CURBING URBAN LOGISTICS –THE INTERACTIONS BETWEEN URBAN LOGISTICS AND SPATIAL PLANNING

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Summary

Efforts to reduce negative externalities of urban logistics vehicle movements often concentrate on two aspects; organizing logistics more efficiently in order to reduce the number of incoming vehicles in urban areas and reducing the emissions of vehicles within urban areas. The stopping practices are an underexposed area, in research and spatial planning. Even if movements into an area are organized more efficiently and vehicles might be zero emission, at the end of the day, logistics vehicles need to stop close to their destination to deliver goods or perform services. Herewith those vehicles put a claim upon – increasingly scarce – urban space with possible subsequential negative effects for both urban residents and drivers. This research develops a typology for urban stopping practices of logistics vehicles, including temporal and spatial aspects. Based on a survey with drivers, and interviews with experts and policy makers, the potential of different interventions to reduce the negative externalities of stopping practices is assessed. Despite the impact on policy goals, urban logistics stopping receives little attention from public stakeholders and is largely left to self-organization. Digitization and (bottom-up) enforcement are interesting interventions, while drivers also indicate that more space allocated to logistics functions is inevitable. The best mix of interventions, including allocation of locations and enforcement, would both be high and low technology. Cities can benefit from a more desired situation by looking into physical interventions before digital interventions are ready for deployment.

1. Introduction

A study of urban logistics and their relation to urban environment is overdue given global trends of growth and development. Already by 2018, over half of the world's population called a city their home (United Nations, 2018). Due to the growth of urban areas, there is an increasing demand for urban logistics operations which support the material needs of cities. Therefore, cities must use spatial planning competencies to facilitate logistics in a sustainable manner (Kin et al. 2023). The increasing prevalence of urban freight transportation is causing several problems for dense populations of urban areas (Ranieri et al., 2018). Commonly detrimental negative externalities of freight noise and air pollution, accidents and congestion (Lemke et al., 2016; Moroz & Polkowski, 2016). Last-mile deliveries are the least efficient and most polluting segment of the total delivery chain. In fact, studies have shown that urban logistics vehicles are stopped more than they are in motion during daily operations (Allen et al., 2018; Fransoo et al., 2022). In the Dutch context, more than 1250 formal complaints were made about urban logistics drivers; including dangerous driving and improper stopping (Molin et al., 2022). The interaction between urban logistics (stopping) and spatial planning is underexposed in studies and subsequently the two fields remain rather separate. This research seeks to decompose spatial and temporal aspects of curbside operations to support better organization and address adverse impacts. The research question of this study is: *How can a problem analysis approach to urban logistics stopping practice first improve current understanding by the decomposition of spatial and temporal aspects, then work towards definitions of the desired scenario, and assess interventions to bring the two stages closer together?*

To address this research question, first a typology of the current stopping paradigm will be developed. Next, the current situation for stopping practices is mapped. Different curbside interventions with the potential to reduce logistics externalities – the 'desired situation' – are identified through literature and their potential is assessed through interviews with experts and surveys with drivers. Used primarily in stakeholder interviews, the desired situation was purposely left ambiguous so that respondents may construct their response without influence. Desired is operationalized for this research as *aspirational* and *preferential* when compared to the current situation of urban logistics. This loose conceptualization accomplishes two goals; to give space to respondents to authentically shape the scope of this research, and to solidify the place that this project has in support of future research.

The background of this study is sketched in the next section, which includes a distinction in different vehicle types and logistics flows, or segments. Furthermore, logistics stopping practices and interventions are part of the literature study. Section three elaborates on the methodology applied, followed by the results and conclusion.

2. Background

2.1 Vehicles and flows

There are two classes of vehicle which are pertinent to the scope of this research. The first vehicle is the delivery van. Delivery vans are defined as used for the carriage of goods and have a maximum gross mass not exceeding 3,5 tonnes (ECE, 2011). The delivery van is also commonly referred to as a *light goods vehicle* (LGV) (Grange et al., 2020). The second type of vehicle, commonly referred to as a *box truck* (McCormack et al., 2019), are also used for the transportation of goods but weigh more than 3,5 tonnes, and can be up to 12 tonnes (ECE, 2011).

