PLANNING OF CARGO BIKE HUBS

A guide for municipalities and industry
for the planning of transshipment hubs
for new urban logistics concepts

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CONTENT

Abbreviations

B2B	→	Business-to-Business (delivery to commercial customers)
B2C	→	Business-to-Customer (delivery to private customers)
Z-Plan	→	Zoning Plan
d	→	Day
IN	→	Inhabitants
E-Van	→	Van with electric propulsion
GIS	→	Geo Information System
Hub	→	Transshipment location of a logistics service provider
C	→	Commune
CEP	→	Courier-, Express- and Parcel Service
cTN	→	Cooperative Transshipment Hub (→ *Hub*)
L	→	Logistics provider
LEV	→	Light Electric Vehicle
CB	→	Cargo Bike
MCC	→	Micro Consolidation Centre
Par.	→	Parcels
sTN	→	Singular Transshipment Hubs (→ *Hub*)
HGT	→	Heavy Goods Traffic
UCC	→	Urban Consolidation Centre (analog: Freight Centre)
p.TW.	→	Permissible Total Weight

1. Objective

Cargo Bikes are emission-free, environmentally friendly and low-noise vehicles. They thus have the potential to contribute to CO2-neutral city centre logistics, as targeted by the EU by 2030. They are also able to significantly reduce nitrogen oxide and fine dust emissions as part of air pollution control. Cargo bikes can make effective and economical logistics concepts possible, especially for the growing area of small consignments such as parcels.

Bicycles and cycle logistics have established themselves in the public discourse on the design of urban transport and urban logistics. However, the specific knowledge about the diversity, functions and special features of cycle logistics with a focus on the last/first mile of logistics chains is still limited. Many pilot projects in German cities show that cycle logistics concepts can be successfully implemented, but so far there is a lack of generalised planning knowledge that allows the establishment and scaling of cycle logistics systems beyond the pilot status. There is a lack of orientation aids that provide municipal planners with concrete process knowledge for planning.

In the "Cargo Bike Hub" project, the Chair of Logistics Systems and the Chair of Environmental Psychology at the Otto-von-Guericke University of Magdeburg dealt with concrete questions concerning the implementation of transshipment hubs in urban areas. This resulting guideline is addressed directly to municipal planners and has the goal,

- to provide a basic overview of cycle logistics in the last/first mile of logistics chains (sections 2 and 3),
- to define a general planning process for the implementation of transshipment hubs for cycle logistics as a blueprint for municipal planning with logistics experts (Section 4),
- to make recommendations from a logistical, traffic and acceptance point of view on the implementation and design of the components of cycle logistics on the last/first mile (Section 5) and
- to present recommendations for the long-term planning and improvement of the framework conditions for cycle logistics (sections 3-6).

This guide focuses on the fast-growing courier, express and parcel (CEP) market and its logistics players. However, many of the findings can also be transferred to other areas or generally to urban, transport and logistics planning.

2. Basics of Urban Cycle logistics

2.1 Definition Cargo Bike

Cargo bikes are bicycles equipped with a box for transporting freight. They are legally a bicycle if the electrical support power does not exceed 250W continuous rated power and the maximum speed for bicycles with electric support remains below 25km/h (data relates to the German regulation on cargo bikes). Some basic performance indicators are shown in Table 1.

Table 1: General data of (electrically assisted) cargo bikes (Assmann & Behrendt, 2017)

Daily mileage per cargo bike (batteries quickly replaceable)	>100 km
Battery capacity	250 Wh-500Wh
Range of one battery	30-50 km (unter Last)
Max. speed (E-support to max. 250W)	25 km/h
Average speed in urban traffic*	12-15 km/h
Radius of use or distance of single trips	Max. 7-10 km

* If necessary, this results in a strong speed advantage compared to passenger cars/Vans, since no search for a parking space is necessary and it is possible to bypass traffic jams and use cycle paths, pedestrian zones, approved one-way streets, etc.

2.2 What types of cargo bikes are available

Cargo bikes can be subdivided into different classes, which have significant differences in design, driving dynamics, payload and usable volume. Table 2 gives an overview of the logistically relevant models; a complete overview can be found in Annex A2. For logistics applications boxes that are lockable, weatherproof (closed) and contain internally flexible boxes with high volumes (approx. 1.5m³ to 2.2m³) are of particular relevance and usefulness.

2.3 What are the potential uses of cycle logistics?

Cargo bikes have a generally high - but within the individual segments of the CEP market very different - application potential. Couriers, especially bike couriers with inner-city, small, time-critical shipments, have a particularly high operational potential. The final report of the project "I am replacing a car" (Gruber, 2015) offers more in-depth information.
When it comes to parcel delivery, cargo bikes are particularly suitable for small, light consignments, which are currently on the increase, especially for deliveries to private customers (B2C) (Bogdanski, 2017). The areas of application are

Table 2: Cargo bikes for logistics applications; standardised volume dimensions (height, width, length in cm)

Cargo Bike: 2 wheels Similar driving dynamics as "normal bicycles" Can usually be driven on any bicycle infrastructure	**Cargo Bike: 3 wheels** Stable standing, slower cornering speeds partly limited use of bicycle infrastructure
Long John Payload: max. 130kg Volume: 65x60x80 Width: approx. 60cm  © PedalPower very good driving dynamics, popular with couriers	**Rear loader** Payload: max. 300kg Volume: 150x100x170 Width: approx. 100cm  © PedalPower Standard type of logistics
Cargo Bike: 4 wheels	**Cargo Bike: >4 wheels**
Rear loader Payload: max. 300kg Volume: 150x100x120 Width: approx. 100cm  © velove, Benjamin Georg Logistics	**Rear loader** Payload: max. 300kg Volume: 150x80x245 Width: approx. 100cm  © Tom Assmann Pivot-mounted trailer, Logistics

dense urban areas (e.g. Wilhelminian style districts) with a high residential share and increased traffic problems. Here, representatives of CEP services cite a potential of between 50% and 80%. Commercial city locations with a high proportion of business customers (B2B) are – to a limited extent - suitable for some parcel services. For the supply of places with high demand (e.g. shopping centres), cargo bikes do not make sense. For express shipments that are time-critical, the cargo bike is particularly suitable for small shipments (e.g. documents) in inner-city locations.

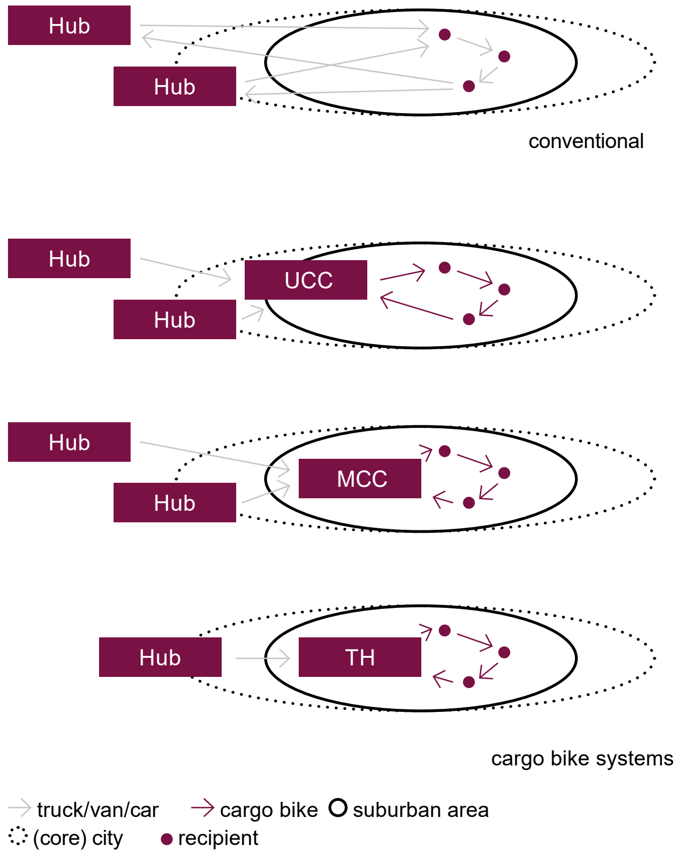
2.4 How is the integration into logistic processes carried out?

For the use of cargo bikes, suitable cargo bike models must be selected according to the specific material flow (goods, type of consignment, type of service). Regarding the material flow structure, cargo bikes can be integrated into two types of logistics systems: monomodal and multimodal. In monomodal systems, only the cargo bike is used as the sole means of transport, for example for direct inner-city journeys (Figure 1).

Figure 1: Bicycle courier, CLAC-Aachen/ neomesh GmbH

In multimodal systems, the cargo bike is used in combination with other means of transport for goods transport. These realize the inflow from a hub (warehouse, transshipment terminal, etc.) to the transshipment hub for fine distribution with a cargo bike and replace the direct line distribution from the hub that is usual in conventional delivery (see Figure 2).

Figure 2: Possible applications for cargo bikes in multimodal systems



Singular transshipment hubs (sTN) can be mobile, semi-stationary or stationary. The concrete evaluation and planning are described in the section (-> Components of Planning). Figures 3 and 4 show exemplary pictures of realisations.

2.5 How are goods transferred to cargo bikes?

The transshipment of consignments on cargo bikes can basically be realised using the two procedures in Table 4. Manual transshipment is currently the dominant method; in individual cases swap bodies are used in the CEP sector. Transshipment equipment such as forklift trucks is of no importance due to the small consignment structure.

Table 3: Overview of different hub types

Hub Type	Explaination
UCC Freight traffic centre (Urban consolidation centre)	Freight transshipment from several forwarders to the same vehicle fovr the last leg of the journey **Not suitable** for cycle logistics due to the long distance to the delivery area!
MCC Micro consolidation centre	Transshipment points close to the delivery area. Operation of separate companies (e.g. cycle courier companies) **Consolidation** via various logistic operators, therefore hardly attractive for CEP services.
TN singular (sTN) Singular envelope hub	Operation of **one** logistics service provider Transshipment hub near the city centre **No** consolidation
TN cooperative (cTN) Cooperative envelope hub	Operation of **several** logistics service roviders on one site. **Separate flows** of goods Transshipment Hub near the city centre **No** consolidation

Figure 3: Micro Consuldation center MCC (Velogista, Berlin); © Martin Schmidt

Figure 4: Cooperatiove hub (KoMoDo, Berlin), © Michael Kuchenbecker

Manual transshipment
No Requirements , but double (or more) manual handling of the goods
© Michael Jäckel-Cüppers

Interchangeable container
Device for winding and unwinding or lifting and lowering necessary. (here provided on the cargo bike)
© DPD

Figure 5: Transshipment variants for cargo bikes

2.6 Logistical procedure of cycle logistics for the last mile

In the following, the focus in the description is on (single and cooperative) transshipment hubs, but similar process sequences with MCC are conceivable. From the hub, the shipments are transported to the transshipment hub in the city centre (or the outskirts of the city) by van or truck (7.5t or 12t). Figure 6 shows this process in the four basic process types.

In the **manual process**, the transshipment of the shipments (parcels) is done manually. These are roughly sorted in the hub, i.e. the consignments for the cargo bike are sorted out and assigned to the relation for the flow into the transshipment hub and loaded manually into the vehicle. At the transshipment hub, unloading and transfer are performed manually. In the transshipment hub, the routes are finally loaded by the drivers in the individual sequence. The time-consuming manual sorting can be reduced in advance by fine sorting into boxes with route assignment.

The use of **mesh-wire containers** can significantly reduce the effort of manual transshipment at the hub and transshipment hub. At the hub, these are roughly loaded with the consignments for the cargo bikes. A route assignment can already be carried out here but does not replace a route sorting in the individual route design of the drivers. The use of mesh-wire containers requires ramps at the transshipment hubs and/or tail lifts so that they can be rolled into and out of the vehicles. This is standard for trucks, but not for conventional delivery vehicles (vans).

When **swap bodies** are used, they are available at the hub and are usually pre-sorted by their destination streets. Transport at the transshipment hubs must be by truck; vans are not suitable for this. The swap bodies are parked on-site, the trucks move away again, and the cargo bike rider carries out a manual sorting of the consignments. Instead of a swap body, lowerable containers are also offered on the market.

The use of **swap bodies** is much discussed and technical solutions are offered by various manufacturers of cargo bikes. In this scenario, the swap body is already loaded in the correct sequence for a route at the hub. It is then driven to the transshipment hub where it is loaded as a closed unit onto the cargo bike. This process is particularly suitable for mobile solutions due to the simple transshipment. It should be noted that in the case of swap bodies, transshipment and transshipment is carried out by rolling the containers, which must be possible. One manufacturer also offers a combination with swap bodies and swap containers remaining on-site as a semi-stationary solution.

Swap bodies are rarely sorted to the finest degree at the hub, but often only at the transshipment hub. The reason is that the cargo bike riders are not present at the hub, however it is they that usually have the expertise to determine the most efficient route within their delivery area.

process	TN
manual	stationary (mobil)
mesh-wire containers	stationary
swap body	semi-stationary
swap body	stationary mobil

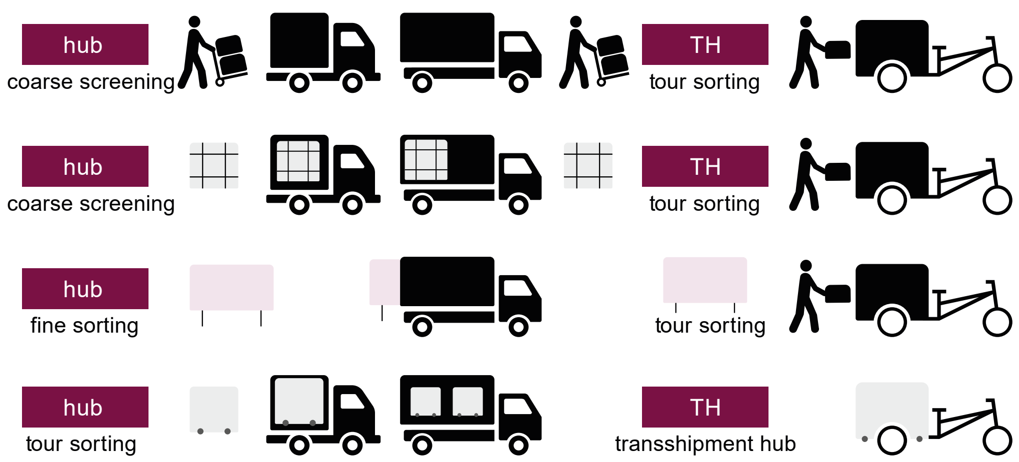


Figure 6: Process description for hubs

Due to the load volume of cargo bikes and the direct location of the transshipment hubs at the delivery areas, it is usual for a cargo bike rider to make several routes per day. Depending on the CEP service, this corresponds to different service offers (e.g. delivery before 12 o'clock). By returning several times, it is also possible to pick up shipments and returns. Usually, deliveries are made very early in the morning and contain the shipments for one day. In the late afternoon/evening the returns, collections and undeliverable shipments are picked up and returned to the hub.

Large pick-up customers are usually still driven served with conventional vehicles. In some cases, it is vehicles that handle the inbound and outbound deliveries and pick-ups in the meantime, thus increasing vehicle utilisation.

Besides cargo bikes other transport means can be used for delivery from the transshipment hubs. For very short delivery distances, the use of a hand truck can also be useful. Likewise, the use of light electric vehicles (LEV) with higher capacity e.g. large-volume shipments is conceivable and is already being practised.

2.7 Micro-consolidation and integration of local cycle logistics providers

In the following, the guide focuses on transshipment hubs of CEP services. However, the involvement of local cycle logistics specialists can be a significant factor for successful implementation and long-term establishment of cycle logistics on site. There are two possible ways of integration for local cargo cycle logistics providers:

• **Micro-consolidation and inner-city hub:** Local cycle logistics specialists transport many purely inner-city consignments and receive orders from supra-regional logistics networks outside the parcel services. They also need transshipment hubs near the delivery areas. With the guide, these can be planned analogously as singular solutions. Alternatively, local cycle logistics companies should be involved in the planning of cooperative transshipment hubs, as they represent a good addition to the parcel services due to the additional quantities of consignments and their local anchoring. Local cycle logistics providers can also be partners for white label deliveries , but their implementation requires further investigation (> Usage)

• **Local cycle logistics providers as service providers:** The acquisition of personnel for delivery is currently a challenge for CEP services. Local cycle logistics providers have better access to a pool of skilled personnel favouring the bicycle due to their local roots "in the scene". The integration of local cycle logistics as service providers for parcel services can thus improve implementation.

3. Selected best practice examples

Below are some well documented best practice examples from Germany including web links.

