

D2.5.4 Transshipment hub for last mile delivery



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GRETA Website

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More information about GRETA can be found on <https://www.interreg-central.eu/greta/>





Abbreviation table	
Abbreviation	Definition
CE	Central Europe
FUA	Functional Urban Area
SUMP	Sustainable Urban Mobility Plan
SULP	Sustainable Urban Logistics Plan
ZEV	Zero Emission Vehicle
CoP	City of Poznań
L-PIT	Łukasiewicz Research Network - Poznań Institute of Technology
ZDM	Zarząd Dróg Miejskich (local City Roads Administration)
DC	Distribution Centre



1. The GRETA project

GRETA project aims to decarbonise the last mile delivery in Functional Urban Areas (FUAs) in Central Europe (CE) and create liveable and accessible cities for all by 2030. The project seeks to implement joint sustainable solutions in CE FUAs using zero-emission vehicles and cargo bikes and reorganise urban spaces with curb management. The pilot actions in the cities of Maribor, Reggio Emilia, Verona, Poznan, and Budapest (with Berlin FUA as an observer) have the potential to quickly deploy as pop-up measures in combination with existing measures. GRETA provides capacity-building activities, strategies, action plans, and tools for public authorities, enterprises, and relevant organisations to ensure financial, environmental, and social sustainability beyond the project's lifetime.

Last-mile delivery generates negative impacts, including emissions, noise, and congestion. Due to the COVID-19 crisis, global parcel distribution volume nearly doubled, further increasing inefficiencies in the peripheral areas. GRETA's FUAs recognise the problems that generate pollution, nuisance, noise, congestion and have jointly recognised three main problems: the lack of use of green zero-emission last-mile vehicles, conflicts between freight and public vehicles, and the lack of knowledge and strategies for a flexible and shared use of the curb and public space. Despite having SUMPs/SULPs, FUAs struggle to activate fitting measures while keeping their centres attractive and alive for residents and tourists.

GRETA addresses the common challenges of all CE FUAs by creating the conditions to promote ZE logistics using micro-hubs, cargo bikes, light e-vehicles, and curb management strategies. Additionally, the project also focuses on paving the way to innovative concepts such as regional collaborative logistics, physical internet, and freight curb management. GRETA facilitates the dialogue towards the acceptance of a business and governance as a service model, where cities must equip themselves with a network of innovative services to guarantee seamless experiences for their users and a mobility plan considering different functions and priorities of the services.

GRETA's objective is to support the urban mobility transition in CE FUAs by jointly developing solutions and strategies with a huge potential for decarbonisation of the last mile in line with the EU Green Deal and the Urban Mobility Package, abating congestion, pollution, and nuisance. The project's success relies on capitalising on previous experiences, exploiting synergies with ongoing initiatives, testing innovative pilots, improving competences and knowledge among PPs and stakeholders.



2. Executive summary

As part of the implementation of Pilot Task 2 in Poznań, a living laboratory was established to facilitate the testing of a transshipment hub designed to support last-mile deliveries using cargo bicycles. The City of Poznań and Łukasiewicz-PIT, in cooperation with the Operator (GLS Poland), identified the location of the pilot installation based on the availability of a municipal plot, its transport connectivity, and the operator's operational requirements. The selected site is situated on Pułaskiego Street, on land owned by ZDM, which is designated for future Park & Ride development.

The implementation of the microhub involved a number of assumptions, designs and arrangements. First, the process was identified, and the equipment was adapted to its needs. A concept was prepared, on the basis of which the contractor selected during the tender process designed the hub and then delivered and installed it, after obtaining all the necessary approvals. During the implementation of the above works, as well as similar works in other pilot projects, there was ongoing cooperation with partners who implemented hub-related solutions.

After a six-month pilot project, feedback was collected from the operator (quantitative and descriptive data), its subcontractor, including couriers, and the hub supplier (qualitative data). On this basis, it can be concluded that the use of the hub has a positive impact on the urban environment (approximately 30% reduction in GHG emissions), a neutral impact on delivery efficiency (recipients were not aware of the form of delivery) and entails additional delivery costs.

The micro-hub has been designed to be transferable. Minor design adjustments (unnecessary heating of the hub space, recommended heating of the battery charging area), resulting from the pilot period, allow the solutions to be better tailored to the needs of future users.

Scaling up of the solution is limited mainly by internal cities regulations (applies in particular to city centres) and is linked to attempts to eliminate objects with poor aesthetic value from urban spaces, which container hubs undoubtedly are.

