URBAN LOGISTICS AS AN ON-DEMAND SERVICE

Summary of practical research trials

ULaaDS D4.7 – Summary of practical research trials

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Project abstract

ULaaDS sets out to offer a new approach to system innovation in urban logistics. Its vision is to develop sustainable and liveable cities through re-localisation of logistics activities and re-configuration of freight flows at different scales. Specifically, ULaaDS will use a combination of innovative technology solutions (vehicles, equipment and infrastructure), new schemes for horizontal collaboration (driven by the sharing economy) and policy measures and interventions as catalysers of a systemic change in urban and peri-urban service infrastructure. This aims to support cities in the path of integrating sustainable and cooperative logistics systems into their sustainable urban mobility plans (SUMPs). ULaaDS will deliver a novel framework to support urban logistics planning aligning industry, market and government needs, following an intensive multi-stakeholder collaboration process. This will create favourable conditions for the private sector to adopt sustainable principles for urban logistics, while enhancing cities' adaptive capacity to respond to rapidly changing needs. The project findings will be translated into open decision support tools and guidelines.

A consortium led by three municipalities (pilot cities) committed to zero emissions city logistics (Bremen, Mechelen, Groningen) has joined forces with logistics stakeholders, both established and newcomers, as well as leading academic institutions in EU to accelerate the deployment of novel, feasible, shared and ZE solutions addressing major upcoming challenges generated by the rising on-demand economy in future urban logistics. Since large-scale replication and transferability of results is one of the cornerstones of the project, ULaaDS also involves four satellite cities (Rome, Edinburgh, Alba Iulia and Bergen) which will also apply the novel toolkit created in ULaaDS, as well as the overall project methodology to co-create additional ULaaDS solutions relevant to their cities as well as outlines for potential research trials. ULaaDS is a project part of ETP ALICE Liaison program.

Keywords

Urban logistics, sustainability, trials, testing, guidelines, framework, Lighthouse Cities, WP4 Effective Trialling, Mechelen, Groningen, Bremen, VIL

Copyright statement

Executive summary

Deliverable 4.7 – summary of practical research trials gives the reader an insight in how the actual trials were conducted during the ULaaDS project, from defining the solutions, over actual implementation to the lessons that can be learned.

The first part of this report discusses the setup of the trials: what was the actual purpose, of trialling, what was the overall methodology to be applied and which aspects should be treated with deeper attention.

The second part of this document, describes the trials that were conducted in each city in detail. Per city and per trial, a deep dive is taken in the setup phase, the actual testing, which barriers and practical obstacles came up – and how did the trial team dealt with these, and most of all: what were the outcomes of every trial. Every trial had its own course and deviations according to the initial proposal, and each trial had specific learnings that can be taken along. These learnings mostly served as input for the assessments that were made within the ULaaDS project, with a focus on the economic, social and sustainability aspect of parcel delivery in a city context.

The third part of the report discusses some overall learnings that can be made, concerning the trial objectives (discussed in the first part of the report). These results are not described in detail, because they are the topic of other publicly available deliverable reports coming from ULaaDS. Yet, it seemed appropriate to at least discuss the main takeaways.

The fourth part takes a step back and looks at the overall process of trialling. After 3.5 years, the ULaaDS-team has the audacity to say it has learned a few things about the actual process of conducting trials, how to retrieve data from testing partners, how to engage stakeholders in collaborating and creating solutions for collective problems,… these lessons were learned by trial and error, and it is therefore important to share these learnings and help future project implementations in having a more smooth, adaptable process than the trial process of ULaaDS.

The end note shortly discusses the overall lesson that every future trial partner, participant, leader,… should take with him/her/they: it discusses a resilient attitude, with a ‘can do’ mentality. This was most necessary during the overall trial period in ULaaDS, and might be the most important (yet easy to say) lesson that can be learned from the trial period within the project.

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Acronyms + list of figures

Acronyms

Acronym	Meaning
EU	European Union
RYTL	Rytle
RUG	Rijksuniversiteit Groningen
IFZ	Interdisziplinäres Forschungszentrum für Technik, Arbeit und Kultur
ODD	On-Demand Delivery
PPP	Public Private Partnership
MaaS	Mobility as a Service
DMP	Data Management Plan
KPI	Key Performance Indicator
GDPR	General Data Protection Regulation
TOI	Transport Ekonomik Institut
P+R	Park and Ride
MEC	Mechelen
BRE	Bremen
SUMP	Sustainable Urban Mobility Plan
SULP	Sustainable Urban Logistics Plan
GRO	Groningen
UFT	Urban Freight Transport
ULaaDS	Urban Logistics as an on-Demand Service
ZEV	Zero Emission Vehicle

List of figures

1. Intro

The ULaaDS project started in September 2020. Shortly after the start of 2021, the three living lab cities – Bremen, Groningen and Mechelen – started under the supervision of partner VIL with preparing the city and the local testing partners for effective trialling within (or around) the city, in real life conditions. Some cities (like Bremen) had a clear idea what it wanted to do and could build upon previous experiences, other cities (like Groningen and Mechelen) were planning to implement new solutions with local partners. During the setup and trial phase, all three cities had unforeseen hurdles to overcome. Not in the least Covid in the beginning, but also other (less external) hurdles. Such as: how to gather data from partners? How to convince stakeholders in participation? And if stakeholders no longer wanted or could collaborate, how to respond and react? How to keep the momentum to go from concept to effective trialling? This document will give the reader an overview of what happened in 3.5 years of ULaaDS within the lighthouse cities, the living labs, what the results were and what project partners learned out of this process. If it is about stakeholder engagement, data sharing and gathering, technologic possibilities, or just plain practical issues: many obstacles came along, within all three cities, and other stakeholders in the field of city logistics or innovative projects can learn from them. And there were very positive results as well, which the ULaaDS-team wishes to share as well, of course.

2. Effective trialling of the ULaaDS-solutions

This part of the document discusses the effective testings in real life conditions, which happened in all three lighthouse cities: Bremen, Mechelen and Groningen. It is built up in a logical setup: It discusses the goals of the trials (why are we doing this?), the methodology used (how are we doing this?), to continue in the next part of the document: the results.

2.1 Goals of the trialling period

Figure 1: ULaaDS solutions and schemes

The project goals are shortly described as the following: to create and test business models for sustainable city logistics operations, so they can be implemented in the future. These trialled solutions were built on two main principles: **collaboration and shared assets between logistics partners and stakeholders**, and the **integration of passenger flows with urban freight networks**. Five theoretical solutions were described:

- **Collaborative and shared urban logistics:**
    - Containerized urban last-mile delivery:

      Instead of traditional vans performing the inner city logistics, containerization introduces standardized and modular load units, such as specific standard sized-containers for the last-mile. These containers allow multiple parcels to be placed

inside at the sorting terminal and then transported to city hubs. At these hubs, the containers are transferred to last-mile delivery vehicles such as cargobikes.

ULaaDS experimented with containerized urban last-mile delivery in its pilots by consolidating parcels destined for the same city area. Sorting occured at a hub, organizing packages based on their delivery zones. Subsequently, containers bound for nearby areas are delivered to city hubs by small vans and e-vans. Cargo bikes are then employed to cover the final distance, collecting the containers for efficient last-mile delivery.

- Sharing economy platforms for on-demand city logistics:

  An increasing number of startups and larger corporations, are providing on-demand delivery (ODD) services. These services are fulfilled by an expanded network of independent delivery couriers. Among the various options utilized by retail businesses for ODD, crowd logistics has emerged as a rapidly growing trend in recent years. Unlike traditional logistics methods, crowd logistics involves enlisting the help of citizens, either individually or collectively, who synchronize the shipment of parcels with their regular routes, utilizing their own means of transportation, ranging from bicycles to motorbikes or cars.

  ULaaDS investigated the potential of bicycle couriers networks and conducted experiments to test different methods of organizing and managing bicycle transport between micro hubs and logistics centers.

  With the aim of enhancing the integration of crowd logistics, ULaaDS explored options such as offering cargo bike sharing programs, accessible to all users. Individuals can register as independent contractors on the ODD platform and choose when and how frequently they wish to work without the need to purchase a cargo bike themselves.

- Citywide platform for integrated management of urban logistics:

  In this solution, all urban delivery capacities operate through a single platform that is neutrally organized and can be operated by the providers themselves, a city-owned company, a third party, or through a Public Private Partnership (PPP). This platform aggregates the flow of goods from all providers and utilizes decentralized warehouses to optimize last-mile deliveries. The city establishes the framework within which the platform operates, including criteria for selection and regulatory interventions.

- **Integrated passenger and urban freight networks**

  - Dual Mobihub:

    Dual flow hubs are based on the existing mobihub concept, which originated in Bremen (mobil.punkt) and has since been expanded to other cities and regions such as Flanders, Bergen, Drenthe, and Groningen. The mobihub serves as an intelligent node in the transportation network, seamlessly integrating various

modes of transport through multimodal supportive infrastructure. This infrastructure includes carsharing parking slots, bike-sharing docks, public or collective transport stations, EV chargers, and public cargo bike-sharing platforms.

The ULaaDS Dual MobiHub aims to combine the current mobility functions of mobihubs with peri-urban and urban freight delivery functions. Moreover, they can feature delivery drop-off and pick-up points, as well as shipping pick-up stations like automated parcel lockers, enabling flexible delivery options.

- Cargohitching:

  This solution integrates the on-demand delivery of small goods with shared passenger transport, utilizing the available capacity of transport vehicles. The following approaches are under consideration:

  - Electric vans deployed as on-demand or regular taxi services within the city, offer shared rides for both passengers and small cargo, such as deliveries from local businesses.
  - (Semi)autonomous electric shuttles running on fixed routes throughout the city as part of the public transport network, provide efficient transportation for passengers and small goods.

  The objective of ULaaDS is to expand shared mobility and Mobility as a Service (MaaS) capabilities, providing a dynamic solution that enhances the level of service for businesses and private recipients in peri-urban and urban areas, including the city centre and residential neighborhoods.

The three lighthouse cities – Bremen, Mechelen and Groningen, were all three supposed to perform at least two trials that could be linked to one or more of the theoretical solutions, built on the main two principles. Together with their local project partners, they were given the time and tools to explore business model opportunities within their local logistics stakeholder community and with the help of the project partners.

2.2 Effective trialling methodology

This section describes the initial methodology prescribed to follow during the trials. This methodology was set up during the beginning of the project phase, and based on the project proposal basics. This resulted in a first deliverable 4.1 - Trial experimental plans description repository for effective implementation (and iterations), renamed to ‘framework for effective trialling’. This deliverable was treated confidential, because it is a living document that underwent iterations during the project.

The ’framework for effective trialling’ is all about giving guidance to the lighthouse cities during the process of the trials. To ensure that trials are implemented correctly and on time, allowing all project partners the time and input for analysis and comparison of results, the different trials must follow

a unified methodology and timeline. This framework listed up all the "do's" and "don'ts" during the three trial phases: preparation, effective trialling and analysis of the results.

During the effective trialling period, it became clear that following a pre-set methodology was nearly impossible to follow, as every real-life trial has its own conditions and things to take in account. However, a few basic principles remained to be challenged during every trial in every city: the inclusion of stakeholders in forming, testing and evaluating the solutions, the retrievement of data and captivating overall lessons learned.

2.2.1 Pre-trial setup

The preparation phase started in February 2021 and concluded 'officially' in December 2021, though this was different for every trial. Throughout this period, the lighthouse cities and their trial partners actualized the solutions and plans they committed to trial. This process began by comprehending the project methodology and crafting solutions in collaboration with other horizontal project partners, with their input from other work packages. Rijksuniversiteit Groningen (RUG) provided the living labs with theoretical research on the pre-developed trials, to create insights and focus points for implementing the effective solutions. Other factors that could influence the trials were listed and gathered in a document called 'city profiles', which contained a trial environment description. This document served as a guideline for cities that were following closely the project results (satellite cities), to get an idea and overview of the implementation factors to be taken in account, and under which conditions that the trials were conducted. The following aspects were taken in account:

- Overall city conditions: a description of the city environment prior to the trials, e.g., narrow/cobbled streets, steep hills, density, etc.
- Trial profile description: an extensive description of the trial setup: what, where, who, etc.
- Before scenario: a description of the current situation of the logistics ecosystem in the city, the impact of parcel delivery on the liveability in the city and why the trials will form solutions for these problems.
- Business-as-usual-scenario: a description of the scenarios that would happen if no actions will be taken: e.g. more traffic jams, accidents, air pollution, etc., within the city. This is a reflective process, to point out the reasons for implementing the solutions.
- Expected scenario: a description of the scenario that will take place during or after the trials are executed and extrapolated to the entire city. This is a reflective process. Together with the business-as-usual scenario, it will describe the value proposition towards the stakeholders and create support by those stakeholders.

2.2.2 Active stakeholder activation process through stakeholder fora

Long-term success necessitates the support of diverse stakeholders. Involving these stakeholders in the development and decision-making processes enhances acceptance among the affected companies and communities. Therefore, stakeholder involvement was a key element in the trials of

ULaaDS. Therefore, partner Interdisziplinäres Forschungszentrum für Technik, Arbeit und Kultur (IFZ) provided a framework for stakeholder activation and involvement at the beginning of the project. This framework was built on a multi-stakeholder approach. This approach aimed to co-create solutions for ULaaDS trials through dialogues with relevant stakeholders, defining the logistic ecosystem and necessary stakeholder involvement for trial success. The methodological approach and engagement framework are tailored to each city's unique trials and requirements.

The multi-stakeholder process encompasses stakeholder mapping, local fora, working groups, a collective target system, and questionnaires. Local fora play a pivotal role, with at least three conducted in each city. The first forum focuses on refining trial parameters based on stakeholder needs before trialling commences. The second, held during the trial, allows for mid-course evaluation and feedback collection. The final forum, at project's end, evaluates lessons learned and explores future opportunities post-project.

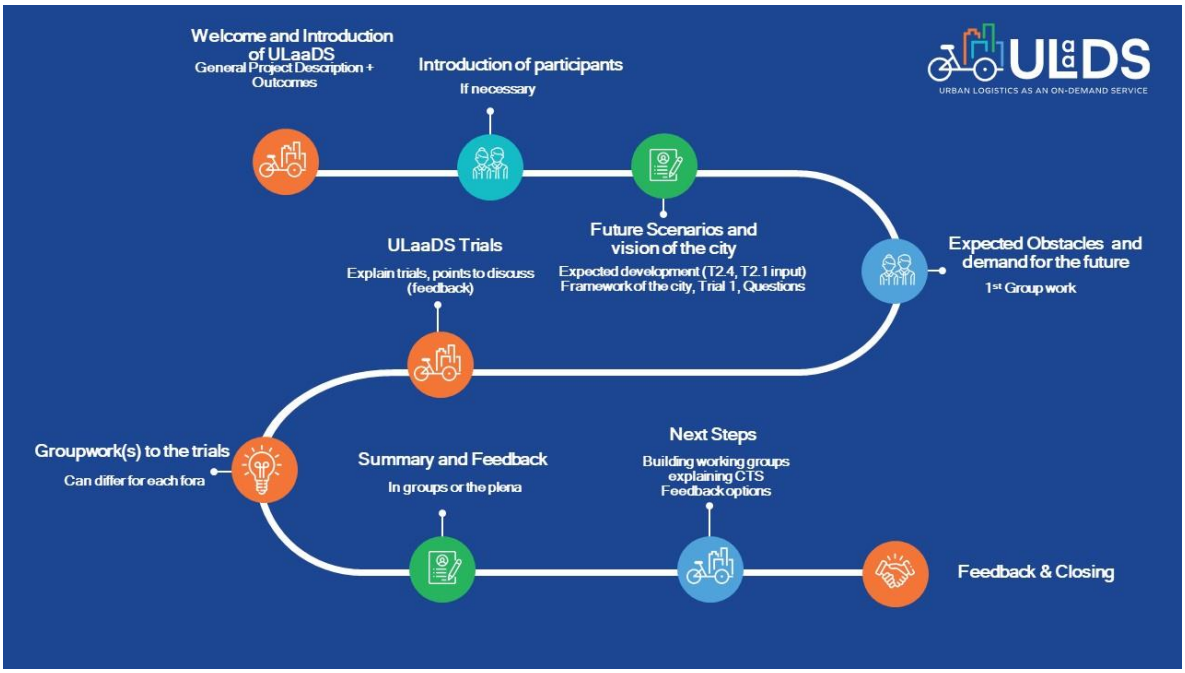

Figure 2: ULaaDS stakeholder forum theoretical course of the day

The collective target system tracks local forum activities to discern common and diverging stakeholder objectives. Additional open data inquiries are addressed through further stakeholder engagement or questionnaires. Finally, a deductive impact assessment was planned to demonstrate how results from previous steps inform adapted and updated trial descriptions for ULaaDS use cases.

2.2.3 Data-retrievement

Data-retrievement was a key activity within the trials of ULaaDS. To ensure a correct data-retrievement methodology was applied during the trials, project partner VIL set up a Data Management Plan (DMP) to guide the living lab partners in the correct application of data-

retrievement. this DMP outlines the collection, requirements, treatment, and security measures regarding the project's data, and provides the correct forms to be in line with GDPR. It serves as a comprehensive guide for managing data throughout the project lifecycle. This DMP also outlines and overview of what type of datasets will be produced, as well as defining a set of attributes to be used to describe each dataset. These descriptions include methodologies, sharing and storage procedures. All project partners involved in data-related activities, including collection, generation, processing, and dissemination, were consulted to ensure their research data was adequately addressed in this deliverable. They provided specific contributions to the development of the DMP.

