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Logistics for a liveable city: A neighbourhood-level approach to spatial efficiency

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Abstract

Urban logistics is vital to keep the urban fabric running, but affects liveability while operators also have to deal with shrinking space in which they have to conduct operations. Despite this, there is primarily a lot of focus on decarbonising logistics as well as on logistics concepts to improve the efficiency of urban logistics going into urban areas. In this study we address the spatial footprint of logistics and possibilities to reduce this on a neighbourhood level. We develop a typology with different archetype neighbourhoods in which we estimate the logistics footprint per area with a decomposition in different logistics segments and number of vehicles towards the year 2035. Based upon that we propose interventions for stakeholders to jointly reduce the negative impact. This study sheds more light on the importance of area-specific approaches to reduce the negative impact of urban logistics.

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1. Introduction

Urban logistics is slowly moving towards zero emission coming years – at least at vehicles' tailpipes. The implementation of zero-emission zones and the growing availability of cost-efficient light commercial e-vehicles, and eventually e-trucks, are expected to lead to a ramp up of battery electric vehicles (see Quak et al, 2025). It goes without saying that the one-to-one replacement of vehicles does little about other urban logistics' externalities: nuisance,

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congestion, safety and inefficiency. Authorities, companies and researchers alike are searching for the catch-all solution to increase the efficiency of the urban logistics system as a whole. Essentially this comes down to reducing the number of vehicles and vehicle kilometres into and within urban areas via logistics innovations such as consolidating flows and a shift to light electric freight vehicles (LEFV) such as cargobikes that have a lower spatial footprint.

But even if urban logistics vehicles are zero-emission and efficiently loaded, a certain number of freight vehicles needs to be inside urban areas as the provision of goods and services is vital to functioning cities. Therefore, a certain urban logistics' spatial footprint remains. In addressing and estimating this spatial footprint, three aspects must be considered. First of all, *urban logistics is highly diverse* and consists of different segments with different vehicles and varying dwell times. We distinguish six segments: temperature-controlled, general cargo and retail, parcels, waste, facility and services, and construction logistics (see Kin & Quak, 2024). Second, the increasing diversity in the morphology within urban areas demand for *area-specific approaches*. On the one hand, the functions in an area determine the freight demand and type of logistics (segments) (De Bakshi et al., 2020). On the other hand, the available space, access (regulations) and provision of infrastructure for logistics such as (dynamic) unloading zones determine the efficiency of operations for companies and the impact upon the area (Dalla Chiara & Goodchild, 2020; Castrellon & Sánchez-Díaz, 2024). In that realm, a historical city centre differs from a suburban residential neighbourhood (Sánchez-Díaz, 2017). Currently we find our cities at a crossroads with public space being reshaped in which walking, cycling and greening of surface is becoming prioritized across different areas (Nieuwenhuijsen & Khreis, 2016). This subsequently affects the accessibility of areas as well as the available space for (un)loading activities. Third, more recently studies show that efforts to reduce the nuisance caused by logistics vehicles while also enhancing efficiency for companies require an *integration of logistics in (long term) spatial planning policies* (Bjørgen & Ryghaug, 2022; Cui et al., 2015; Haarstad et al., 2024; Kin et al., 2024; Kin & Quak, 2024).

This paper is based on a study that developed a Dutch outlook of urban logistics in 2035 considering the diversity in logistics segments and the built environment within cities, addressing the importance of the integration of (space for) logistics in spatial planning policies. More specifically there are three research goals: 1) develop a typology of archetype neighbourhoods; 2) estimate the logistics footprint per area with a decomposition in segments and number of vehicles; and 3) provide action perspective to urban logistics stakeholders to minimize the impact of urban logistics (see Quak et al., 2024). The next section elaborates on the background with regard to the three goals, including relevant literature. The methodology is spelled out in section 3, after which the results are presented.

2. Research approach

Figure 1 depicts the research approach. First, based on a literature study and validation through experts, a typology of archetype areas has been created. Kleerekoper (2016) developed a neighbourhood typology with regard to climate adaptation. With this typology of 16 neighbourhoods as a starting point, we selected several indicators based on which neighbourhoods can distinguished from one another. The main indicators being population density, number and type of functions (residential, amenities and businesses), car ownership per household, average income, share of single-person households, employment and average distance to a supermarket.



Fig. 1. Research approach.