To minimize limitations of transfer, it is recommended to involve the city's authorities in the process, to cooperate with car park operators / owners and to avoid locations that are subject to protection for historical reasons.



3. Solution

3.1. General information

Poznań is one of the most important academic and cultural centres in Poland, with a stable economy, offering numerous knowledge-based services and a high quality of life. It is the fifth most populous city in the country, with more than 535,000 residents - about 1 million in the entire agglomeration. Among them are 104,000 students, who provide Poznań with an incredible dose of energy and contribute to its atmosphere.

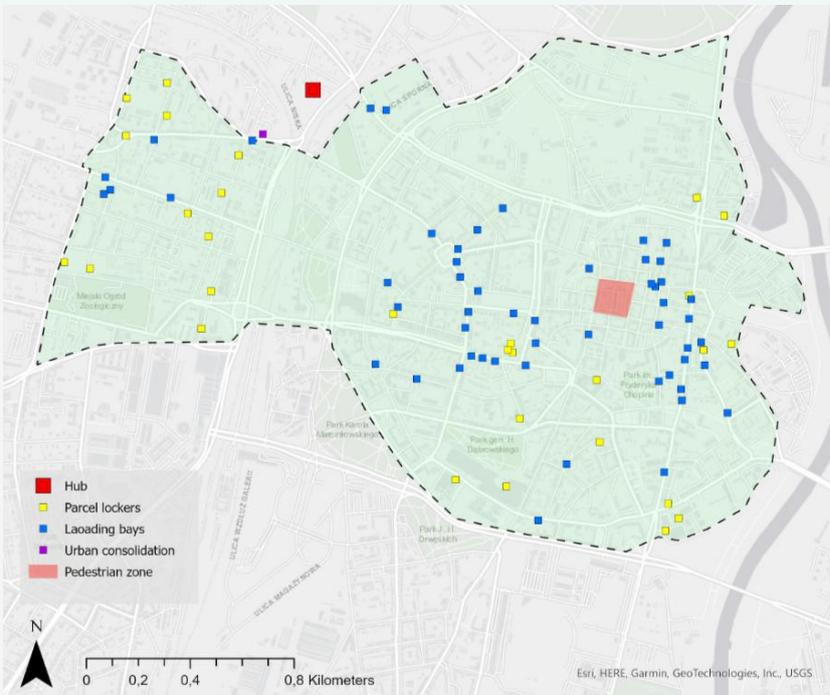
The city is located in Central Europe, halfway between Berlin and Warsaw. Travel is easy, as the city is very well connected to major European and Polish cities, including Frankfurt, Munich, Copenhagen, Warsaw and London.

Poznań is a fast-growing, dynamic, compact and modern city that attaches great importance to its heritage. Its history, location, accessibility, high-quality urban and tourist infrastructure and services, as well as investment in cutting-edge solutions, make the city not only an unforgettable tourist destination, but also a place to live.

Table 1: General information

Location	Poznań, Poland
Map (general map of the municipality + detailed map of the city centre)	 <p>Figure 1: General location map Source: GLS</p>



	<p>Detailed location map The map shows the location of the expected reach of the hub in relation of its location.</p>  <p><i>Figure 2: Detailed location map.</i> <i>Source: GLS</i></p>
<p>Area characteristics</p>	<p>Reach area type: partly residential (North from the location), partly old city centre (South from the location) Reach area size: 5.2 km² Access restriction: mostly without access restriction, apart from Old Market Square (pedestrian zone) Description of the area: there can be specified three types of areas:</p> <ul style="list-style-type: none">- mixed areas with historic buildings, mainly offices, hotels/hostels, restaurants and shops of various types, from groceries to exclusive goods, apartment buildings- single-family development, with detached house (flats and offices too)- residential areas (blocks of flats)

3.2. Strategy description

Solution description

The primary functions of the micro hub are: i) to serve as a backup facility for transshipment from delivery vehicles arriving from the distribution centre, equipped with cargo bikes, and ii) to provide temporary storage for parcels. Shipments delivered from the distribution centre are unloaded, sorted and then partially loaded into the cargo boxes of the bicycles. The remainder of the shipments, once sorted, are temporarily stored (optional) in the hub until couriers from subsequent rounds of deliveries arrive.

Once the deliveries are completed, the hub serves an additional function as a cargo bike garage space.



