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Integrating city logistics in spatial planning – Creating the conditions for decarbonization and hubs

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Abstract

There is a lot of attention for the reduction of city logistics' emissions. But also if city logistics' vehicles are zero emission, the vehicles remain present in urban areas. Zero emission vehicles also occupy valuable urban space during unloading on the road and on sidewalks. Despite the spatial impact of city logistics, it is rarely considered in spatial planning. Based on four case studies, we explore possibilities to actively integrate city logistics in spatial planning policies and practices in order to reduce nuisance, but also to enhance efficiency of deliveries. In the end, spatial planning determines the physical urban conditions in which city logistics operations are taking place for many years. From the results we distil a research agenda to bridge the gap between city logistics as a traffic issue and its integration in spatial planning policies.

Keywords: spatial impact; city logistics; urban planning; logistics facilities

1. Introduction

Policies, strategies and studies to reduce city logistics' emissions as well as reorganize city logistics are abundant. The latter mostly focuses on different types of decoupling points to organize the logistics in cities more efficiently with fewer vehicles, such as urban consolidation centres. Even if urban freight vehicles are zero emission, in the end, these vehicles – varying from cargo bikes to heavy trucks continue to be present as the provision of goods and services is vital to thriving cities. Vehicles continue to occupy valuable urban space by unloading on the road and on sidewalks. Despite their impact, logistics vehicles are rarely considered in urban planning (Cui et al., 2015; Heitz and Dablanc, 2019; Kin et al., 2023). It is mostly approached as a traffic issue and regulated as such with measures such as time

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windows and low emission zones. More facilitating measures include unloading zones and on-street parking infrastructure, but these are increasingly under pressure (Cruz-Daraviña and Bocarejo Suescún, 2021; Muriel et al., 2022). This enhances illegal parking and blocking roads, while also delaying deliveries. Only more recently, the need for land use planning inside cities to minimize the impact of logistics received more attention (Baker et al., 2023; Holguin-Veras et al., 2021; Kin et al., 2023; Xiao et al., 2021).

The need to get logistics higher on the spatial planning agenda is driven by two distinctive, yet intertwined, developments. On the one hand, logistics facilities re-appear in cities due to companies' needs to be located in close proximity to customers (Buldeo Rai et al., 2022). Around such facilities – in various forms including dark stores, transshipment points and parcel lockers, traffic intensity and externalities increase. On the other hand, we observe a transition of urban areas whereby space for road infrastructure is being reduced for the benefit of pedestrians and cyclists, climate adaptive measures (such as greening the urban surface) and, more conceptually, to move towards '15 minute cities' (e.g. Di Marino et al., 2022). There is simply less space available for (logistics) vehicles as more areas become pedestrianized. Besides, due to densification and compact building to accommodate more residents in cities, without a serious extension of the infrastructure the amount of urban space available for logistics activities reduces even more. Logistics vehicles do not simply disappear as cities remain the epicentre of consumption due to a continuing growing population.

In this paper we argue that city logistics must be actively integrated in spatial planning in order to reduce its nuisance (the space consumed by vehicles), but also to enhance the efficiency of deliveries, primarily by reducing dwell times. It seems like a paradox, but if regulated well, various types of logistics facilities and spatial requirements can reduce this negative impact (e.g. Katsela et al., 2022). There is already a growing body of literature on this topic when it comes to consolidation facilities around urban areas (Björklund and Johansson, 2018), but the integration of facilities and other spatial interventions for logistics are rarely considered in spatial planning in more denser parts of cities. In four cases studies, undertaken in the Dutch research project CILOLAB, we explore different possibilities and requirements to integrate logistics in urban space that allow minimizing the spatial footprint of logistics vehicles while facilitating logistics operators' efficiency. The next section presents the research approach after which the main outcomes of the four use cases are presented. Based hereupon we present a research agenda with recommendations.

