatives. They can be divided into two main categories: physical and behavioural concepts. The physical category contains all possible additional transhipment points of which the urban consolidation centre is the best known one. The behavioural concepts again are subdivided into two categories: horizontal and vertical concepts. When these concepts aim at changing or adjusting the behaviour of only one stakeholder, they are called horizontal. However, when vertical consultation and cooperation within the supply chain is needed, the concepts are called vertical. Practice demonstrated that the two main stakeholders to be addressed with these behavioural concepts are the carrier and the receiver. The many cited examples establish that there

is a future for alternative urban freight bundling but that all four categories need further research and development.

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