The location of the micro hub was strictly limited to available plots of City of Poznań. On the other hand, the location (see figure 2) directly next to the city centre with movement restrictions was very important. The final location is a compromise between available space and the requirements of the logistics operator.

Hub characteristics:

Specific dimensions were decided as external (length x width x height): 6,058 x 5,800 x 2,591 mm, internal (length x width x height): 5,897 x 5,700 x 2,392 mm (see Figure 3). The hub was made of at least 90% recyclable materials. It was a temporary facility, not connected to the ground. It was equipped with a docking system for reloading vehicles, the ability to work with 4 cargo bikes transshipment modules simultaneously and the ability to simultaneously reload 4 cargo bike transport boxes and 1 cargo box of a delivery vehicle. The hub had a secure garage space for 4 cargo bicycles (off-hours of the hub). It provided protection from weather conditions, i.e. rain, snow and hail, to enable handling of shipments. It ensured compliance with relevant regulations (including health and safety) and ergonomics for couriers and drivers.

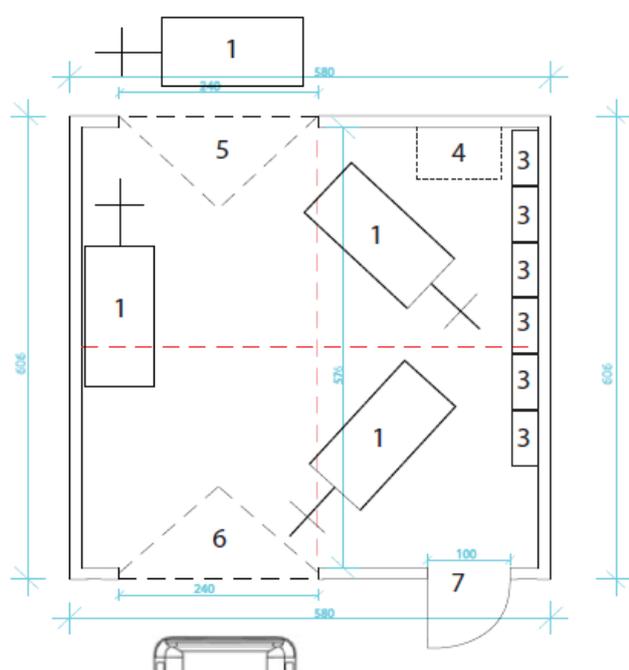


Figure 3: Microhub designed dimensions and main elements locations: 1. cargobike, 2. van (visible partially) 3. shelves, 4. charger location, 5. bike gate, 6. van gate, 7. doors (source: WCG design)

Bikes model description

Main parameters of the cargo bikes¹:

- vehicle weight: approximately 120 kg,
- length: 2705 mm,
- width: 900 mm,
- height: 1994 mm,
- electric power steering: 5 gears,
- range: 40-100 km on a single charge,
- battery change time: about 30-50 seconds,
- driver's protection roof.

¹ Details: <https://www.maxpromobility.com/pl/ecocargoxl>



Figure 4: Cargobike during the pilot duration (source: L-PIT)

Process execution:

The logistical process of handling parcels in the micro hub was initiated by the arrival of employees (bicycle couriers) at work and with the confirmation of their working hours in the internal system. Next, bicycle couriers opened the micro hub, followed by positioning the parked bicycles at the designated loading stations. After all activities inside the micro hub have been completed, couriers waited for the arrival of the delivery of parcels from Distribution Centre DC Głuchowo. The parcels were delivered to the microhub using a delivery vehicle (van). The parcels inside the vehicle were already be sorted into individual sub-regions. Once the delivery vehicle arrives, the sub-routes were assigned, and courier terminals were handed over to individual couriers. The next step in the process was the unloading of shipments by couriers and the simultaneous sorting into individual rounds of shipments on a given route (based on the experience of couriers and markings on labels) with their simultaneous registration. Shipments were distributed in cargo bike boxes and in a warehouse like microhub (there will be no need to record this operation). At this stage the handling ended. The delivery vehicle that delivered the shipments can drive away. At the end of this part of the process, the hub were closed.

Activities during the day:

Activities carried out during the day included the arrival of a courier from the next round of the sub-route and opening of the microhub. In addition, it was necessary to unload undelivered and (incidentally) shipped packages with simultaneous registration of operations in the terminal. Each day, the loading of parcels for the next turn (without registration) and the closing of the microhub were also performed.