In total five archetype areas have been determined: historical city centre, historical city block, suburban neighbourhood, car-free neighbourhood and high-rise neighbourhood. National statistics (CBS) from actual neighbourhoods that match these five archetypes have been used to construct averages of each area. For the historical city centre, for example, data from four actual historical city centres in the Netherlands have been used. The same goes for the other areas, except the car-free neighbourhood; as there are no large car-free neighbourhoods yet, plans

for areas that will be developed the coming years have been used as input here.

In the second step, a trend analysis towards 2035 is conducted through desk research. More specifically, we focused on exogenous trends that shape cities as well as demand for logistics across different areas and segments in the coming decade. These trends do not affect all segments and archetype areas similarly. The creation of the five archetype neighbourhoods and the way the trends shape different areas as well as the six logistics segments has subsequently been validated with experts from the mobility and urban planning field as well as policy makers during two sessions (7 participants in each session).

In a third step, we used the characteristics of the area to determine the daily number of logistics vehicles: the logistics footprint. In order to compare the neighbourhoods, those have been normalized to size (square km). The methodology to estimate the logistics footprint is elaborated in Rondaij et al. (2025). This estimation includes a decomposition in six urban logistics segments, which is in turn based on the characteristics of the area. In an area with a lot of restaurants such as a historical city centre there will be more temperature-controlled vehicles compared to a suburban neighbourhood. As we aim for the year 2035 a growth factor over segments has been estimated. The kilometres driven by urban logistics vehicles is expected to increase by 19% until 2035 (Quak et al., 2024). This 19% is not equally divided over segments and neighbourhoods. Based on the trend analysis and expert sessions, varying changes in the number of vehicles across the segments and neighbourhoods have been identified (for an overview see table 7.7 in Quak et al., 2024). For instance, in older neighbourhoods a higher number of vehicles related to renovation works can be expected.

Based on the logistics footprint per neighbourhood, we organised interviews with policy makers, experts and companies. During these interviews we presented the results and discussed where they expect problems for companies and / or the society. The problems relate to different aspects such as efficiency, liveability, emissions and service level towards customers. Figure 2 shows the intervention framework with the main criteria per stakeholder. In total, three types of stakeholders are identified: the municipality governing the urban area, the receivers that demand goods and services (varying from individuals to businesses), and the (logistics) service providers providing those goods and services.

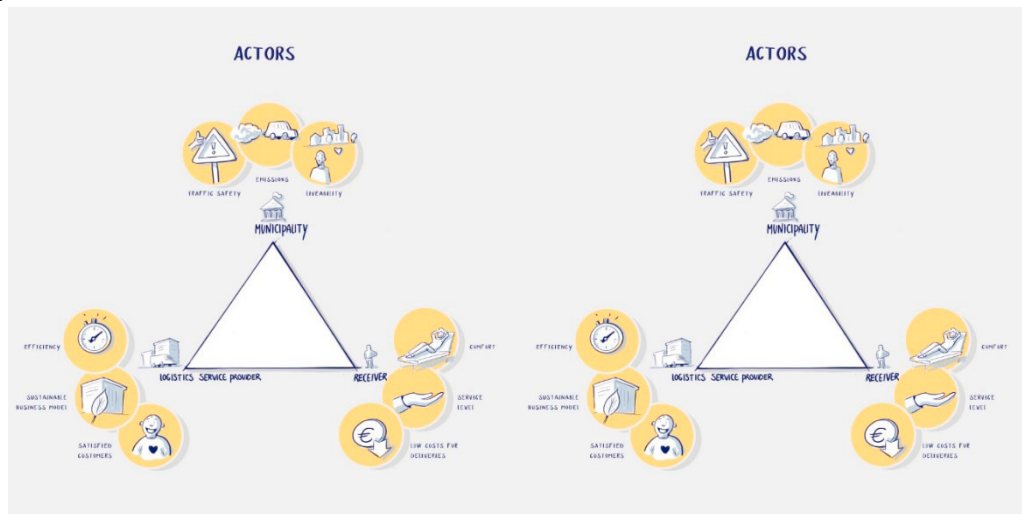


Fig. 2. Stakeholders and intervention framework

The latter also includes shippers transporting on own account as well as different types of service providers such as construction companies. This framework is based on a synthesis of the available literature on stakeholders in urban logistics (see for instance Ballantyne et al., 2013). In addition to the interviews, the interviewees as well as other experts scored the criteria per stakeholder, thereby assessing how the criteria for the specific stakeholders for the various segments in the different neighbourhoods in 2035 are affected (positive, negative, not affected). The results are depicted as a dot in the triangle (see figure 2, right), whereby the location in the triangle represents which stakeholder interests are served more. If the dot is located further from the stakeholders, this group will encounter more challenges compared to today. Based on the interviews, we selected six segments in different neighbourhoods