Next to a correct application of the data retrievement methodology, it was most important to find out which data could be generated and what would be calculated and monitored during the trial phase. Therefore, a list of possible KPIs (key performance indicators) was set up by partner Transport Ekonomik Institut (TOI). six areas of impact were defined, where the ULaaDs trials and schemes theoretically should bring a (positive) impact. These areas are environment, land use, traffic efficiency, logistics efficiency, economic impact, user experience and acceptance and awareness. To each area of impact, different objectives were described, with underlining KPIs.

Objective	Key Performance Indicator (KPI) (unit of	Support indicator	Unit of measurement per support indicator
ENVIRONMENT			
Reduced greenhouse gas (GHG) emissions	CO2 eq. emissions (kg)	No. of vehicles	Quantity
		Km driven	Km
		Vehicle type (diesel, petrol, bio fuel, electric)	Vehicle type
		Size/category of vehicle (cargo bike, van truck)	Tons OR category
		Energy consumption	Kilowatt-Hour (kWh)

Figure 3: Example out of KPI list

To define these KPIs, stakeholder interviews were conducted to clarify the KPIs and their associated support indicators, which are the datasets required to measure the KPIs. The list of KPIs was exhaustive and started from an 'ideal' situation, with a long list of potential KPIs. Stakeholders provided feedback on their feasibility for providing the data. If certain KPIs were deemed unfeasible, solutions were sought collaboratively to either obtain the necessary data or approach the KPI goals differently. The initial KPIs were defined by November 2021, following the first and second feedback rounds from trial partners. As the trials continued to take shape, the initial list of Key Performance Indicators (KPIs) remained subject to change throughout the preparation process. These changes depend on several factors, including data availability from partners and stakeholders, the effectiveness of the KPIs once the trials start, and feedback gathered from the stakeholders.

In the KPI definition process, an exhaustive list of 6 areas of impact, 13 objectives, 29 KPIs and 95 support indicators were defined.

3. Report of the trials

This section of the report will discuss the setup, deployment and results from the trials, with its key learnings. The trial setup phase started in month 6 of the project, and ended in month 36: from January 2021 until June 2023.

3.1 Trials Bremen

As the process of trialling in Bremen was an exhaustive work with a lot of ups and downs, this section will provide qualitative explanation on the existing results, or in some cases, the lack of existing quantitative results. The document is built up in three separate parts:

- Trial 1 in Bremen, where Rytle (RYT) has operated a containerised last mile solution in collaboration with partners from the freight village (GVZ) and other local stakeholders
- Trial 2 in Bremen, where ADFC implemented a cargobike sharing service to enhance and further integrate the dual MobiHub concept in the urban and peri-urban area of Bremen
- Trial 3 in Bremen, where Via (VVA) developed a dedicated use case of their novel solution for on demand urban logistics, involving electric vans operating on-demand offering pooling for cargo (“cargo-hitching”)

3.1.1 Trial 1: Microhubs for last/first mile delivery

3.1.1.1 Trial setup and goals

The initial research trial in Bremen focused on the inner city region, utilizing ULaaDS solution 1: collaborative and shared urban logistics solutions – scheme 1: containerized urban last mile delivery.

Project partner Rytle provided the containerized microhubs and cargobikes, that can pick up standardized sized boxes and pallets. They partnered with the freight village Bremen (GVZ) and other local stakeholders to facilitate containerized last mile solutions, expected to span 12 months.

3.1.1.2 Trial evolution

Trial 1 focuses on the conception and implementation of a logistical concept for the "last mile" in the energy-efficient, climate-friendly, and environmentally friendly supply of the city center of Bremen. Within the scope of UlaaDS trial 1, the activities that were initiated as early in 2019 (as project “Urban-BRE”) have been successfully continued and significantly scaled up / expanded.

The core idea of the trial 1 concept is to organize the delivery of shipments (pallets and general cargo) to the city center of Bremen from the Freight Village (GVZ) by introducing an additional distribution stage (via a micro-depot). The goal is to reduce pollutant and noise emissions, improve

logistical performance for end customers, and simultaneously enhance the competitiveness of the participating companies (see figure 3).

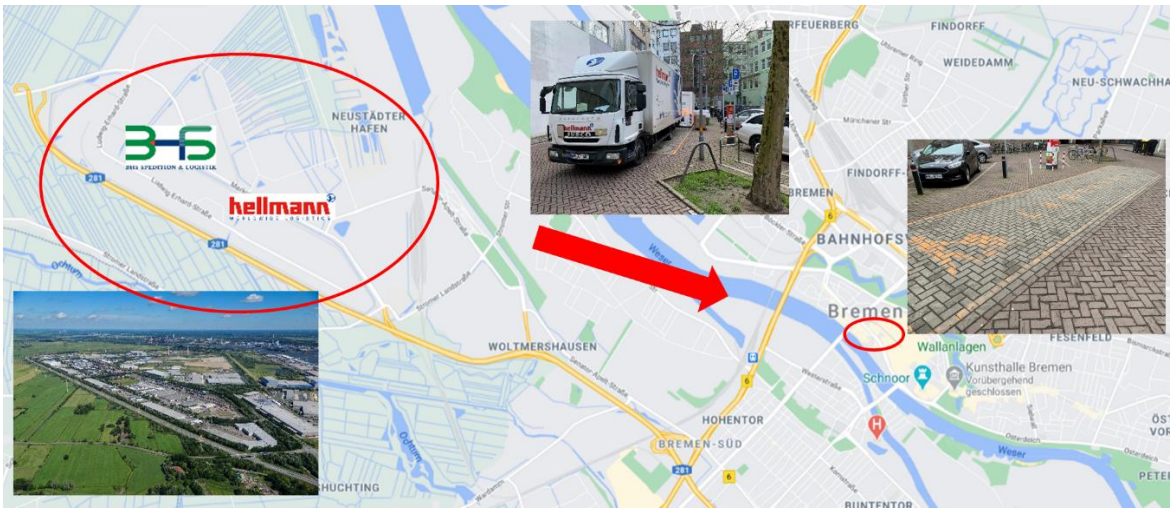

Figure 4: Supply chain process ULaaDS: From GVZ Bremen to the ULP Umweltladepunkt (restricted transhipment point)

The following photo shows the 10-foot container stationed at the ULP (restricted transhipment point), located at Jacobikirchhof (Bremen, Martinistr. 57), which is used as a micro-depot. The ULP is a public area (public street space) that could be reserved for the exclusive use by the trial 1 under a special use agreement (“Sondernutzungsvereinbarung") issued by the City of Bremen.

Figure 5: ULaaDS – micro depot at ULP

As part of trial 1, it has been successful up to the time of writing to transport the shipment quantities for the areas of Bremen city centre and a bordering area ("Viertel") of the logistics companies

"Hellmann Worldwide Logistics" and "BHS-Spedition und Logistik GmbH" in an environmentally friendly manner through the deconsolidation points (micro-depot) at the transhipment point Jakobikirchhof and (later) Lübecker Straße. Shipments (packages and pallets) from the established deconsolidation points (micro-depots) are taken over by electric cargo bikes provided by project partner RYTLE and the (subcontracted) service provider "Bremer Radkurier", and delivered to the respective consignees.

Figure 6: ULP – Handling from truck to cargo bikes

Through the consolidation and pre-commissioning of shipments at the Freight Village (GVZ), the transportation of goods into the city center with significantly fewer trucks and the use of electric cargo bikes for the final distribution, a sustainable, innovative, and highly service-oriented distribution concept for the "last mile" was established. This approach provides significant ecological benefits for the population of Bremen, including a reduction in traffic congestion, noise, and emissions. It also offers economic advantages for the involved stakeholders and added service value for the end customers in logistics, such as increased flexibility. Thus, the concept represents an integrated approach to connectivity also in the context of electric mobility.

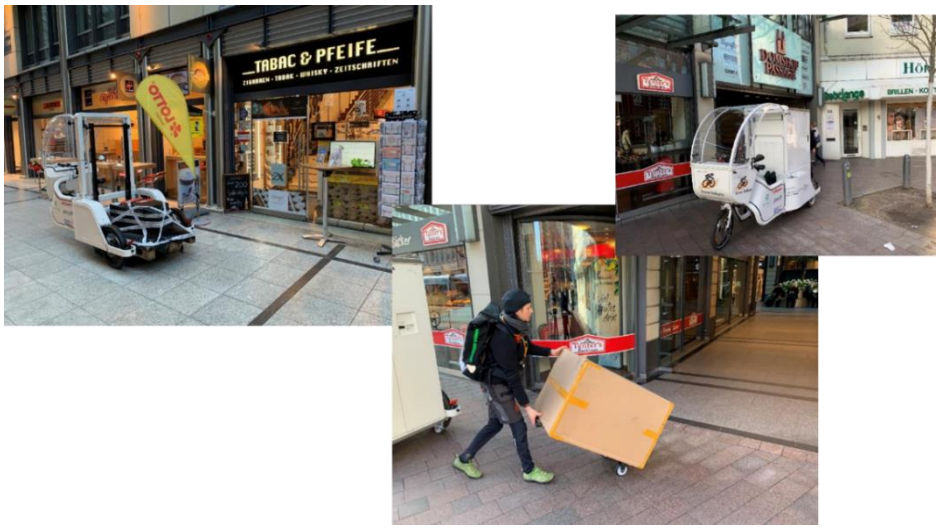

Figure 7: Delivery in the inner city of Bremen

The USP of trial 1 is the delivery of entire pallets using cargo bikes. To achieve this, a cargo bike equipped with a forklift technology was used (see figure 7). This is unique and a first in Germany,

thereby representing an important innovation of the project. Thus, “classic” freight shipments can be transported by cargo bikes. Before, this had only been feasible for packages (in boxes – see photo right side). In trial 1, it was successful to transport a combination of various shipment sizes by cargo bike.

Figure 8: Equipment Pallet MovR + Box MovR

Due to the positive experiences, the establishment of a second micro-hub allowed for doubling the shipment volume (see Bremen map and next section).

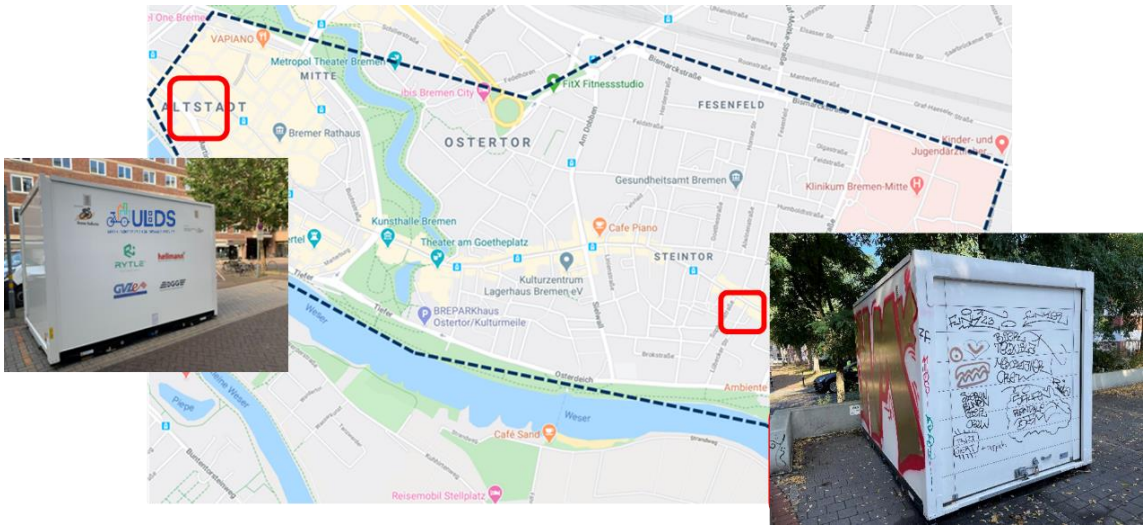

Figure 9: Opening (07/21) additional location for micro hubs (Lübecker Straße)

3.1.1.3 Trial results

One of the overall goals of trial 1 is the establishment of a sustainable distribution concept for the city center of Bremen and the densely populated residential neighborhoods near the city center. Emissions and noise are avoided through the fine distribution of shipments (by electrified heavy cargo bikes). This addresses the current challenges of goods distribution in urban areas in a novel way. Through the innovative system solution and the development and implementation of a novel and energy-efficient distribution concept, trial 1 contributes to achieving the climate protection goals of the city of Bremen and counteracting climate change by using new electric mobility technologies.

Additionally, the trial 1 focuses on economic objectives. By consolidating the flow of shipments outside the city center (at the GVZ Bremen), the participating logistics companies can increase the utilization and load factor of their trucks. By avoiding the fine distribution traffic to the city center that was previously carried out by the freight forwarders themselves, cost advantages in terms of transportation costs can be expected with the appropriate shipment volume. The overall goal of trial 1 was to develop and implement a sustainable, efficient, and highly flexible urban logistics system for general cargo and parcel deliveries in the city center of Bremen. This goal has been achieved.

The achieved successes are documented below.

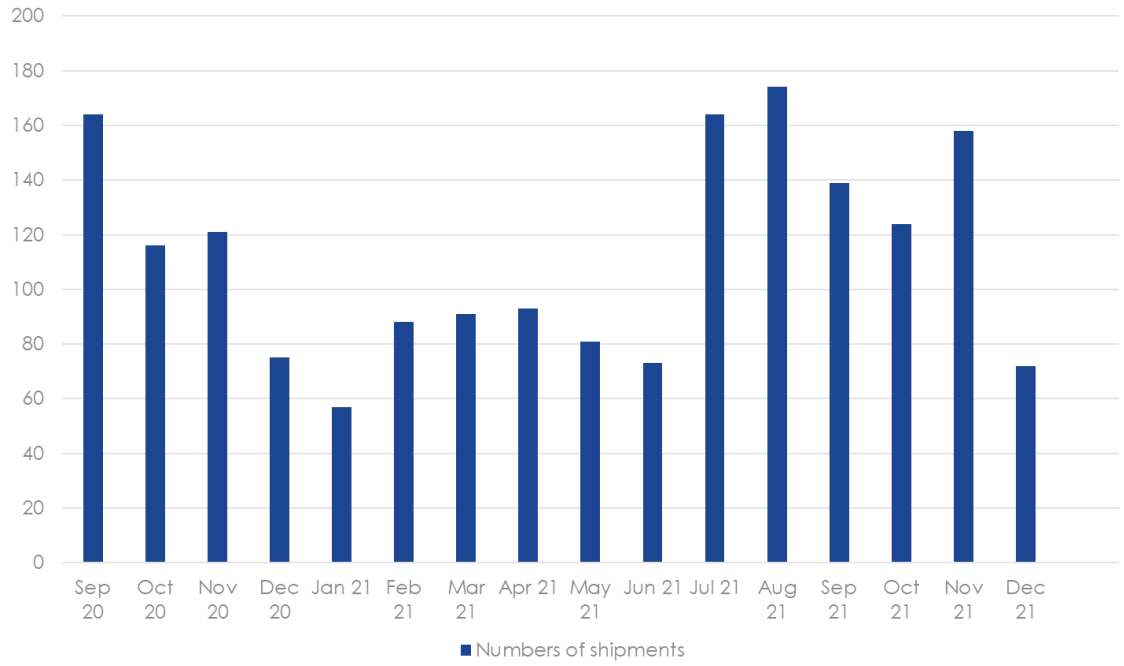

Figure 10: Focus ULaaDS period (2020-21): Numbers of shipments

The figures of shipment quantities (number) and shipment weights document a trend marked by seasonal fluctuations, often referred to as "peak seasons" (like Christmas). Furthermore, the fluctuations in the period from September 2020 to December 2021 can also be attributed to the effects of the COVID-19 pandemic, including lockdowns.

A significant success to highlight, therefore, is that despite all the challenging circumstances, trial 1 has consistently performed well. All stakeholders have contributed to this with their commitment. The opening of the second micro-depot in the “Lübecker Straße” in July 2021 has even led to an increase in shipment quantities. This has clearly contributed to the stabilization and establishment of trial 1 in practice.

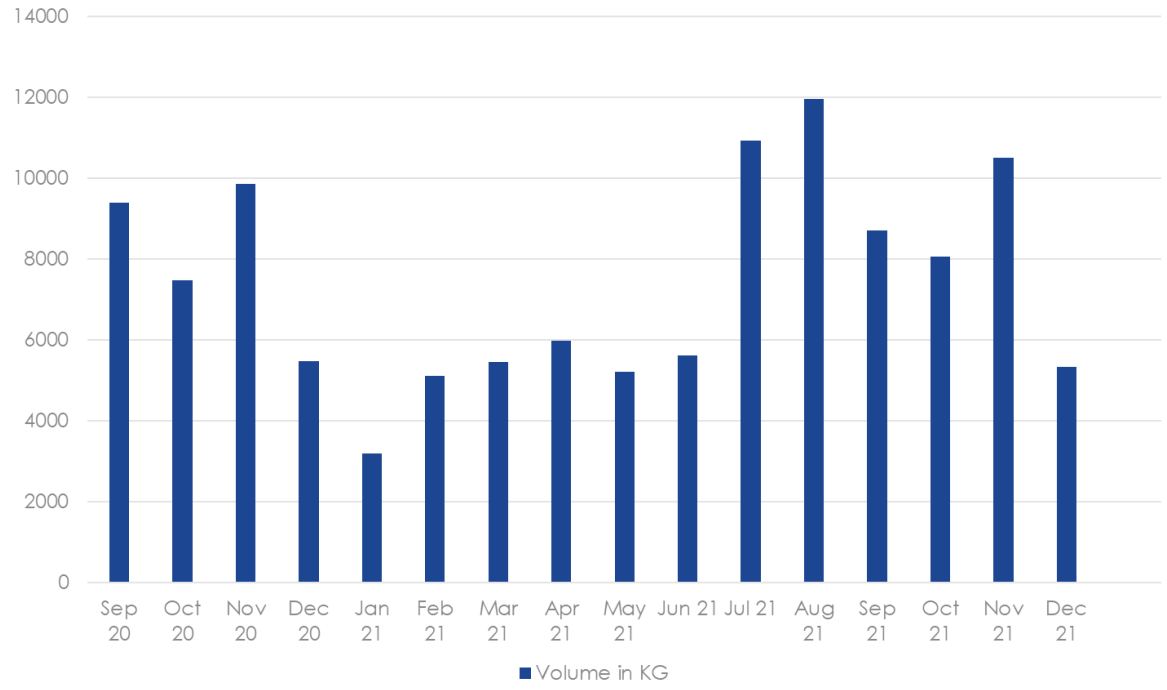

Figure 11: Focus ULaaDS period (2020-21): Transport/handling volume in Kg

The following table provides an overview of some very interesting and important facts about trial 1. What is striking and unique for trial 1 is the (very) high average shipment weight. While other projects (e.g. in Germany) report (typical CEP) average shipment weights of 5-10 kg, this value here is approximately 65 kg. The reason for this is the traditional pallet shipments from logistics companies, which often have a high weight (over 100 kg).