Activities at the end of the day:

At the end of the working day, bicycle couriers were returning from the last route of deliveries made. It was necessary to transfer cash from collections to commercial deposit machine (optional). After the couriers return from the route, there will be an opening of the micro hub and unloading of undelivered and (accidentally) shipped packages with simultaneous registration of the operation with the terminal. Once the tasks were completed and the operational processes finished the hub was closed. The bicycles will then be parked inside the microhub for garaging. Once all these steps were carried out, the work will be officially concluded.

In addition, the last of the terminating couriers was required to wait for the arrival of a delivery vehicle from DC (probably one of the couriers from nearby routes). The vehicle that arrives was taking the



undelivered and posted packages and pick up the couriers' terminals. Once everything is done, the micro hub was closed.

Volumes:

The volumes of daily deliveries depend on the day of the week and the season, but it is assumed to be around 19 000 parcels during whole pilot's period.

3.3. Governance model

Local policies and regulations

The area where the micro hub was located belongs to the City Roads Administration (ZDM) and is managed by the local government of the city of Poznań. The ZDM is also responsible for the city's road network. Within Poznań, a Parking Zone and a Downtown Parking Zone have been designated. Currently, there are more than 100 delivery envelopes in the Paid Parking Zone and Downtown Paid Parking Zone (part of them - see Figure 3). Delivery envelopes are a solution aimed at businesses. Parking on them is time-limited, i.e. up to 15 minutes, and only possible with a purchased badge. In Poznań, there have been restrictions on the movement of trucks with a gross vehicle weight of more than 16 tons since 1997². In addition, vehicles with a gross vehicle weight of more than 3.5 tons are immediately allowed to enter the city centre itself.

The documents setting the directions for sustainable mobility in Poznań are the following, adopted in 2021. Sustainable Urban Mobility Plan for the City of Poznań and Transport Mobility Policy for the City of Poznań. Both documents include the most important scopes on logistics in the city and provisions from the Sustainable Urban Logistics Plan developed for SULPiTER project. In addition, in 2023, the Sustainable Urban Mobility Plan for the Poznań Metropolis until 2040 was adopted, which includes guidelines for Poznań and neighbouring municipalities. In addition, in Poznań, in 2020, the Strategy for Electromobility Development for the City of Poznań until 2035 was adopted, which indicates the directions for moving towards electromobility.

In terms of the pilot involving the micro hub, the most relevant are the regulations on temporary construction facilities. According to Article 29, paragraph 1, item. 12 of the Construction Law, temporary construction facilities only require notification to the competent administrative authority. In the case of Poznań, this is the Poznań City Hall. Due to the above regulations, the pilot can be implemented for a maximum of 6 months. A longer pilot and micro hub location would require a building permit. In addition, national regulations limit the width of cargo bikes to 90 cm (10 cm less than in most European countries), which affects the availability of bike types.

National policies and regulations:

Law of September 6, 2001, on Road Transport³ defines, among other things, the rules for undertaking and carrying out national and international road transport, as well as the conditions and procedure for obtaining certificates of professional competence.

The Road Traffic Law of June 20, 1997⁴ specifies the rules of road traffic on public roads, as well as the terms and conditions that vehicles must meet in order to be admitted to traffic.

Law of November 15, 1984, Transportation Law⁵ sets out rules for the transportation of passengers and goods.

² Ustawa z dnia 20 czerwca 1997 r. - Prawo o ruchu drogowym, Dz.U. 1997 nr 98 poz. 602

³ Ustawa o transporcie drogowym Dz.U. 2001 nr 125 poz. 1371 / Road Transport Act, Journal of Laws 2001 No. 125, item 1371

⁴ Prawo o ruchu drogowym, Dz.U. 1997 nr 98 poz. 602 / Road Traffic Act, Journal of Laws 1997 No. 98 item 602

⁵ Prawo przewozowe Dz.U. 1984 nr 53 poz. 272 / Road Transport Law, Journal of Laws 1984 No. 53, item 272



The purpose of Law of January 11, 2018, on electromobility and alternative fuels⁶: is to define the rules for the development and operation of infrastructure for the use of alternative fuels in transportation. It aims to encourage drivers to choose electric cars and those powered by other alternative fuels. The law introduced the possibility of establishing Clean Transportation Zones in Polish cities, among other things.

EU policies and regulations:

European Commission Transport White Paper setting the goal of a 'carbon-free urban freight distribution', i.e., zero direct carbon dioxide (CO₂) emissions by 2030; the proposed revision of TEN-T Regulation is followed with great attention from the cities, especially the part related to the definition of the Urban Nodes, which will influence also city logistics planning, as well as the ambitious target of phasing out ICE vehicle sales by 2035.