where problems may arise for one or more stakeholders. Several interventions to ‘move the dot’ more to the centre and subsequently serve the interests of multiple stakeholders more equally have been proposed and are discussed. Figure 2’s right part shows potential interventions, with the location of the intervention representing the stakeholders that primarily can take action. For instance, municipalities can govern urban space through access regulations (short-term) and spatial planning (more long-term). Electrification of vehicle fleets is a responsibility of logistics service providers, although municipalities might have a role in providing sufficient (public) charging infrastructure. Another possibility is for shippers and logistics service providers to nudge ordering and pickup behaviour of receivers. There are specific interventions per segment. All interventions are thoroughly discussed in the full report (Quak et al., 2024). Per intervention, the potential impact, challenges for implementation and requirements to enhance implementation are described. Note that we focus on interventions that require cooperation between multiple actors, rather than on technical innovations that a single stakeholder could implement alone.

3. Logistics footprint per neighbourhood

The functions in an area determine the demand for specific goods and services, resulting in both the number and type of logistics vehicles. Figure 3 illustrates the daily logistics footprint per neighbourhood type.

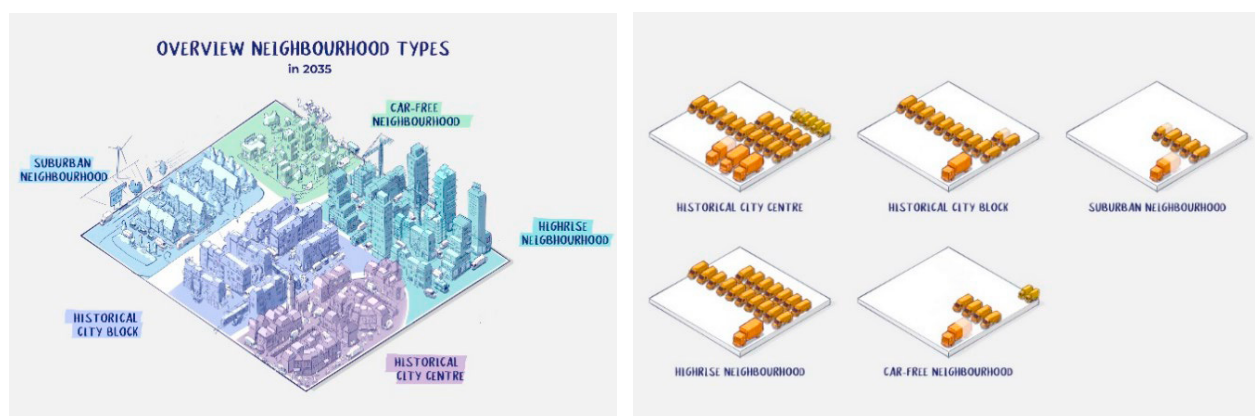


Fig. 3. Neighbourhood types and logistics footprint per neighbourhood

The *historical centre* has the highest logistics footprint. The high logistics footprint is primarily caused by the high density of amenities, restaurants, retail as well as inhabitants. The latter will grow. Furthermore, a serious number of vans related to construction logistics can be expected due to the renovation task. In addition to trucks and vans, LEFV can be expected here due to reduced accessibility and a reduction in road infrastructure. The latter is, amongst others caused by greening of surface due to climate adaptation and a reduction in parking spots. Primarily in inner-cities we will see a growth in electric vehicles due to the planned implementation of zero-emission zones.

The *historical city block* is a neighbourhood type that often surrounds the centre with ring roads that have grown organically over time. These areas are usually mixed and lively in terms of businesses and residential streets. Buildings are mostly from the first half of the twentieth century, or older, which leads to a constant stream of construction-related transport for renovation works. A lot of businesses in this area also have an own logistics vehicle.

In *high-rise neighbourhoods*, living and working are also mixed. In this type of neighbourhood the average income as well as the number of single-person households is relatively high. Consequently, it is characterised by a surge of different types of home deliveries (meals, quick commerce, parcels, groceries).

Car-free neighbourhoods also reside a wealthier part of the population. Car ownership is low, but so is population density. So although there are also a lot of home deliveries, the absolute number of logistics vehicles is quite low. Some of these vehicles are LEFV as access is limited. Furthermore, vehicles related to facility and services are present.