Semi-stationary transshipment hubs

// Hamburg

Ninnemann, Jan et al. (2017): Last-Mile-Logistics Hamburg – Innerstädtische Zustelllogistik. Hamburg: HSBA Hamburg School of Business Administration.
https://www.hsba.de/fileadmin/user_upload/bereiche/forschung/ Forschungsprojekte/Abschlussbericht_Last_Mile_Logistics.pdf

Henrich, Philipp; Tetens, Gönke (2018): "Mikro-Hubs als Lösungsbeitrag für die nachhaltige Belieferung auf der letzten Meile. Erfahrungen aus Hamburg." In: Lieferkonzepte in Quartieren – die letzte Meile nachhaltig gestalten Lösungen mit Lastenrädern, Cargo Cruisern und Mikro-Hubs. Hrsg.: Wulf-Holger Arndt; Tobias Klein. Berlin: Deutsches Institut für Urbanistik.
https://difu.de/publikationen/2018/lieferkonzepte-in-quartieren-die-letzte-meile-nachhaltig.html

// Munich

Bauer, Uta; Lindloff, Kirstin; Stein, Thomas (2018): "Mikro-Depots in innenstadtnahen Wohnquartieren. Erste Ergebnisse und Diskussionen im Rahmen des Forschungsprojekts „City2Share"." In: Lieferkonzepte in Quartieren – die letzte Meile nachhaltig gestalten Lösungen mit Lastenrädern, Cargo Cruisern und Mikro-Hubs. Hrsg.: Wulf-Holger Arndt; Tobias Klein. Berlin: Deutsches Institut für Urbanistik.
https://difu.de/publikationen/2018/lieferkonzepte-in-quartieren-die-letzte-meile-nachhaltig.html

Niels, Tanja; Hof, Moritz Travis; Bogenberger, Klaus (2018): "Design and Operation of an Urban Electric Courier Cargo Bike System." In: 21st International Conference on Intelligent Transportation Systems (ITSC) Maui, Hawaii, USA, November 4-7, 2018.
https://www.researchgate.net/publication/329196075_ Design_and_ Operation_of_an_Urban_Electric_Courier_Cargo_Bike_System

Stationary transshipment hubs

// Nuremberg

Bayer, Marius; Seidenkranz, Markus (2019): "Erfolg durch Methodik beim Mikro-Depot-Projekt in Nürnberg." In: Nachhaltige Stadtlogistik. Hrsg.: Ralf Bogdanski. München: Huss-Verlag.
https://www.th-nuernberg.de/fileadmin/thn_forschung-innovation/ Vorlaufforschung/2017/1_MikroDepotKonzept.pdf

Cooperative transshipment hubs

// Berlin

https://www.komodo.berlin/

4. Planning process for cargo bike transshipment hubs

Necessary preliminary remarks

- The description of the planning process and the components is based on nine qualitative planning-centred expert interviews with logistics planners and municipal planners conducted in the project "Cargo Bike Hub" (for more details see Annex A1). A review and assessment were carried out based on 19 acceptance-oriented expert interviews in the course of the same project.
- The illustrated planning process is ideal-typical and starts with the first intention of planning a sustainable delivery. Practical experience can deviate greatly from this. This is especially the case if one side (municipality or logistics operator) already starts formulating objectives with very concrete ideas about deeper planning steps (e.g. objective of unconditional cooperative use or objective of unconditional use of a certain area). Depending on the planning case, some planning steps can be consolidated or summarized.
- The planning of a transshipment hub is a so-called "brownfield planning" (planning in the given). The aim of planning is therefore not an optimal solution, but a solution that makes sense for all involved actors. There is no universal solution: every city and every logistics provider are different. In order to preserve the anonymity of the parties involved, it is not possible to provide any information on specific cities or service providers. Important in planning is the willingness to iterate during the process.
- The focus in the process depiction is on cargo bikes and the transshipment to them to carry out the last mile; however, the depictions are basically also valid for other alternative, road-based means of transport.
- For individual tasks in the planning process, recommendations for suitable responsible persons are given for processing. These are marked as follows: "[LA]" = local authority, "[L]" = logistics. "Logistics" is a synonym for CEP logistics service providers.
- The cargo bike is not the universal solution. There will always be goods or places/customers in the city for which the cargo bike cannot be used in an economically viable way. The project advisory board of the "Cargo Bike Hub" project therefore agreed on substitution scenarios of 50% and 80% of the parcel volumes from vans to cargo bikes for mixed inner-city districts.

The following timeline provides an overview of the resulting planning process.

4.0 Initiation of planning

Planning is essential in the introduction of cargo bike transshipment hubs. In this step, a stakeholder (> Stakeholder) approaches the other actors with a planning motivation resulting from a certain problem situation and with a corresponding motivation to act. Initiating actors are usually:

> Municipal administration or an entrusted department of a municipal administration [LA]
> CEP services, other logistics companies, cycle logistics companies [L]
> Research projects or research institutions
> trade or business associations
> City policy / City council. [LA]

The involvement of the municipality is explicitly recommended. For logistics providers, the fact that responsibilities and contact persons vary from city to city represent a major obstacle when it comes to establishing contacts (> Drivers & Barriers). The political will to implement the initiative is also essential for logistics providers. The city's initiative sends a clear signal of this and also determines the contact persons within the municipality for logistics issues from the outset.

The political will to implement the initiative should be strongly expressed in the perception of logistics, especially at the top administrative levels. These have the political power to realise implementation. A successful initial contact with logistics companies in a municipality can therefore be made by senior administrative levels or directly by the head of department or the mayor.

4.1 Definition of targets

This step should take place at a strategic level with appropriate decision-makers.
Key targets should include:

> Analysis of the concrete problem situation and need for action [LA]
> Internal target definition of the city [LA]
> Definition of the constellation of actors including public participation [LA, L].
> Joint definition of objectives by city and logistics [LA, L].
> Determination of evaluation criteria [LA, L]
> Agreement on responsibilities [LA, L].

Logistics actors often experience that cities start the planning process with unclear objectives. The explanation of the (cargo bike) logistics and the identification of the need for action by the municipality then often takes several rounds of coordination. The internal, precise definition of a concrete goal in the city is recommended in order to effectively manage this planning step.

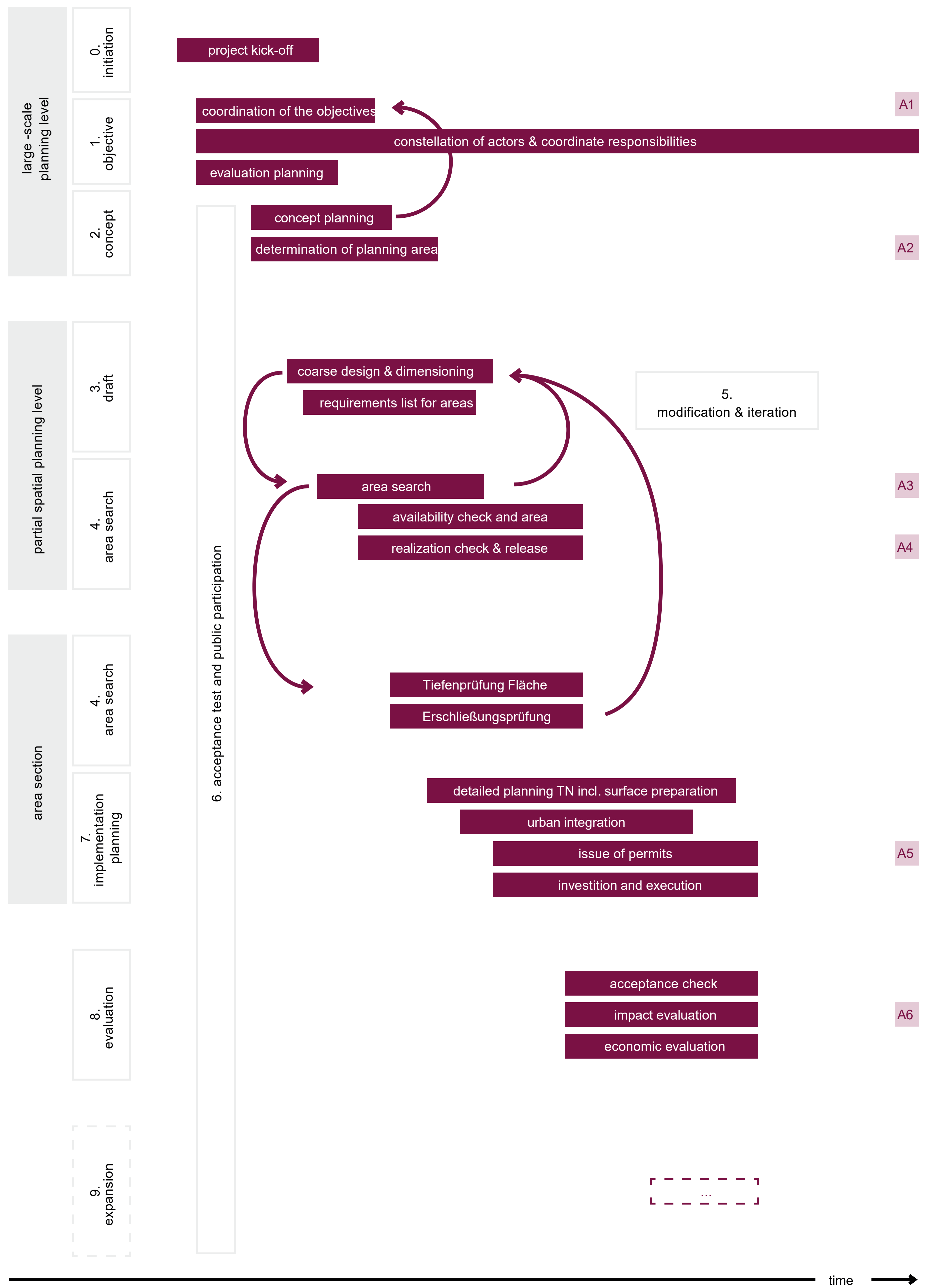


Figure 7: Timeline of the planning process (note: A1 to A6 are cancellation criteria in the process, see respective sections)

Essential aspects to be specified are the intended effect (e.g. CO_2 reduction, reduction of air pollution, reduction of second-line parking) and the planning horizon (pilot, permanent solution, holistic logistics concept). It is essential that cities think about new solutions and the future development (10-15 years) of city and logistics in the target setting. Depending on the intended effect, measures other than cycle logistics (e.g. delivery concepts with e-vans) may also be suitable.

Every planning is a new search and cycle logistics is a learning process. It is recommended to start with simple solutions and pilots. They serve as learning and test objects for a city, from which further projects (spatial/conceptual) can be carried out.
The analysis of the constellation of actors needs to be clarified:

- How many and which logistics service providers are to be involved?
- Who is to be included and when at municipal level? Who perhaps in the further process? (> stakeholders)
- To what extent is the public involved? Are the needs of residents (i.e. residents and businesses in the direct vicinity of the location/potential locations) known to such an extent that resistance can be countered while there is still room for manoeuvre? (> public participation)
- When should service partners of the CEP services be involved?
- Who is responsible for which tasks? How often does the coordination take place?

On the municipal side, the appointment of a contact person to accompany the process, ideally with logistics competence, is recommended (> improvement), who is well connected locally.

Cancellation criteria:

A1 - The objectives of the city and the logistics providers cannot be reconciled.

4.2 Concept planning

With the planning objectives defined, a basic concept of the logistics processes between hub and recipient is developed. This includes the following points:

> Singular or cooperative hubs? [LA, L]
> Identification and definition of the concrete implementation area in the city [LA, L].
> Selection and definition of possible types of hubs [LA, L]
> Coordination and definition of possible combined uses [LA, L].

Essential for the design of the concept is that if there are several logistics service providers, it is determined whether the transshipment hub should be cooperative or singular (> usage). Most CEP services are open to cooperative solutions (> use) if basic requirements are observed. Cooperative transshipment hubs have a significantly increased space requirement. If no suitable space is available then several single hubs can be useful.

Different types of urban areas show a varying suitability for an economic cargo bike application (> location). Therefore, urban areas and zones must be specified exactly in the concept planning. The delivery area around a transshipment hub is approx. 500m to 1.2km and is strongly dependent on the CEP service and its respective local consignment structure. Therefore, the desired areas of the city must be compared with the (internal!) shipment data of the CEP services. Suitable are high and very high stop densities (> location). Furthermore, the allocation to service partners who often have territorial protection must be checked. Ideally, they are congruent. In the case of several CEP services, this can make it considerably more difficult to identify and coordinate a cooperative location. If larger urban areas (> approx. 1km²) are to be planned, several transshipment hubs are advisable.

When determining the types of transshipment points (> transshipment points), it must be agreed which variants of CEP services or the city are preferred or excluded. In addition, it should be agreed whether other alternative delivery vehicles are to be used. For the following step, a common definition of preferred transshipment points is to be determined.

Combined uses (> urban integration; > use) can promote urban integration and offer added value for urban life. If they are desired, they should be defined, and their feasibility compared with the specifications for the transshipment points.

Cancellation criteria:

A2 - The analyses of the intended city or urban as do not reveal enough potential for cycle logistics

4.3 Rough concept and determination of requirements

This step is used to specify the quantitative framework and to determine the requirements for the areas for transshipment hubs according to the envisaged type, in relation to the intended area of use. Possible service partners should be included here.

> Determination of package quantities suitable for cargo bikes in the planning area per CEP service [L].
> Determination of the use of vehicles for goods that are not suitable for cargo bikes [L]
> Determination of the ideal position in the application area [L, AL].
> Determination of the required area size of the envelope hub [L, AL]
> Definition of development and equipment requirements [L].

The CEP services have, depending on the specific area of application and the logistics process, individual parcel volume shares which can be shifted to cargo bikes. It is necessary to determine these in order to be able to determine the size of the area by means of a rough draft (e.g. "How many swap bodies have to be accommodated?"). In the draft, shunting and holding areas, parking areas for cargo bikes and any social and sanitary rooms that may have to be created should be taken into account (> transshipment hubs).

When selecting the type of transshipment hub and the preferred areas, it should be considered what form of public participation should be planned for (> public participation).

The CEP services can determine ideal locations and optimal routes from their shipment data. The city has preferences from traffic and urban planning requirements (> location, > urban planning integration, > development). Search areas for ideal locations can be formed from the coordination of both.

For the search of concrete suitable areas, a catalogue of requirements is to be created, which includes in particular:

- Are bicycle traffic facilities required for the development of the area? (> infrastructure)
- Is the access for trucks (up to 12t z.GG.)/ a main road necessary?
- Are power connections, charging station(s) required; if so, with what capacity?
- Are social and sanitary rooms required?
- How high is the willingness to pay?
- Are combined uses (> uses) desired?

4.4 Search for areas

The search for suitable areas (> areas) is at the core of the planning process. This step is complex due to the scarcity of suitable sites and the diverse demands of the city. For the search for sites, it is advisable to first search for roughly suitable sites using the catalogue of requirements (section 4.3) and then have them checked in detail for suitability by logistics providers and the city. For the rough area search the following are suitable:

> Queries with service partners for suitable properties/ areas [L]
> Inquiries in the city for its own suitable areas (city/ affiliated companies/ associations etc.) [LA]
> Analyses of aerial photographs, GIS data and real estate databases [LA]
> Site Visit at the planning area [LA, L]

If already at this level no suitable space/area along the requirements can be found, continue with modification and iteration (section 4.5). If a suitable space/area or several space/area are found, these must be checked in detail.

The following aspects must be considered:

// Logistics

Is the cost structure suitable (examination of economic efficiency, including approval)?
Is the logistical suitability (access road, shunting areas, logistics areas) given?
Is there enough space for all necessary equipment?

// City

- Who is the actual owner, and would this area be usable under this owner?
- For public areas:
  - Is a special use or rededication possible?
  - When and how long can this area be made available?
  - At what cost can the space be made available?
- Are the necessary supply connections (e.g. electricity) available?
- Are there any further claims or conflicts of use (also long-term)?
- Are there claims/conflicts due to environmental protection, preservation of historical monuments, etc.?
- Is the project permitted for traffic (traffic authority)?

If areas are not suitable after the in-depth test, the cycle of modification and iteration can be repeated (section 4.5). Public areas can be set in value by the city.

In the event of conflicts with adjacent forms of use or users, monument protection or the cityscape, procedures for public participation in the modification or design of the hub can increase the corresponding acceptance (section 4.6, see also > stakeholders and acceptance).

Cancellation criteria:

A3 - No areas are found for the transshipment hubs in the intended area of use

A4 - The cycle logistics system is not economical for the areas in question

4.5 Modification & Iteration

The experience with realized plans shows that planning is an iterative process consisting of requirements, logistics process and available space. The availability of the latter represents the main barrier to planning and implementation. CEP services are aware that space is often not available in the logistically optimal location. If no suitable areas could be found with the first draft, a modification in the following points and an iterative re-entry at the corresponding planning step is useful:

> Search of areas outside the ideal position, change of delivery vehicles [LA, L].
> Modification of the type of the envelope hub [LA, L].
> Modification of the design of the envelope hub [L, LA]
> Modification of the parcels quantities for smaller space requirements [L]
> Modification of combined uses [LA, L]

- > Modification of the monetary framework conditions [LA, L]
- > Modification of the time horizon [LA, L].

Modifying the transshipment hub type can open new potential areas. For example, changing existing buildings to containers can enable brownfields to be used. The modification of the parcel volumes can be done by reducing the volumes for interested CEP services, if economically reasonable, depending on the area. The reduction of actors can also be a possible measure. Both can reduce the required area size and tap potentials.

In the case of combined uses, it may be that no areas can be found which allow this. Then it may be sensible to reduce them or to focus only on logistics.

When modifying the monetary framework conditions, cities should examine whether public funding is possible for areas that are too expensive or whether a reduction in user fees (e.g. the special user fee) is possible for public areas.

Modifying the time horizon postpones implementation. This enables the city to include the areas in the planning (e.g. development plan) for subsequent new construction and conversion measures, including those of private investors.

During the modification it must be checked whether this requires a variation of the public participation.

4.6 Public Participation

The people living in the vicinity of a hub (residents and businesses in the immediate vicinity) have to deal with the hub every day in their daily lives, so their needs should be given special consideration. Especially if the planned area was previously used by the public, it can be expected that there will be reactions to the planned new use. If the residents are involved in the planning and can actively participate, there is a chance that they will identify with the project and see it as an enhancement of their neighbourhood.

For the planning of the participation process, answers to the following questions should be found:

1. Clarify the framework conditions
- What is the aim of the participation process?
- What is the significance of the process results?
- For which decision-making steps is participation envisaged?
- How are decisions made?

2. Selection of the participants
- Which stakeholders are involved?
- Are there specific vulnerable groups (e.g. elderly people or children) that should be included? How can they be adequately involved?
- Who decides on who participates?
- Are there criteria that ensure that the participants are representative?

3. Extent of participation
- To what extent do those involved actively influence the outcome?
- How pronounced is the control function of those involved?

In any case, residents should be informed about the plans as early as possible. It is important to communicate the background to the plans (> why cycle logistics?) - not only describing the advantages, but also clearly identifying possible negative aspects.

However, informing is only a first, basic step. There can only be talk of participation when those involved can contribute their own ideas. The extent of participation can be categorised into five levels (Table 4).

Table 4: Gradations of the extent of public participation

Non-participation	
Information	Leaflets, information stands, media reports
Consultation	Surveys, citizens' forum
Partnership	Future workshop, planning cell, Backcasting
Control by citizens	

4.7 Implementation planning

Implementation planning will be carried out as soon as a suitable area for the intended, and possibly modified, concept has been found. This step aims at implementation up to the operation of the transshipment hub (> hub).