It supports EU goals for sustainability, decarbonisation of transport, and improved urban mobility while contributing to environmental and public health objectives. By aligning with the EU's Green Deal, urban mobility frameworks, clean Vehicle directive⁷, and vision zero for road safety⁸, the project can help meet broader EU targets for a greener, safer, and more efficient transportation system.

3.4. Digital and physical infrastructure

To the pilot's digital and physical infrastructure can be included:

- innovative microhub, with photovoltaic (optional grid-off possibility), with green wall,
- cargo-bikes corresponding with the needs of the operator,
- own operator system (software, terminals) and procedures, modified for the utilization of the microhub,

The cross-dock operations were conducted in a safe and a weatherproof area, with ensured safety for both couriers and parcels.



Figure 5: Microhub and cargobike visualization (source: WCG design)

⁶ Ustawa elektromobilności i paliwach alternatywnych Dz.U. 2018 poz. 317 / Act on Electromobility and Alternative Fuels, Journal of Laws 2018, item 317

⁷ DIRECTIVE (EU) 2019/1161 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 20 June 2019 amending Directive 2009/33/EC on the promotion of clean and energy-efficient road transport vehicles

⁸ European Commission: Directorate-General for Mobility and Transport, *Next steps towards 'Vision Zero' - EU road safety policy framework 2021-2030*, Publications Office, 2020, <https://data.europa.eu/doi/10.2832/391271>



4. Impact of the solution

4.1. Environmental impact

Based on the assumptions made the estimated GHG emissions reduction is about 30%, which means a decrease by:

- 2,57 t eCO₂ (in the case of minimising combustion engine vehicle traffic)
- 1,52 t eCO₂ (in the case of minimising electric vehicle traffic)

over the pilot period of 6 months.

4.2. Economical impact

However, the indicated reduction requires expenditures on the part of the operator. This has been estimated in three ways:

- taking into account the Operators rates, paid for each delivery,
- minimising traffic of electric delivery van,
- minimising traffic of diesel delivery van.

Depending on the calculation method, the introduction of deliveries by cargo bikes involves additional costs of different levels, which can, however, be simplified to estimated increases in delivery costs, respectively by 6%, 8% and 14%.

Base on above stated data approximate cost of reducing GHG emissions by minimizing the use of cars amounts to:

- combustion engines EUR 1,80 / kg eCO₂
- electric EUR 3,04 / kg eCO₂

4.3. Social impact

The informal interviews with bicycle couriers leads to summaries:

1. Recipients did not report any changes in the efficiency of deliveries made by bicycle compared to traditional deliveries; in fact, most recipients were unaware of the method of delivery.
2. Couriers reported positive interest from bystanders who, in addition to friendly comments, expressed a desire to be employed as couriers or to purchase ice cream (both cases authentic), which further emphasises the positive connotations of cargo bikes.
3. Couriers reported some difficulties related to overcoming architectural barriers, which are often less significant for traditional bicycles but hinder the comfortable ride of cargo bikes, which are assumed to be much heavier and slightly less manoeuvrable.

From the point of view of local benefits, the introduction of cargo bikes has reduced the number of kilometres travelled by delivery vehicles by approximately 31%, which directly translates into traffic intensity on the streets, obviously on a pilot scale and scope (micro scale). In the case of a reduction in combustion engine vehicle traffic, this is associated with a proportional reduction in harmful emissions from this type of vehicles.

The application of similar solutions for all e-commerce deliveries will result in similar results on a macro scale.



5. Transnational Cooperation

5.1. Scaling-up

One of the primary tasks of the pilot project was to create a solution that could be scaled and transferred to other locations within the city and to other cities.

Table 2: Scaling up – plans and recommendations

Plans for scaling up the solution in the pilot area.	Pilot was planned for one microhub. Scaling-up is the matter of operators and the city.
Suitability for scaling-up	The pilot microhub is one module prepare to operate with one operator and max 4 cargo bikes. In case of scaling-up more “modules” can be added, independently of whether by an additional operator or by one of the operators planning to use another four cargo bikes. In principle, there is no technological limit to the number of modules, it is only limited by the availability of space and obtaining development permits.
Identified risks for scaling up and solutions to overcome them (risk mitigation).	In case of scaling-up on the same location congestion of cargo bikes and trucks have to be considered. The limitation of use the containers in the city environment is additional limitation of scaling-up.