2. Research approach

In order to map the spatial requirements and the extent to which this allows the impact of logistics vehicles to be minimized, four case studies in different contexts were been conducted. The commonality is that all case studies took place in a relatively small area. The focus is not on ways to reduce the number of vehicles towards the specific area, but on ways to minimize the impact of the vehicles that actually arrive in the area. Four steps have been undertaken per case study (with some deviations per case study). First the case study area is scanned, with a particular focus on mobility and logistics. Table 1 provides an overview of the four case studies.

Second, based on the characteristics of the area, the number and type of logistics vehicles for the area on a daily basis are estimated. In Topsector Logistiek (2020) we developed a methodology to quantify the number and type of logistics vehicles based on the characteristics of the area in terms of number of households, and type and size of businesses in square meters and full time equivalents. These characteristics determine the freight attraction. With this methodology not only the total number of vehicles is estimated, but a decomposition is additionally made. This decomposition is relevant as city logistics is highly diverse. City logistics consists of different vehicle types that transport different types of goods and services, that have different load factors, dwell times, drop densities, etc. To structure this diversity, a distinction is made between deliveries related to retail (to retail chains and SME), temperature-controlled (retail, hospitality and home), parcels, waste, construction logistics and service logistics (Topsector Logistiek, 2017). This is relevant in this research as a heavy truck supplying a supermarket has different requirements with regard to time and space usage in an area compared to a plumber that merely needs a spot to park the vehicle, which again differs from a parcel delivery van that has a lot of stops. Rondaij et al. (2023) present a schematic overview of the methodology to estimate the number of vehicles in the area, based on known plans.

Table 1. Overview case studies.

Case study	Description	Method
Spoorzone Zwolle	Re-development of a (largely) car-free area in the city of Zwolle next to the train station with houses, education, retail and hospitality.	Two workshops with policy makers, real estate developers and urban planners. One workshop included a serious game.
Beurskwartier Utrecht	Development of a new car-free residential area close to the city centre of Utrecht with offices, retail, hospitality and various institutions such as education and health care.	Three workshops with policy makers.
Oude Westen Rotterdam	Logistics in an existing mixed-use neighborhood close to the city centre in Rotterdam – future scenarios	One workshop and scenario development with urban planners and architects
Urban high rise towers Rotterdam	Exploration of spatial requirements to minimize the impact of logistics around two new urban high rise towers that will be developed in Rotterdam.	Interviews with various stakeholders, using a multi-criteria analysis (MCA).

As a third step, an assessment is made of the logistics facilities and spatial requirements that are available to potentially mitigate the impact of logistics vehicles. This is in all cases done through desk research, followed by workshops and interviews with stakeholders that are involved in the use cases. A twofold distinction is made here. On the hand, potential logistics facilities are mapped as physical locations, mostly inside buildings, where goods can be bundled, delivered, stores and/or picked up. Those facilities include microhubs, waste collection points and parcel lockers (for more specific facilities, see the results per use case). On the other hand, spatial requirements relate to interventions in public space where vehicles can park after which a driver can deliver goods or conduct a service. Examples are (temporary) unloading zones in public space, unloading docks inside buildings and space for logistics vehicles in parking garages and mobility hubs. Impact relates to either removing a logistics vehicle from public space or minimizing its dwell time. Where possible, the possibilities are linked to specific segments.

Finally, per use case, the possibilities are discussed and described to be included in the further development of the area. In all cases logistics was not on the agenda in a detailed way. In one case, Beurskwartier Utrecht, an additional calculation of the potential reduction in the number of vehicles has been made.

3. Results

3.1. Spoorzone Zwolle

In the Spoorzone area in Zwolle, which is being developed and foreseen to become largely car-free, logistics is barely included in the future plans. The development includes 3000-4000 houses, the municipal building, a large educational institution, and hospitality and retail. Table 2 shows the estimated number of incoming logistics vehicles on a daily basis once the area will be finished in 2035. The bandwidth is caused by two uncertainties: the amount of through traffic as well as a proportion of light vehicles (vans) that could potentially be parked at the residence of the driver (Rondaij et al., 2023). The table shows that the number of vans is five to ten times higher as the number of trucks. Vans are particularly related to service and construction logistics. These vehicles often are more service-related than actually transporting goods. Furthermore, light electric vehicles such as cargobikes are not included as data is lacking. Detailed data collection on an area level is required to better estimate the logistics footprint.