Equally noteworthy is the total shipment volume transported by e-cargo bikes, which amounted to nearly 170,000 kg within the specified observation period. The operational use of cargo bikes functioned at all times and under all weather conditions. This is a crucial demonstration of practical feasibility. This primarily contributes to gaining acceptance among logistics partners who cannot afford disruptions in their operations.

2.629	167.719,000	544	4,8	63,796
Total number of shipments	Total weight in KG	Days in operation	Average number of shipments per day	Average weight in KG per shipment

From Umweltladepunkt (ULP – first depot) by cargo bikes
since Nov. 2020 HELLMANN + BHS and since July 2021 second depot „Lübecker Straße“

Figure 12: Urban BRE and ULaaDS: Basic effect cargo bikes sep. 2019 – dec. 2021(real)

Another milestone of the trial 1 is the integration of a courier express parcel (CEP) service provider ("trans-o-flex") into the existing system. This was accomplished in May 2022. This also involved the establishment and operation of a second micro-depot (see next photo) at the ULP.

Figure 13: Umweltladepunkt (ULP) – opening 2 Micro-hub (05/22)

The next table shows the effects of integrating CEP shipments into the trial 1 system. There is a clear and significant increase in the number of shipments from April to May 2022. Other key performance indicators, such as the average shipment weight and the number of shipments per day, have also consequently changed. In the year 2022 alone, a total of over 125,000 kg could be transported by cargo bikes.

Summary no. Of Shipments ALL	Total volume in kg ALL	Max. operating days ALL	Average number of shipments per day ALL	Average weight on kg per shipment ALL
92	5.432,000	15	6,1	59,043
112	8.155,000	20	5,6	72,813
193	14.040,000	23	8,4	72,746
April 110	7.425,000	19	5,8	67,500
May 952	11.872,000	21	45,3	12,471
1.050	10.864,000	21	50,0	10,347
1.042	11.032,000	21	49,6	10,587
1.114	10.522,000	23	48,4	9,445
1.193	14.132,000	22	54,2	11,846
1.036	10.487,000	18	57,6	10,123
1.240	12.760,000	22	56,4	10,290
1.047	8.855,000	21	49,9	8,457
9.181	**125.576,000**	**246**	**37,3**	**13,678**

Figure 14: ULaaDS: Basic effects cargo bikes 2022 (real jan. – dec.)

3.1.2 Trial 2a: Cargo-bike rental service for private micro-logistics use by citizens

Logistics doesn't solely revolve around commercial operations; it's also crucial for private households. We have labelled this aspect “private micro-logistics”.

In Germany, a significant 30% of all trips are related to shopping. Within urban areas, the average shopping distance is approximately 4 km. This constitutes about 17% of the total mileage driven and contributes roughly 10% of transport-related CO_2 emissions. Given these needs and the relatively short distances involved, there's a substantial potential for substituting car trips with cargo bike journeys.

3.1.2.1 Trial setup

The use of cargo bikes may strengthen local businesses in neighbourhoods and city centres and generally strongly support SUMP objectives and supplement SULPs. In terms of private micro-logistics, ADFC was involved in the ULaaDS project offering a small-scale rental-free cargo bike sharing scheme run by the ADFC Bremen, the local branch of the German national cyclists’ federation. Cargo bikes were available for booking by users after registration on a dedicated website (www.fietje-lastenrad.de). The stations are local shops, community centres and similar - mainly in dense, city-centre neighbourhoods. The shop owners/employees serve as hosts to the bikes in each neighbourhood. Station hosts receive no remuneration for this task. Users also pay no fee for the use of the cargo bikes.

Figure 15: Fietje cargo bikes in front of their local stations

3.1.2.2 Trial evolution

The initial plan entailed making at least one of the ULaaDS cargo bikes available 24/7 through a lockable garage from which users could book and then remove the bike and use it for periods shorter than an entire day. This plan became impractical shortly after the beginning of the project as the city of Bremen had independently applied for – and been awarded – funding to put out a call for tenders to establish a larger (roughly 40 bikes at 20 stations) station-based cargo bike sharing system for the city, with the cargo bikes available for booking, with 24/7 access to the bikes. This plan was established after the ULaaDS plans had been set. The idea then became to incorporate the ADFC ULaaDS cargo bike into the planned city-wide sharing system. However, the development of the city's shared cargo bike system was delayed, making the integration impossible in the context of ULaaDS.

At the same time, interest in cargo bikes in general was growing – including in more peripheral areas of the city. In such areas, the issue of space for storing a cargo bike is less of a problem, but the cost of owning a cargo bike could be a higher barrier. In addition, people in peripheral areas generally travel longer distances and are more car oriented.

Given these circumstances, the ADFC developed a plan to extend cargo bike shared to more peripheral and less dense areas of Bremen to see if the interest there would be as high as in central neighbourhoods.

3.1.2.3 Trial results

This aspect of logistics addresses several sustainable urban mobility issues. One of these is reducing the need for car use (and ownership). According to Fietje user surveys, 56% of Fietje users would have taken a car to carry out the journey if they had not had access to a shared cargo bike (see figure 15). In the 2021 version of the survey, users were offered the option “use a car”. This was differentiated in the 2022 survey to include both private and shared car use.

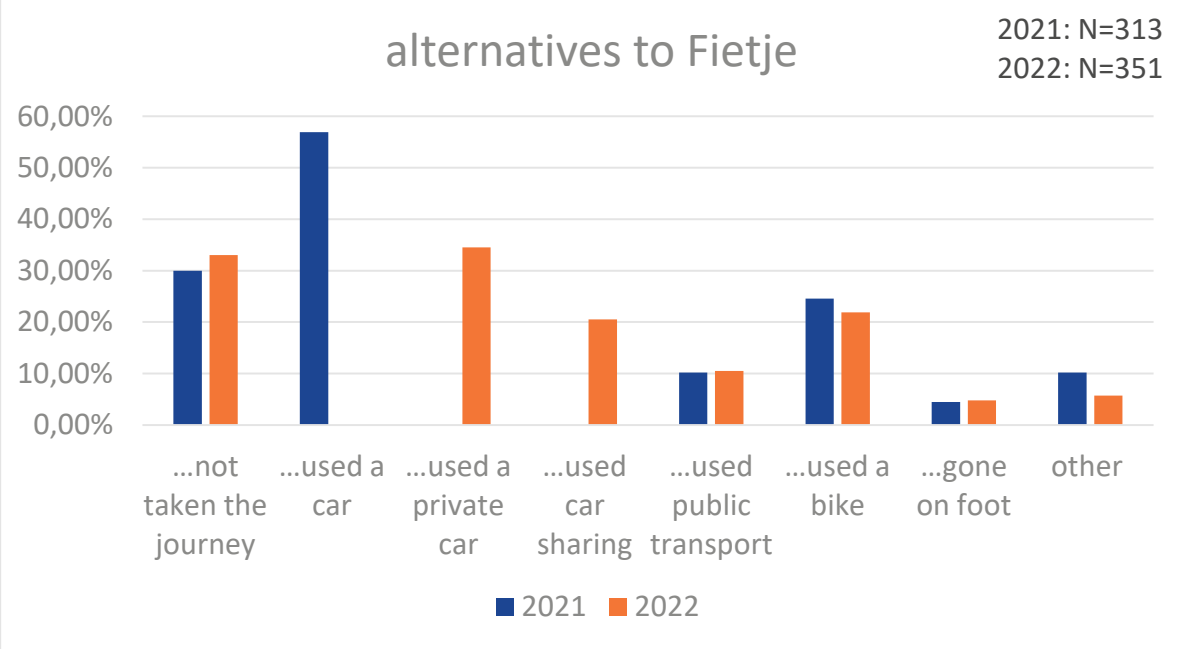

Figure 16: Responses to user survey prompt “without Fietje, I would have…”

Another issue addressed is the possibility to make cargo bikes available for use without the need to purchase. In 2021, over 60% of users who completed a user survey said they did not plan to purchase a cargo bike of their own (or with others). In 2022, this number increased to nearly 70%. In 2022, the reasons for not purchasing a cargo bike were also asked. Cost, limited need and space to park it were the three most cited reasons for not purchasing a personal cargo bike (see figure 16).

Such a sharing programme directly in local shops and community centres also puts cargo bikes in the public eye and offers a point of direct contact (the station hosts) to ask questions. It also makes cargo bikes available close to home and saves urban space by reducing the need for individual ownership. Finally, a shared cargo bike system contributes to social equity by making the bikes available to those without space to store one or who can’t afford to buy one themselves.

The bikes in most locations were not booked significantly less in winter than in summer, indicating a willingness to use them in all types of weather (although snow is rare in Bremen).

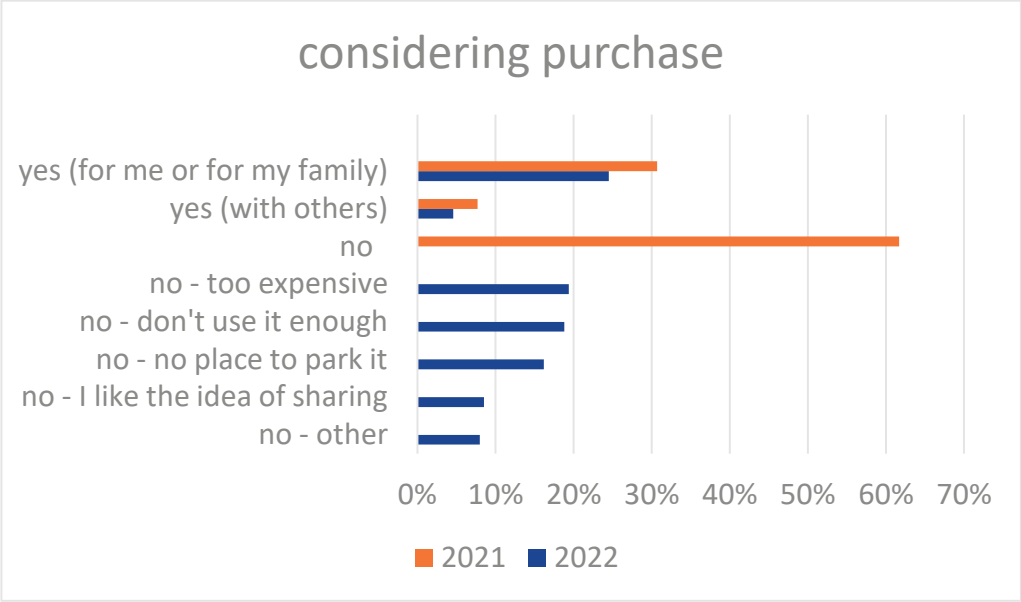

Figure 17: Responses to user survey prompt: "I'm considering buying my own cargo bike."

Supplementing other shared modes in Bremen

Bremen is working to integrate car sharing in urban development and transport strategies. New developments in Bremen must provide a mobility management plan rather than just providing car parking. Besides car sharing, shared cargo bikes may also be part of such plans. The 30,000 current car sharing users in Bremen have either gotten rid of or not purchased 8,000 cars. About 80% of car sharing users have no car in their household. With their shopping activities concentrated in the city centre and neighbourhoods, the frequency of going to shopping malls is about a quarter of the reference group[1]. Cargo bikes may be seen as an additional mobility option in the bundle of sustainable mobility options.

Expanding to peripheral areas

Fietje was initially set up to address the issue of space in dense urban areas where bikes are a normal form of daily transport, thereby offering people one less reason to need a car. Within ULaaDS, the Fietje system also expanded to more peripheral neighbourhoods, where residents are generally more car focussed, and often travel longer distances.

Nonetheless, the reservations at the more peripheral stations were very comparable to those at the central ones. In 2022, the Fietje cargo bikes were booked for an average of 2.15 days per reservation. In two less central neighbourhoods (Habenhausen and Mahndorf), the average reservation was 2.2

[1] team red, 2018 – Analysis of the impacts of car-sharing in Bremen, Germany; on behalf of Free Hanseatic City of Bremen, Bremen 2018
download: P450_Endbericht_Bremen_englisch_c_cm.indd (northsearegion.eu)

days and in more central neighbourhoods (Mitte, Hulsberg, Viertel, Findorff, Neustadt and Schwachhausen), this number was 1.9.

Further, during sample time windows in June 2023, the cargo bike at the station Mahndorf (peripheral) was booked 12/15 days (80% of the time) and ridden a total of 202 km (an average of 17 km/day). The Schwachhausen Fietje (central) was booked 19/24 days (79% of the time) and ridden a total of 274 km (an average of 14km/day). Thus, it seems the interest in shared cargo bikes also exists in peripheral neighbourhoods.

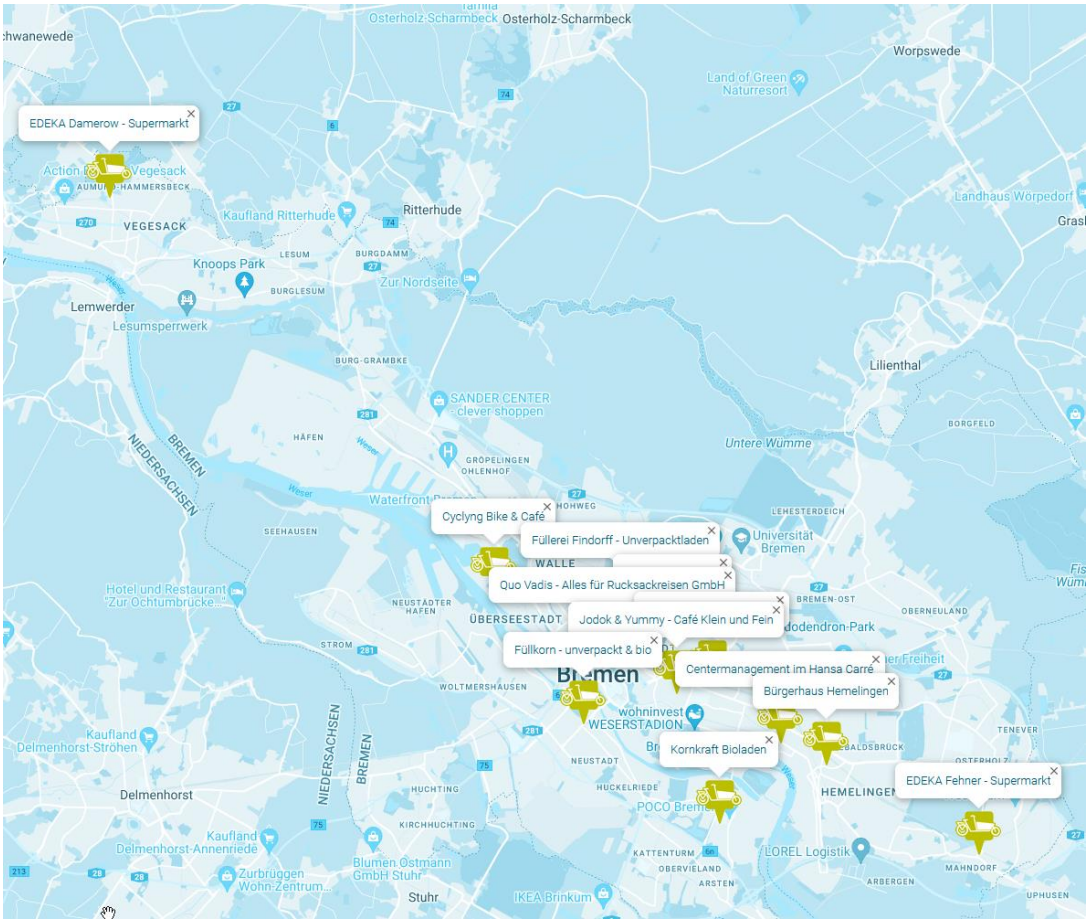

Figure 18: Map of Fietje locations in Bremen

3.1.2.4 Learnings

Such a shared service comes with its challenges. For example, with a free service, people occasionally forget to cancel bookings, meaning the bike they reserved is not available to other users. This is addressed with e-mail reminders to users of their bookings – and a request to cancel if they no longer need the bike. This has proven quite effective in reducing no-shows. In addition, maintenance and repairs are an ongoing challenge that needs to be tended to. As the users may be people who are not used to riding a cargo bike, there may be some small incidents that wouldn't occur with more experienced riders. In addition, some people may not be as careful with "somebody else's" property as they might be with their own – particularly when the service is free.