Table 1. Vehicle types (ECE, 2012; McCormack et al., 2019)

Vehicle type	Maximum gross weight	Spatial footprint
Light goods vehicle / delivery van	Up to 3.5 tonnes	Length ≤ 2,60m
Box truck	3.5 – 12 tonnes	Length ≤ 12,00m

The LGV dominates urban logistics modal choice across European cities. In 2022, LGVs comprised 73% of the urban logistics fleet across the European Union. This figure ranges from over 90% in Prague and Brussels to being relatively even in Barcelona, and finally to the outlier case of Bremen where the share of HGVs outpaces that of LGVs (Cartolano et al., 2022). In the Netherlands this generally exceeds more than 85% (Topsector Logistiek, 2020; Visser et al., 2018). With a focus on these two vehicle types, the research project maintains a parsimonious scope, and embeds findings within the two urban logistics vehicle types (excluding truck trailers).

Urban logistics is diverse and, as described by (Topsector Logistiek, 2017), can be decomposed in six different segments: fresh, general cargo, parcels and express, waste, facility/service and construction logistics. The study focuses on three segments of urban logistics, or logistics flows: general cargo, fresh, and parcels and express. These flows comprise the focus of this research as the survey captured responses from logistics firms in these sectors. Of the omissions, construction logistics have been suggested to be less bothered by stopping externalities (Lordieck et al., ND) and therefore were not approached for participation. Facility / service as well as waste logistics remain a key flow for future investigation of stopping behavior and spatial interaction.

Logistics flows with general cargo and fresh goods are highly visible in the urban landscape. General cargo transports non-perishable goods such as fashion, electronics and household items, etcetera. Fresh cargo encompasses fruits, vegetables meats and other perishable goods. These goods are transported to retail outlets and horeca, but also increasingly to individual customers and home (Kin & Quak, 2023). The vehicular make up of this flow is quite diverse and can range from trailer trucks to cargo bikes.

Most commonly, retail locations receive shipments via tractor trailers and box trucks, while specialists are increasingly likely to receive (and send) shipments via box trucks or light goods vehicles. At home deliveries rely on a range of vehicle types, from box truck and delivery vans or cargo bikes (Topsector Logistiek, 2020a, 2020b). The range of vehicle types and delivery destinations leads to the hypothesis that the stopping behaviors of general and fresh cargo will show great diversity and may lay claim to a range of spatial and temporal requirements around the urban landscape.

The *parcel and express* flow is a dynamic sector of logistics which has arisen over the past two decades to differentiate itself from the traditional general cargo flow. This flow facilitates delivery of small and light parcels (maximum weight of around 30kg) quickly and accurately across the globe, and is conceptually distinct from postal services (Ducret, 2014). The deliveries made in this flow can either be B2B or B2C, with the latter increasing greatly in visibility due to consumer behavioral changes stimulated by the COVID-19 pandemic (KiM, 2022). This flow relies heavily on LGV and smaller vehicles to make quick deliveries across the urban service areas (Allen et al., 2018). Stopping for this flow is expected to consistent temporally, with drivers likely stopping for very short times. Spatially, however, stopping is expected to be more varied, given the short stop times and competitive nature of the sector.

2.2 Logistics stopping

Parking is commonly used as a catchall which lacks the specificity that this research requires. Therefore, this research proposes the new term of stopping which encompasses both parking and unloading. Parking is used to signify a logistics drivers stopped for the reason of providing a service. Unloading is then used when parking for the purpose of delivering goods to their destination. This dichotomy of uses further strengthens analysis and allows for specificity in the current typology.

The temporal indicators are split into short- and long-term stopping. Based on work from authors (Allen et al., 2018; Fransoo et al., 2018; Schmid et al., 2018), the point to use as a cut off for short term is 15 minutes, thus leaving long term parking to mean all operations over 15 minutes. This is supported by their findings which confirm the median nature of this time window.

The selected spatial indicators for this typology are as follows; Random, Dedicated, Authorized, and Unauthorized. Random is an arbitrary selection of a parking space (Dalla Chiara and Goodchild 2020). Dedicated spaces are reserved for parking or unloading whether demarcated by signage or other methods to reserve space for logistics operations (Nourinejad et al., 2014). Authorized parking spaces are those which are legally provided for parking operations. Unauthorized are spaces used for parking but not legally authorized such as double parking or stopping on a sidewalk or bike path (Jaller et al., 2013). The typology is presented in the results and discussion section.

2.3 Interventions

The following interventions aim to provide an antidote to externalities and inefficiencies associated with urban logistics stopping practice. Selected from a topical literature review, the following interventions are all directly applicable to the intersection between the urban curbside and the selected logistics flows. The first intervention is the very basic concept of better *enforcement* of parking violations which occur in and around the curbside spaces reserved for logistics operations. In fact, enforcement is singled out as one of the most important aspects for success of stopping and unloading initiatives (Quak, 2008). A number of authors have claimed that there would be significant benefits if enforcement can be stepped up (Alho et al., 2018; Fransoo et al., 2022; Quak, 2008). Providing more stringent enforcement of logistics parking spaces has been proven to improve efficiency for operators and can even stimulate more deliveries on foot in suitably dense areas (Fransoo et al., 2022).