To minimize the impact, several workshops led to an overview of potential measures specifically tailored to the different segments. These are categorized along three categories:

1. The integration of hubs, which includes adding logistical functions to the planned mobility hubs as well as parcel lockers at strategic locations,
2. Various interventions in the road network such as preferred routes for light electric vehicles and implementing the ‘superblock’ concept to minimize the impact of heavy duty vehicles,
3. Embedding logistics in buildings and public space such as temporary unloading zones and in-house waste collection.

Table 2. Estimation of the number of vehicles in Spoorzone in 2035

Segment	Light vehicle	Heavy vehicle
Waste collection	0	10-12
Construction	47-123	21-27
Parcel	26-69	1
Facility and service	271-719	38-50
Retail	52-136	27-34
Fresh	38-97	21-26
Sum	466-1229	118-150

3.2. Beurskwartier Utrecht

Beurskwartier will be a largely car-free area with 2,500 houses, retail (2,600 sq m), offices (50,000 sq m), hospitality (5,350 sq m) and other types of institutions such as healthcare and education (8,000 sq m) (Rondaij et al., 2022). The logistics footprint shows that an estimated 400-1000 light commercial vehicles and 75-95 trucks will arrive on a daily basis to supply the area with goods and services. The proposed logistics system to deal with these logistics vehicles, consists of four possibilities:

1. Parking garages. Below the residential building blocks parking garages will be created. A number of parking spaces will be reserved for light logistics vehicles. Parcel lockers can be placed here as well as in the residential building blocks. Besides parcel deliveries, this solution could also be used for service-related vehicles.
2. Loading and unloading zones. At the edge of the Beurskwartier loading and unloading zones will be created for logistics vehicles. The loading and unloading zones can be used in combination with a dynamic reservation system to ensure availability upon arrival. In addition, large freight attractors such as supermarkets and the (logistics) entrance of office buildings can be located on the edge of the neighbourhood rather than inside. This avoids certain logistics vehicles from entering the area.
3. Mobility hubs. The remaining vehicles can go to one or more mobility hubs at the edges of Beurskwartier. At the mobility hubs transfer to light electric vehicles and cargo bikes can be facilitated to enable delivery of goods and service provision in the neighborhood.
4. Increased use of light electric freight vehicles. A share of the urban goods movement can be conducted by light electric vehicles entering Beurskwartier from other parts of the cities, for example a city hub.

3.3. Logistics in an existing neighbourhood – Oude Westen Rotterdam

City logistics affects traffic and public space. The latter is increasingly under pressure due to densification and sustainability goals. In an existing neighborhood in Rotterdam, together with a creative agency we designed four scenarios on how logistics flows can be facilitated, while also maintaining livability for residents and visitors. The scenarios have been developed along two axes: degree of collaboration in the logistics sector (integrated or more white label versus segregated or more competitive) and spatial planning that is either more focused on fluently facilitating transport or livability for residents and visitors (see Figure 1). The scenarios consist of three building blocks that compose the logistics system: 1) vehicles (varying from bikes and trucks to autonomous vehicles in different sizes), 2) infrastructure that is being used by vehicles, 3) logistics facilities in different forms, including transshipment points, (pickup) stores, parcel lockers and dark stores. Overall, the presence of logistics vehicles as well as facilities in public space varies per scenario. In more city-oriented planning the basic premise is placemaking where logistics is either strictly regulated to minimize its presence (scenario 1) or separated from other activities and functions as much as possible (scenario 3). The focus in the other two scenarios from a spatial planning perspective is more on facilitating traffic.