Peripheral stations add to the challenge of maintenance and repairs as they entail longer journeys to check the bikes, and longer journeys to repair shops, when this is needed. This can include train travel – adding the challenges of accessibility to platforms and stations with a large and heavy bike.

Finding locations willing to serve as a host in the selected neighbourhoods can be a challenge. They must be willing to carry out minor administrative tasks (checking the bikes in and out) and have space to store the bike overnight when it is not in use. Even if they are willing, not all station hosts have the capacity to check the basics (brakes, oil, etc.) before the bikes go out. The alternative is to send someone (either paid staff or a volunteer) to each station to check the bikes regularly. Depending on their locations, this can be time consuming.

With regard to the business case for shared cargo bikes, having shops, community centre, etc. serve as station hosts means that the bikes can only be lent out by the full day – even is a user only needs it for one or two hours. This makes less efficient use of the bikes that would be possible with a more automated system.

With a free-of-cost service, it's possible to inform a user that their reserved bike is not available on a given day without having to provide a replacement. If users were paying for the service, the fleet would need to include a set of replacement bikes in case of repairs – and to deliver a replacement bike to the station for the user. These costs are outside the means of a small NGO.

User surveys asked about willingness to pay to use Fietje shared cargo bikes. While there is a degree of willingness to do so, this would not cover the costs of running such a programme (see figure 18).

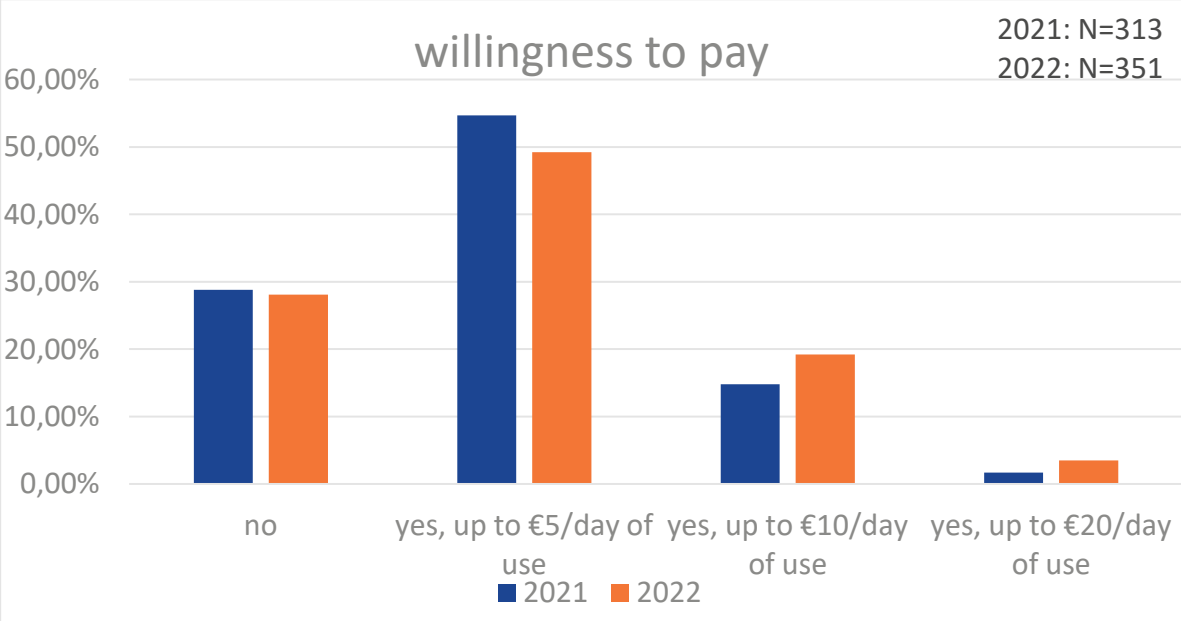

Figure 19: Responses to the user survey prompt: "I would use Fietje even if I had to pay for it."

When it comes to covering costs, finding a sponsor to support the purchase of a new bike is significantly easier than finding funding for ongoing administration and operating costs.

The number of free-of-cost shared bike systems in Germany has increased significantly in recent years. This seems to be associated with a general growth in interest in cargo bikes – as well as a

growth in the range of models and styles available. The interest seems also to correspond too many cities' desire to make cycling more attractive so as to reduce the need for car use by offering yet another carrot rather than implementing "stick" measures of regulating driving or parking.

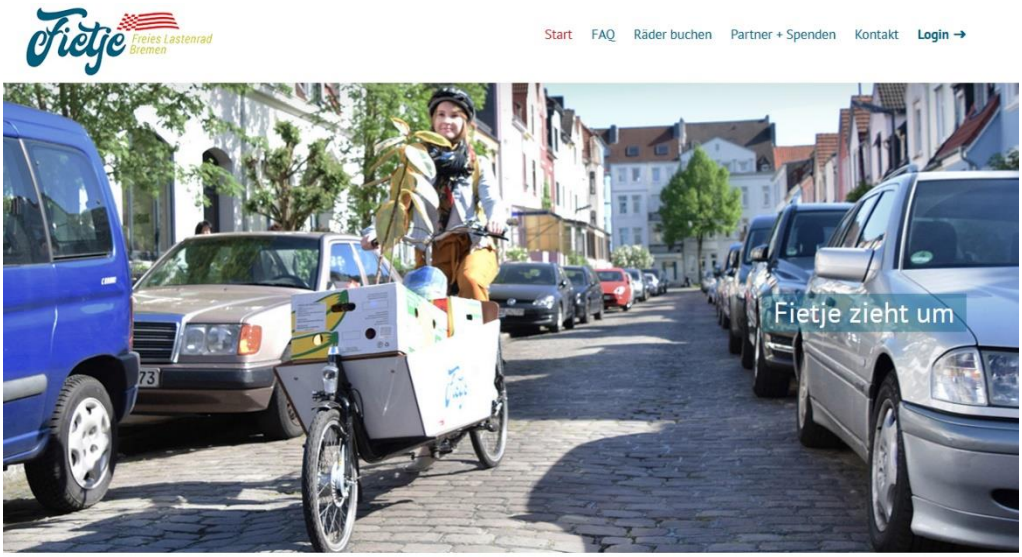

Figure 20: Image from Fietje website demonstrating possible uses of the shared cargo bikes – and showing the streets of Bremen filled with parked cars

At the same time, at least two market-based operators of shared cargo bike systems in Germany have gone bankrupt in the past year, indicating that a business case for renting cargo bikes is still a challenge, presumably because operating costs could not be covered by the amount that users would be willing to pay.

It could be argued that the presence of free (subsidised) services reduces the willingness to pay a reasonable market price for the use of a shared cargo bike. On the other hand, shared cargo bikes provide a wide range of societal benefits beyond simply mobility. They fill a gap in logistics services by allowing people to transport goods by bike that they would otherwise use a car for, they contribute to equity by allowing access to a cargo bike without the need to own one and they provide a healthy means of transport – both in central and in peripheral neighbourhoods.

3.1.3 Trial 2b: Simulating cargo-hitching with taxi-services

As part of ULaaDS, Via Technologies Europe B.V. (Via) carried out an urban on-demand cargo-hitching digital pilot. The goal of the Via pilot was to explore the potential impact of a cargo-hitching service in Bremen, Germany.

This work was conducted as part of ULaaDS' Scheme 5: Transport Vehicle Capacity Sharing work and took place during March-May of 2023. This digital pilot is a version of the first modality: an on-demand service offering pooling for passengers and small cargo.

3.1.3.1 Trial setup

Project partner ViaVan in January 2021 changed its structure, from a joint venture between VIA and Daimler, to a new entity owned directly by VIA. While the nature of this change, according to the EU's "H2020 AGA — Annotated Model Grant Agreement", is a "universal takeover" (or "universal transfer of rights and responsibilities" – UTRO – as it was called in the FP7 program preceding H2020) with no legal implications or major changes, this has also affected the trial definition in BRE.

ViaVan was founded in 2017 as joint venture of Via and Mercedes Benz. Via and Bremen initially planned to implement a trial for on-demand urban logistics using electric vans to offer on-demand pooling for cargo and passengers. The trial was to be in collaboration with Daimler at their local plant in Bremen, evaluating the operational outcomes of combined human and cargo transport within a controlled environment (Daimler's campus).

The proposed trial had been considered viable due to Via's existing relationship (JV) with Mercedes; both companies had experience working together on transport issues across Europe and could streamline planning and implementation. Additionally, the location was well-known to Daimler, who would be able to provide insights into the local needs and operational complexities.

3.1.3.2 Trial evolution

Via conducted its work on the pre-trial setup during months 3-16 of this project and, in collaboration with the City of Bremen, determined that it was not possible to move forward with as proposed in the original documentation. After extensive exploration, it was determined that the logistics flow at the Mercedes plant had already been optimized internally for the flow of both passengers and cargo. Additionally, the existing external environment (e.g. global supply chain challenges, Covid19, etc.) made it more challenging for local leadership to prioritize a cargo-hitching trial that had no specific short term benefit for the stakeholders. The pre-trial work made it clear that running a pilot would not be value-additive for the identified location, and any such trial would not produce the operational and economic data for research questions of interest to ULaaDS.

Via explored other options for running a similar trial, but it was determined that a similar trial could not be implemented with a new partner in a new location within the UlaaDS timeframe. The existing Mercedes relationship created synergies that made the project feasible under the task's time and budgetary limitations; however, it was determined that it was not feasible to implement an entirely new project with a new partner under the same requirements. Therefore, an alternative pathway to further understand the potential and impact of cargo-hitching was developed after discussions between project partners and relevant players.

Key problems for cargo-hitching were on the practical side. Mercedes was open to try the cargo-hitching – despite running contracts with operators for their internal logistics. But some practical questions remain unsolved: whereas today the logistics operator offers a service picking up the items at the sender – how does the item get to the on-demand vehicle. If the driver had to leave the vehicle (e.g. for emptying a box), this would mean to have extended travel time for passengers. The same problem applies at the destination point.

Additionally, many of the drivers have physical limitations ("Kiloschein") and are not able/allowed to carry items of certain weight.

New approach

When it was determined that it was not possible to conduct a physical trial at the Daimler facility in Bremen (*3.34*), Via pivoted to conducting a digital pilot. Via's proprietary simulation and modelling technology was used to run a simulated, digital pilot, with the aim of providing similar types of insights and data sets as a physical trial. Via leveraged its operating experience across the world, including the deployment of technology for logistics pilots in North America, Europe, and Asia. The simulated trial allowed more flexibility for scenario testing that would not have been possible in a physical scenario, elucidating the impact of cargo demand, operational decisions, density, and more.

This pivot is aligned with the core ethos of on-demand technology: an assessment of current conditions and flexibility to adjust to shifting realities to deliver the most efficient and impactful results in line with what was planned and adapting to the current situation.

In conversation with the ULaaDS team, Via proceeded with a digital pilot for the following zones:

1. **Module 1: Comparison city in Germany** - Via selected a comparison city in Germany with an existing Via service that has similar population dynamics to Bremen
2. **Module 2: Bremen simulations**:
    a. Residential area that would be a viable for on-demand transport and cargo delivery
    b. Cargo Distribution Centre (GVZ), also known as the freight village

For each zone, Via would run four simulations:

- **Scenario 1:** Passenger-only
- **Scenario 2:** Cargo-only
- **Scenario 3:** Passenger and cargo - commingling full demand from Scenarios 1 and 2
- **Scenario 4:** Passenger and cargo - commingling full passenger demand and incremental cargo demand (the amount of cargo that could be delivered by a passenger service without increasing the vehicle count)

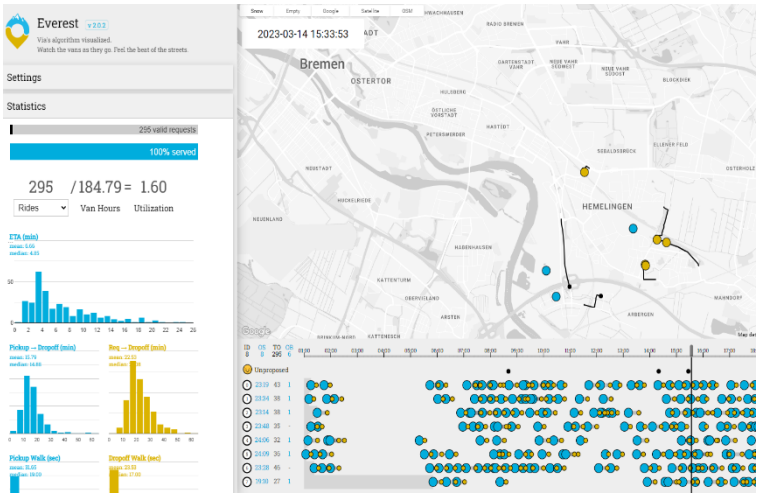

Figure 21: Bremen simulations (ViaVan)

3.1.3.3 Trial results

Many existing on-demand transport services have additional capacity, especially at off-peak times. Simultaneously, there is a demonstrated market for local on-demand deliveries. The simulations show that commingling passengers and packages can yield efficiencies - when full demand volumes were commingled there was roughly a 15% decrease in service hours required to complete the same number of trips. The greatest efficiency gains occurred when the volume of packages was incremental to the volume of passenger trips and did not add to the total number of vehicles required for the service. These simulations showed a roughly 50% increase in utilization compared to passenger-only scenarios.

Both modules showed commingling yielded greenhouse gas emissions reductions of 1-7%. The volume of reductions depended on the volume of commingling - the greater the total volume of trips, the greater the emissions reduction. The smallest commingled service, Bremen Scenario 4, reduced greenhouse gas emissions by 0.4 tons of CO2, while the largest service, comparison city Scenario 3, yielded a 12 ton decrease in CO2 emissions.

Financial analysis showed Scenario 3 for both cities was over 50% more expensive than running two separate services, because packages alone can be delivered with a lower-cost model than passengers. Thus, adding additional vehicles to a service to accommodate package delivery raises the price of package delivery to an undesirable level. Meanwhile, Scenario 4 yielded a 13% cost reduction in both cities due to increased efficiency. Analysis showed that if the package service is integrated into a passenger service as a mechanism to generate revenue (assumed €10 per package), the service could achieve a cost savings of about 15 - 25%.

3.1.4 Overall learnings for the city of Bremen

Urban logistics is a core task for a functioning city. The overlap of the ULaaDS project implementation with the Covid lockdown has brought some difficulties but also some additional insights. The structural changes of city centres and neighbourhood shopping areas has been accelerated, the growth in online shopping and related deliveries was above all forecasts. The dialogues with shopkeepers, but also other players for a lively city centre is crucial. Initiated by ULaaDS, there is a special manager for urban logistics in the Bremen Mobility Authority. Urban logistics is more in the public awareness.

The function of the inner city micro-hub is well established and extended. It was internationally well recognised that within the ULaaDS trial, also quite heavy items were delivered by cargo bike – an average weight of about 65 kg shows also which advantage a heavy cargo bike may develop when it is able to stop directly close to the recipient.

The performance of another ULaaDS micro-hub in an inner-city housing district was rather weak. As long as delivery vans can block streets practically without any risk of fine, the advantages of a smaller vehicle cannot be fully exploited.

Just recently in autumn 2023, the German Ministry for Transport announced to create a street sign and related legal framework to have on-street delivery zones – as they exist in other countries. It

will be a challenging exercise to create such delivery zones in the packed neighbourhoods where residents fight for every parking spot.

Another frequently discussed topic of SULP-approaches is cargo-hitching. It is the privilege of a research project to move into somewhat unknown land. The intense scenarios that we discussed with the practitioners of the Mercedes plant brought some insight, that cargo-hitching is often presented as a big solution – but there are severe practical barriers. The setting with a limitation of passengers transport to Mercedes employees circumnavigated the legal question of subsidised or advantaged public transport (bus lanes, traffic light priorities) being used for market based, competitive freight transport.

There is some interaction of private micro-logistics and commercial transport. It is still unclear whether online shopping reduces the transport impacts or not. There are a lot of transport trips of private households. As part of the general SUMP approach, Bremen wants to reduce the dependence on the private car with related impacts on space consumption and travel behaviour. The ULaaDS trial of cargo bike sharing brought valuable insights – especially the level of replace car trip- and underlines the public interest of offering some wider cargo bike sharing.

So urban logistics will remain a hot topic. To what extend new technical solutions (e.g. automated transport) will help to have a balance of the interests of logistics operators and the liveability of cities will be subject of further logistics projects.

3.2 Trials Groningen

Groningen stands out as one of the pioneering large municipalities in the Netherlands, committed to implementing a zero-emission zone in its city centre by 2025. This initiative aims not only to reduce emissions but also to enhance the overall liveability, vitality, and attractiveness of the city centre. The goal is to shift away from a dominance of cars, trucks, and vans in the urban landscape, prioritizing the needs of residents and visitors. The city is actively engaged in facilitating policies to support this vision. With the ULaaDS trials, Groningen actively investigates possibilities to provide flanking policies to benefit the affected stakeholders.

the Groningen trials comprehended all ULaaDS solutions and schemes, in two trials. Trial 1 focuses on developing and promoting a platform for shared zero-emission vehicles to enable collaborative delivery models for shopkeepers and other entrepreneurs in the city. Trial 2 focuses on the implementation of logistics services at a multi-modal mobility hub for commuters. Below, each of the trials is discussed in more detail.