Immediately after the pilot project was completed, the operator began distributing parcels via the hub on commercial terms, which indicates the potential interest of entrepreneurs in such activities and the possibilities for their commercial development.

During the project, meetings were organised for representatives of interested city councils, local governments and NGOs. Most of the participants expressed interest in implementing similar initiatives in their own ‘backyards’. Independent initiatives were launched in Wrocław (organised in parallel with the Poznań pilot, starting operations slightly later), Gdańsk and Warsaw. Although each of these initiatives adopted slightly different assumptions (for example, in Wrocław, the space is shared and organised in an underground car park), the Poznań experience has had an impact on these and similar local initiatives.



5.2. Transfer

The hub design is based on the principles of transferability and universality, with specific possibilities to be defined during the design phase of the hub and pilot preparation. Additionally, a transferable model of cooperation with stakeholders, primarily cities, will be tested, along with a flexible, open-concept technological solution for the hub that will be validated during the pilot phase.

Table 3: What to expect - problems and solutions

Problems and solutions	
Problems faced	The biggest limitations on hub transfer include: i) the possibility of locating a hub in the form of a container in urban space, limited by the procedures of city architects and, where applicable, the conservator of monuments (if the location of the hub is within his jurisdiction), ii) obtaining formal permits for the location of the hub as a structure not connected to the ground, firstly, obtaining such permits at all, and secondly, the duration of the procedures for obtaining these permits.
Corrective actions taken	Ways to avoid these restrictions include: i) locating the hub on private land where the location of such facilities has already been agreed, ii) locating the hub in underground car parks, where there are fewer restrictions, iii) using existing infrastructure for transshipment operations or local industrial zones, if they exist in the neighbourhood of the delivery regions concerned, iv) allowing sufficient time in the schedule to obtain formal approvals for the location of the hub in the form of a container.
What to watch out for	Suggestions/recommendations: i) involve the City in the process of preparing and launching the hub, ii) cooperate with an (car park) operator with experience in obtaining permits for the location of hub-type facilities, iii) set an appropriate launch date for the hub in relation to the expected dates for obtaining permits, iv) avoid locations that are subject to protection for historical and/or environmental reasons, v) verify all potential location options for the hub within the existing infrastructure.



6. Lessons learnt

Experience on a micro scale proves that it is possible to reduce emissions by using cargo bikes and microhubs. However, the incomplete utilisation of the potential of cargo bikes (4 hours of deliveries per day on working days) leads to positive environmental effects associated with increased costs. The positive social effects are indisputable, with a neutral impact on the process efficiency of deliveries.

This leads to the final conclusion that the pilot project was successful, proving the validity of implementing similar solutions on a wider scale.

Transferability was the condition of hub design. Hub was design as one module, which can support up to 4 cargobikes with reloading, ruffed space. The module can be moved (with crane support) and installed in sets of several units. The design is intended to be universal and will probably work well in other locations. The only equipment that was not used was the heating, despite piloting in winter (in fact it was only used to ensure optimal battery charging conditions at low ambient temperatures).

Combining modules into sets requires careful location of individual modules in order to reduce congestion of vehicles servicing hubs and cargo bikes, for example due to similar courier delivery times.

Despite the support of local communities and city authorities, the launch of the hub is facing difficulties related to paperwork. Firstly, containers are not welcome in city centres, especially historic ones, which is understandable. Secondly, obtaining all the formal approvals for the hub's location is a tedious and time-consuming process, despite the aforementioned support. The hub, as a building structure, is no exception, and as it is unusual, it may encounter unforeseen procedures. Therefore, the creation of a container-based hub should be preceded by consultations with the relevant municipal services in order to find a happy medium between architectural and formal compliance and the reduction of harmful emissions.



7. Conclusions

The pilot project proved the usefulness of micro-transshipment hubs in reducing emissions in urban environments without affecting process efficiency.

The solution developed in cooperation with the project partners has the potential for scaling and transfer, although this is limited in some areas of the city, especially historic ones. However, this does not change the outcome of the project in the form of a concept for limiting car traffic in favour of cargo bikes and a design solution which, after adaptation to local requirements and conditions, can support distribution and cities in reducing harmful emissions and congestion.

Restrictions on the location of hubs in city centres are most often due to internal regulations, which are understandable, but should be somewhat 'flexed', as the emerging innovative solutions will have a different, non-visual beneficial impact on the quality of life in the city.