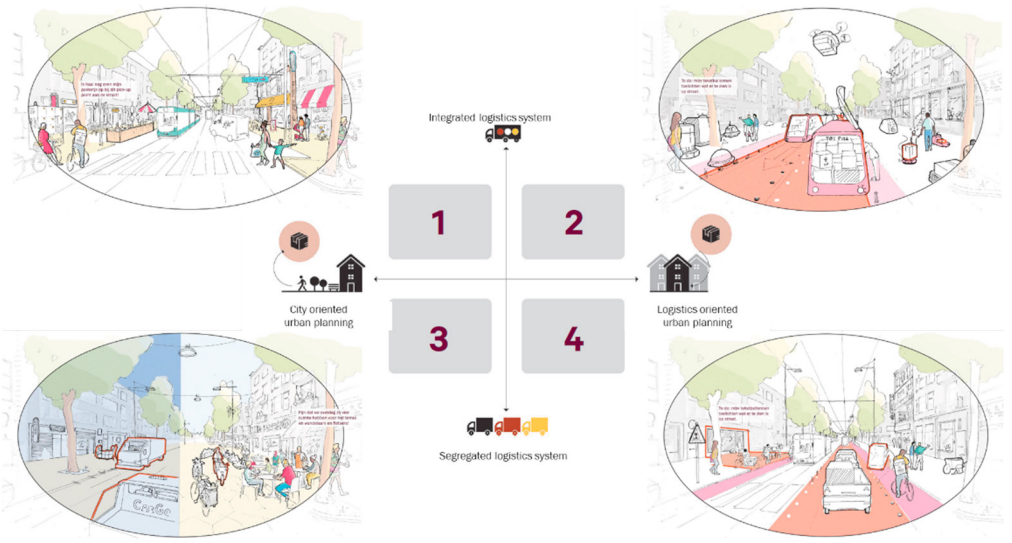

Fig. 1. Scenarios for future city logistics in an existing neighborhood (Posad Maxwan and TNO, 2022)

The four scenarios give insight into the relation between the (often) quick development of the logistics system and spatial planning. The latter is mostly planned for decades, whereas the former is short term and highly dependent upon market developments. An example is the rise of instant deliveries (Dablanc et al., 2022). Such market developments can provide nuisance on a local level, but if integrated well potentially contribute to minimizing the impact of logistics vehicles. The explorative study, however, showed that not everything can be done everywhere at once: trade-offs must be made between liveable streets aimed at a high quality of living and locations where this quality is (partly) sacrificed to cater for (efficient) logistics.

3.4. Logistics around urban high rise towers – Rotterdam

In the Netherlands an estimated one million new houses must be built in the coming decade. A significant proportion is planned in cities, which leads to more high rise buildings and a further densification. In the second largest city, Rotterdam, 50,000 new houses are planned, partly in high-rise buildings. From other cities, it is known that a significant proportion of logistics vehicles use the curb and (illegal) double curbside parking for unloading goods and sometimes parking to carry out a service (Aljohani and Thompson, 2020; Chen et al., 2019; Girón-Valderrama et al., 2019). Possibilities to minimize the occupancy of logistics vehicles and enhance delivery efficiency are often not or only to a limited extent taken into account during development of such large freight attractors. Through a literature study and interviews, the following possibilities for logistics were identified:either inside the building or in the wider area, while also taking into account the diversity in vehicles and respective segments:

- Four types of hubs to minimize the dwelling time in public space by not having to conduct deliveries until the doorstep: parcel locker, manned pickup point, microhub (for transshipment) and indoor unloading space.
- Three types of parking facilities to minimize the nuisance while conducting (delivery and service) operations by securing that vehicles are being parked at the designated places: parking (also for light electric freight vehicles), parking garage (including space for logistics vehicles in mobility hubs) and (temporary) unloading bays.

Those different possibilities have a twofold impact on the use of public space, a direct impact if public space is (temporarily) used which is the case with an unloading bay, and an indirect impact which relates to the vehicles around such locations (e.g. traffic intensity around a microhub). There are various judicial and spatial policy instruments to make sure logistics is taken into account during development. In Paris, a good example are ‘location perimeters’ where

developers are obliged to integrate logistics facilities on private land parcels when building or renovating (Buldeo Rai et al., 2022). A challenge, however, remains enforcement when the location is operational, as was indicated during an interview.