3.2.1 Trial 1: shared vehicles for logistics purposes of local businesses

In Trial 1, the municipality of Groningen (GRO) and the Groningen City Club (GCC) organized the development, implementation, and promotion of a platform that enabled local shopkeepers and other entrepreneurs with access to different types of shared zero-emission vehicles. Trial 1 tested a platform for the on-demand supply of shops and delivery to consumers in the city of Groningen. Generally, the aim of such platforms is to pool resources and freight flows from different actors in

the city. The pooled resources may include either vehicles or facilities—or both, and can be owned by local shops, suppliers, or logistics service providers. The platform can help to meet the regulatory framework of a city, such as time-access restrictions and emission zones.

Trial 1 addressed the following ULaaDS solutions:

- Sharing economy platforms for on-demand city logistics
- A city-wide platform for integrated urban freight transport management

It addresses three main principles within these solutions:

- Effective integration of passenger and urban freight mobility services and networks
- Location and infrastructure capacity sharing
- Transport vehicle capacity sharing

3.2.1.1 Trial setup and goals

In this trial, the municipality of Groningen (GRO) and the Groningen City Club (GCC) collaborated to develop, implement, and promote a platform for on-demand supply from shops and delivery to consumers within Groningen.

GCC, a community of local shopkeepers, stepped in as the replacement partner in this trial, taking over from Dropper (DRO) following a bankruptcy during the Covid-19 pandemic. This change has slightly shifted the focus of the trial from platform technology development to enhancing stakeholder involvement for the optimal design and utilization of the platform.

The platform enables local shopkeepers and entrepreneurs to access various types of shared zero-emission vehicles. This initiative aligns with the municipality of Groningen's policy, aiming to achieve zero emissions in city centre logistics by 2025. Additionally, it fulfills a municipal council wish to assist small businesses in transitioning to zero-emission vehicles, which can be challenging due to high investments and the limited availability of suitable vehicles.

The shared vehicles will be stationed at different locations across the city, integrating mobility networks and sharing location and infrastructure capacity and vehicles. Shopkeepers and entrepreneurs can utilize these vehicles to supply their shops and make deliveries to customers within the city, its peri-urban areas, and rural regions. The platform also facilitates organizing deliveries from multiple participating shopkeepers, linking to the second trial by enabling deliveries to parcel lockers located at various mobility hubs, parking garages, offices, hotels, etc. This supports the design and implementation of collaborative delivery models and a city-wide platform for integrated urban freight transport management.

While the trial initially focuses on making zero-emission vehicles available to local businesses, it allows for the integration of additional schemes, such as the inclusion of crowd-sourced bike couriers and containerization, as it progresses. This trial design aims to gradually build towards the

integrated management of urban freight transport in Groningen and its surrounding peri-urban and rural regions.

Groningen wanted to set on a collaborative approach with the shopkeepers and the GCC shopkeepers organisation. Advantage of such an approach is the high acceptance among stakeholders, since they are actively shaping the solution that will be implemented later on. As such an approach needs significantly more time, only one local forum before the trial phase did not seem sufficient.

Figure 22: picture of stakeholder forum in Groningen

In a first meeting, the ULaaDS project as well as the vision of the city for the future were introduced. This led to an open discussion about the obstacles that shopkeepers are concerned about. With the inputs collected from the first meeting, an interview guide was prepared with the aim to analyse the logistic profiles and prepare for the next meeting. In total 20 interviews with shopkeepers were conducted in order to gain further and more detailed insight. The results of the interviews were presented in a second meeting where the specifications of the ULaaDS trials solutions were elaborated. With the inputs gained from the second meeting the needs were structured and narrowed down to possible solutions/trials. The third meeting also included other stakeholders, like providers of logistic services. In this meeting, solutions have been formulated with the collaboration of those stakeholders involved.

During the development of the Groningen trial, the ULaaDS Local Fora resulted in a strong focus on assisting local shopkeepers and entrepreneurs in meeting the future regulatory frameworks of Groningen. Especially for smaller-sized vehicles (e.g., light electric freight vehicles and vans), concerns about the lack of availability and higher total cost of ownership are alleviated due to changes in the market. Nevertheless, many local shopkeepers and entrepreneurs are not able or willing to invest in a new vehicle, which narrows their access to the city in which they operate. What is more, local authorities see an opportunity to limit the number of vehicles used in the city. Combined, these observations resulted in a trial design where the focus is on rolling out a platform where local shopkeepers and entrepreneurs can organize shared use for electric vehicles.

3.2.1.2 Effective trial

After the Local Fora the first aim defined for the trial was as followed:

Develop and promote a platform for shared (zero-emission) vehicles to enable collaborative delivery models for shopkeepers and other entrepreneurs in the city. The main goal is to stimulate a platform that:

- Can organize the delivery of orders from multiple shops in the city center to consumers in the city and its neighboring peri-urban and rural areas. The deliveries may include possibilities to deliver via mobihubs/parcel lockers, parking garages, offices, hotels etc.
- Provides access to multiple zero-emission vehicles for shared use by local shopkeepers and entrepreneurs.

Described objectives of the trial:

1. Increasing the use of cargo bikes and other zero emission vehicles (and decreasing the use of polluting vehicles)
2. Increasing the efficiency/use of transport vehicles
3. Increasing livability and safety because of the use of smaller, silent, and clean vehicles
4. Giving more target groups the opportunity to use electric vehicles.
5. Reducing CO2 emissions

Based on the requirements, a selection for a party that could provide the platform took place. While the broad budget constraints and total costs are more or less clear, the precise division of costs for the different parts of the implementation were still uncertain at this stage. For example, the relation between the cost of developing the platform itself versus the costs for onboarding its users depends on the specific requirements and or platform provider chosen. After selecting the platform provider, local entrepreneurs needed to be onboarded and provided with the logistics services and/or vehicles made available through the platform.

GCC, RUG and GRO were responsible for monitoring the impact of the platform in the city of Groningen. The testing phase started with two different vehicles: an electric cargo bike and a Carver (Light Electric Vehicle). Both had limited capacity. The third vehicle that was tested proved to be the most popular: an E-Van.

Figure 23: picture of ULaaDS vehicles used

Business and operating model

The focus of the platform on sharing vehicles had implications for the business and operating model, (Table). Specifically, the mission statement becomes to pool zero-emission vehicles and freight flows

of multiple local shopkeepers and entrepreneurs. The value proposition focuses on the use of shared, zero-emission vehicles, which on the one hand should facilitate shopkeepers in exploring how these vehicles can be used in their operations, while on the other hand ensuring they keep their access to the city as the regularly framework becomes increasingly stringent.

<table>
<tr><td colspan="5">Mission statement: To pool zero-emission vehicles and freight flows of multiple local shopkeepers and entrepreneurs</td></tr>
<tr><td rowspan="2">Key partnerships:
1. Vehicle provider
2. Platform provider
3. Local authorities</td><td>Key activities:
1. Provide an overview of where and when vehicles are available
2. Facilitate the reservation of vehicles</td><td rowspan="3">Value proposition:
1. To enable the use of shared, zero-emission vehicles
2. Familiarize local shopkeepers with the use of zero-emission vehicles
3. Ensure that local shopkeepers and entrepreneurs keep having access to the inner city.</td><td>Buy-in & support:
1. Local shopkeepers and entrepreneurs that need a vehicle for urban freight flows</td><td rowspan="2">Beneficiaries:
1. Local shopkeepers who keep having broad access to the city
2. Citizens and other people staying in the city benefit from improved efficiency (e.g., less vehicles, fewer buildings for logistics)
3. Platform/vehicle provider who will obtain a new business model</td></tr>
<tr><td>Key infrastructure and resources:
1. Zero-emission vehicles
2. Infrastructure for parking the vehicles
3. Platform for checking vehicle availability and booking</td><td>Deployment:
1. Find entity that provides the vehicles
2. Find entity that provides the platform
3. Identify locations for parking the vehicles</td></tr>
<tr><td colspan="2">Budget costs:
1. Cost involved with the use of the vehicles
2. Cost involved with developing the platform
3. Transaction cost involved with the reservation system</td><td colspan="2">Revenue streams:
1. Fee for using the vehicles
2. Membership fee for access to the platform
3. Advertisement</td></tr>
<tr><td colspan="2">Environmental costs:
1. Energy for operating the vehicles
2. Energy for infrastructure changes
3. Energy for operating platform</td><td colspan="2">Environmental benefits:
1. Reduced greenhouse gas emissions from the use of zero-emission, rather than traditional vehicles
2. Reduced greenhouse gas emissions from better utilization of vehicles</td></tr>
<tr><td colspan="2">Social risks:
1. Not all shopkeepers and entrepreneurs may benefit from the use of the shared vehicles and may lose access to the city as a result
2. Vehicles use public space, which may result in less space for other social activities</td><td colspan="2">Social benefits:
1. A reduced number of vehicles operating in the city
2. More compliance with rules and regulations due to unlocking of up-to-date information directly to logistics providers</td></tr>
</table>

Figure 24: Updated business model canvas for integrated management of urban freight transport in Groningen Trial 1

In terms of key activities, the platform should provide an overview of when the vehicles are in use and where and when they are available. The platform should also provide an easy booking system through which vehicles can be reserved and paid. The vehicles are of course a key resource, as are the locations where the vehicles can be parked. In this trial, different types of zero-emission vehicles were used, namely a zero-emission van, a light electric freight vehicle, and an electric cargo bike. The vehicles were assigned to a fixed parking location. Shopkeepers and entrepreneurs had to collect and return the vehicle to that location. Key partnerships involved the vehicle provider, the platform provider, and local authorities. In this trial, the vehicle and platform provider were the same party. Local authorities needed to approve the use of the vehicles, their parking location and potential changes to the charging infrastructure to enable recharging of the vehicles.

The main costs were involved with the vehicles. In this trial, the vehicles were owned by a service provider that also provides that platform through which the vehicles can be reserved. Based on the usage of the vehicles during the trial, important lessons can be learned about a viable business model for both the user and provider of the vehicles. Specifically, different types of local shopkeepers and entrepreneurs can be determined based on their usage, for example, in terms of frequency, duration, and the moments at which the use the vehicles. This information can feed into

a rental cost structure with some form of dynamic pricing to accommodate different user types. The service provider needs to be able to receive a return on investment on the vehicles as well as cover the cost of operating the platform. While being without exhaust pipe emissions—that is tank-to-wheel emissions—the vehicles do use energy. At the current energy mix in the EU, this will involve well-to-wheel emissions related to generating the required energy. Potential infrastructure changes and the platform will also require energy. A social risk of the platform is that not all shopkeepers and entrepreneurs find out about the availability of the shared vehicles, or that they have operating models that are not well suited for the use of those vehicles. Because the platform is seen as a mitigation strategy for more stringent access regulations of the city, those shopkeepers and entrepreneurs may need to buy their own zero-emission vehicles to avoid limiting their access to the city. In order to make the vehicles visible and attractive in use, they will need to be parked in visible and convenient locations, which will consume scarce public space.

The buy-in and support of local shopkeepers and entrepreneurs that (may) use the shared, zero-emission vehicles is crucial for the success of the platform. For the deployment of the platform, a company that provides the platform and/or vehicles need to be found. In principle, these two can be separated and a platform may also provide access to vehicles that are owned by external stakeholders. For example, a shopkeeper may also bring in a vehicle as a resource to the platform that can then be used by another shopkeeper. In this trial, however, all vehicles were provided by the same company that provided the platform and no vehicles owned by shopkeepers were included. During the deployment of the platform, local authorities had to identify suitable locations for parking the vehicles. These can be dynamic locations, when the system is free-floating, or fixed locations, when vehicles in the system need to be collected and returned to the same, fixed location. In this trial, the latter applied. Key beneficiaries of the system were the local shopkeepers and entrepreneurs, who by using the vehicles kept their broad access to the city, got access to vehicles at relatively low cost and could develop new business models using the vehicles. Residents of the city benefitted from improved efficiency of the urban freight flows, but also by a broad range of local shops. Lastly, the provider of the platform and/or vehicles obtained a new channel for their services.

The main source of revenue for the platform will be the fee for using the vehicles. In this trial, the fee will not apply to users to first explore how the vehicles can be used. But, based on the lessons learned by the users and provider, a fee structure will be developed as part of the trial. This fee structure should be high enough to cover all cost associated to the vehicle and leave some profit for the provider while still low enough to remain attractive for broad use by shopkeepers and entrepreneurs. Other potential sources of revenue could be a membership fee of users—hence, not only charging per time or km used, but also for having access to the platform in the first place—and/or by placing advertisement on the vehicles. Environmental and societal benefits stem from a reduced number of vehicles and more efficient use of vehicles. Societal benefits further come from enabling more stringent regulations while not limiting the range of shops in the city.

A key reason for not fixing this prior to the start of the trial is that these fees and other revenue streams depend strongly on the usage of the solutions. Specifically, the fixed investment costs in are clear and make up the majority of the total cost. In Trial 1, these investment costs concern the purchasing price of the zero-emission vehicles. The depreciation period for these assets is also given in advance. In order to have a viable business model, the total revenue stream should cover the

initial fixed investment costs as well as the variable operational costs and a profit for the provider of the vehicles. This is largely determined by the usage of the vehicles. The more frequent the use, the lower the fee per use could be.

Another key reason not to fix the fees is related to the perspective of the user. In this trials the use of the solution requires a shift from business as usual—both in terms of behaviour and operational processes. By starting both services at low cost or for free, potential users can explore the services at low cost. This may enhance their willingness to make changes to other parts of their operation and explore new ways of doing business. It seems important that the initial users know that the low cost of free use of the solution is only because they are initial users. That is, that they are explicitly taking part in the discussions about a viable business model, including the cost for using a vehicle or locker. In the trial, the risk for the providers is covered as part of the project. A potential shortcoming would be that potential users think the services are indeed free, and will no longer be interested when they need to pay. Of course, it could be that there is no viable business case where the users are accepting the fee while the providers make a sufficient profit.

3.2.1.3 Key learnings

A key change during the trial, was the bankruptcy of initial trial parter Dropper. With them falling away and being replaced by GCC, the focus changed from a tech-push trial to a stakeholder engagement trial. This proved to be very successful, as the shopkeepers took ownership and responsibility in the formation and implementation of the trial. This makes that key stakeholders were no longer opposed to the 'threat' of a zero-emission zone (ZEZ), but interested in the possible solution. As they were the instigator of the change, they were more easily convinced in following up and participating in the trials.

As of November 1 2023, vehicles and platform provider Century will switch to a ULaaDS follow-up model with payment by entrepreneurs. A joint plan for scaling up the number of vehicles will also be made. ULaaDS trial 1 will therefore continue to exist.

3.2.2 Trial 2: logistics hub at park & ride outside the city centre

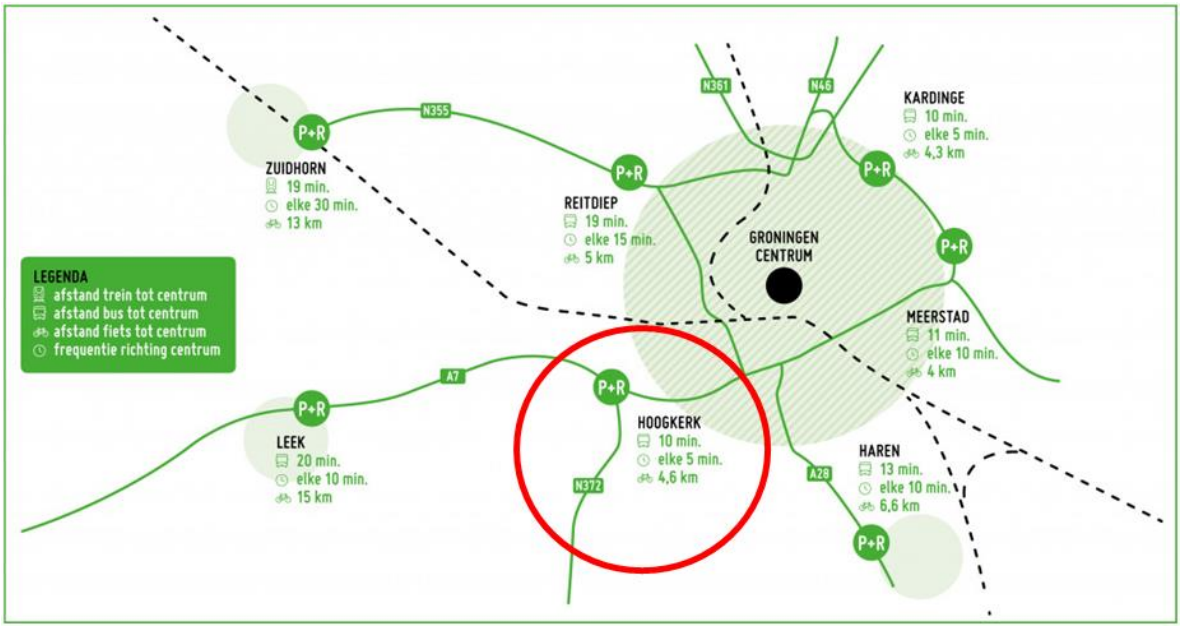

Figure 25: map of P+R zones around Groningen

Trial 2 was intended to add a logistics service to a P+R (Park and Ride) area on the outskirts of Groningen. Many commuters travel to the P+Rs around Groningen every day. The aim of this was to develop an attractive service for commuters and to make logistics more sustainable by reducing and replacing the transport kilometres driven. Target groups for this Trial were commuters, national delivery services, local couriers and local SME companies. Trial 2 addressed the following theoretical ULaaDS solutions:

- Sharing economy platforms for on-demand city logistics
- Dual Mobihub

It addresses three main principles within these solutions:

- Crowdsourcing platform marketplace for city logistics
- Location and infrastructure capacity sharing
- Transport vehicle capacity sharing

3.2.2.1 Trial setup and goals

In this Trial the municipality of Groningen (GRO) and the public transport organisation of the provinces Groningen and Drenthe (OVB) planned to experiment with the addition of logistics services to multi-modal mobility hubs for commuters.