- > Preparation of permits by the city (if necessary) [LA]
- > Drafting of contracts (if necessary) [LA, L]
- > Commissioning of the equipment [L]
- > Commissioning of measures for upgrading (electricity, development, security, etc.) [LA]

This step involves investment and long-term expenditure. It is therefore important to pay close attention to the coordination of responsibilities (who pays what?). This also requires binding schedules so that the process change in logistics, including the recruitment of (cargo bike) riders, can be reliably planned.

Cancellation criteria:

A5 - The final detailed planning of the hub does not receive approval

4.8 Evaluation

The evaluation serves to check the effect of the cargo bike transshipment hub. In short: Has, what was intended at the beginning been achieved? For this purpose, a before-and-after comparison is carried out on the basis of the evaluation criteria specified in the definition of objectives.

Logistics companies automatically carry out an evaluation of the economic efficiency of such projects. This is decisive for a possible further consolidation or expansion of the concept.

In addition, it makes sense to check, especially on the municipal side, whether the use of the cargo bikes has achieved the goals with regard to CO_2, air pollution and the traffic situation. For the continuation it is also of interest whether the new logistics concept is accepted by the stakeholders involved, especially by trade, recipients and residents.

The evaluation can be carried out by the actors involved in the transshipment hub themselves. However, cities can also have it carried out by external experts or research institutions.

Cancellation criteria:

A6 - The cargo bike system was not economically viable / did not achieve the desired effect / was not accepted

4.9 Consultation

If the evaluation is positive, there is the possibility to stabilize the cargo bike concept in this form; that is, to convert the pilot test into a regular concept. This step may involve a change from temporary transshipment hubs (containers, swap bodies, trailers) to long-term, better integrated forms that require partial re-planning including a new area search.

In the case of cooperative transshipment hubs, it may be the case that consolidation does not make sense for all logistics companies. In this case, an operator model via neutral actors (> utilization) should be chosen, which allows for continuity with fewer actors than in the pilot phase.

In addition to stabilisation, it is also possible to extend the concept to other, similar urban areas. With the experience gained there, planning processes can be carried out faster and more efficiently.

Continuation can also consist in the development of an overall urban concept for sustainable delivery with specific solutions for the different area types (> improvement of planning). This is recommended for cities in the long term.

4.10 Additional Consideration: New planning of quarters

When planning new districts, logistics should always be considered and integrated into the planning process. If a city wants to plan a new district, the city should approach and involve logistics companies directly.

In principle, the procedure described above can also be followed in such planning processes. If the planning is done on the drawing board, the areas can be planned directly according to the ideal requirements of both sides and incorporated into the master plan or the urban land-use plan. Here, special attention should be paid to the inclusion of further logistics innovations (parcel boxes, concierge service, etc.).

If the new planning of an existing quarter (urban redevelopment) is carried out, logistics should also be integrated from the beginning. Corresponding areas should be strategically recorded in the notified conversions and conversions of properties and areas. Attention: If the determination is only informal, it must be repeated in the urban land use planning.

4.11 Additional Cosnsideration: Scaling and standardization

In strategic planning, especially in urban land use planning, cities are dependent on possibilities for the concrete determination of logistics areas. This requires knowledge of space requirements in relation to the quantities of goods and cargo bikes. Logistics experts work with standardised systems and want solutions that are highly scalable, so that they can roll out cargo bikes on a wide scale like other means of transport that are city-orientated. For the CEP sector and other logistics companies, it is therefore advisable to develop standardised requirements for transshipment areas as a planning basis for cities.

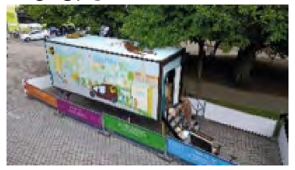
5. Components of planning

This section presents the components of the planning process and essential recommendations or aspects to be considered.

5.1 Implementation planning

The basic types of transshipment hubs are described in Table 5 according to the existing equipment and space requirements. Stationary transshipment hubs are further subdivided into the type's "container" and "property", as there are significant differences in equipment, requirements and effects on the cityscape.

Table 5: Overview of transshipment hubs

Type	Advantages	Disadvantages	Equipment	Requirements
Semi-stationary				
Swap body (sTN) © UPS 	Quick realisation Designable Mobile Area theoretically usable anytime	Large area requirement Organisation of transport required (trucks) Interim solution Aesthetically unattractive	No social rooms necessary	Parking space or similar Area Shunting area Delimitation of the area required
Trailers (sTN) © UPS 	Quick realisation Easy parking space use Area theoretically usable anytime	Low capacity	No social rooms necessary	Parking space or similar Area Shunting area Possible area delimitation
Stationary (Container)				
Sea container (sTN, cTN) © DPD 	Fast, cost-effective, flexible, designable Simple solution Flexible arrangement possible Stable value Dimensions normalized	Interim solution Aversion to cities Partially logistically cumbersome Aesthetically unattractive	Individual CEP equipment possible	Loading and parking facility for cargo bikes Holding/shunting area
Building / office containers (sTN, cTN) © Otto-von-Guericke-Universität Magdeburg 	Fast, cost-effective, flexible, designable Simple solution Flexible arrangement possible Aesthetic design possible	Interim solution Aversion to cities Partially logistically cumbersome	Individual CEP equipment possible	Loading and parking facility for cargo bikes Holding/shunting area
Stationary (Object)				
Premises (shop, cellar etc.) (sTN, cTN) © Tom Assmann 	Easy integration into the cityscape	Partially logistically complex Frequently high space costs	Heating, Sanitary (ramps)	Ramp (ideal) Holding/shunting area Loading and parking facility for cargo bikes Accessibility for cargo bikes/grid carriages Social rooms (offices)
Car park compartment (sTN, cTN) © Tom Assmann 	Easy integration into the cityscape Good access	Fire protection require-ments (e.g. container with fire load F30) Container currently not available on the market. Restricted height for delivery vehicles	Partly offices / washing facilities (old buildings)	Loading and parking facility for cargo bikes Holding surface Entrance van/ truck

Social rooms can include changing rooms and sanitary facilities as well as rest rooms for riders.

Depending on the CEP service, between 2 and 5 cargo bikes are used at the transshipment hubs. The package quantities for swap bodies are indicated with approx. 250-500 packages for trailers with approx. 150-200 packages. For containers analogous quantities can be assumed, for properties it depends on the available space.

For CEP services, dimensions for transshipment hub units are known from some previous implementations. Depending on the concept and CEP service, however, these vary greatly; general specifications are therefore not possible. Basically, the dimensions are dependent on the environment and result from the urban area and the planning process.

Table 6: Exemplary dimensions for sTN

Swap body	Building container	Car park compartment
7.4m x 2.6m x 4m when stationary exclusive holding zone for cargo bikes and shunting zone for the truck	7m x 6m area (3 parking spaces) including holding area	Box in multi-storey car park, 2 parking spaces approx. 4.6m x 5m, 1.9m high exclusive holding area

5.2 Area

The availability of suitable space is the greatest barrier to the implementation of cargo bike concepts. Table 7 shows possible surface types and their suitability according to the experience of interviewees (Annex A1) and usability for certain types of cargo transshipment hubs. In principle, the areas should always be considered in conjunction with use, infrastructure and location.

Table 7: Overview of suitable areas

Type	Advantages	Disadvantages	Transshipment hub	Comment
Railway areas	Suitable for neutral operators Unattractive for other uses	Often sold at top prices	Semi-stationary Stationary (container) (Stationary [Object])	
Portfolio real estate (commercial space/shop)	No approval necessary Good integration into the cityscape	High competition, e.g. with crafts Expensive Partially not wanted by landlords (less use)	Stationary (Object)	Ideally on the ground floor/ basement Access to lattice carts/cargo bikes
Shopping centres / department stores (also logistics areas)	Partially vacant Logistic infrastructure (ramps) City centre locations	Frequently reused elsewhere after vacancy	Stationary (Object)	Also view connected car parks/parking garages
Industrial yards	Partially inner-city peripheral locations Municipal/ Neutral operator	Partly high traffic load High space costs displacement of craft trade	Semi-stationary Stationary container Stationary (object)	
Backyards (private)	Private rental No approval for containers necessary Hardly any disturbance of the cityscape		Semi-stationary Stationary (object)	Do not create dark corners for more safety
Marketplaces/ Public places	Proximity to recipients	Many other temporary uses Hardly all year-round usability	Semi-stationary Stationary (container)	
New buildings (pure logistics object)		High construction costs Long construction planning/ high expenditure Long service life	Stationary (object)	Think logistics for general new buildings
Parking garage (including bike tower)	Video monitored Partially free capacities	Partially strong occupancy of the residential environ-ment Fire protection container required Access to property partly too small	multi-storey car park	
Parking spaces	Dedication of public parking spaces possible	Private parking spaces need a business concept Street is quickly filled with KEP Safety concerns with increased public traffic	Semi-stationary Stationary (container)	
Storage Complexes	Truck/car delivery possible Flexible internal use	Partially peripheral locations	Stationary (object)	

In general, the logistics sector has a very low willingness to pay for space due to the very pronounced cost pressure in the CEP market (one German company put this at 6€/sqm per month). This must always be considered for suitable areas.

Planning reliability is essential for the selection of space. The area must be usable all year round, always be accessible during the day and available for at least 2-5 years.

The provision of municipal properties is often mentioned. These can fall into several area types. Logistics experts note that cities are often reticent about this. A more active attitude can promote cycle logistics.

5.3 Usage

Regarding uses, a distinction must first be made between the forms of logistics cooperation and the connection with external uses. Depending on the form of use, different effects on the number of cargo bikes are to be expected.

5.3.1 Cooperative vs. concessionary use

In logistics cooperations, these two forms are fundamentally different in terms of organisation and acceptance. They must therefore be strictly differentiated in terms of planning and terminology.

In cooperative use, CEP services share an area. However, the flow of goods, means of transport and transshipment, employees and information flows remain strictly separated. Logistics providers are generally willing to implement this. The recommendation is to implement the operation via a (semi-)public neutral actor. This can be a separate, logistics-related company, e.g. a port operator. The aim is to reduce the concerns of CEP services regarding the absorption of process knowledge. Security technology, social rooms etc. can be shared. The operating model should be chosen in such a way that it allows for a change in the constellation of actors (fewer, other logistics providers) to ensure a good transition from the pilot phase to continuous operation. The involvement of local cycle logistics providers can improve continuity from the outset.

However, since possible areas/urban areas do not have to be equally suitable for all logistics service providers, it makes sense not to make implementation dependent on the participation of all companies. Problems can also arise when delivery areas overlap with service partners of a CEP service.

Concessionary delivery is also known as "white label". In the basic concept, logistics companies deliver their consignments to the transshipment hub and a delivery company delivers them to the end customers on behalf of all logistics companies on a consolidated basis.

This concept would be frequently favoured by cities but is mostly rejected by logistics companies. The CEP services consider the potential for traffic reduction to be low. The legal framework for concessionary deliveries is currently not considered to exist, neither by cities nor logistics companies.

5.3.2 Combined uses vs. mixed uses in the object

With CEP services, there is a basic willingness to implement transshipment hubs in conjunction with other uses. For planning purposes, it is useful to distinguish between the following forms of use:

- Combined use: Targeted organisational or structural integration of other uses to generate synergies.
- Mixed use in the object: Other forms of use (e.g. living, trade) are also to be found in an object (existing building, commercial yard).

So far, no combined use of CEP services has been realised. This is due to the fundamental lack of suitable space and the lack of necessary economic efficiency. Possible combined uses, which are being discussed among experts include:

- Bicycle repair shop
- Bicycle rental station
- Package station, multi-label package station, return station
- Charging station, possibly as part of mobility stations, for e-vehicles or exchangeable batteries
- Café, kiosk.

In interviews citizens named other combined uses in addition to those mentioned above that they would perceive as upgrades to their neighbourhood include

- Food sharing station
- Parking spaces (for bicycles, prams)
- Passenger transport (rickshaw service, e.g. for children or persons with reduced mobility)
- Temporary storage for private objects

One city sees particular potential in the use of housing for swap bodies/containers and the integration of e.g. standing cafés and kiosks. However, combined uses increase the complexity of the planning and are therefore not recommended for initial or rapidly realisable implementations.

Mixed uses in the property occupy existing, otherwise unused areas. Possible forms are:

- Logistics areas in a department store
- Logistics areas in residential and commercial properties
- Logistics areas in multi-storey car parks, storage buildings, commercial yards
- Logistics areas at marketplaces or event locations.

5.3.3 Cargo bike volume depending on the type of use

Transshipment hubs for cargo bikes are often referred to as "micro-depots". However, this term is not suitable for establishing cycle logistics. The conversion of a large part of the CEP consignments of a city district to cargo bikes entails high volumes, cargo bike quantities and the corresponding space requirements.

To shift the supply of a district with 2 city quarters of 1km² area each to cycle logistics, the cargo bike volume was estimated. The basis for this were substitution scenarios of 50% and of 80% of the parcels (>Basics of urban cycle logistics) that can be transported by cargo bikes.

To determine the volume, three strategies (ST1-3) for the realisation of transshipment hubs were examined in comparison to the reference (conventional strategy/ no cycle logistics) (Figure 8):

- ST1: Central cooperative transshipment hub in peripheral location for both quarters
- ST2: Two co-operative transshipment hubs are located centrally in the neighbourhood
- ST3: Decentralized singular hub concepts with scattered transshipment hubs per CEP service
- Reference: Delivery by diesel vans from conventional hub.

"Decentralized" singular transshipment hubs are accepted as swap bodies for truck delivery and stationary transshipment hubs for van delivery. For "central" cooperative transshipment hubs and "neighbourhood" cooperative transshipment hubs, stationary objects that are delivered by truck with mesh containers or van were assumed.

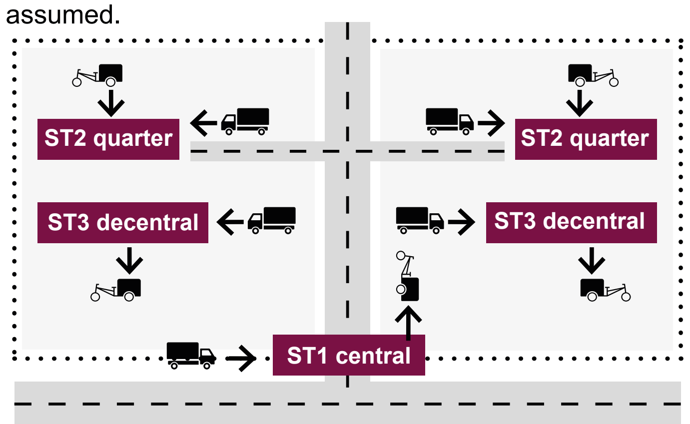


Figure 8: Scenario of volume modelling

Table 8: Basic parameters of the model calculation (from interviews; Bogdanski, 2017; Esser & Kurte, 2017; Schäfer et al., 2017)

Reference year	2025	Inhabitants	10T-35T/km²
Day	normal day	Parcels	0,18 Pac/Inh./day
parcels per cargo bike	40	CEP-Services	5, separatly by market share
Pac. per stop	1,6	Holding period	3,6min

The results (Figure 9) show that on normal days in central scenarios, up to 80 cargo bikes can be used at one hub. At single transshipment hubs 3-4 cargo bikes are in stable use. However, the number of transshipment hubs to be distributed increases significantly with the volume. In planning, the trade-off between a large number of decentralized hubs, each with low strain/pollution from cargo bikes and corresponding access vehicles, and a few central hubs with high strain/pollution must be taken into account.

The values refer to a normal day. On days with high consignment volumes, e.g. during the Christmas period, these can increase significantly.

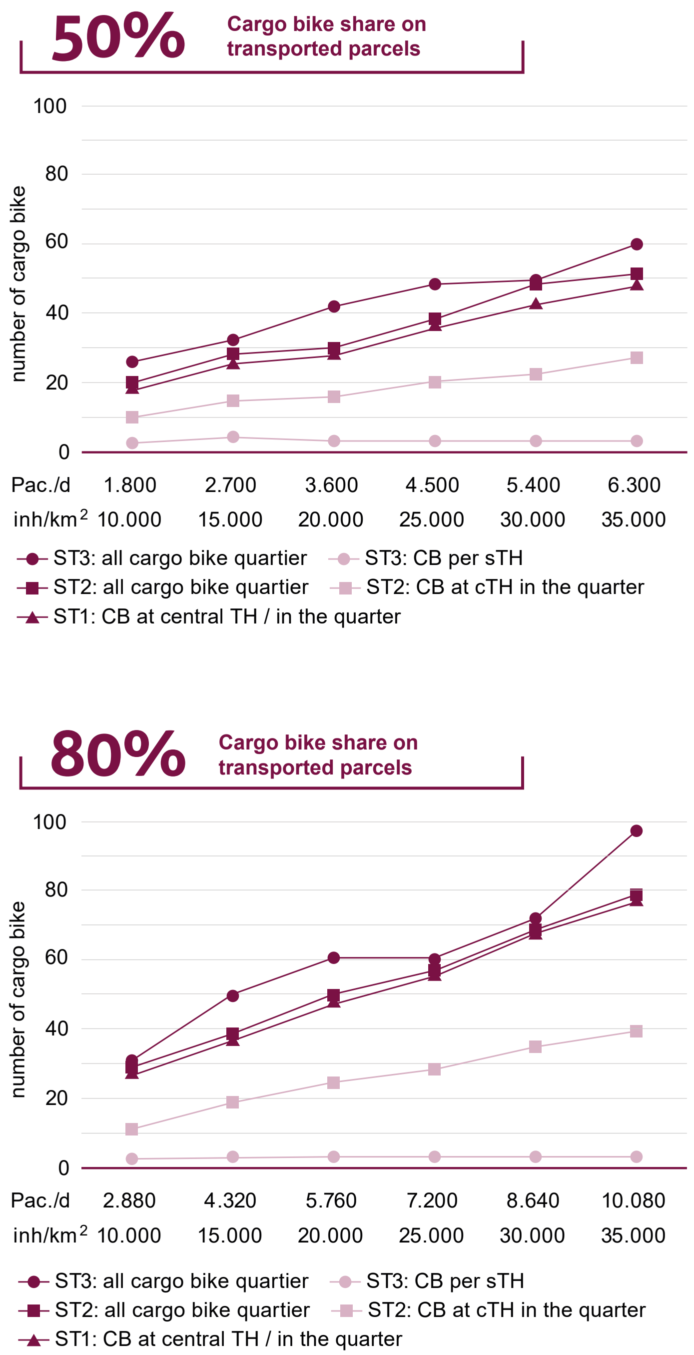


Figure 9: Number of cargo bikes depending on location type and population density, reference 2025, parcel/d = parcels per day, E/km2 = inhabitants per km²

5.3.4 Additional Consideration: Air pollution improvement potentials of cycle logistics

Cycle logistics can contribute significantly to the improvement of air pollutant emissions in the three emission types. However, in the case of high volumes, the direct access roads of the transshipment hubs must be closely examined for possible local emission increases due to a change in traffic (section 5.5.2). Away from the direct access roads, cycle logistics further improves the traffic flow in the neighbourhood and thus air pollutant emissions (section 5.5.4).