Digitization is a key area of focus for enabling more efficient and sustainable curbside logistics organization. Benefits from such integration of technology are numerous, but two major advantages offered to the city are one: that they gain a wealth of data about the logistics operations on their streets -including vehicle type, stop duration and location preference and two: enforcement of parking violations is subsequently possible via a similar application. This technology is still largely theoretical and full implementation will require further dedicated research. Theoretically, digitization would likely increase the length of stops, but decrease the number of stops, and would enable a higher number of deliveries on foot. Another interesting possibility is shifting delivery locations, or unloading/parking space allocations, based on historical demand. If the data is properly collected, these possibilities could contribute to a much more efficient city.

Dedicated Infrastructure rounds out the discussion of interventions. These interventions include infrastructure to *restrict* and infrastructure to *facilitate*. The former may be done by time windows which can restrict an area for part of the day, or by physical means such as rising bollards – which often work in concert with time windows (Quak, 2008). The latter includes provisions such as increasing dedicated unloading zone stock, largely by conversion of existing parking infrastructure, and by providing support infrastructure to drivers in order to facilitate deliveries on foot in the densest areas of a city (Hesse, 2004; Mizutani, 1999; Patier, 2006).

3. Method

Both interviews and a survey are applied in this research. As the interviews were semi-structured, the supporting guide was more of a tool to prompt the conversation, and not designed to structure the interview minute by minute. The interviews were conducted around three themes, which were in line with the main research question. These themes were as follows:

- How does the interviewee see the current situation of logistics stopping in their field?
- What does the desired situation entail, how does the interviewee envision such a situation?

- Opinions and conversations on the feasibility of interventions, relating to area of expertise

Around these three basic themes, the interview was generally open to leverage the opportunity for discussion about more specific and unique insights applicable to interviewee competencies were not missed. The participants were selected by purposive sampling, which allowed for the selection of well-informed cases and is the most efficient use of resources on behalf of the researcher (Patton, 2002). Seven interviews were conducted, with interviewees representing academic interests, the municipalities of Rotterdam and Amsterdam, and the Netherlands based stakeholder associations of TLN and CROW.

The target audience of the survey were the drivers for logistics companies who operate within cities in the Netherlands. The respondents were recruited via non-probability voluntary sampling, via electronic messages from logistics managers, and prompted by the dissemination of posters with QR code access. The survey was supported by Microsoft Forms software. The survey went online during the first week of July 2023, and remained open until the 10th of August, 2023. The questionnaire consisted of ten questions which asked a range of questions about how drivers currently stop in the urban landscape, difficulties they face, and looked for feedback on potential measures to improve their on-the-job experience. During its operational availability, the survey received 80 responses from drivers in the parcel and express and general and fresh logistics flows. At a number of stages the drivers were reminded that their responses were confidential. They did not receive any compensation for their participation.

4. Results

4.1 Current situation

As a result of the literature review and thematization of the interview and survey components, the following typology was produced in order to structure understanding of urban logistics stopping practice, and to classify behaviors in a systematic way.

Table 2. Typology of stopping practices

Level	Area of inquiry	Selected constructs	
One	Stopping	Parking	Unloading
Two	Spatial	Authorized	Unauthorized
		Dedicated	Random
	Temporal	Short	Long

This proposed typology offers a useful tool for understanding the key theme of this research project, namely "how do urban logistics vehicles use time and space for stopping?". It is intended that this typology offers a useful and practical method of making sense of the field of urban logistics which was noted in the interviews as "a bit of a blind spot".

The predominant theme derived from the expert interviews when discussing the current state of logistics stopping is that much is left to the drivers to sort out on their own. The ad-hoc and even haphazard nature of the current paradigm was captured in many interviews and summarized well by a policy maker who echoed the sentiments above, noting that conversations on the topic are "quite limited" and that the practice is "self-organizing" to a large extent. To add further specificity about reasons for the current issues, another interviewee mentioned that "logistics is not typically an activity that is welcomed into the city with respect to zoning laws" and that this feeling of ambivalence extends from the building site to the curbside. Interviews also uncovered the need for more communal awareness of the realities which reliance upon logistics services entails such as giving more space to stopping operations. An academic highlighted this dilemma, stating that "it is very obvious we need to allocate more [urban] space for freight delivery and then everyone would be better off, [but] the difficulty is that everybody is better off but not everybody is better off all the time".