The addition of logistics services is centred around the instalment of a parcel locker system at the Park and Ride (P&R) location Hoogkerk, just outside the city of Groningen. This location attracts many commuters parking their car or arriving by bus, to travel their final leg towards the city of Groningen by bike, bus, or taxi. The parcel locker system is integrated into the public transport system, sharing its location and available infrastructure capacity. Commuters can use the parcel locker for returning parcels they received before or collect parcels they had delivered to the parcel locker.

The parcel locker system can also be used by shopkeepers and entrepreneurs in the city. This is facilitated by means of a collective service, focusing on reducing the dependence of shopkeepers and entrepreneurs on their car or van. Specifically, shopkeepers and entrepreneurs can drive from home to the mobility hub, where they can drop off their goods and travel to their shop by means of bike of public transport. Goods are then bundled and delivered to the shops from the mobility hub. Reversely, the parcel lockers can also be used for the "first mile"—that is, e-commerce deliveries can be taken from the shop to the parcel lockers at the hub.

Figure 27: pictures of P+R and locker that was installed

During the project, two local stakeholder fora were held to discuss the purpose of the logistics service at the P+R site, and the purpose of logistics services at mobility hubs in general. The main focus was on the question whether a parcel locker network would be profitable and if a parcel locker network would bring down the number of driven kilometers by motor vehicles and would bring down the amount of emissions.

The cautious conclusion after the first forum was that the city would benefit most from either a comprehensive and dense network of parcel lockers, or no parcel lockers at all. The second forum was the starting point of a market exploration by the municipality of Groningen. The central question was under what conditions parcel locker suppliers can realize a network of pick-up and drop-off points for parcels. This market exploration is the preparation for a concession that the municipality of Groningen wants to set out for the operation of parcel lockers in public spaces.

3.2.2.2 Effective trialling

The local fora resulted in valuable input for setting up a real life trial. To install a functioning parcel locker, a land use agreement, a building permit and an electricity connection were required. It was a difficult process to meet these preconditions, this led to delay in the Trial. One of the causes of the difficult process was the lack of a policy framework for parcel lockers in Groningen. Below follows a deeper explanation per topic.

Spatial integration

The pressure on public space is great throughout the city. All space has already been allocated to a function. In recent years we have seen that new functions are making a claim on the existing public space. with the parcel lockers, we are now addressing a new object with a spatial claim in the public space.

Another issue with spatial integration is the size of the parcel lockers. A small parcel locker measures 2.5*2*0.5m. A regular sized parcel lockers measures 5*2*0.5m.

- All objects and buildings are designed in such a way that they border the public space with a representative side. Searches in practice show that it is difficult to find a location for a parcel locker that respects existing facade views and representative greenery.
- By obstructing visibility, a parcel locker can undermine road safety.
- By blocking visibility, a parcel locker can undermine social safety.

There is also a practicality issue for the accessibility of the parcel lockers by car.

- The parcel locker needs to be easily accessible for the delivery van to pick-up and drop-off parcels.
- For customers, the parcel lockers must be accessible by foot or bicycle. The parcel lockers should not make it attractive for customers to collect parcels by car.

Land use agreement

Due to the increasing pressure from various functions on public space, the municipality of Groningen has in recent years implemented a stricter policy on granting use of municipal land to third parties. In the absence of a policy framework for parcel lockers, reaching an agreement for land use was a difficult process.

- Based on new policy for land use, the municipality of Groningen applied a standard rental price for the land use, which corresponds the land use price for all other third parties.
- The provider of the parcel locker did not agree to this rental price, even though it was reimbursed by the ULaaDS project. The provider was afraid of precedent effect and saw the risk that similar prices would eventually be charged by other (Dutch) municipalities.

Eventually the city of Groningen and the parcel locker provider came to an agreement under specific detailed conditions, concerning the land use and (un)availability after the project's end.

Conditions for land use agreement during the Trial	
1.	The user is aware that the installation of parcel lockers is in a pilot phase that will run until the end of 2024;
2.	The user is aware that the municipality issues a tender to which the various providers of parcel lockers can respond;
3.	The user is aware that there is a possibility that the parcel locker(s) will have to be removed after the pilot phase or adapted to the applicable (policy) rules;
4.	The user is aware that if the parcel lockers are allowed to remain permanently after the pilot phase, this land use agreement will be converted into a rental agreement or that a '*Right of Building*' will be established;
5.	The user is aware that the costs relating to the possible establishment of the '*Right of Building*' are at his expense;
6.	The user is aware that a land use agreement will only be concluded for one location in the context of the pilot phase.

Figure 28: conditions for land use agreement during the trial

Electricity connection

There is a waiting period of three to sometimes six months in the Netherlands to have a new electricity connection installed. During the trial process, we discovered that we could not use an existing electricity connection that had recently been installed for a storage of electric shared bicycles at the P+R. This has led to delays in the execution of the trial.

3.2.2.3 Key learnings: policy framework for parcel lockers

At the same time as applying for permission to install the parcel locker for the trial, the municipality of Groningen started drawing up a policy framework for parcel lockers in public space. The need for this framework was a main outcome of the local stakeholder fora.

Delivery companies are looking for options to deliver parcels as efficiently and quickly as possible. They prefer to deliver each parcel in first time and drive as few kilometres as possible per parcel. A network of parcel points in the municipality where they can deliver packages is an efficient way of working for these companies. That is why many parcel points have been established in stores (especially in the past). This is more difficult nowadays, because stores cannot cope with the increased pressure. As a result, the delivery companies are looking for alternatives; such as parcel lockers in private or public space. Installing parcel lockers offers a solution for delivery companies. This allows them to expand their network of parcel points and deliver parcels more efficiently.

Parcel lockers in public spaces have a spatial impact on the living environment. The appearance of buildings, streets and squares can be affected. The accessibility and safety of certain places may be affected because delivery vans and residents come to this point. Furthermore, the positive impact of fewer CO2 emissions and fewer buses in residential areas is highly dependent on the locations of the parcel lockers. Reducing CO2 emissions is not a given, because if the parcel locker is too far away from residents, they are more likely to pick up the parcel by car.

The following principles and preconditions have been elaborated in the policy framework for the installation of parcel lockers.

Principles

- Delivery companies should use the same parcel lockers, preferably in the same network. This can be achieved through 'white label' parcel lockers (managed by a third party) or through 'open/single label' parcel safes (managed by an offering party, which opens the safe to other providers).
- The white or open/single label parcel lockers have a certain appearance, but this is further tailored to the appearance of the Hub where they are placed.
- Parcel lockers may only be placed at specific locations in public spaces:
    - Mobility hubs. Mobility hubs are places where different forms of transport come together and where people can quickly switch from one mode of transport to another. By integrating parcel lockers into these hubs, we can reduce the number of kilometres driven by delivery parties and reduce congestion in urban areas. This also increases the chance that parcels will be picked up during an already existing trip.
    - Social neighbourhood and community centres (community hubs). Community hubs have a safeguarding function and bring people together from different social layers. Shopping centres and community centres are examples of a social hub. Parcel lockers at these locations may be placed on private land or on public land, this must be considered on a case-by-case basis. Placing parcel lockers at these social hubs makes them widely accessible. Picking up a parcel can also bring people into contact with each other, with organized activities or with the local shops located there.
- Parcel locker providers can install a parcel locker on private land (in consultation with the relevant landowner). They must comply with the municipal zoning plan and aesthetic policy (where applicable).

Spatial integration

- Placing parcel lockers within the hubs with the back-side to the wall of buildings or objects. Preferably not as a stand-alone object.
- The appearance of the parcel lockers must match the appearance of the relevant mobility hub.
- Social safety of the location is examined prior to installing the parcel locker.
- Parcel locker must be safely accessible for both the delivering company and the customer picking up the parcel. No nuisance should be caused to local residents.
- The usual size of a parcel locker is approximately 5*0.6*2m, each hub will determine which size fits best.

Flexibility and temporariness

Because it is unclear how long the parcel locker will be a solution for the delivering parties, and developments in this sector are changing rapidly, it is important that the parcel safes are movable. It must be possible for the parcel lockers to grow with the development of the hub and with new developments. If necessary, the parcel locker can be removed by the managing party.

Land use

- The mobility hubs are located on municipal owned land. A land use agreement will be concluded with the municipality for a parcel locker.
- The space around the parcel locker must be accessible to all residents and delivery services and remain properly managed.

Data sharing

- It is crucial for monitoring and evaluation that the municipality has access to the data of the installed safes.
- General figures about usage: number of parcels in/out per day, the average time a parcel stays in the locker (delivery vs. return), how the delivering company delivers the parcels (what kind of vehicle), how customers pick up the parcels (car vs. walking /bicycle, combined ride), occupancy of the locker, etc.

Spatial analysis parcel locker network

In collaboration with Bax & Company, a study was conducted into suitable locations for parcel lockers. This takes into account various local characteristics, such as population density, street networks, locations of mobility and community hubs, existing closed networks of parcel lockers, etc. A spatial analysis showed the coverage gaps in the current distribution of parcel points. This research revealed approximately 20 hub locations where parcel lockers could be installed. When a hub is developed, this research serves as input for the possible location for parcel lockers, guided by the principles of the hub implementation program.

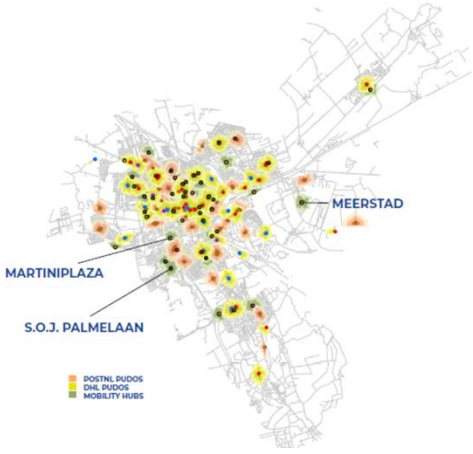

Figure 29 results spatial analysis for parcel lockers in Groningen

The spatial analysis followed different stages in continuous consultation with the city's employees, helping Groningen find the most suitable spots for parcel lockers. The aim was threefold:

1. To ensure accessibility for active travel, avoiding car travel for parcel pick-ups

2. To complement the existing private parcel locker networks, adding facilities in underserved areas
3. To develop an integrated approach which embeds logistics services in the city's mobility hubs strategy

The insights can serve as a guide for public authorities looking to develop a well-thought, coordinated approach. They are also beneficial for parcel locker providers interested in improving their services and adapting to different city requirements, including accessibility and aesthetics. Although complex, Groningen's approach is replicable in other contexts, too, allowing public and private stakeholders to work together in the transition towards sustainable urban logistics. This way, municipalities can ensure that their ambitious zero-emission policies can be implemented with less pushback from the local community. This is bolstered by tangible support for businesses and citizens, ensuring sustained economic activity within the city.

3.3 Trials Mechelen

Mechelen is a medium-sized typical European city and municipality in the province of Antwerp, Flanders, Belgium. It has 86.000 inhabitants and it is estimated that it will grow to 100.000 inhabitants by 2030. The city has attracted in the last years more inhabitants, entrepreneurs, employers, visitors and tourists which imply a lot more traffic and transport flows. On the one hand Mechelen has an historic centre with a car-free pedestrian shopping triangle. In 2012, Mechelen took a big step in installing a car-restricted inner city. On the other hand, Mechelen wants to stay reachable for all sorts of visitors and logistic players. To find a good balance between liveability and reachability, the city has to work on and develop new and innovative ways to perform the deliveries and pick-ups in and out of the centre.

The city of Mechelen, by participating in previous European projects, has built up a network of stakeholders involving entrepreneurs and shop owners in the city and the main players in the logistics sector with a focus on parcel delivery (DPD, DHL, UPS, GLS, PostNL, Bpost). By becoming partner in ULaaDS, the city could further build on previous experience and could set-up multi-actor pilot projects and experiment in an advanced way with innovative solutions in logistics.

Mechelen, located in the heart of Belgium, has a track record being a partner in European projects evolving around sustainable urban mobility. With participation in projects such as Cyclelogistics, CityChangerCargoBike, Novelog, Mobimix and Surflogh, the city of Mechelen was ready to continue its efforts and redeem previous experience in a new project – UlaaDS.

The city of Mechelen had and still has a very clear ambition on urban logistics – to make logistic streams both more sustainable and more efficient. To reach these ambitions, policy measures, push and pull actions and pilot projects were and will be necessary. With the participation in ULaaDS, the city had a focus on two areas that were until then not explored and in line with our ambition:

- a (structural) cooperation between local and national e-commerce players to make their inner city logistic streams both more efficient and more sustainable.

- a follow-up exploration of the potential of autonomous vehicles, this time with a combination of transporting both goods and people.

Mechelen wants to make urban logistics more efficient and sustainable. The city believes that more efficiency can be gained by stimulating bundling opportunities. In past projects it already tried to support city hub initiatives. The main conclusion was that for making bundling and city hubs profitable, it needs a **cooperation between different logistics service providers (LSP).** Therefore, the city saw ULaaDS as a change to try and take this necessary step and to create cooperation between several LSPs. This was the main aim of trial one.

Next to that, Mechelen has the ambition of being a frontrunner and wants to be at the first row in **trialling innovations**. The city already had done a demonstration with an **autonomous** shuttle in cooperation with VIL in 2018. Within ULaaDS, the aim was to build further on that experience and to take it a step further, by combining people with goods traffic.

3.3.1 Trial 1: inner city first-mile collaboration between LSP's for pick-ups at local shopkeepers

Courier servers entering the inner city with vans and trucks put pressure on the scarce space and cause unsafe situations and pollution. The structure of the city would highly benefit from alternative last mile transport with lighter vehicles that pollute zero to none.

In the inner city trial, Mechelen tried to stimulate cooperation between several LSPs in order to create less vehicle movements and less driven kilometres. It tried to create a cooperation between two national and international players and the local bike courier company for realising the pick-up of online sold goods.

By combining the services of different local and national players, the city of Mechelen hoped to achieve a win win cooperation: a more efficient means of working for the three logistic players as well as reduced pressure in the inner city.

3.3.1.1 Trial setup and goals

At the moment of writing the grant agreement, the city of Mechelen had several 'building blocks' that could prove useful in trialling on demand solutions in an urban logistics environment. At that time, national courier server bpost was installing microhubs and investigating their potential. Next to that, the ECOkoeriers – the local bike courier in Mechelen – were ready to increase their handled volume, operating from a cityhub in the South of the city. In addition, UPS planned to park a Rytle bike in the same cityhub and operate from there as well. With the participation of Dropper in ULaaDS, the city of Mechelen hoped to join forces with them and build a platform where different logistic service providers would be able to connect to and have the last mile performed by ECOkoeriers. By combining these building blocks, the city was confident in setting up relevant solutions.

Initially, three different trials were planned in scheme 3 within the inner city of Mechelen.

- UPS would trial a collaborative delivery model together with ODTH (real-estate warehouse provider in Mechelen). UPS would rent an SME-box in the city hub, have their goods delivered in their box and drive out with cargo bikes, provided by Rytle, for the last mile. With this initiative, available infrastructure is used wisely and UPS avoids the burden of driving in and out the city with their vans.
- Bpost is the national courier server in Belgium, both for regular mail as for parcels. They are an autonomous public company and employ more than 26.000 people. Sustainability has come high on the bpost agenda since a few years. The combination of an ambitious city as Mechelen and a national company with far reaching sustainability intentions, gave both parties ample opportunities to test innovative ideas. The Belgian national postal service Bpost has made impressive progress with its Ecozone-initiative that started as part of the European Surflogh project. It entails smart lockers, electrical vans and cargo bikes that all operate in the inner city of Mechelen. Bpost has found in Mechelen a real-life testing zone and is eager to continue trialling what combinations of the current building blocks – microhubs, lockers, different vehicles - are interesting in finding sustainable solutions for urban freight handling in the frame of ULaaDS.
- The ECOkoeriers position themselves as the go-to partner when it concerns first and last mile deliveries in Mechelen. They are not only offering bike courier services (both pick up and drop off), but also warehouse activities such as stocking, order picking and preparing for sending. Although ECOkoeriers are very experienced, they could make next steps in further professionalizing their business. At the moment, they have no track and trace system which is a barrier for future clients. Therefore, ECO had a keen interest in a collaboration with project partner Dropper, who could provide the necessary software modules. With the bankruptcy of Dropper, their commitment to the Mechelen inner city trial also fell away. ECOkoeriers had to rethink their role in ULaaDS and suggested to investigate reverse logistics. To make their business more efficient, return streams could be focussed on as well within the frame of ULaaDS. ECOkoeriers drive into the city fully loaded, but aren't as efficiently loaded to exit the city again. This free volume could be used and capitalized. ULaaDS would give the needed impulse to investigate what return streams to focus on.

When shaping the three different trials (each with their specific setbacks) and at the same time touching back upon the project proposal, the trial partners wanted to focus more on collaboration and strengthen their trials by integrating the aspects in a joint trial.

The first version of a joint trial consisted on ECO providing consolidated pick-ups at the inner-city merchants that use BPO or UPS as sender of their parcels. They deliver a neutral service and are not linked to a national player. ECO could perform the first mile and deliver the parcels in the city hubs of UPS and BPO, respectively.