4. Conclusion and research agenda

Research on ways to integrate logistics spatially in spatial planning and area developments inside cities is very limited. In practice, this becomes obvious in new area developments, where the future attraction of logistics vehicles are mostly not considered in the design of urban space and buildings. Rightfully so, in such areas the presence of logistics vehicles potentially increases as car ownership is low. Neglecting logistics in the planning process potentially negates the effort to improve livability in those areas. At the same time, this applies to existing areas. A major challenge here remains that regulation and adaptations in physical infrastructure are typically too rigid to anticipate on changes in the logistics market. Currently there is, nonetheless, a momentum in cities as space is redesigned. As shown in these case studies there are ample opportunities that can be divided across roughly two types of interventions.

The first is to consider the (future) presence of logistics vehicles in public space by taking interventions for those vehicles by providing unloading space, specific routes (e.g. superblocks) and only allowing entrance for small vehicles such as cargobikes. Second, in the design of an area logistics could be considered by making sure there are specific logistics facilities such as microhubs, indoor unloading docks and parcel lockers. This can also be done by adding 'logistics functions' to other locations such as mobility hubs and indoor waste collection points in buildings. Two factors must be considered when integrating logistics in spatial planning. First, the diversity in spatial claims by different logistics vehicles is important. A craftsman with a van merely requires a parking space (in a parking garage or mobility hub), whereas a large truck supplying a supermarket demands an unloading dock attached to the supermarket. Second, the size, type and specific characteristics of an area are important. A residential high-rise building has a different freight attraction than a larger mixed area development with retail, offices and houses that is car-free. In both cases, an important starting point to include logistics vehicles is to quantify the number and type of vehicles. This provides a point of departure for designing (physical) facilities and spatial requirements to integrate logistics in the spatial planning of an urban area.

The way logistics is facilitated (or not) in the current spatial plans determines some of the (physical) boundaries in which the city logistics activities have to be organized for the coming decades. So the better city logistics is integrated in these current urban spatial plans, the lower the future negative impacts might be. Based on these four explorative case studies, we present a research agenda to bridge the gap between city logistics approached as merely a traffic issue and its integration in spatial plans.

- Continuing attention should go to ways to minimize logistics vehicles that enter areas in the first place, such as horizontal collaboration and urban consolidation centres.
- Other stakeholders than the usual suspects, policy makers from the mobility domain within municipalities, logistics service providers, shippers and receivers, should be included more in logistics research, primarily real estate owners, developers and urban planners.
- The development of car free neighbourhoods requires some kind of decoupling points / urban consolidation centres or hubs to supply these neighbourhoods. As a result, these hubs could also be used as logistics solution for areas that are not (yet) redeveloped.
- In spatial planning and the design of areas, mobility is often included, but logistics is often only considered as a percentage of all traffic. Measures that are considered are parking norms, public transport and shared mobility concept. For logistics, however, measures are only included to a limited extent. Moreover, those vehicles put a different claim upon urban space and a tailored approach is therefore required.
- The impact of an increasing diversity of light electric vehicles on urban space occupancy is underexposed. These vehicles have an impact on existing cycling infrastructure and public space.
- As space is becoming scarcer, multifunctional usage in time should be considered more. An example is unloading inside a parking garage.
- Smartly combine different urban functions, for instance, add logistics functions such as a parcel locker to parking facilities and public transport locations.

- Logistics footprint: based on (traffic) counts and a better decomposition of logistics in models, more accurate estimations of freight attraction to areas based on the specific characteristics could be made.
- When (re-)designing streets and areas, logistics must be considered as it has a different claim upon space than passenger mobility. Important indicators to consider are: costs of infrastructure, traffic safety, impact on the local economy, service level, liveability of streets, social cohesion and nuisance. This becomes even more apparent in '15-minute' cities where cars are to a certain extent being pushed out, whereas this is not always possible for logistics vehicles as areas have to be supplied with goods, waste must be collected, etc.
- The impact on delivery efficiency, primarily captured through dwell time, that different logistics facilities (e.g. microhubs in an area) and design (e.g. superblocks) can have, deserves attention.
- Even though logistics can be integrated in spatial planning and the design of areas, enforcement during implementation is key. Dynamic reservation presents an interesting possibility.

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