Finally, *suburban neighbourhoods* are characterised by high car ownership (2.0 per household) and a limited

number of amenities and businesses, which makes these areas car-dependent (as people have to travel). Most logistics vehicles are related to different types of home deliveries, some services and construction as well as some entrepreneurs with a logistics vehicle living in these areas.

4. Interventions

Compared to today, conflicts may arise more intensely in certain neighbourhoods. In this section two conflicts are discussed to demonstrate the intervention framework: temperature-controlled deliveries in a historical city centre and for different types of home deliveries (e.g. parcels, meals, groceries) in a car-free neighbourhood.

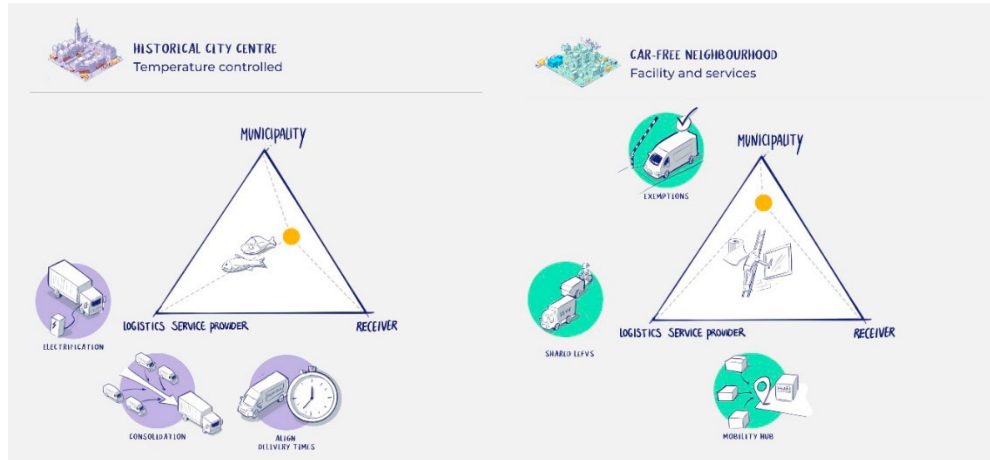


Fig. 4. Interventions for temperature-controlled deliveries in a historical city centre (left), and for facility and services in a car-free neighbourhood (right)

The number of vehicles to deliver temperature-controlled goods to restaurants, bars, hotels and supermarkets is expected to increase in 2035 due to the growth in these locations. Reduced accessibility of inner-cities in combination with zero-emission zones make this more challenging for logistics service providers (see location of the dot in figure 4). The latter comprises a diverse group with large professional logistics service providers, wholesalers transporting on own account and small specialists. Three interventions that are proposed are: electrification of vehicles, more consolidation and aligning delivery times with receivers in order to optimise routing (see table 1).

Table 1. Interventions for temperature-controlled deliveries in a historical city centre.

Interventions	Potential impact	Challenges to address	Requirements for implementation
Electrification	-Improved air quality -Reduced carbon footprint	-Grid capacity -Investments in electric vehicle fleets -Deploying smaller vehicles can lead to an increase in the total number of vehicles	-Enforcement and access conditions -Space for decoupling and charging infrastructure locations must be included in spatial planning -Managing limited grid capacity at high demand locations -Facilitation of microhub locations for light electric freight vehicles
Consolidation	-(relative) reduction in number of vehicles, leading to lower nuisance	-Data sharing by businesses to exchange load -Outsourcing the last mile reduces control	-Space for hubs must be included in spatial planning

		-Agreements on liability and service level	-Awareness of alternative delivery models to specialists and receivers
Align delivery times	-Lower number of vehicles at specific times	-Logistics service providers have to agree with customers, which might reduce service level (e.g. receiving deliveries at inconvenient time) -Agreements on liability (if the receiver is not present)	-Time windows to limit deliveries during peak hours -Actively engaging shippers and receivers

Facility and services is a large and diverse segment including, amongst others, plumbers and cleaning services. The commonality in this diverse group is that the companies primarily deliver a service rather than transporting goods (Beziat & Heitz, 2024). Data from multiple cities show that more than 50% of the number of incoming vans is related to this segment (Rondaij et al., 2025). Currently multiple streets and neighbourhoods are (slowly) becoming more car-free with limited access (under strict conditions) for both passenger cars and logistics vehicles. This trend fits within the transition towards the '15-minute city' concept. One of the instruments applied in these neighbourhoods is a low parking norm (e.g., 0.2 cars per household). At the same time, the people and businesses in such areas require goods and services. The latter category is diverse, as said, and are often service-driven companies with a van being the workshop, lunch spot and office. There are limitations in prohibiting all vehicles and looking for alternatives (e.g. sewage works or moving companies). In order to minimise the impact of those vehicles while being able to provide the necessary service, a mix of solutions is required. Table 2 shows the different interventions. Notable are the mobility hubs in such areas, where (additional) space for service vehicles must be considered.