A final theme of discussion was an acknowledgement of the high degree of stress placed on drivers to make their deliveries quickly. This stressful nature of the vocation is a large part of the overall negative externalities associated with urban logistics. The current situation is marked by externalities wrought by the competitive nature of logistics economy.

The survey also investigated the current situation for drivers. On vehicular make-up, the survey confirmed Cartolano et al., (2022) in highlighting the prevalence of LGVs. This vehicle class made up 87% of the respondent's vehicles. Further differentiation showed preferential differences between the two logistics flows captured, with general cargo and fresh overwhelmingly driving a "box truck" while parcels and express favors a "delivery van". Another highlight is the comparison between logistics flows and their stop time, shown in Figure 1. This graphic illustrates the importance of very short stop times for parcels, and that general cargo and fresh logistics can be characterized by longer unloading periods. A notable takeaway from these findings is the need to incorporate understanding and support for the very short stops of parcel delivery drivers. The short term cutoff used in the temporal KPIs was too broad to capture this sharp divide in behaviors of the two flows.

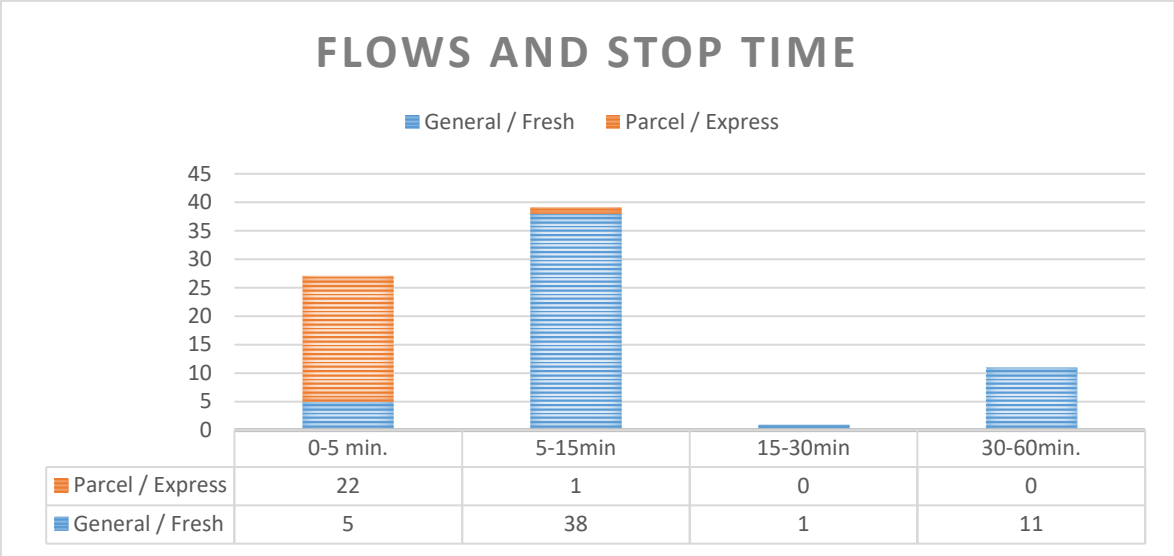

Figure 1. Logistics flows and self-reported stop times

4.2 Desired situation

The second main question for all the interviews was about how urban logistics might look in a desired future scenario. In the conversations with experts, two themes emerged; a difficulty in defining how the future should look and the need for a balanced approach to the problem. A policy maker summarized the difficulty by noting that "there is not one silver bullet for this problem" and that "there is difficulty because [logistics stopping] is such a new field, especially for people working at the municipality". He said that it is hard to envision where to go from the current situation. However, another policy maker suggested that "the guiding principle would be developing policies in dialog with the stakeholders" and for success, there is a need to have a clear picture about what city logistics entails. To enable a balanced approach, interviewees suggested the benefits of an investigation into KPIs which are both important to logistics and may be used to measure the urban quality of life – and that future planning would be wise to take this dichotomy into account. If properly integrated, then logistics may "run smoothly and safely, but then only for the time being of the operations. After that, the space is given back to the people." The survey asked drivers to report both where they most often stop and where they would most like to stop. In answers to the first question, there was a relatively even distribution of both authorized and unauthorized stopping practice but, the drivers reported that they do not want to park in an unauthorized manner, and they would much prefer to park in a dedicated L/U zone or in a general parking space.

4.3 Interventions

Takeaway messages from this section include a rethinking of the enforcement paradigm, the usefulness of low-tech solutions, and digitization to enable a more desirable organization of urban logistics.