In principle, centralised systems with truck delivery lead to high CO_2 savings throughout the city (including inlets). In the case of a peripheral location, NOx and PM_{10} emissions in the district can also be greatly reduced. In the case of cooperative transshipment hubs in the districts, these emissions increase. Decentralized systems with trucks are only advantageous in the overall view for small parcel volumes. For the reduction of NOx and PM_{10} emissions in decentralised systems, delivery by van is recommended. Guideline values depending on the density of use and the package quantity can be found in Annex A3.

5.4 Location

5.4.1 Location in the city

Within a city, different areas are differently suited for cycle logistics. Basic characteristics for a high suitability are:

- Inner city area, preferably with a strong residential component (core city, partly not city)
- High or highest stop density in delivery
- Poor conditions for conventional vehicles (e.g. areas for pedestrians, access restrictions, etc)
- Increased traffic problems (e.g. high proportion of second-row parking).

The inner city as a field of application results quite arbitrarily from the prevailing problem situation in traffic, air pollution or quality of stay in the respective city. The inner city can include the city centre as well as dense mixed residential areas (e.g. Wilhelminian style neighbourhoods). The suitability of the city centre with large, central depressions is not given for all CEP services. Residential areas are not suitable for CEP services with a very strong B2B structure. For orientation purposes, some exemplary characteristic values for suitable areas are given:

- 15-20 stops per hour in mixed areas, high B2C share, parcel service
- Approx. 65 stops per day, high B2B share, express business

5.4.2 Location in the city area / quarter

If the site is located in the city area, it is recommended by the local authorities to place transshipment hubs on main roads or arterial roads or on the edge of neighbourhoods. An important advantage is the good manoeuvrability of the delivery vehicles outside of quiet streets as well as lower demands on the integration into the cityscape. Emissions (air pollutants, noise from delivery) are also kept out of the neighbourhood.

In the case of CEP services, location preferences vary greatly in detail. It is important that there is immediate proximity to the delivery area. This means that this is no more than 500m away from the transshipment hub or that the delivery radius around a transshipment hub does not exceed 1.2km. The shorter the distance between the hub and the main focus area of the stops, the more efficient and thus economical a cargo bike concept is. However, even for locations within a quarter, accessibility by van and truck and generally good accessibility with little congestion must be ensured.

5.5 Infrastructure

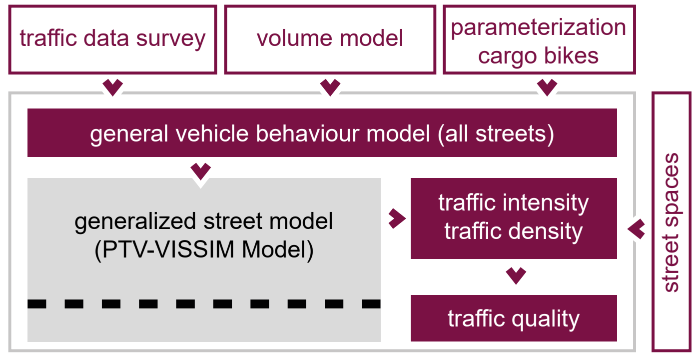
The expansion of the bicycle infrastructure is considered to be beneficial for cycle logistics. In particular, congestion on this infrastructure is to be avoided in order to enable better scaling of cycle logistics.

5.5.1 Traffic Design Suitable for Cargo Bikes

Riders in the cycle logistics sector prefer to ride their bikes on the road (mostly 3-wheeled rear loaders). At cooperative, central transshipment hubs, a high volume of cargo bikes as well as trucks and vans on the incoming routes can occur (> uses). The volume of cargo bikes can also be increased by the general trend towards cargo bikes among the urban population.

The traffic impact of cargo bikes has so far been unknown. Microscopic traffic simulation (PTV-VISSIM) was used to develop traffic loads from cargo bikes at transfer points and strategies for traffic-compatible transshipment for generalized roads in inner-city areas. The generalised roads were developed on the basis of 12 urban roads in Germany. The traffic data were collected between May and June 2018 (measuring distance 50m). The calibration was based on vehicle volume, the validation on the number of overhauls of bicycles by motor vehicles. Subsequently, scenarios of the traffic burden caused by cargo bikes (3-wheeled rear loaders, peak hour, one direction, 0-120 LR/h) were imported. The traffic quality was determined from the simulation models (6 simulation runs each) via the traffic density (of motor vehicles) according to HBS-2015. Figure 10 gives an overview of the methodology of the study.

The traffic qualities for the generalised road types (5.5m; 6.5m; 7.5m; 8.5m) are given in detail in Annex A1. For the scenario with 0 cargo bikes, the results are analogous to an earlier, comparable study (Ohm et al., 2015). For the study case of a road at 30 km/h, there was no discernible effect from more cargo bikes on the track. The limit consideration in the comparison of the increase in traffic density by 200 cars/h or 200 bikes/h shows that in most cases the motor vehicle has a stronger influence on traffic density than the cargo bike. This is particularly true for wide roads and situations with a high proportion of bicycle traffic. The reduction of the motor vehicle volume by avoiding traffic is therefore fundamentally recommended.



Street width (elevation)	5m to 9m	street types	quarter, driveway, shop, collection
speed	50km/h	Guide Bike	Mischverkehr
public transport	no tram	Length of investigation	50m

Figure 10: Methodology of the traffic study

5.5.2 Recommendations for roads suitable for cargo bikes

Increasing the volume of traffic by means of more cargo bikes under otherwise identical conditions has the expected effect of a poorer traffic quality. In many cases, the reduction of motor vehicle traffic is the basic solution. Alternatively, various measures of road space redesign suitable for cargo bikes are possible for the road types. Road types with 5.5m and 6.5m are summarized below due to the very high similarity in the simulation results.

The recommendations are based on the results of the simulation and the following parameters:

- Mixed traffic without protective strip at 50km/h up to max. 400 cars/h (ERA-10)
- Mixed traffic without protective strip at 30km/h up to max. 800 cars/h (ERA-10)
- Bicycle roads can be introduced up to 400 cars/h and 30km/h (Rast-06).

The possible use of footpaths in exposure area II (ERA-10) was not pursued because of the wide cargo bikes, as well as a change in footpath widths. The protective strips that are possible there can be created but are a great source of danger due to their narrow layout and should be widened to approx. 2m or designed as cycle paths in the side area (Richter et al. 2019). If this is not possible, the guidance in mixed traffic with adjustment of the speed to 30km/h should be checked (ibid.). The justification for the speed reduction can also be based on the necessity of air pollution control. The aim should be to provide cycle traffic facilities suitable for heavy goods vehicles with the possibility of overtaking in the lane. Experts state a guideline value of at least 2m width. A study by Gaffga and Hagemeister (2015) indicates a width of 2.25m for cycle lanes and 2.4m for cycle paths.

5.5.2.1 (Cargo-) bike-friendly design of road types 5.5m and 6.5m

Roads between 5m to 7m width react identically to cargo bikes. Overtaking bicycles and cargo bikes is only possible with a lane change. The increase in cargo bike traffic contributes to the change in traffic quality at approximately the same rate as the increase in bicycle traffic. The average speed of motor vehicles is below 30km/h from approx. 200 bicycles/hour, regardless of the cargo bike strength, and adjusts to the bicycle speed with increasing bicycle traffic volume (Table 9).

Table 9: Recommendations for road types 5.5m and 6.5m; X/Y/Z = number of deteriorations of the traffic quality level at 120/80/40 compared to 0 LR/h

car/h													
1.800	2/1/1	1/1/0	1/1/1	0/0/0	0/0/0	1/1/0	1/1/1	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0
1.600	1/1/1	0/0/0	1/0/0	1/1/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	1/0/0	1/1/0	0/0/0
1.400	1/1/0	1/1/1	0/0/0	0/0/0	0/0/0	1/1/0	1/1/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0
1.200	0/0/0	0/0/0	1/1/0	1/1/1	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0
1.000	1/1/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	1/0/0	1/1/1	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0
800	0/0/0	0/0/0	1/1/0	1/1/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0
600	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	1/1/0	1/1/1	0/0/0
400	0/0/0	0/0/0	0/0/0	1/0/0	1/1/0	1/1/1	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0
bike/h	1	50	100	150	200	250	300	350	400	450	500	550	600

(no color) Implementation of a cycle lane suitable for cargo bikes (Figure11)
The implementation of a protective lane for bicycle traffic is necessary. A cycle lane is useful for a design suitable for load-bearing bicycles (Figure11)
no changes necessary
Examination of the introduction of a bicycle road by determining case-related daily traffic volumes. The vehicle speed is already at <30km/h
Reduction of the permissible maximum speed to 30km/h, as the line speed ≤ is 30km/h. Alternative: Implementation of a cycle lane suitable for cargo bikes

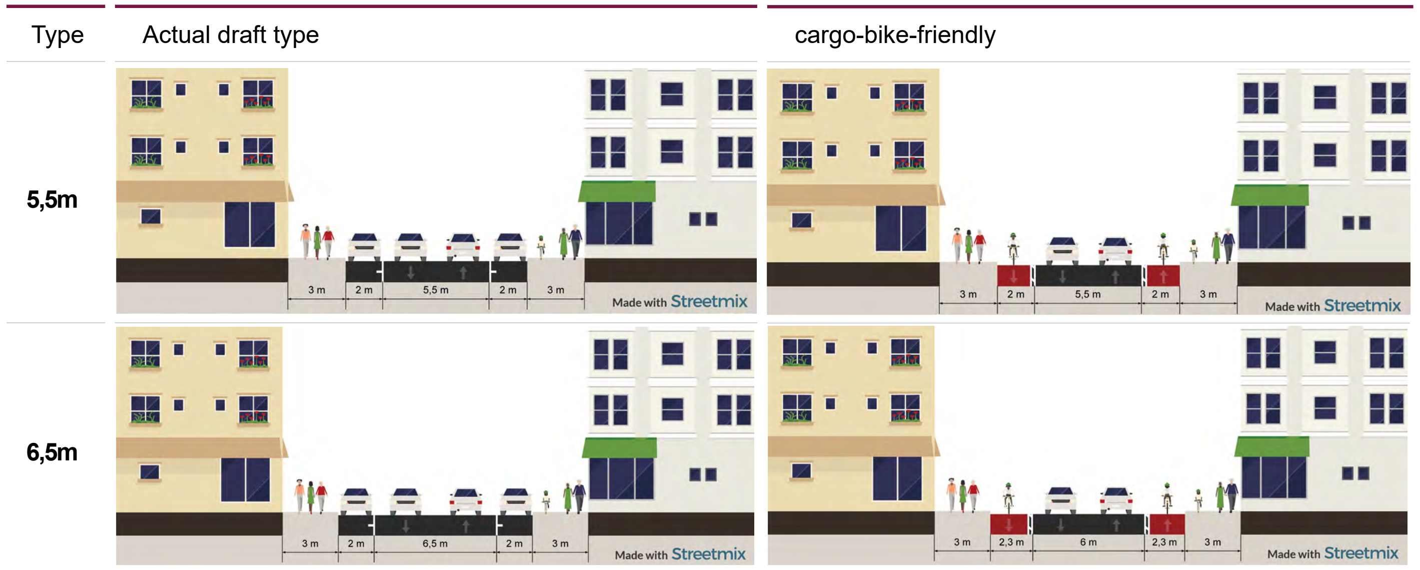


Figure 11: Road configurations suitable for cargo bikes on 5.5m and 6.5m wide roads

Within the design types of the Rast-06, the space for cycle lanes can only be created by eliminating longitudinal parking (Figure 11). For normal cycle lanes this would have to be at least on one side, therefore a double-sided cycle lane is recommended. In the case of wider road spaces, the cycle lanes should be approximated to a width of 2.25m. For road spaces with 6.5m width, corresponding widths of the cycle lane can be achieved by reducing the lane to 6m, with a low proportion of SV and public service buses. Otherwise, 6.5m road and 2m cycle lane including marking to the road must be provided.

5.5.2.2 (Cargo-) bike-friendly design of road types 7,5m

Roads in the range 7m to 8m have a better traffic quality. Here, many overtaking manoeuvres are already taking place within the traffic lane (including guard rails and by not observing 1.5m lateral overtaking distance). The wider cargo bikes still require changing lanes for overtaking. Here, the increase in cargo bike traffic has a greater impact on traffic quality (factor 2.5) than bicycle traffic (Table 10).

In the "no change" area, safe cycle traffic guidance and good traffic quality can still be assumed. The separate guidance can be designed as a 2.25m wide cycle lane (Figure 12). In case of low SV and regular bus traffic, a cycle lane with 0.5m separation from the lane and 2.25m width can also be set up for better protection. A separation by bollards is recommended.

Table 10: Recommendations for road type 7.5m; X/Y/Z = number of deteriorations in traffic quality level at 120/80/40 compared to 0 cargo bikes/h

car/h													
1.800	2/1/1	1/0/0	1/1/0	1/1/0	1/1/0	1/1/1	1/1/1	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0
1.600	1/1/1	1/1/1	1/1/1	0/0/0	0/0/0	1/0/0	1/0/0	1/1/0	1/1/1	1/1/1	1/1/1	0/0/0	0/0/0
1.400	1/1/0	1/1/0	1/1/0	1/1/1	1/1/1	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	1/0/0
1.200	0/0/0	0/0/0	0/0/0	0/0/0	1/0/0	1/0/0	1/1/0	1/1/0	1/1/1	1/1/1	0/0/0	0/0/0	0/0/0
1.000	1/1/0	1/1/1	1/1/1	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0
800	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	1/0/0	1/1/0	1/1/0	1/1/1	1/1/1	1/1/1	0/0/0	0/0/0
600	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0
400	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	1/0/0	1/0/0	1/1/0	1/1/0
bike/h	1	50	100	150	200	250	300	350	400	450	500	550	600

(no color) Implementation of a separate cargo bike guide (Figure12)
- The implementation of a protective lane for bicycle traffic is necessary. Separate cargo bike guidance is useful for a cargo bike design (Figure12)
- No changes necessary with existing protective strip (>400km/h)
- Examination of the introduction of a bicycle road by determining case-related daily traffic volumes. The vehicle speed is already at <30km/h
- Reduction of the permissible maximum speed to 30km/h, as the line speed ≤ is 30km/h. Alternative: Implementation of a cycle lane suitable for cargo bikes

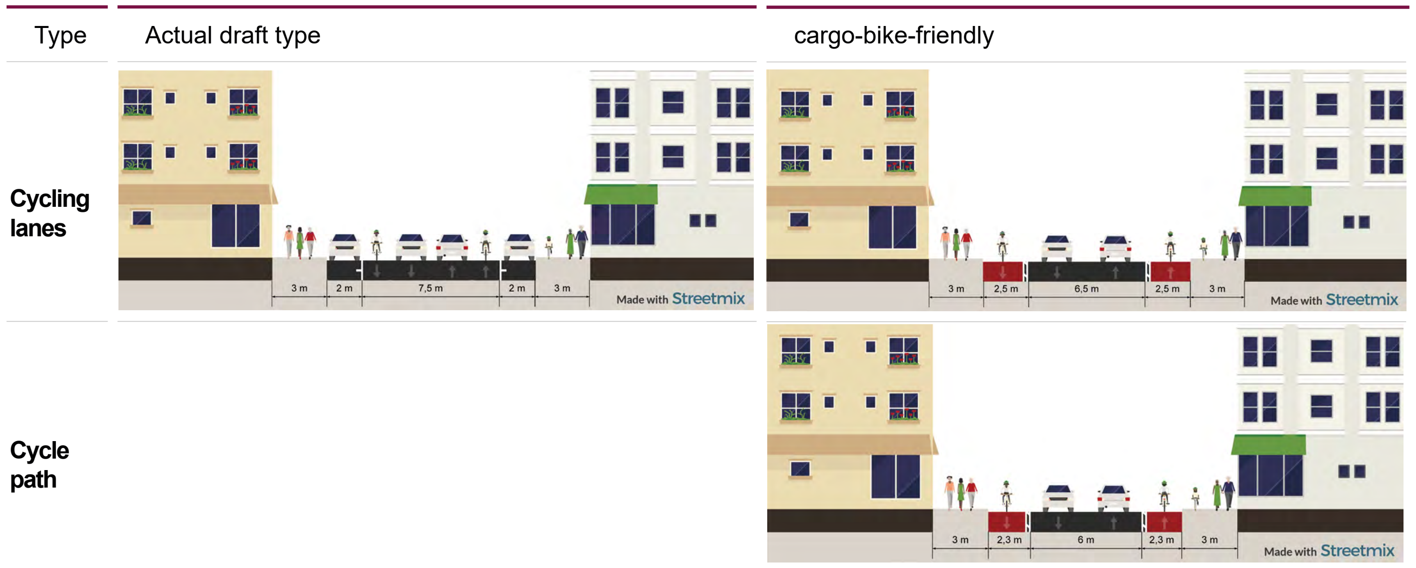


Figure 12: Road configurations suitable for cargo bikes on 7.5m wide roads

5.5.2.3 (Cargo-) bike-friendly design of road types 8,5m

Roads in the 8.5m width range generally have a significantly better traffic quality with medium and high percentages of cycle traffic due to rule-compliant overtaking in lane. For cargo bikes, however, this must still be changed. Thus, the increase in the number of goods vehicles on the road affects the traffic quality to a much greater extent than the increase in bicycle traffic but has only a minor effect on the speed of the vehicles (Table 11).