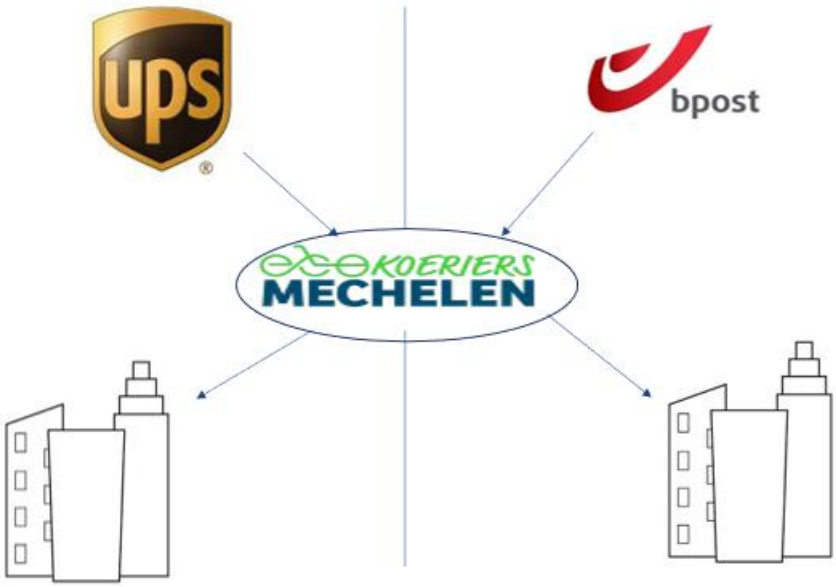

Figure 30: setup of inner city trial in Mechelen

The reason to choose this specific logistic stream, is the fact that B2B logistics were not in the scope before to make them more efficient and sustainable. B2C and C2B logistics were made more efficient and sustainable by placing more than 50 parcel lockers in Mechelen. But B2B logistics – retailers sending parcels through a logistic service provider – were not explored. To make these streams more sustainable and more efficient, ULaaDS was a perfect catalysator. The joint trial with the ULaaDS partners of BPO, ECO and UPS would meet a very specific need in the logistic realm of Mechelen.

The trial should answer to the following theoretical schemes described in the collaborative and shared urban logistics solution:

- Sharing economy platforms for on-demand city logistics
- Citywide platform for integrated management of urban logistics

3.3.1.2 Effective trialling - not successful

Agreements between BPO and ECO were made, including a business agreement. ECO offered retailers that send parcels with BPO to pick up these parcels at their shop and bring them to the BPO cityhub by cargobike. For the service, ECO charges 5 euro per ride. BPO agreed to have ECO inject the parcels in the Mechelen city hub, during the trial period (instead of their national injection points in Brussels and Antwerp).

The setup of agreements between UPS and ECO lasted for months – between September 2021 and June 2022- and were unsuccessful. The main reason for such complication in the cooperation agreement was the fact that UPS had joined forces with a subcontractor for the Mechelen area parcels, for both pick-up and delivery. This process was done outside of the knowledge of ULaaDS,

but it had a very big influence on the trial progress. By agreeing to give a part of the subcontractors' volume to ECO – even if only for the duration of the ULaaDS trial – UPS was breaching its contract with the subcontractor. To overcome this hurdle, UPS proposed for an agreement between their subcontractor and ECO, in order to still make the ULaaDS joint trial possible. ECO did not want a collaboration with the subcontractor, stating that the current climate of subcontracting last-mile services in Belgium is not something they want to support: earlier that year multiple news items stated that larger parcel logistics players exploit subcontractors in order to reduce costs (UPS was never mentioned in any news items). ECOkoeriers did not want to be affiliated with such practices, even though no allegations have been made for exploitation of subcontractors towards UPS. Next to this, the subcontractor would have to become a project partner, which was not foreseen or possible at that point in the project.

In June 2022, more than a year has passed to define a useful trial within ULaaDS. The preliminary foreseen starting date had already passed by a year ago and progress was hard to book at this point.

- **UPS** was restricted in participating due to them subcontracting the Mechelen parcel-deliveries. In addition, internal safety concerns were raised to set up a trial with a Rytle bike, as was the first planned trial set up.
- **BPO** stated that the nearing deadline of the ULaaDS project put the organisation off to engage in a possible new trial.
- **ECO** stated it would not start a collaboration with an unknown subcontractor, due to the fact it could not prove it has clear and appropriate working conditions, and a mandate to collaborate in a European project.

Due to these circumstances, the project team decided to end the trial. This meant that no actual operations took place during the effective trial period of this trial.

3.3.1.3 Key learnings

Despite the obstacles and not successful trial, lessons can be learned.

- After a lot of bottom up trialling in European projects, the formulation of policy should be a priority in the city now. Flanking policy that steers the logistic streams in a more sustainable and efficient direction.
- The city needs to keep up the conversation with the logistic service providers that serve the city. Twice a year, Mechelen already holds a stakeholder fora as a zero emission working group and the city will continue to do so.
- Data sharing seemed to be more sensitive as predicted. Even though the trial partners were actual project partners, certain data could not be shared (delivery addresses, amount of goods, costs,…). Generally, the bigger the company, how more difficult this was.

- Brand exposure while serving the city is highly important. Parcel delivery companies are in a high competition for market share, where losing market share is considered a bigger loss than performing operations with a negative revenue.
- Last mile logistics and parcel delivery is a highly complex ecosystem, where the transport companies themselves even subcontract the last mile (depending on the companies' strategy). Those subcontractors use the branding of the transport company, for commercial reasons (the presence in the city is highly important).

To create a reduction in number of driven kilometres and number of vehicle movements, bundling and cooperation is needed. With the existing policy, LSP's aren't motivated enough to develop their activities in that way. It will be crucial in the coming years to formulate the right flanking policy as a city.

Even though the outcome of this pilot isn't tangible and no concrete results could be noted, the city actually learned valuable lessons. The process showed how difficult it is to have (inter)national parcel delivery companies work together and have them trust each other to perform first and last mile activities. Even when it's only on a trial base. All technical issues could have been overcome, the solution was in place and detailed enough to start trialling. But if trust between partners lacks, no efforts in the direction of a successful trial can be expected. It can be noted that trust is no issue when it comes to subcontracting third parties when performing last mile activities. However, when the cooperation is with a commercial competitor, the situation seems to be different. Neutral platforms based on Physical Internet principles in combination with neutral orchestrators, with thorough knowledge of city logistics, could be future catalysators of the barriers encountered in the trial.

The city is involved in next European funded projects that will focus on especially these catalysators. In addition, projects with a focus on taking the next step in formulating legislation will also be in our portfolio the coming years.

3.3.2 Trial 2: Cargo-hitching with an autonomous vehicle at a local business park

The preparation of the trial with an autonomous vehicle started in the beginning of 2021, with a feasibility study and afterwards, the creation of a tender for subcontracting the deployment of the vehicle service. After this, the actual implementation phase started with a risk assessment and permit gain procedure, whereafter the actual trial took place between June and August 2021. The first month, the vehicle performance was tested with only passenger transport (in the context of the liaised Interreg project Art.Forum). The second month, a locker system was implemented in the daily operations of partner bpost, and tested as a cargo-hitching scheme where the vehicle transported people and packages within the business park Mechelen Noord at the city boarder, on open accessible public roads.

3.3.2.1 Trial setup and goals

During the setup phase, VIL and Mechelen commenced a preparational study to investigate the most feasible trial setup for impactful outcomes. It investigated the state of the art on legal restrictions, technological possibilities and business opportunities for autonomous driving. In the inquiry, five scenario's for implementing autonomous shuttles in Mechelen were proposed to a group of relevant stakeholders: policy makers on national and regional level, technology providers of autonomous driving, academic experts and business representatives with interests in autonomous driving. The five scenarios were:

- Last-minute delivery of goods to restaurants with Metro (food wholesaler), a trajectory of about 15 kilometres over national roads (described In the project proposal)
- B2B delivery in the inner city (a new version of tests done in Mechelen in the regional project ALEES)
- B2C delivery of goods
- Dynamic autonomously driving parcel lockers
- Cargo-hitching with an autonomous vehicle at a business park, with a parcel locker installed inside the vehicle (operational in the bpost parcel locker network)

The last scenario was chosen by all stakeholders as the most feasible and interesting one to continue in real life conditions. This answers to the cargo-hitching scheme of ULaaDS theoretical solutions.

During the setup phase of the trial, different key matters took place, worth mentioning in this report.

Merging with Art.Forum

The city of Mechelen was also involved in another European project concerning autonomous driving: the Interreg project ART-Forum. The city saw the opportunity of combing the efforts of both projects to enlarge the testing scale and duration. By combining both projects in one testing period and using the same subcontracting partner after tendering, tests could be held longer and larger, to outgrow the phase of pure one day pilot testing. The scenario of cargo-hitching was also in line with the conditions of ART-Forum, and therefore both project trials combined forces to facilitate one large testing phase of multiple months.

Tendering

VIL and Mechelen conducted a tendering procedure to select a vehicle provider. Out of three contestants, USH was selected as subcontracting partner to provide the vehicles (from provider Easymile) for testing. Other candidates failed to match expectations concerning the cargo-hitching setup: placing a parcel locker in the vehicle that is in use at the bpost parcel locker network in Mechelen.

Permit procedure

Immediately after the tender procedure ended, Easymile, VIL and the city of Mechelen started the procedure to gain a permit for effective testing on open roads. This took five months to receive: the regional (Flanders) and national (Belgium) governmental departments were unclear on who was responsible for delivering a testing permit. They had bilateral meetings on the subject, but the starting date of half June was in danger to actually receive a permit beforehand. For this reason, an

exception was made by the hand of the national minister of transport Georges Gilkinet, based on the positive risk assessment and necessary documentation on the vehicle. This process led to the start of a policy work group on autonomous vehicle implementations, where national and regional experts have come together to define a framework and vision text for future autonomous driving in Belgium, with clear agreements on the division of tasks for future testing and implementation.

Risk assessment

To ensure a safe testing on open road would be implemented, a risk assessment of the vehicle and route was conducted. This assessment defined the route obstacles and proposed solutions (which were executed before gaining a permit). Those obstacles where: dents in the road, possible traffic jams due to parking zones for cars, trees that could block the data-transfer signals,…

3.3.2.2 Effective trial

The aim of this trial was to test the concept of "cargo hitching", i.e. the combination of freight and public transport. Furthermore, in order to increase the level of service, the combination with an autonomous shuttle was made to carry out this trial. The total duration of this trial was 5 weeks, with the autonomous shuttle starting 3 weeks in advance, exclusively for public transport, on 13 June. Several meetings/workshops were held before, during and after the trial to gather the opinions of different types of stakeholders. These were the businesses near the trial, the city services, the residents, the trial partners and the ULaaDS project experts from different cities. During the trial, only one adaptation was made to test the parcel delivery part of the trial by sending own parcels to the shuttle, which is described further in the report.

Trial partners

The project has been implemented in cooperation with several partners. VIL and the city of Mechelen were in the lead of this trial, and ULaaDS partner bpost joined as a testing partner.

First of all a tender was published to select an operator and provider of the autonomous shuttle. The Belgian company USH was selected. They provided all services that are needed to realise an autonomous mobility project. USH provided a shuttle from the French company Easymile. Swipbox was the provider of the parcel locker inside the shuttle, the same type that is used by bpost in the ecozone parcel locker network in Mechelen. Bpost incorporated the (now mobile) locker in their parcel locker network, so it could be used in their daily operations.

The route

The route was located in the industrial area called “Mechelen-Noord” within the city region of Mechelen. The route of the autonomous shuttle is shown in **Fout! Verwijzingsbron niet gevonden.**12. The direction of the shuttle is clockwise and there were a total of 6 stops. These are shown as green and red dots in **Fout! Verwijzingsbron niet gevonden.**12, with the green dot being the main stop. The locations of these stops were chosen to be close to businesses that supported the project and to existing bus stops that the shuttle passed on its route. The main stop was located in a car park, and there was an existing bpost locker near this stop at the start of the pilot (installed

during the setup phase of the trial). The shuttle was operated on weekdays between 11am and 6pm. The total travel time of this route, excluding stops, is 17 minutes and the total distance is 2.1 km.

Figure 31: Route of the autonomous shuttle (blue line), stops (red dots) and main stop (green dot).

The shuttle

The shuttle used during this pilot was an autonomous electric shuttle owned by the company Easymile. It has a capacity of twelve people, which was reduced to nine during this trial as three seats were replaced by a parcel locker. In theory, the maximum speed of this shuttle is 25 km/h, but for safety reasons, the maximum speed of the shuttle was limited to 15km/h. Inside the shuttle was a parcel locker with three small and three medium lockers (see figure 13 (right)). The shuttle could also be set to two different modes, bus and tram, meaning that it would stop only on request or stop everywhere. In this pilot, the bus mode was used as the operating mode. At the end of each working day, the shuttle goes to a warehouse from supporting partner Continental at the business park, where it could recharge until the next morning.

Figure 32: autonomous vehicle and parcel locker used in Mechelen

Infrastructure adaptations and signalisation

In order to increase the level of service provided by the shuttle, a number of infrastructure and signalling adjustments were made. One of the measures was to reduce the speed limit on the public roads that formed part of the shuttle's route from 50km/h to 30km/h. This was done to increase safety, as the shuttle's maximum speed was limited to 15 km/h. In addition, all parallel parking spaces on the right-hand side of the route were removed to reduce the number of potential conflicts with other vehicles leaving their parking spaces. Another measure to improve the shuttle's performance was the removal of weeds and branches near the road to prevent the shuttle from slowing down when it detected an obstacle. To make other road users aware of the presence of the autonomous shuttle, a number of visuals were placed along the roads within and around the route. In particular, ramps were placed at the entrance and exit of the car park where the main stop is located to help overcome the difference in height. To indicate the shuttle stops, signs (see figure 14) were placed with a QR-code that takes users to the website to request a stop.

Figure 33: Sign which indicates the stop of the shuttle

Usage of the shuttle and locker

To use the shuttle's two functionalities (public transport and parcel locker), an external application and/or website must be used.

To use the shuttle as a mode of transport, users had to go to a website created by Ush, who was also the shuttle's operator. This was also the website users would go to when they scanned the QR code on the signs at the stops. On the website, users saw a map showing the route of the shuttle, the real-time location of the shuttle and the expected waiting time at each stop. (see figure 15). By clicking on a stop, users could request the shuttle to stop at their location.

To use the parcel locker, users first follow the same steps as for transport to have the shuttle stop at a bus stop. The user can then select their parcel within the bpost app and open the parcel locker when they are nearby to collect their parcel. This locker specific part is the same methodology as for the standard fixed parcel lockers.

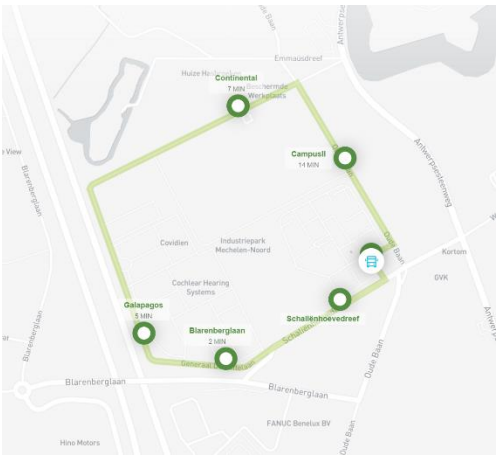

Figure 34: Screenshot of the browser based app of the autonomous shuttle where a stop could be selected

Stakeholder involvement

In order to gather opinions and views on this pilot project, several stakeholder groups were consulted. This took the form of stakeholder workshops, questionnaires or interviews with passers-by at various locations in Mechelen.

- Physical setup

  In order to ask the inhabitants of Mechelen for their opinion on driverless transport and the opportunities it would bring, a physical setup was chosen. The aim was to reach a broad and diverse public, and for this reason this physical setup was positioned at 5 different locations during the course of the project. These physical setups were primarily used as conversation starters to further explore the themes of mobility and driverless transport.

- Stakeholder workshops

  A more specific approach was taken with the stakeholder workshops. There were 5 separate workshops, each with a different group of stakeholders. These groups were:

  - Experts, these were experts from different European cities who visited for a study day on the topic of logistics.
  - Residents' panel, this was a combination of members of older people's organisations and representatives of people with less mobility.
  - Municipal services, employees of the following departments: public space, management, urban planning, mobility, projects and planning.
  - Businesses, companies located on or near the route of the autonomous shuttle.
  - Pilot partners

  The different groups withheld different opinions on the state of autonomous driving and the possibilities within the trial.

  To maximise the potential of the autonomous shuttle, a fixed route would be the preferred option for city services. Operating on its own infrastructure will minimise the possibility of conflicts, and allow the vehicle to operate more efficiently. If it is on a fixed route, it will be part of shared mobility and there will be no individual on-demand use. The main concern with autonomous vehicles is that they will compete with cycling or walking as a mode of transport. The focus should be on reducing the number of cars, not the number of cyclists or pedestrians.

  The inhabitants of Mechelen can be categorised according to their age, where in the city they live and how mobile they are. Among the younger citizens, from children to young adults, reactions are mixed. On the one hand, there is a group that welcomes the technology with open arms. On the other hand, there is a group that is more sceptical about the technology and doesn't want to give up all control to machines. Both groups agree that it is inevitable that it will be part of the future and that it can be a complement to the current

public transport network. Older people and people with reduced mobility share the view that this will be a solution for them to be more mobile. Therefore, the accessibility of the shuttle should always be taken into account. For people living in the city centre, it would be less useful because they can walk or cycle to most of their destinations. For people living on the outskirts of the city, the car is still an important means of transport. At the moment there is poor bus service to their neighbourhoods, and an autonomous shuttle could be one way of addressing this. It can also be part of a P+R solution, where the shuttle connects outlying car parks with the city centre.