Table 2. Interventions for facility and services in a car-free neighbourhood.

Interventions	Potential impact	Challenges to address	Requirements for implementation
Mobility hubs	-Reduced number of vehicles inside the neighbourhood	-Alternative (small) vehicle might be required to transport material and tools to the location -Additional capacity is required in the mobility hubs -Reservation system to manage the number of vehicles	-Intelligent access system -Should be included in the design phase of the (re)development of the area
Exemptions (under certain conditions)	-Possible to conduct the vital services	-Determining which services are considered to be vital -Requires administrative burden and additional work at the municipality	-Additional capacity at a municipality for enforcement and intelligent access -Coupling system of companies to the municipal system for access and exemptions
Shared LEFV	-Improved air quality (compared to conventional vans) and lower spatial impact	-Transshipment to (shared) LEFV on the edge of the city or neighbourhood -Decentralization of the operations of service providers might lead to delays and other disruptions -Lack of willingness or barriers in the operations to replace a van (with material) for a shared LEFV -Additional space for park and ride is required -Requires a behavioural change	-Insight into the availability of LEFV -Reservation system -Managing party for the park and ride and the LEFV

5. Conclusion

Urban logistics is vital to keep the urban fabric running, but affects liveability while operators also have to deal with shrinking space in which they have to conduct operations. In essence there is a growing battle for urban space and logistics vehicles are inherently part of that. Despite this, there is a lot of focus on decarbonising logistics as well as on logistics concepts to improve the efficiency of urban logistics coming *into* urban areas. More recently, we see an increasing effort to reduce the spatial footprint and dwell times of urban logistics vehicles in order to minimise nuisance and enhance the efficiency of operations *within* urban areas.

This study sheds more light on the importance of area-specific approaches to reduce the negative impact of urban logistics. It shows that decisions local authorities make on the different (economic) functions that are allowed in a neighbourhood determine the logistics profile to a large extent. In some areas more conflicts will arise and those conflict are not evenly spread. Particularly in dense areas with a lot of functions (residential, businesses and other amenities) the pressure on public space is high. This is further enhanced if it concerns older neighbourhoods that have been developed in the pre-car era. What is lacking throughout areas, is a comprehensive policy in which urban logistics is not only considered as a temporary phenomenon but as an inherent part of public space that unavoidably must be dealt with.

In order to reduce the negative impact of urban logistics, three lessons can be drawn. First, an integral logistics policy on an urban level is required, but area-specific approaches are an important part of that. In the end, conflicts in public space and nuisance due to the logistics footprint do not rise equally everywhere. Second, interventions to reduce the negative impact are available but require collaboration between different stakeholders. Not only authorities, governing and designing urban space, and logistics service providers using that space, but also receivers and real estate developers must be involved. And finally, various interventions require space to be (temporarily) dedicated to logistics. This varies from placing parcel lockers in buildings, (dynamic) unloading zones or microhubs. Altogether it is important to consider this early in the (re)development of areas and urban planning policies.

This study has several limitations from which new avenues for research sprout. Various studies and models are available that estimate the logistics footprint (e.g. Sánchez-Díaz, 2017). In the further development of such models it is important to consider both logistics vehicles as well as other commercial – service-driven – vehicles that distinguish themselves from passenger transport. Furthermore, a distinction between more predictable flows (e.g. retail distribution, parcel deliveries) and unpredictable flows has an added value. The latter are those flows that are not based on the functions in the area (e.g., number of establishments), but other developments that generate – periodic – traffic such as construction or renovation projects. Our model can be further validated with additional data. This is, however, challenging in newly developed areas such as car-free neighbourhoods of which currently little knowledge is available. Although this study focused on cities in the Netherlands, case studies in other cities in other countries can be explored. Finally, the effect of spatial and behavioural interventions on traffic intensity and the spatial footprint could be modelled in the future.

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