For the 8.5m roads, the recommendations are strongly dependent on the amount of cargo bikes. The variants shown in Figure 13 are conceivable for a redesign suitable for cargo bikes. The variant "protective strip" can be useful due to the safe side clearance in the dooring zone in the "no changes" area. It is particularly suitable for areas with high parking pressure.

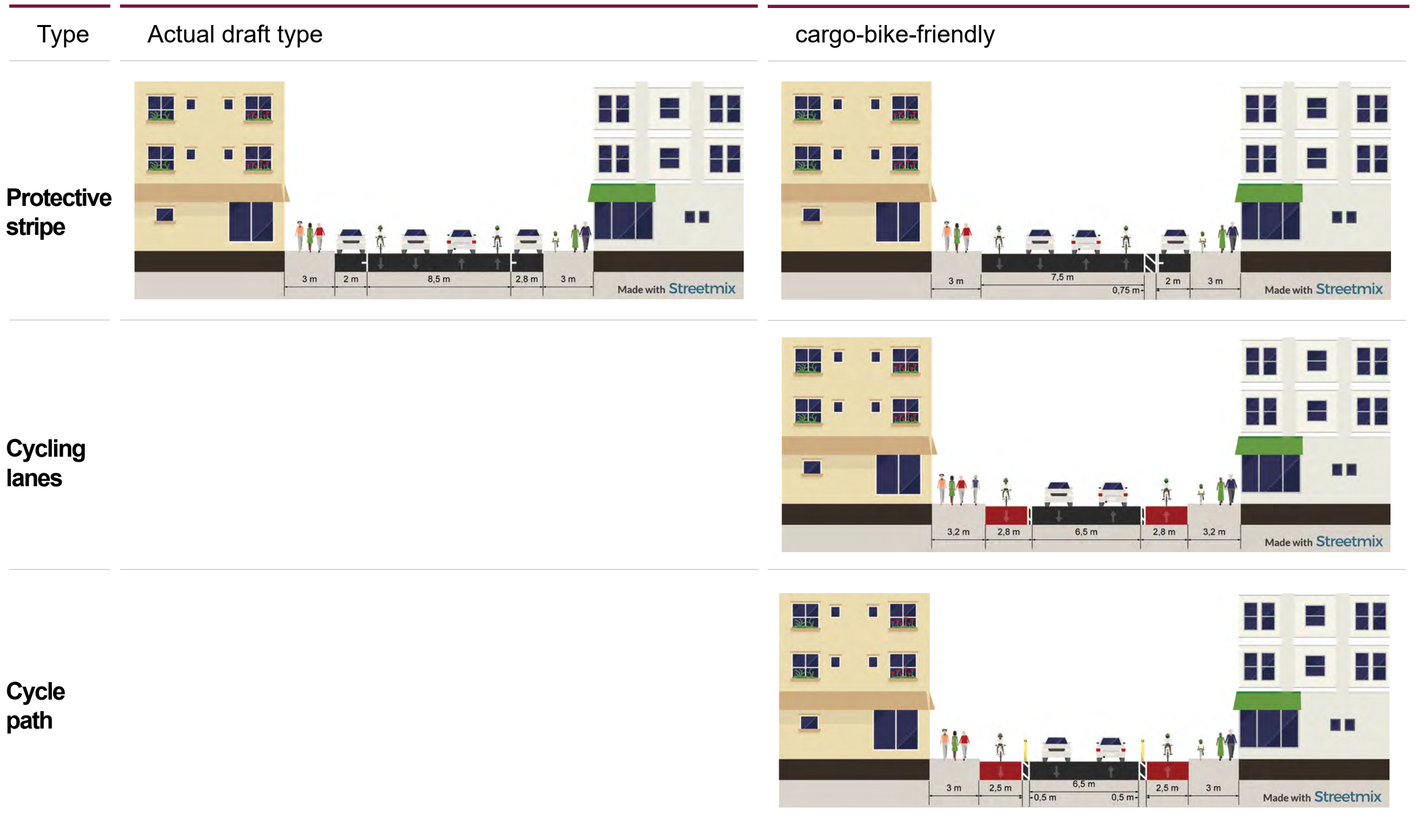


Figure 13: Road configurations suitable for cargo bikes on 8.5m wide roads

Table 11: Recommendations for road type 8.5m; X/Y/Z = number of deteriorations of the traffic quality level at 120/80/40 compared to 0 cargo bikes/h

car/h	120 LR/h												
1.800	0	1	1	1	0	0	0	0	0	0	0	0	1
1.600	0	1	1	1	1	1	1	1	0	0	0	0	0
1.400	0	0	0	0	0	1	1	1	1	1	1	1	1
1.200	0	0	0	0	0	0	0	0	0	0	0	0	0
1.000	0	1	1	1	1	1	1	1	0	0	0	0	0
800	0	0	0	0	0	0	0	0	0	0	0	0	0
600	0	0	0	0	0	0	0	0	0	0	0	0	0
400	0	0	0	0	0	0	0	0	0	0	0	0	0
bike/h	1	50	100	150	200	250	300	350	400	450	500	550	600

car/h	80 LR/h												
1.800	0	1	1	1	0	0	0	0	0	0	0	0	0
1.600	0	1	1	1	1	1	1	1	0	0	0	0	0
1.400	0	0	0	0	0	0	0	0	1	1	1	1	1
1.200	0	0	0	0	0	0	0	0	0	0	0	0	0
1.000	0	0	0	1	1	1	1	1	0	0	0	0	0
800	0	0	0	0	0	0	0	0	0	0	0	0	0
600	0	0	0	0	0	0	0	0	0	0	0	0	0
400	0	0	0	0	0	0	0	0	0	0	0	0	0
bike/h	1	50	100	150	200	250	300	350	400	450	500	550	600

car/h	40 LR/h												
1.800	0	1	1	1	0	0	0	0	0	0	0	0	0
1.600	0	1	1	1	1	1	1	1	0	0	0	0	0
1.400	0	0	0	0	0	0	0	0	1	1	1	1	1
1.200	0	0	0	0	0	0	0	0	0	0	0	0	0
1.000	0	0	0	1	1	1	1	1	0	0	0	0	0
800	0	0	0	0	0	0	0	0	0	0	0	0	0
600	0	0	0	0	0	0	0	0	0	0	0	0	0
400	0	0	0	0	0	0	0	0	0	0	0	0	0
bike/h	1	50	100	150	200	250	300	350	400	450	500	550	600

(no color) Implementation of a cycle lane suitable for cargo bikes (Figure13)
The implementation of a protective strip is necessary. Separate cargo bike guidance is useful for a cargo bike design (Figure13)
No changes necessary with existing protective strip (>400car/h), protective strip suitable for cargo bikes is recommended

5.5.3 Types of routing

In order to be able to make a statement on how the distribution of space in the street space is perceived, respondents were asked to evaluate different street spaces in an online survey. As an example of traffic routing, as is often found in cities today, they evaluated either a two-lane road on which the bicycle traffic is handled as mixed traffic with cars, or a four-lane road on which the bicycle traffic was guided on a single-track cycle path at sidewalk level.

The interviewees were residents of large German cities. When evaluating their assessments, we considered which means of transport they mainly use in their everyday lives - whether on foot and public transport, by bicycle or by car. In addition to the survey of city dwellers, a group of cyclists who use the cargo bike for work was also interviewed.

In order to make the cycle traffic routing suitable for the use of cargo bikes, two possibilities for redesigning the two traffic areas stand to reason: A parking strip at the edge of the road can be removed and the area used as a cycle path instead. In the four-lane road space there is also the possibility of converting one lane for cars for the use by bicycles (see Figure 14). Both options were evaluated by the respondents.

The possibility of converting a parking strip into a cycle path was positively received in both scenarios. This possibility is particularly well accepted by cyclists (see Figure 15).

The possibility of converting a car lane into a cycle path in a four-lane road area is not perceived as an improvement of the situation. The advocacy and assessment of the attractiveness of this option is like that of a cycle path at sidewalk level. As can be seen in Figure 15, the assessment of the transformation options varies depending on the means of transport used by the respondents in their daily lives: For cyclists and pedestrians, the possibility of using the parking strip as a cycle path represents a significant improvement in the traffic situation, while for car drivers it makes little difference which of the three design options is considered - neither in positive nor in negative terms.

In both two-lane and four-lane road space, the space for cargo bikes is perceived as insufficient. The possibilities for redesign, i.e. the use of the area of a parking strip or the area of a lane, are perceived as a clear improvement with regard to the usable space for cargo bicycles - the users of all means of transport agree on this (Figure 16).

Both transformation scenarios reduce the space available for cars. It is therefore particularly interesting to see how this reduction in space is perceived. In both transformation scenarios, the respondents perceive that the space available for cars is reduced. However, this reduction is perceived only slightly as an actual deterioration of the situation for cars. The available space is also described as approximately optimal in the redesign scenarios (Figure 16).

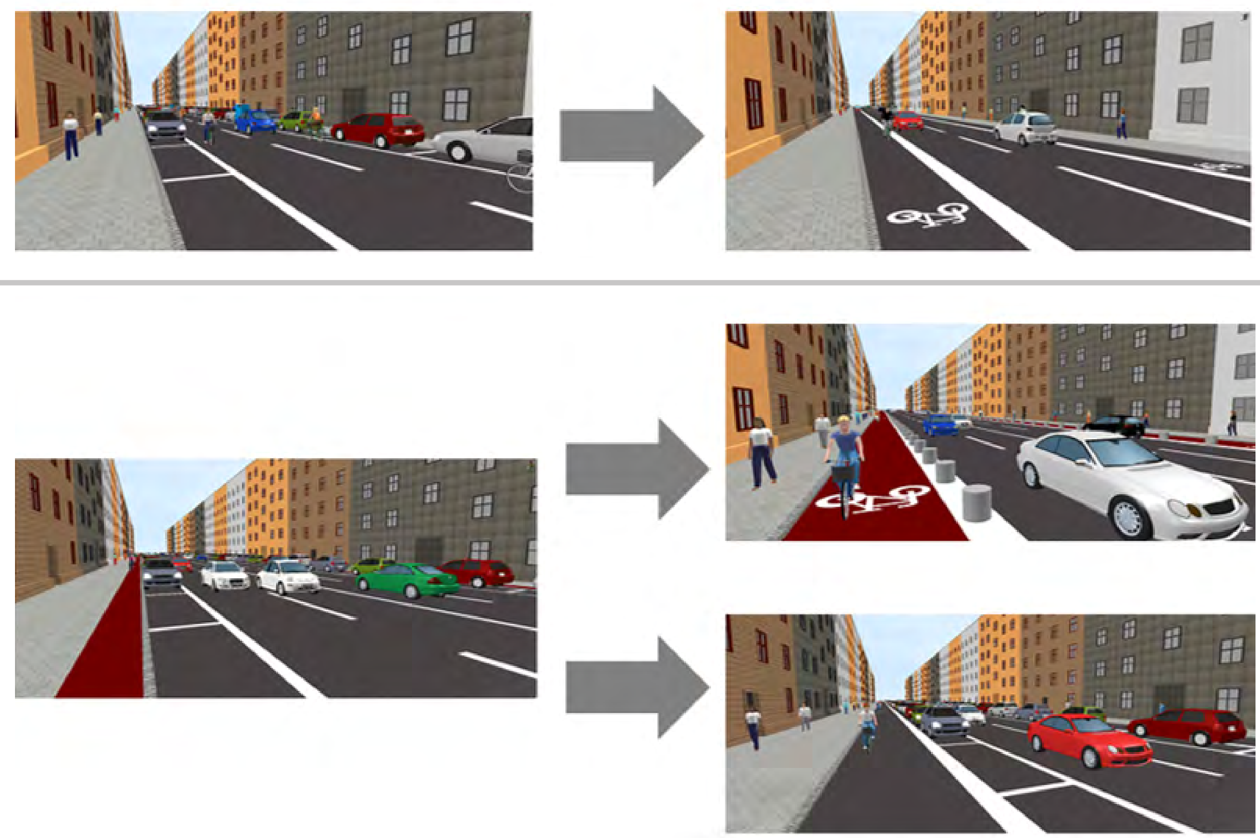


Figure 14: Redesign proposals for a layout suitable for cargo bikes

From these results it can be deduced that there is general agreement among the general population that parking areas can be reduced in favour of bicycle and cargo bike traffic and that this is perceived as an improvement of the road space. This perception is shared by the different stakeholder groups (car drivers, cyclists and pedestrians). The reduction of the area for car traffic is perceived as appropriate.

These results are also reflected in the survey of the cyclists with cargo bikes. They see an improvement of the initial scenario in the two transformation scenarios and see an improvement in the distribution of space for cargo bikes. Overall, however, they evaluate the scenarios with a more critical eye than the other respondents. In all questions they express a more negative evaluation. This is also reflected in the assessment of conflict situations in road traffic, which are described in more detail in Section 5.5.5. In this context, they have a higher sensitivity, especially for dangerous points in traffic routing. They explicitly problematize the routing of bicycle traffic along stationary car traffic and the associated danger of suddenly opened car doors ("dooring zone"). This is therefore an aspect that should be given special consideration, even though it may not be the focus of attention for the general population.

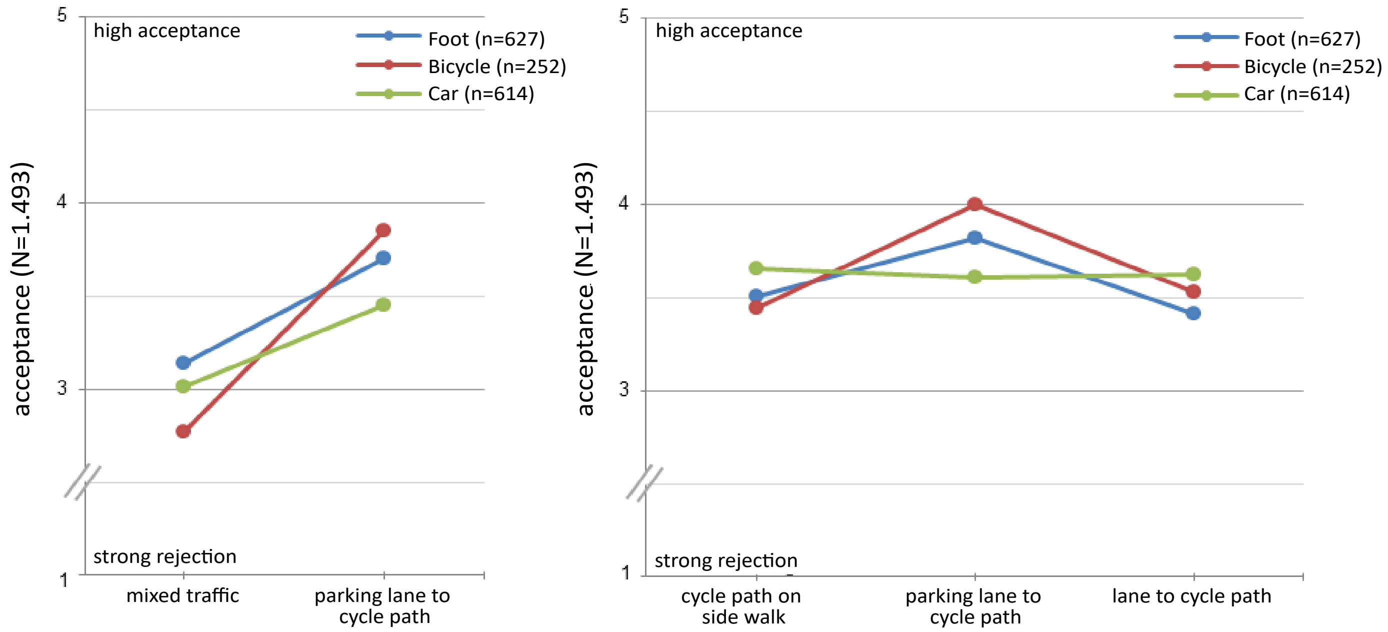


Figure 15: Approval of forms of guidance in two-lane (left) and four-lane (right) roads from the perspective of different means of transport

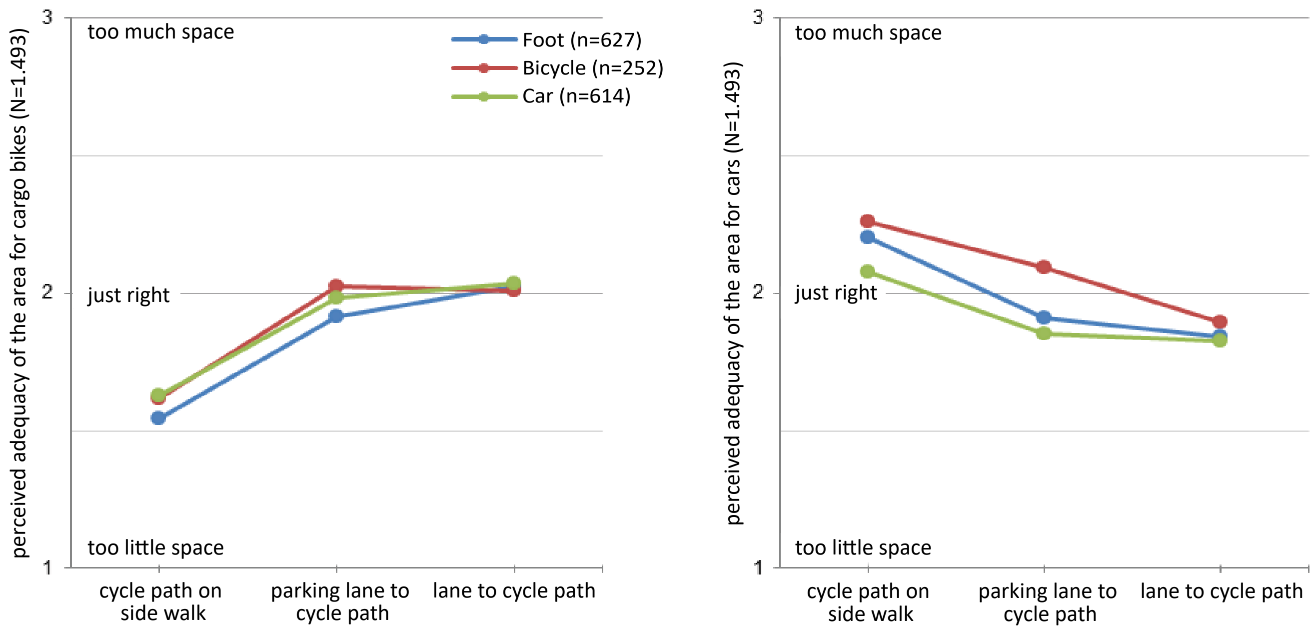


Figure 16: Perceived adequacy of space for cargo bikes (left) and cars (right)

5.5.4 Improvement of traffic through cargo bikes

The introduction of cargo bikes is linked to the objective of improving traffic flow by reducing the disruptive effects of second row stops. This was investigated with the developed simulation models. The following scenarios were incorporated into the models (Table 12).
The stops for the generalised road widths were investigated using the parameters listed in Table 13.