Interviewees frequently discussed digitization of the curb. An academic was the expert who is closest to the real-world application and research of digitization measures. This person highlighted the importance that for a digital system to work, it must guarantee or strongly suggest the availability of a space when it is needed for logistics stopping – possibly by of back casting the aggregated data to predict future occupancy and facilitate usage. Another academic stressed that any digital management system must be designed in a way that any logistics driver is able to use it, and that it must actually provide benefit to the driver. The driver usability and benefit were widely agreed upon as a key determinant in success of this potential system

In contrast with the optimism of the interviewees in academia, those with a professional background in policy advocated a more cautious treatment of digitization. One interviewee advised that digital management, while promising, must come at a point when other more traditional paths of regulation have been fully implemented or exhaustively explored. Going forward, logistics stopping policy and regulation needs to be more clearly demarcated than it currently is, and the curbside problem better understood, before steps towards digitization should commence. Another interviewee, who comes from a similar municipal background, commented that while "technically [digitalization] works, but in real life it relies upon the right situation to be successful."

Enforcement of logistics stopping was a conversation which engaged all the interviewees as well and ran almost in parallel with that of digitization. On a basic level, the consensus was the enforcement is necessary for any policy to function as intended. At the same time, good enforcement is difficult to achieve as it is expensive for municipalities, requires clear communication and the heterogeneous nature of urban logistics stopping adds a level of complexity not inherent to more homogenous passenger car parking practices. Research of one of the interviewees has shown the benefits of stringent enforcement on improving logistic efficiency, and overall positive outcomes. He shared that there may be two different ways of looking at the topic; top-down enforcement driven by the municipality or bottom-up enforcement which places the role in the hands of drivers or other stakeholders, enabled by technology to report violations they come across. As top-down enforcement relates to the challenges such as cost and judgement, bottom-up enforcement may be a productive new direction of inquiry. A hypothesis supported on behalf of a policy maker of the municipality of Rotterdam. An academic echoed this stance in stating that bottom-up enforcement should again focus on usability, acceptability, and practicality for all involved stakeholders, especially drivers.

The survey also targeted drivers' perceptions about various interventions applicable to their work.

Far and away the most popular intervention choice amongst the drivers was to increase in specially reserved parking spaces or L/U zones. This option received 54 votes. Tied for second place, with 23

votes apiece were interventions to make the spaces larger and to give more time at the spaces for delivery operations (i.e., longer than the current default of 15 minutes). The integration of technology (such as space reservation or availability maps) did not appear to be a popular option for the drivers, receiving only 5 of the 136 total votes. However, the survey design likely limited the ability to fully explain what the inclusion of technology could entail and how it would fit into their day-to-day tasks, therefore it could be a topic of further research. Another interesting aspect of responses to this question was the drivers' ambivalent reactions towards enforcement as a helpful measure which is surprising given the high level of importance placed upon enforcement in the interviews and contemporary planning literature.

The last question was an open response that asked if the respondents had any further comments to share about their work and on the topics of the survey. More time for deliveries and per customer was mentioned twice. Interventions to address safety were also foregrounded as one driver mentioned that some areas where there is not currently enough space for their vehicle to park, especially in new (green) developments, and that due to this lack of space they must frequently double park which causes "aggression from road users [to increase] significantly and alarmingly".

5. Conclusion

This study shows that urban logistics stopping receives very little attention from public stakeholders. Generally, from policy and the design of (public) urban space, the focus is on the negative externalities of logistics, such as congestion, emissions, accidents and conflicts. How stationary vehicles in the city behave and where and how long they stop is largely left to self-organisation (of drivers and service providers on site). The heterogeneity in the sector and in the behaviour of delivery drivers makes it difficult to fully understand stopping behaviour. The desired situation of urban logistics is to organise the field so that logistics can operate reliably in an urban environment while minimising current negative externalities. This desired situation can be achieved when curbs can be dynamically allocated and enforcement helps rather than hinders policy goals. To achieve the desired situation, interventions are needed. Two key areas to focus on because of their role in enabling the desired situation are digitisation measures and bottom-up enforcement. The benefit of both is that there is an interdependency which may be leveraged to provide both via the implementation. However, more work needs to be done before they are feasible. From the drivers' perspective, they are aware that more space is needed for logistics functions. Clearly, with any implementation of digitalization, drivers need to see tangible benefits in their daily activities. In conclusion, the best mix of interventions would be both high-tech and low-tech. Cities can benefit from a more desirable situation by looking at physical interventions before digital interventions are ready for deployment.

Recommendations for further research include reconstructing the survey element to include all four streams, rather than just the two represented in this study. A second direction is to focus on establishing

the feasibility and use of technologies for digitalization along the curbside. A final direction for future research is to look at how changes in consumer behaviour can play a role in influencing a more desirable situation.Acknowledgement

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