Table 13: Parameters of the simulation of CEP stops

Road width	6,5m to 8,5m
Traffic volume	400 cars/h and lane 50 bikes/h and lane 10 trucks/h and lane
CEP holding procedures	3 holding procedures/h 8,5min duration per stop

Table 12: Variation of CEP delivery with cargo bike

Actual Scenario	Actual with cargo bike	Cargo bike on sidewalk	Cargo bike parking zones
Van stops in second row	Cargo bike drives on roadway Cargo bike stops in second row	Cargo bike drives on the sidewalk Cargo bike stops on the sidewalk	Cargo bike drives on roadway cargo bike stops in cargo bike parking zone

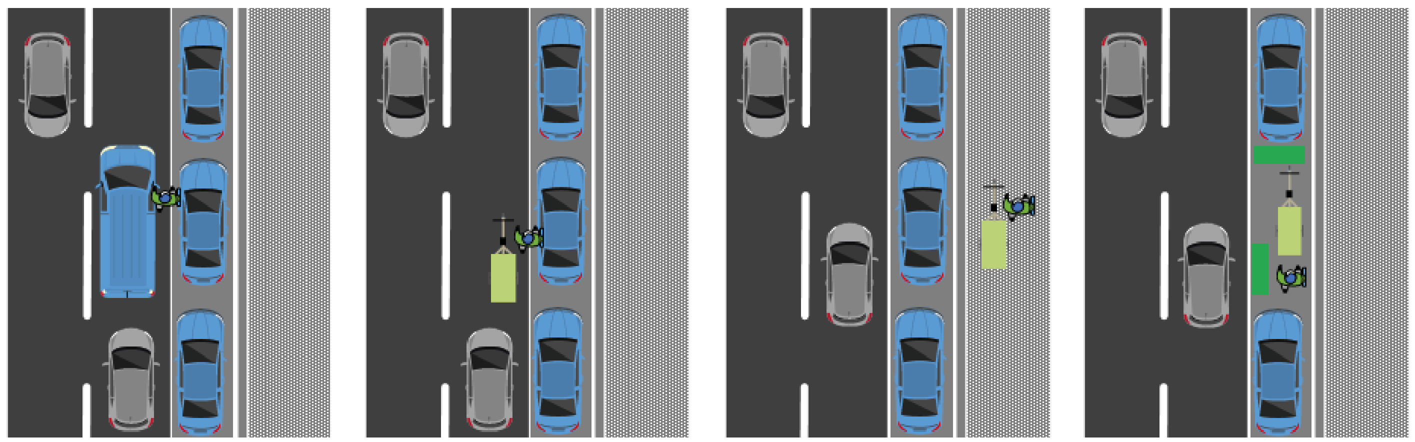


Figure 17 clearly shows that the substitution of vans by cargo bikes has positive traffic effects. When stopping in the second row, these are strongly dependent on the width of the road. Here, cargo bikes allow for better overtaking in the lane on wide roads. At 6.5m this is only possible for cyclists inside, which leads to a marginal improvement. With the potential of stopping on sidewalks or in cargo bike stopping zones an almost undisturbed traffic flow can be achieved. The effect of transport improvements on emissions is shown in Annex A5.

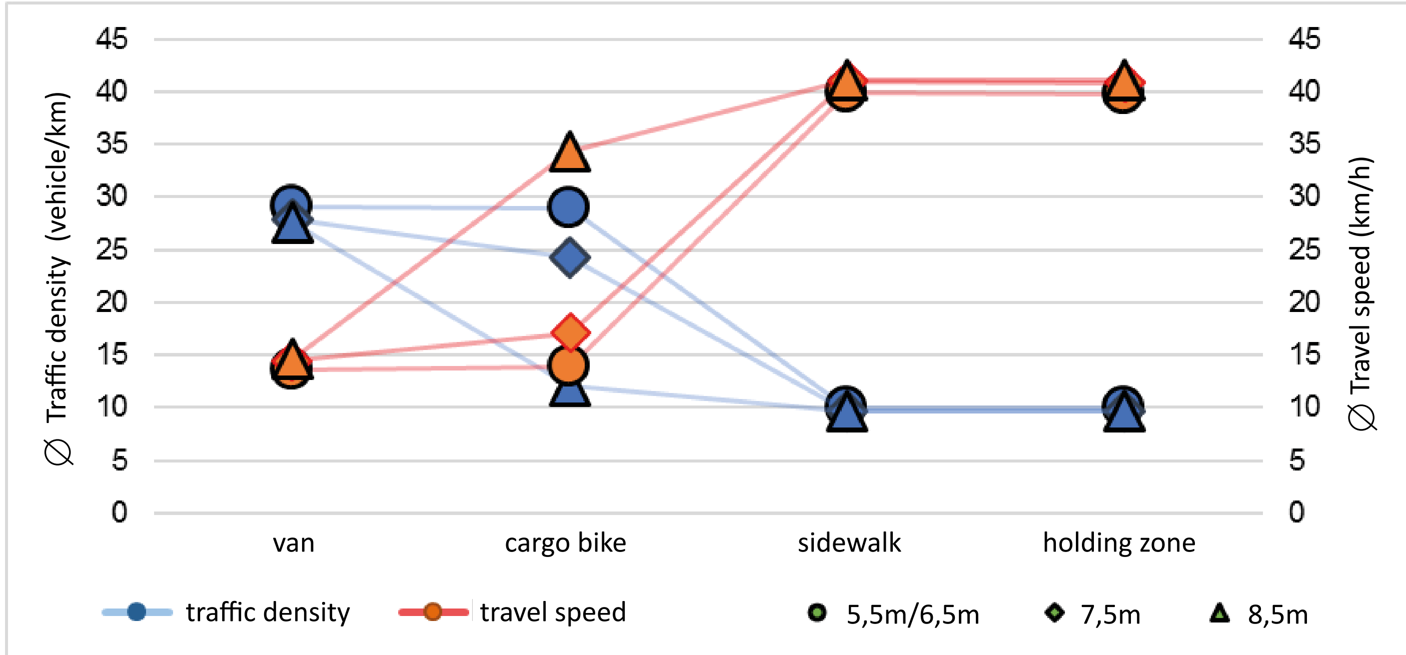


Figure 17: Perceived adequacy of space for cargo bikes (left) and cars (right)

5.5.5 Improving the perceived safety with cargo bikes

For many people, the vehicles of CEP services in the city represent a recurring nuisance. In the interviews with experts and citizens, the perception of delivery vehicles that are seen double-parking, for example, was repeatedly mentioned. Cargo bikes, on the other hand, are described as a possibility to reduce this. In order to examine more closely whether this is reflected in the perception of citizens, the respondents to the online survey rated videos of simulated traffic situations on how safe, conflictual,

Figure 18: Screenshots from the conflict videos in the online survey

confusing, controllable and stressful they perceived them. These videos showed conflict situations with delivery vehicles - either a van or a cargo bike (see Figure 18). Because people with different routines and needs can evaluate the situations differently, they viewed the videos from the perspective of the means of transport they use most in their daily lives. It was also considered whether they have children. If they were parents, they should imagine that it is their children who move through the situation independently (on the bicycle or on foot).

Traffic situations in a street with a cycling protective strip are generally considered to be less safe than those with cycle traffic guidance at sidewalk level. Apart from this, the following results are independent of the cycle traffic guidance.
There is great agreement in the assessment of conflicts caused by parked vans. Regardless of the means of transport used by the respondents and whether they assessed the situation from a parent's perspective or not - conflicts with vans are unanimously assessed as negative. These conflicts are rated more negatively by all groups than conflicts with cargo bikes (Figure 19).

The distinction between supplier vehicles is relevant for all road users - but especially for cyclists. They perceive traffic situations in the same way as car drivers or pedestrians, unless the conflict situation is caused by a cargo bike. Situations in which a parked cargo bike is in the way are perceived more positively by cyclists than by other road users (Figure 19).

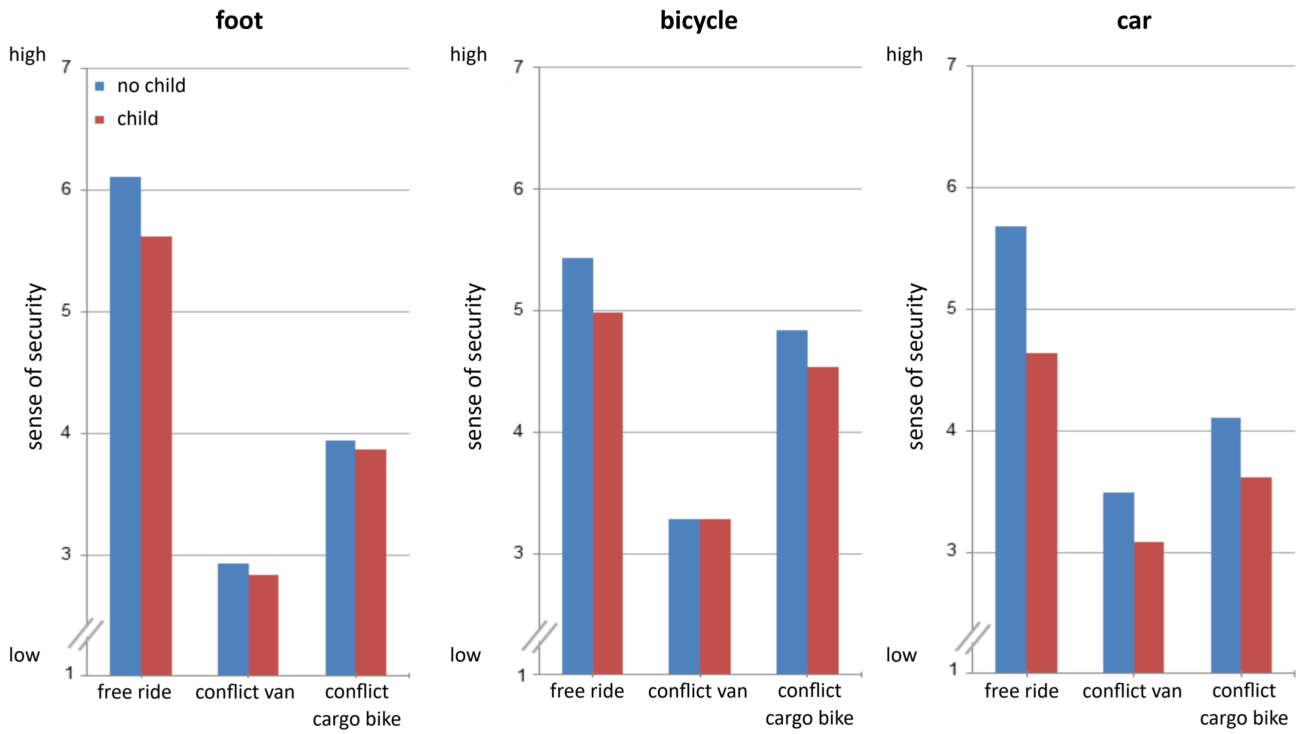


Figure 19: Conflict assessment for parenthood and different modes of transport

Overall, parents with young children generally perceive traffic situations more negatively (i.e. as more dangerous) than people who do not have children. This reflects an overall greater sensitivity to the uncertainties of road traffic when taking on the perspective of a particularly vulnerable group. Such adoption of the perspective (or direct questioning of the relevant groups) makes sense in order to include the concerns of vulnerable groups in cycle logistics and other planning (> public participation).

In summary, it can be concluded that situations with conflict potential, in which cargo bikes obstruct traffic, are subjectively perceived as safer than in the case of vans. Parents are particularly sensitive to the uncertainties of road traffic when adopting their children's perspective but share this perception. Thus, compared to vans that are parked, a better overall perception of road safety can be expected from parked cargo bikes.

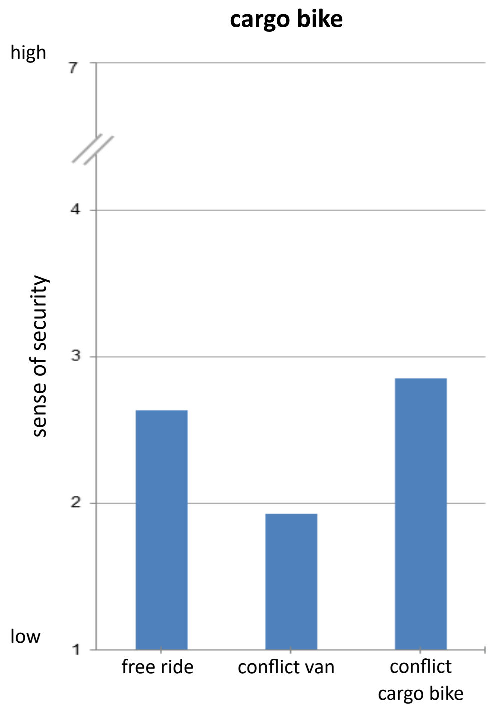


Figure 20: Assessment of conflict situations by freight cyclists

In comparison to the general urban population, professional cyclists evaluate the traffic situation as a whole much more negatively (see Figure 19 and Figure 20). Conflicts with vans are also assessed most negatively here. However, even the most positive situation - the encounter with another cargo bike - is perceived as less safe than the conflict with a van among the general population. As a reason for this, cyclists often remarked that the cycle traffic routing shown did not meet their needs. Cyclists with heavy loads are particularly sensitive to the danger of the "dooring zone" (i.e. the cycle route along stationary traffic, which involves the danger of serious accidents due to the sudden opening of car doors). As this has implications for the design of guidance systems, this point is discussed in the corresponding chapter (see section 5.5.3)

5.5.6 Cargo bike loading zone

The design shown in Figure 21 was developed for the traffic simulation scenario "Cargo bike loading zone" (section 5.5.4). The design prevents parking by conventional vehicles. The Cargo bike loading zone can be installed in parking strips with longitudinal installation from a minimum length of 5.2m (Rast-06).

The documentation for the cargo bike loading zone is available from tom.assmann@ovgu.de.

Figure 21: Visualization of a cargo bike loading zone © Otto-von-Guericke-Universität Magdeburg

5.6 Urban integration / design requirements

As part of the model of liveable cities, attention should be paid to the urban integration of transshipment hubs. Here there are different requirements, depending on whether the hub is set up in a semi-stationary or stationary manner (for common locations of hubs in the street space, see Figure 22). Since public space in cities is usually heavily used anyway due to the space required for different types of transport, stationary solutions should be preferred, especially in the long term. However, if no suitable areas or objects are available, there are possibilities to carefully integrate semi-stationary solutions into the cityscape. For semi-stationary and stationary solutions some concrete aspects of the design should be carefully considered. In the following, the approval of design proposals by the general population is used as an indicator for successful urban integration.

In the case of semi-stationary transshipment hubs, interviews with experts and citizens showed that the external design of the containers or swap bodies is of great importance for the general population's approval. It is recommended that citizens should be directly involved in the design as experts for their immediate urban environment. In the representative online survey, the respondents were given the opportunity to express their preferences regarding the design of semi-stationary transshipment hubs in road space. Based on the evaluation of different scenarios, four characteristics proved to be very relevant (see box p.32).

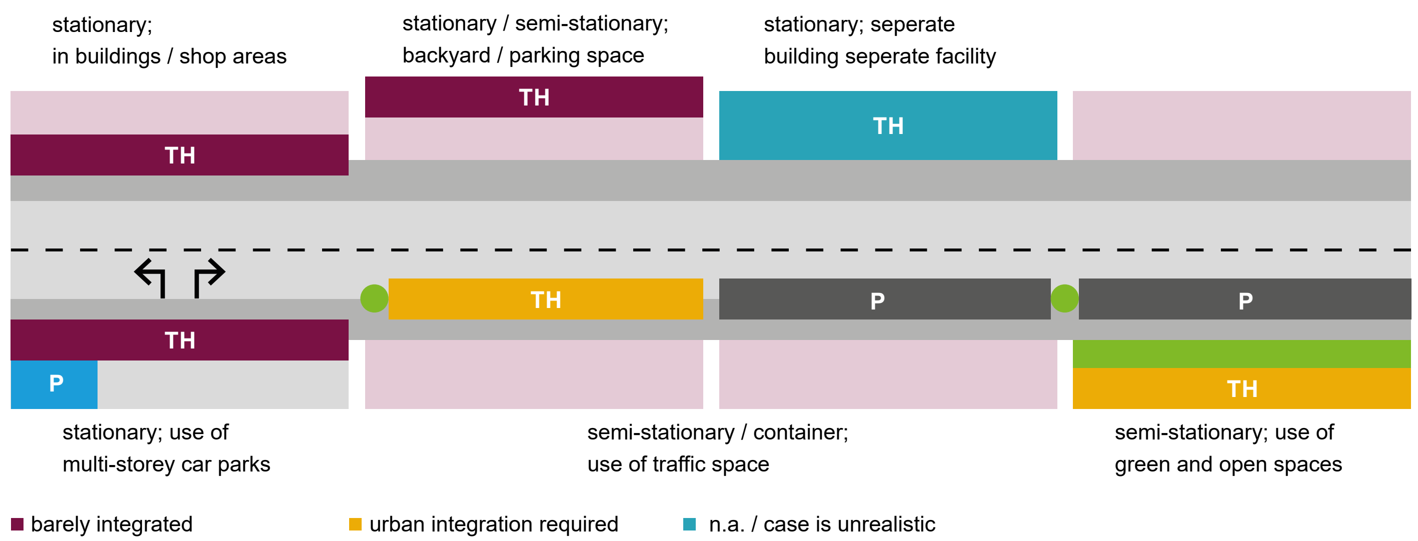


Figure 22: Possible location characteristics in the spatial section and demand of measures for urban integration

- **Number of transshipment hubs in the street**: There is a risk of "containerisation" of public spaces if large parcel volumes are to be transhipped on cargo bikes in dense urban areas. Scenarios in which five transshipment hubs (derived from the current number of large CEP service providers in Germany) within a street were shown to be much less popular with the public than scenarios with only one transshipment hub.
- **Shape of the transshipment hub**: Swap bodies stand on stilts and are therefore higher than containers and more visible. The view of the surroundings is also more restricted. In the scenarios, containers standing directly on the ground were preferred to swap bodies.
- **Design:** The choice of motifs and colours when painting the container or the swap body was much more important for public approval than the two previous aspects. In the scenarios, artistic painting was preferred to a simpler corporate design (see example in Figure 21). Here, individual and creative forms of design are conceivable, which can also be developed via participation formats (for example, design competitions for schoolchildren).
- **Separation:** CEP service providers attach importance to separating the envelope hub from the public space in order to not disturb the operational processes. Separation by a fence is usual. However, such a separation was strongly rejected in the scenarios. A separation by benches was seen more positively here than a fence; a separation by plants was the preferred form of separation among the general population. Overall, the form of the partition was as important for approval as the design of the envelope hub. Overall, it was noticeable that aesthetic aspects were given greater relevance than functional aspects.

Design preferences of semi-stationary transhipment hubs in the general public
(✓ is preferred in comparison, ○ is partly preferred in comparison, ✗ is rejected in comparison)

number
- ✓ singular transhipment hub
- ✗ multiple transhipment hub

shape
- ✓ container
- ✗ swap body

design/painting
- ✓ artistic / creative
- ✗ company design / neutral

seperation
- ✓ plants
- ○ benches
- ✗ fence

Info: Design preferences of semi-stationary hubs in the general population

Figure 23: In the assessment of scenarios by the general population, the artistic design of the paint (right) scored significantly better than a simple corporate design (left).

In the case of stationary transshipment hubs (considered for existing buildings), the use of vacancies can have a stimulating effect on urban space. As far as the external design is concerned, CEP services often dispense with outdoor advertising so that people do not mistakenly hand in their parcels at transshipment hubs (unless they offer corresponding services there). In general, the external design of stationary solutions is largely predetermined and plays a subordinate role based on interviews with experts and citizens. More relevant is the delivery process, where noise emissions and space requirements for the delivery vehicle can cause disturbances to the surrounding area. In the online survey, respondents were asked to express their preferences regarding the delivery of stationary transshipment hubs in existing buildings. Two characteristics proved to be very relevant (see box).

- **Place of unloading**: During loading and unloading of the delivery vehicle, there could be traffic disturbances due to the stopping place as well as disturbances due to noise emissions. The general population strongly rejected the idea of transshipment in road space of flowing traffic (road and sidewalk), with transshipment on the sidewalk being much more strongly rejected than on the road. Transshipment in a forecourt or in a car park (both options performed about equally well) was rated much more positively. From the point of view of the general population, the backyard was by far the preferred place for unloading or transshipment (Figure 24).
- **Delivery vehicle**: Regarding noise emissions and space requirements, the delivery vehicle is also relevant. Delivery by van is clearly preferred by the general population to delivery by truck (7.5t). The choice of an appropriate unloading area was generally the more important aspect, but the choice of a suitable delivery vehicle is also very relevant for the perceived integration.

Design preferences of delivery from semi-stationary transhipment hubs in the general public
(✓ is preferred in comparison, ✗ is rejected in comparison)

place of unloading
- ✓ backyard
- ✓ forecourt
- ✓ parking space
- ✗ street
- ✗ sidewalk

delivery vehicle
- ✓ van
- ✗ truck (7,5t)

Info: Design preferences of the delivery from semi-stationary hubs in the general population

Figure 24: In the assessment of scenarios by the general population, deliveries to a forecourt (centre) or backyard (right) performed significantly better than deliveries with a stop on the carriageway (left).

Recommended measures for the urban integration of transshipment hubs:

- Preference of stationary solutions (especially in existing buildings) over semi-stationary solutions (containers, swap bodies)
- Stimulation/ promotion of cooperative use (e.g. to avoid "containerisation" through several semi-stationary solutions)
- Location and delivery in as inconspicuous a location as possible (e.g. in the backyard)
- Avoid disturbance of moving traffic during cargo transshipment (no transshipment on roadways or sidewalks)
- Delivery with the smallest possible vehicles (e.g. vans instead of trucks)
- No delivery to sensitive urban development areas (monuments, shop windows or similar) by transshipment hubs or vehicles
- Use containers rather than swap bodies for semi-stationary solutions
- Use of high-quality, aesthetically pleasing construction and office containers
- Rather use creative/ artistic exterior designs than simple corporate designs, if possible, with the involvement of local actors
- Attractive design of the enclosure; separation by replanting and combination with other uses (> uses)
- Design as street furniture with possible combined uses (> uses)
- In addition to individual case regulations, the preparation of a design manual can be useful.

5.7 Stakeholder and acceptance

Within the planning process many stakeholders can become relevant. These all have specific roles and can promote or hinder the implementation process. A collection of relevant stakeholders is shown in Table 14.

As important stakeholders regarding acceptance, the views of residents were examined more closely. For example, it is conceivable that resistance could arise when residents are confronted with a cargo bike hub in their neighbourhood. However, the project results indicate that such resistance is unlikely to occur or only to a very small extent. The online survey showed a strong support for cargo bike logistics: 68% of the respondents said they were in favour of cargo bike logistics. On average 42% consider it probable or very probable that they would take actions that would favour the implementation of cargo bike logistics in their living environment. This includes actions such as expressing themselves positively in (social or traditional) media, participating in citizen participation procedures or addressing a responsible person in a positive way. In contrast, only 5% said that it was likely or very likely that they would take action against implementation. In scenarios where respondents were able to decide what kind of hub they would like to see in their neighbourhood (section 5.6), they indicated that they would welcome a hub in their street in about three-quarters of the cases. In interviews and in the online survey, respondents stated that they would welcome such a transshipment hub in their neighbourhood.

The main purpose of the online survey was to develop a better understanding of the acceptance of the use of cargo bikes and transshipment hubs by local residents and the factors that influence it. An adapted psychological action model was used as a basis for the selection of potential influencing factors (Huijts, Molin, & van Wee, 2014). A reduced number of factors influencing acceptance could be confirmed. These are shown in Figure 25.

Factors influencing acceptance can be understood as possibilities to encourage support for the implementation of a hub. If local residents are aware of the problems that can be solved by the use of cargo bikes and they experience an implementation process on an equal footing with trustworthy planners, this will encourage them to accept the hub on the basis of their feelings and norms.

Two factors have a decisive influence on the intention to accept cargo bike logistics in the direct living environment:

- The **feelings towards cargo bike logistics** describe what the respondents feel when they imagine that a cargo bike hub will be used in their street. The feelings that are most strongly represented are exclusively positive in nature, e.g. satisfaction, joy or hope, while negative feelings such as stress or anger are only rarely reported.

Table 14: Overview of stakeholders in the planning of cargo bike transfer hubs

Steakholder	Role	Drivers	Barriers
City	Long term planning Implementation planning; initiator; (mediator and controller of R&D projects)	Road transport authority is usually open-minded; willingness to compromise; pronounced political will; development of logistics competence;	Often dependent on individuals/the top of the administration; Difficult internal contact person structure; Disagreements between departments; Low significance of logistics; Unclear objectives; Problems with the provision of space
Economic promotion	Contact person; process support; (implementation planning)	High level of understanding of logistics in business development; cross sectional resort	Partially low domestic orientation
Communal logistics planning	Consulting; process support; overall concept; process initiation	Professional competence	
Communal logistics planning	Consulting; process support; overall concept; process initiation	Professional competence	
Public officials	Permits; implementation planning		
Municipal/ neutral company	Neutral operation of cTN; land development	Not purely profit-oriented	
CEP services	Strategic planning, preliminary planning; process initiation; definition of space requirements; logistical implementation planning	Strategic partners are easy to convince; Strategic guidelines of companies; Dealing with possible driving bans; Real efficiency problems; Long-term usability promotes willingness to compromise	High cost and competitive pressure generate risk aversion; decision-makers are seldom cycling enthusiasts themselves; currently high planning and implementation costs; low willingness to pay
Service Partner	Operational implementation planning; (contact mediation); (process initiation)	Timely involvement; use of bike couriers "from the scene"; strong will; real efficiency problems	Acceptance problems with drivers* and partners; little own effort
Logistics hub	Implementation planning		
Economic/ trade associations	Process initiation; implementation planning; long-term planning (working groups)	Profiling as active players; well networked, good staff; want to promote trade/logistics	Critical attitude towards car park management
Trade	Reception	Type of delivery indifferent as long as service and reliability are assured; growth in e-commerce; increase in the quality of stay	Partial fear of unreliability in delivery of cargo bikes; partial lack of interest in cooperation; conflicts with shop windows
Logistics Associations	Contact mediation; long-term planning		
R&D facilities	Process initiation; monitoring / evaluation		
Associations and initiatives	Process initiation (through public pressure); (implementation planning)	Active lobbying	Objections to projects
Citizens	Residents (participation); (provision of land)	Consider participation offers; high acceptance and positive reactions; benefits should outweigh disadvantages	Purely residential area problematic
Architecture and art	Implementation planning; design/ layout		
Real Estate Industry	Distribution of logistics space; space database; implementation planning; long-term planning	Objective: To avoid the desertification of city centres; city centres are prime investments	Impairment due to logistics space

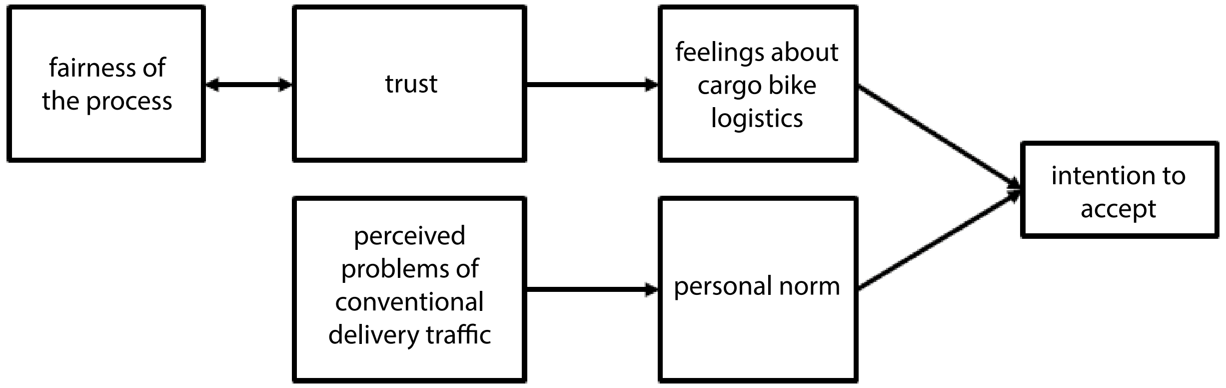


Figure 25: Factors influencing the acceptance of cargo bike transshipment hubs on the street people live in.

- A person has a **strong personal norm** when he or she feels a sense of obligation to act for or against cycle logistics because of their own values. Approximately 90% of those surveyed are in favour of actions that favour the use of cycle logistics. But the feeling of obligation to carry out these actions themselves is only weakly developed.

On a second level, factors were identified which have an influence on how strongly the feelings or the personal norm are expressed. This is where approaches to increase the acceptance of projects become apparent:

- Feelings are influenced by **trust in responsible persons**, e.g. in the responsible city administration or the corresponding logistics company. The question here is whether they can take the interests of residents into account, assess risks and benefits appropriately, solve problems that arise, etc. The overall level of trust in the survey is average. The respondents do not completely deny to trust responsible persons, but they also do not fully trust them. Thus, there is a lot of potential to increase trust through e.g. successful communication and transparency which should result in a positive effect on acceptance overall.

- Trust interacts with the perceived **fairness of the process**. This expresses the extent to which respondents expect the planning and implementation process of a hub in the neighbourhood to be fair and how important this is to them. Fair in this case means that they can also bring their needs into the planning and implementation process, that their concerns are considered and that they can contact with the responsible persons if they so wish. While all these points are predominantly important to the respondents, the expectation that they will be fulfilled is lower. The respondents expressed moderate expectations - neither do they assume that they will not be considered at all, nor are they sure that this would be the case. A high level of trust in responsible persons favours that residents assume that they will experience a fair implementation process. The expectation or experience of a fair process can in turn strengthen (or in the negative case weaken) the trust in those responsible. The expectation that a constructive exchange is possible in the event of concerns should be strengthened, for example, through the sensible choice of participation formats (> public participation) and the clear designation of possible/preferred forms of contact and responsible contact persons.

- The **perceived problems of conventional delivery traffic** influence the personal norm. These describe the extent to which the respondents perceive conventional delivery traffic (mainly with vans and trucks) as problematic. Nearly 80% of the respondents perceive problems of climate protection, air pollution and traffic flow caused by conventional delivery traffic in cities and about 70% problems regarding road safety and noise pollution. Accordingly, the personal norm tends to be higher among these individuals. In the communication of projects, the corresponding potentials of cargo bike logistics should be clearly highlighted and explained in an easily understandable way.

The survey showed no influence of some other expected influencing factors (see Huijts et al., 2014). These include the opinion of the social environment on cargo bike logistics or the assessment of the advantages and disadvantages of these. It also includes the expected distributive justice, i.e. the expectation that advantages and disadvantages are fairly distributed through the implementation of transshipment hubs (e.g. that those who must live with the negative aspects of delivery via transshipment hubs also feel the positive aspects). The increasing prevalence of cycle logistics could lead to a change in the relevance and evaluation of advantages and disadvantages and thus to a stronger influence of the aspects mentioned.

5.8 Funding

Cycle logistics can be promoted by means of bans and regulations, infrastructure development and monetary subsidies, each with different instruments and effects.

In the case of **bans and regulations**, general entry bans, also regarding diesel driving bans, are beneficial. Such restrictions would also increase the willingness to pay for land but are undesirable in terms of logistics. Prohibitions and regulations that specifically aim at logistics or CEP logistics are complex and almost impossible to implement legally. Here it is difficult to make a precise delimitation of the areas (good, urban space, time), which is court-proof in the justification. In the case of regulations and prohibitions, logistics expects a reduction in delivery quality, especially in frequency and time, which can have a negative impact on trade and other players.

The creation of a car-free city centre or other car-free urban area is more of an urban planning measure but can promote cycle logistics.

The **expansion of the cycling infrastructure** (> infrastructure) is conducive to cycle logistics. Some interviewees cite it as necessary to ensure that cycle paths are not overloaded when scaling up their use. Wide distances and a good, safe network can highlight the advantages of the means of transport and create an alternative to the congestion of conventional vehicles. However, this approach is an improvement for many road users and only indirectly promotes cycle logistics. Essential points for the promotion of this are:

- The expansion of parking areas and loading zones for cargo bikes
- The widening of cycle paths / cycle lanes to at least 2m for safe overtaking
- Avoiding additional stress on pedestrian traffic.

Monetary support is a third instrument. Logistics welcomes the existence of an urban programme as a sign of political will. In addition, monetary support can create incentives for local service partners. The subsidisation of land can mitigate the price difference between the market price and prices appropriate to logistics in a tense situation and generate profitability.

5.9 Improvement of planning

Various measures are proposed by experts to improve concrete implementation planning:

- Better cooperation between logistics service providers
- Development of logistics expertise in municipal administration/planning
- Establishment of a central contact person in the municipal administration, ideally in business development with a distinctive network
- Establishment of a continuous process and planning support
- Faster provision of space (target horizon: 3-6 months)
- Consideration of the right actor structure
- More courage for implementation in cities.

The following instruments are proposed for the planning implementation of cargo bike transfer hubs:

- Determination of the use of the cargo bike in the operating licence
- Conditions for the provision of land by the city for the use of certain vehicles
- Consideration and determination of logistics areas in zoning plans (if corresponding projects are realised in the planning area)
- Provide for concrete rules and prices appropriate to logistics in special use statutes
- Inclusion of logistics areas in municipal property and GIS databases

The experts propose the following measures to improve planning and to better consider logistics in long-term planning:

Improve knowledge and data concerning urban logistics:

- Better mapping of logistics in planning models (transport planning, air emission models)
- Better data exchange between logistics and cities; establishment of a common data platform
- Improving the position of logistics in the administration as a part of supply and disposal.

Create logistics areas strategically in the existing stock:

- Preparation of guidelines for logistics-compatible building and area development
- Consideration of the logistics of new buildings (buildings, quarters) in zoning plans (quarters also possible informal plans); designate logistics on certain areas as a form of use, while keeping the exact design flexible
- Sensitization of investors and landlords for the consideration of logistics areas
- Reservability of logistics areas in pedestrian zones; installation of parcel boxes in residential buildings
- Consideration of logistics areas in parking space statutes
- Conversion of parking space on access roads to multi-storey car parks into logistics space
- Integration of logistics in urban land supply.

Designing logistics and transshipment hubs appealingly:

- Participation of citizens in long-term logistics planning
- Consideration of logistics hubs in design manuals.
- For the long-term planning and possible stockpiling of areas, a clear definition of requirements for logistics areas on the part of the city is desired by the industry.

6. The "ideal" transshipment hub

A transshipment hub is situation-specific and suites the surroundings. Table 15 characterizes a possible "ideal" transshipment hub based on the project results.

Table 15: Characteristics of an "ideal" transshipment hub

Type of transshipment hub	Stationary, in an existing building
Equipment	Ramp, access with cargo bikes and mesh carts
Delivery	By van; truck possible
Usage	Cooperative, actors flexible
Settlement structure	Dense mixed areas, many stops with smaller shipments
Location Quarter	Main road, close to the delivery centre
Location in the road section	Unobtrusive, set back or within existing building
Areas	Existing buildings, backyards, parking garages Min. 20m² for unique UK about 6€/m² per month Min. 2-5 years usable
Infrastructure	Access by van/ truck possible, Unloading the vehicle on shunting and loading areas Cycle paths suitable for freight bikes (ensuring a sufficiently developed cycle infrastructure; converting parking strips into cycle paths) Power supply to recharge batteries for electric assist cargo bikes/trikes Safe overnight loading and storage facilities for cargo bikes and other delivery vehicles.
Urban planning integration/ design wishes	External design is not necessary due to location (existing building / backyard) For semi-stationary solutions in public spaces: artistically and creatively designed, replanted container
Stakeholder and acceptance	Early identification and information of relevant stakeholders Transparency during the implementation process for residents (open and timely communication) Participation offerings for the population Communication of the environmental benefits and safety gains (especially for vulnerable groups) through cycle logistics

Annex

A1. Methodological remarks

The presentation of the planning process and the components is based on nine qualitative planning-centred expert interviews with logistics planners and municipal planners conducted in the project "Cargo Bike Hub". The data basis was checked and enriched by 19 acceptance-oriented expert interviews (see below). The qualitative data was paraphrased in the evaluation process; within the groups of actors, similar statements of actors were then summarized. These statement blocks were assigned to the planning levels according to Assmann, Fischer, & Bobeth (2019). Within the fields of level and actor group, thematic clusters were formed.

The clusters resulted in the sequence of the planning process described in the guideline as well as a description/ evaluation of components of a cycle logistics system. The planning sequence was transformed into a comprehensive flow chart using existing process models of logistics planning (Schenk & Glistau, 2019; Ziems, 2012), urban commercial transport planning (Flämig, Hertel, Jaeger, & Schneider, 2006) and a general planning model of urban planning (Albers & Wékel, 2017; Frick, 2011). This was validated by the advisory board of the project "Cargo Bike Hub" and by the interviewed experts and enriched by process durations from the empirical knowledge.

Furthermore, findings from the preparation of literature, own calculations of publicly available data as well as own data collection (field studies) and simulations were incorporated into traffic and logistics statements.

Statements on acceptance issues are based on a preparation of the literature of psychological acceptance research as well as extensive own data collections. Thus, 19 acceptance-oriented expert interviews (with operators of transshipment hubs, cargo cyclists, residents, among others) were conducted in the project. The evaluation procedure was as described above (paraphrasing, content clustering and hierarchization).

Furthermore, a representative online survey was conducted with residents of German cities, in which 1,493 participants participated. The survey served to deepen questions of acceptance and consisted of four parts. In the first part, several scenarions with for the preferred design of semi-stationary or stationary transshipment hubs in two decision experiments were presented to the participants (discrete choice experiment). In the second part, video sequences from the logistics simulation environment were used to assess the perception of safety in conflict situations between road users and stopping cargo bikes or vans (here and in the following parts respondents answered on scales). In the third part, the participants were asked to evaluate the redesign of infrastructure with the help of visual material from the simulation. Finally, in the fourth part, possible psychological predictors of the acceptance of (hypothetical) transshipment hubs in the respondents' own streets were assessed. The data were evaluated with common descriptive and inferential statistical methods.

In order to record the perspective of freight cyclists on some of these aspects, another short online survey with 30 participants was conducted.

A2. Overview of current cargo bike models

Cargo Bike: 2 wheels
Similar driving dynamics as "normal bicycles"
Can usually be driven on any bicycle infrastructure

Baker's Bike

Payload: max. 125kg
Volume: 43x40x40
Width: approx. 60cm

© DLR

reinforced, conventional frames

Long John

Payload: max. 130kg
Volume: 65x60x80
Width: approx. 60cm

© PedalPower

very good driving dynamics, popular with couriers

Backpacker

Payload: 120kg
Volume: 100x60x60
Width: approx. 60cm

© DLR

Load outside the field of view, good driving dynamics

Cargo Bike: 3 wheels
Stable standing, slower cornering speeds
partly limited use of bicycle infrastructure

Frontloader

Payload: max. 150kg
Volume: 60x60x80
Width: 80-100cm

© DLR / PedalPower

popular with families, Height of load limited by field of view

Rear loader

Payload: max. 300kg
Volume: 150x100x170
Width: approx. 100cm

© PedalPower

Standard type of logistics

3-wheeled Long John

Payload: max. 150kg
Volume: 65x60x80
Width: approx. 60-80cm

© DLR

combines very good driving dynamics with good stability

Cargo Bike: 4 wheels

Rear loader

Payload: max. 300kg
Volume: 150x100x120
Width: approx. 100cm

© velove, Benjamin Georg

Logistics

Cargo Bike: >4 wheels

Rear loader

Payload: max. 300kg
Volume: 150x80x245
Width: approx. 100cm

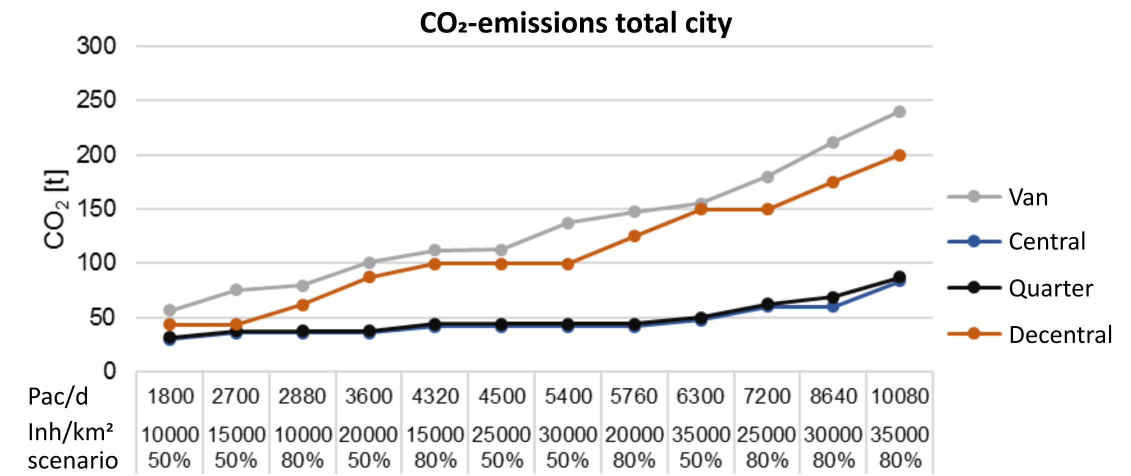
© Tom Assmann

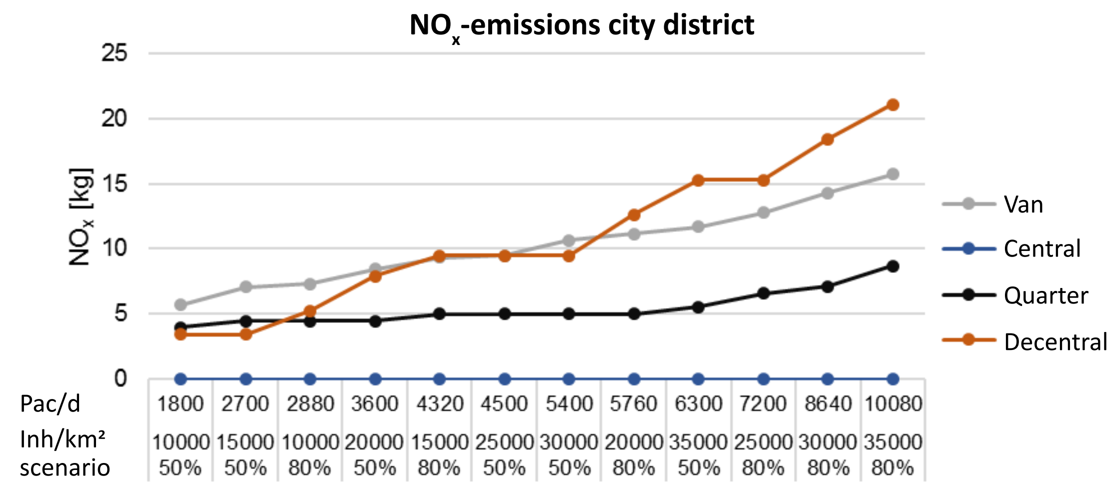
Pivot-mounted trailer,
Logistics

A3. Reference values for improving air pollutant emissions

Figure A.1 and Figure A.2 give guideline values for the possible improvement of air pollutant emissions for the scenarios of substitution of 50% and 80% of CEP deliveries by cargo bikes (section 5.3.1). However, the package quantity can be used for other areas under the condition of an approximately equal distribution of the sinks in the area.

"Van" refers to the conventional delivery with diesel vehicles. The representation refers to a mixed inner-city area. CO_2 emissions have a global effect and are shown for the entire city, including the inflow from the hub. NOx and PM_{10} have a local effect and refer absolutely to the district. The delivery to the transshipment hubs is from hubs that are on average 15 km away. Attention: For NOx there is no updated data with real tests.





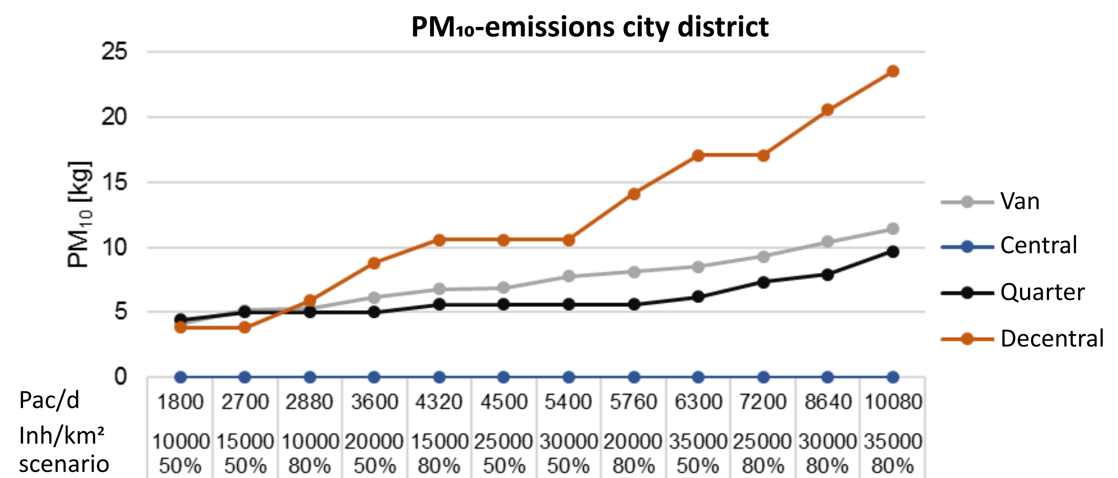


Figure A.1: Environmental impact of cycle logistics in neighbourhood deliveries per year in the delivery of transshipment hubs by truck

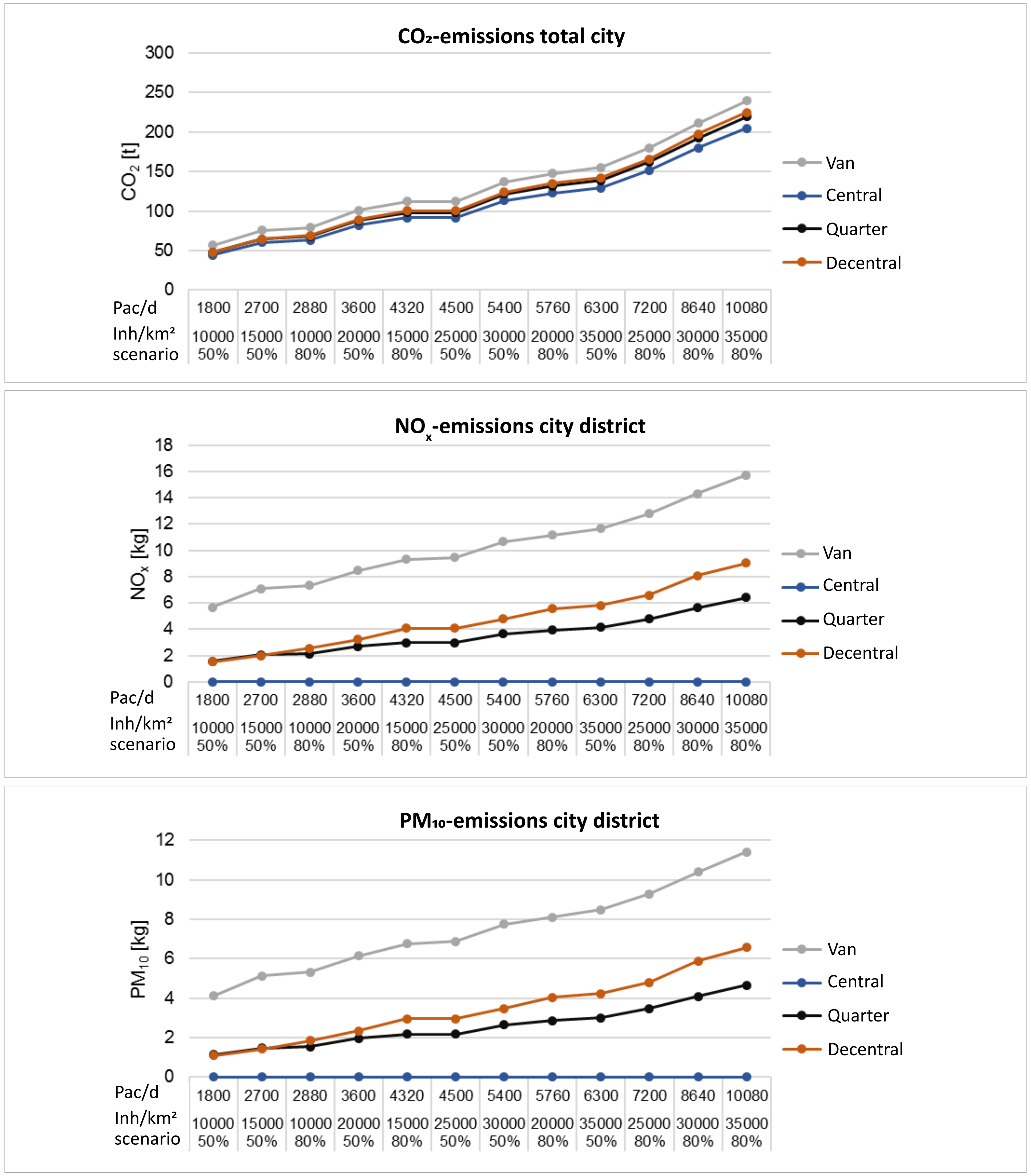
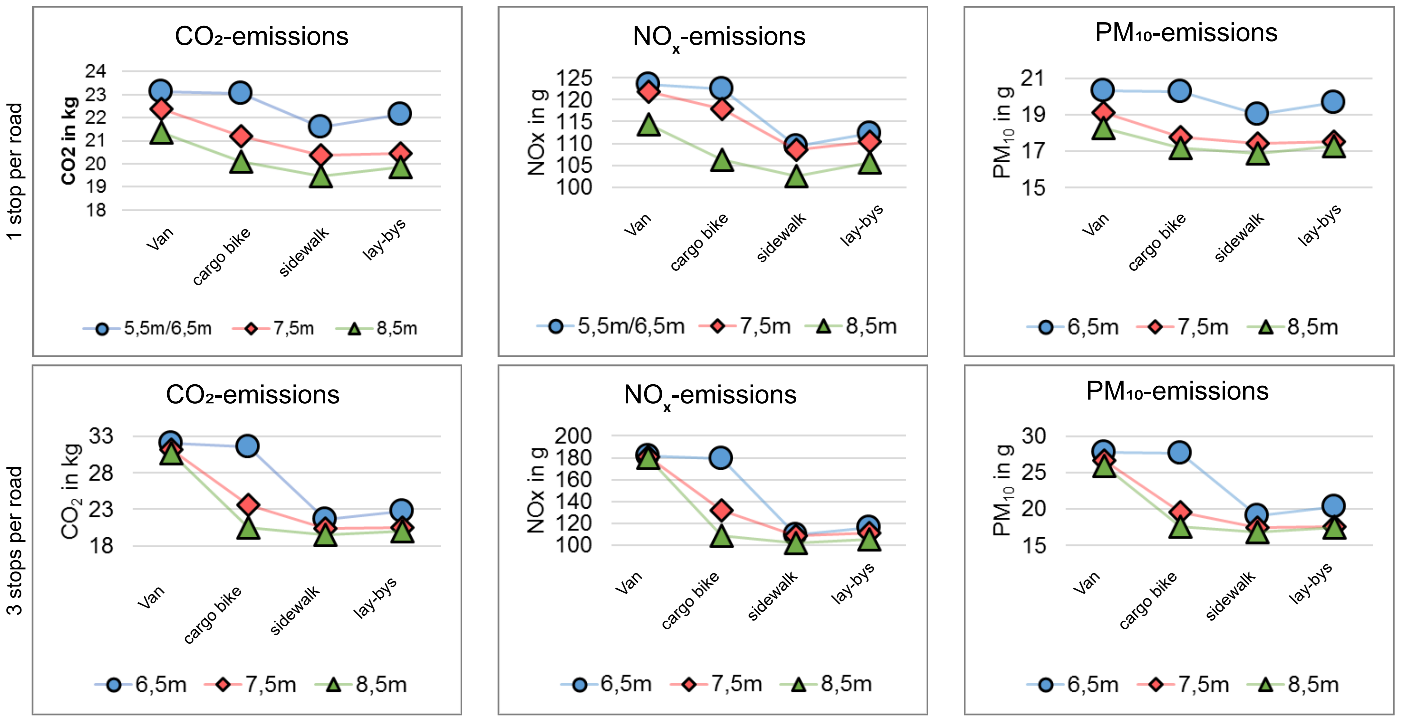


Figure A.2: Environmental impact of cycle logistics in neighbourhood deliveries per year for delivery of transshipment hubs by van

A4. Traffic quality of generalised urban roads

A5. Air pollutant emissions from delivery by vans and cargo bikes



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