Workers in the Mechelen Noord industrial zone see the greatest potential in a ferry service between the industrial zone and Mechelen station. They also strongly believe that autonomous transport can be integrated into their own supply chain and logistics, but not in the short term. Being green is important to the companies and they want to combine this with increased efficiency and time savings by using this technology.

- Online survey

  An online survey asked people what they thought about the autonomous shuttles and the use of the parcel locker on the shuttle. This survey was distributed via the website of the city of Mechelen and posted on social media. Brochures were also distributed with a reference to the survey on the shuttle and the physical installation.

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3.3.2.3 Learnings

The practice learned us that the combination of goods and people are not that logic as it seems. They follow the same trajectory but often with a different timing.

The introduction of autonomous shuttles into the mobility system has been received both positively and negatively. On the positive side, the reduced reliance on a human driver could eliminate staffing costs and make a 24/7 service more feasible. In this way, it could also function as a 24/7 service between out-of-town car parks and the city centre. This will reduce the number of cars in the city and provide an opportunity to free up parking space within the city, creating more space for citizens. For people with reduced mobility, it could be a reliable solution to replace a taxi. Overall, people are confident in the technology, but say it's not ready yet. On the negative side, removing a human driver from the system leads to less social control and for some this is part of their social contact. There is still a long way to go before this system can be used in real-life situations. The speed would need to be higher than demonstrated in the pilot and it should be able to react more fluently on obstacles. Another option would be to provide specific infrastructure for the autonomous vehicle, but this will lead to more occupation of open terrain. There is also a difficult balance between flexibility (an on-demand service) and sustainability/shared transport on a fixed route. Combining

freight and passenger transport is seen as difficult because the two flows could conflict, with people driving the shuttle having to wait while parcels are unloaded. Separating them would give more opportunities to optimise them on their own, cargo hitching would be possible in niche situations.

Vehicle performances

The pilot also showed that a level 4 is still not possible in a western European traffic context with a mixture of cars, vans, trucks, cyclists and pedestrians. Therefore the technology still has to develop further and mature more. And in Belgium there still has to be necessary policy and legislative steps taken. The board of aldermen therefore decided to wait until the technology has developed further before encountering again in an autonomous adventure.

Overall, stakeholders gave valuable input concerning expectations, reflections and experience with autonomous driving and a mobile parcel locker. This can be best visualised in an expectation management table:

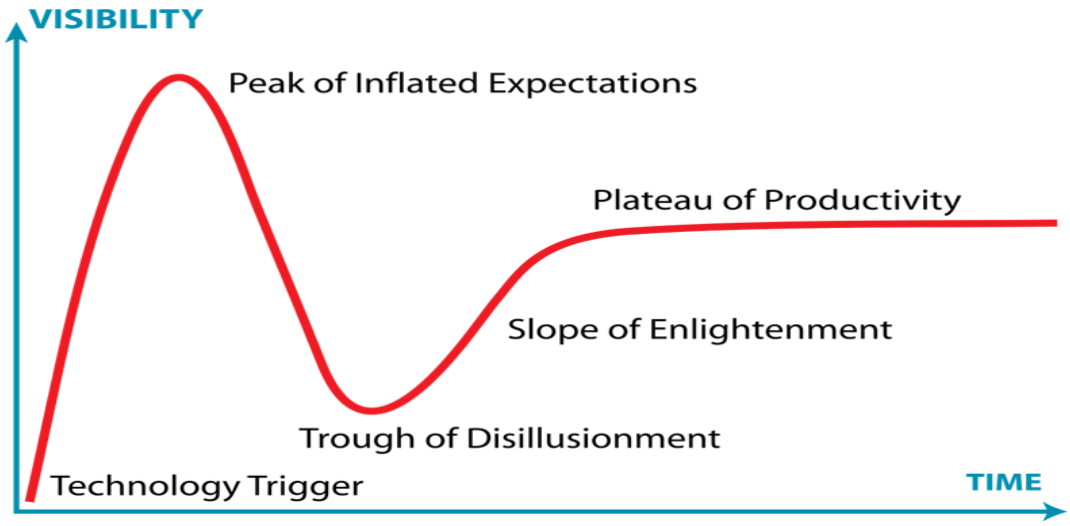

Figure 35: expectation management curve for innovation

All stakeholders were positive towards the idea of autonomous shuttles, but were a bit let down with the performances of the vehicle: slow average speed (12 to 15km/h) and several 'unlogical' decisions that the vehicle made. These were mainly due to the extremely high risk measures, taken in account of the programming of the vehicle: if the vehicle would come in the environment of an obstacle that was in movement, it would be extra cautious to avoid collision. A person driving a vehicle, would take a lot more 'risk', and come a lot closer. Also, the autonomous vehicle did not take priority as a 'normal' driver would do, to avoid collision. The question could be raised if this high safety level was necessary, but as it is a test with new technology, for the first time in open, public roads during daily traffic, no risks were aloud. Next to this, the vehicle could not estimate if the moving obstacle would form a risk or not: for example, passing by a pedestrian, it would slow down just as much for a mature, sober and healthy looking adult, as it would for a five year old

child. This is a very important judgment that is made by a driver, but it happens naturally. For an autonomous vehicle, this judgement is not yet possible (at least not during the trials).

Parcel locker usage

Usage of the parcel service on the autonomous shuttle was low. Only a few parcels were actually send and/or received and transported within the vehicle. The opinions gathered through the online survey, the physical setup and the stakeholder forums ranged from neutral to negative. Many saw many inconveniences in this combination. For example, when people want to collect their parcel, the people on the shuttle who are using it as a means of transport have to wait. The parcel locker in the pilot also had a lower level of service compared to current practice. Currently, people can access their parcels in the parcel lockers 24/7, whereas in the pilot this was only 11am-6pm, Monday to Friday. People also have to wait at a bus stop until the shuttle comes to collect their parcel, which is not the case with a static parcel locker. Especially for people working in the industrial area, it was common practice for their parcels to be collected by the warehouse worker. This way, the employees can take it with them on their way out. This is a higher level of service than getting your own parcel out of the parcel locker in the autonomous shuttle. It was also in direct competition with a static parcel locker at the main stop of the autonomous shuttle, of which the usage was on a normal level during the trial. During the stakeholder forums, people said that cargo hitching would only be useful in very niche applications.

Suggestions on how autonomous vehicles could be used for parcel delivery, involved separating the two flows of people and goods. Autonomous vehicles could be used to transport goods between sites or directly to the customer. It could also be a solution for more rural areas. It can drive around and stop for a longer period of time to allow people to collect their parcels before continuing on to another rural area. Another option is that it could autonomously replenish a static parcel locker.

On an operational side, the project results were quite positive: the loading and unloading of the vehicle by the postmen, was very easy, as it could track down the vehicle easily and it only took about 30 seconds to load and unload the parcel locker (it must be said that the involved postman was highly skilled in his job).

Next steps for implementation

In the following section, it will be discussed what would be needed if this pilot were to be repeated in order to make it more effective.

In terms of infrastructure, a separate lane without obstacles could be chosen if the vehicle's ability to interact would remain the same. Otherwise the shuttle should be able to interact better with obstacles and other road users. The speed could also be increased to be less of an obstacle to other road users and more attractive if the journey time is reduced. Even if it could be fully autonomous, people would feel safer if there was still a way to intervene, for example from a control room. In order to increase the use of autonomous vehicles as a means of shared transport, the same needs to be addressed as for public transport today. Namely, to make it attractive enough to compete with the private car. For both passenger and freight transport, a sufficiently long familiarisation period is needed to change people's attitudes. Vehicle experts would suggest improving safety if there wasn't a steward on the shuttle, for example by visible cameras and lower windows to improve visibility.

Accessibility, especially for less mobile people, is important, as the ramp sometimes malfunctioned or was too steep. Separating cargo and passenger transport also means that they do not compete for space in the shuttle, which could improve passenger comfort. Another possible solution would be to redesign the shuttle to optimise the space for both. For logistical purposes, availability should be increased, preferably 24/7. It would also be important to avoid every failed delivery due to size restrictions by adapting locker sizes to the expected parcel sizes. The use of the parcel lockers should also be made more convenient for the user by integrating everything into one app and making it an open system where any parcel from any provider can be sent to the parcel locker. The route should also be rethought, with a clear choice of origin and destination points that are connected, for example the Mechelen railway station with the industrial area. In addition, a good balance must be found between extending the route (e.g. including residential areas) and the travel time between the largest destinations and origins. Including the more rural areas could also be an opportunity, as the availability of public transport or parcel lockers is lower than in urban areas.

After the trial, the regional and federal governments concerning mobility and transport, decided to create a clear vision note on future autonomous vehicle implementations in the country. This vision note also describes necessary procedures and who needs to evaluate these procedures, which was a huge obstacle in the trial. Also, the Flemish government decided to start a taskforce autonomous driving, which had a kick-off meeting end of September 2023.

4. Learnings on the ULaaDS-solutions through effective trialling

The real life trials served as a testbed to try out new business models and technologies, and gave therefore valuable input on the proposed theoretical solutions by ULaaDS. The final results of those impact analyses are fully described in other public deliverables, that will be shared at the end of the project (March 2024). This section will give some brief, practical, main takeaways per type of solution, but for a comprehensive results document, it is recommended to read the following deliverables:

- D5.4 Economic impacts, user experience acceptance and awareness by MIE
- D5.5 Impacts on logistics and traffic efficiency, land use and the environment by TOI
- D3.5 Final validated business and operating models, by RUG

4.1 Collaborative and shared urban logistics models

This section describes the main practical takeaways for the two theoretical schemes linked to collaboration in parcel logistics and shared assets.

4.1.1 Containerised urban last-mile delivery

The basic principle of containerization in last-mile processes should provide a faster, more efficient handling time in the logistics processes. The trials in Bremen showed that there certainly is a lot of interest and possible gain, but that a holistic approach is necessary. The main idea was that from a freight village, 10 kilometres outside of the city centre, pre-filled boxes could be transported and immediately loaded on to cargobikes, to reduce handling time significantly. But in real life conditions, it became clear that multiple end users of the hubs (logistics parcel transport providers) did not use the assets as proposed. The courier preferred to load its vehicle to its preferences, so it could already study the packages and route before take off. This saved more time than arriving on drop off point and search for the correct parcel. To further optimise this process, a guided track and trace app should be necessary, which lacked at the moment. It must be said that these types of guidance apps are a bit unusual in the process of actual transportation, in (un)loading, and expensive. It would need a scanning procedure with dedicated spaces in the containerized box, which could also impact the available space (diminish it, as boxes might not be able to be stapled).

4.1.2 Sharing economy platforms for on-demand city logistics

The testings in Groningen and Bremen concerning shared vehicles (cargo bikes, e-van,…) were both received very positive. In both cases, they were highly involved in the execution of the operations. In Groningen as end users, but also in the maintenance communication and making internal agreements. This provided support and involvement in the operations, and resulted in a high level of ownership taken by the local shopkeepers. This way they were also ambassadors for a positive implementation. It must be stressed out that in both cases, the stakeholder involvement process of involving the local shopkeepers is a key ingredient for success in the trials.

In both trials, due to a high use of the vehicles, clear and positive results could be noted. Inquiries showed that most of the trips made by the CO2-neutral vehicles, would otherwise be made by a polluting van or car. The shared vehicle replaces the need of car/van ownership, and therefore has a big impact on investment costs for the end user.

4.1.3 City-wide platform for integrated management of urban logistics

The solution of a city-wide integrated management platform, was tested through different smaller aspects in the trial. As such a city-wide platform is very comprehensive, it cannot be integrated during a trial, with limited resources, and without compelling flanking policies. Nevertheless, the inner city trial in Mechelen was a good example of the barriers and challenges such an implementation can bring along. In this trial, it was clear that even though the proposed solution would bring positive results for the participants in the costs of operations, a collaboration could not be established. Most important factors to take in account are a highly competitive market, where competitors prefer not to collaborate because they are afraid clients might run over to their competitors, if they see a vehicle of another company in front of their door. In Groningen, the process of installing white label parcel lockers, showed similar results: some nation-wide players preferred not to use the parcel lockers, as it would also contain parcels from competitors. Even though the end client does not see which parcel is delivered by other companies in other vaults, this

was not an option. The larger companies wanted to have the lockers for themselves and use it also for promotional reasons, by branding it in their own colours. This shows how highly competitive the last-mile market is.

The trials also showed how fine-mazed the networks in a city are, with different layers of subcontractors: a sender uses a logistics provider to unburden itself from the transport process, who will also use subcontractors to unburden themselves for the use of last-mile transport. This process makes it very difficult to get a view on the effective stakeholders, and create an impact with the final transport operator. This process is not applicable for every company: there isn't such a thing as a standard process in last-mile operations.

4.2 Integrated passenger and urban freight networks

This section describes the main practical takeaways for the two theoretical schemes linked to integrating passenger and freight flows in an urban environment.

4.2.1 Dual MobiHub

The dual mobihub concept was tested in the P+R trial of Groningen, where logistics assets were installed at a P+R hub outside of the city centre. The trial learned that it is important to keep a systemic view while implementing a solution, as multiple unexpected practical challenges popped up during the implementation phase. Ensuring electricity was an issue for over a year and when this was in place, the department of land-use made valuable yet unforeseen remarks on safety implications: the locker blocked the view of the cameras.

These delays created also the opportunity to take a closer look at the parcel locker systems and create a SULP measure for this solution. This process learned that a dense network of parcel lockers is necessary to ensure a critical mass will use the lockers, and real impact will be reached. Therefore, one should not look at the mobihub as a key solution, but more to the use of parcel lockers, where the mobihubs provide strategic places for placing lockers in the network.

4.2.2 Cargo hitching

The simulation trial in Bremen and the cargo hitching trial with an autonomous vehicle, both provided good insights on the solution. An important takeaway, is that even though the planned routes of the people and parcels might show similarities, their sense of urgency and timing does not. This makes it difficult to combine the two streams. A person going from A to B expects to go as fast as possible, and stopping to deliver a parcel is considered a time loss. If the vehicle would divide its time between people transport and parcel delivery, it would optimize the use of the vehicle, but no kilometres and CO2-emissions would be saved. It is therefore not considered a sustainable solution (though the optimized use of a vehicle, also ensures a smaller pool of vehicles is needed for both operations, and therefore saves the negative impact of producing the vehicle).

Also, the point of responsibility of the driver came up in Bremen. To which point could he/she/them be considered responsible over the parcel conditions, and does it have the 'right' (insurance-wise) to transport freight? Normal drivers are required to take courses on transport regulations, this would be a necessity for the driver in cargo hitching as well.

Overall, the ULaaDS trials concluded that cargo-hitching is certainly interesting for multiple uses, though the right use case needs to be searched and it remains a niche solution that can provide extra business opportunities, yet it won't become a main priority business opportunity.

5. Learnings from the effective trialling process in real-life conditions

The real-life trials, incorporated in the daily operations of the partners and the cities, gave meaningful insights, not only about the proposed solutions – but also about the process of running trials. Trial by error, learning out of mistakes, but also positive surprises, coming out of unforeseen setbacks. The following sections will report on these overall learnings, that are not about the actual solutions, but about the process of trialling itself.

5.1 Defining the solution and business model for trialling

Most of the trials were not clearly defined before the start of the project. There was an idea of what the solution should be, which schemes, objectives and/or results it should aim to have, but it was not clearly defined which testing partners would do which exact task. This created in a sense a freedom for the cities to search for the most meaningful implementation possible, together with the testing partners. The main issue with this approach, is the timeline: testing partners became project partners during the proposal phase, and only had to start defining the solutions in detail once the project already started: this process took about 1.5 year. For companies, this is a big stretch. Leadership changed for some partners, one partner went bankrupt due to Covid-19, and others just had different priorities. Therefore, even if the willingness to participate in the project was high, the ability to work in collaboration is not immediately there: some trial partners are direct competitors, which creates difficulty in collaboration. A good example of this evolution is the failed inner city trial in Mechelen: all three testing partners were more than willing to participate in the project, but no common ground could be found to collaborate. The value proposition was just not high enough to convince the board of directors, as their main priority was to maintain or conquer a bigger market share and collaboration could risk this position (in their opinion). Also, the trial was not fully described in the proposal, only certain elements (use of cargo bikes, city hubs,…) were clearly defined. No commitment to collaboration with each other, in performing operations together, was written down. On the other hand, the VIA cargo-hitching trial in Bremen, had no actual

trial partners, only the Daimler (Mercedes) plant that had agreed to look in to the collaboration, and this failed as well. The principle element that can be found in both trials, is that the testing partners were already defined at the proposal phase, before Covid-19 even started, and that 2 years later, the world was a different place – certainly for the industrial partners that (understandably) had other priorities. Or also, in the case of Daimler, already looked into the possibilities and found no value for itself in the trials. The time between writing the proposal and the moment a test partner can start its work in the project, is just too long.

Looking into some other trials, it was important that a city had the freedom and possibility to be flexible and adaptive to the stakeholder needs. Groningen for example, had an inner city trial where a partner became bankrupt. The city also took this as an opportunity to turn the trial upside down, and create a new solution, based on the same principles and have a bigger emphasis in creating a solution in collaboration with the end users. This resulted in a high ownership and involvement of those end users. Mainly because they were involved, even in the lead for some parts, in creating the solution and how it would be deployed, but also because the runthrough time was a lot shorter: between coming up with the solution and actual testing, was only one year of time difference, so a lot of breakthroughs and progress could be noted in the trial process.

In an ideal project timeline, project testing partners can be added to the project as a full on board partner after the start of the project, so their commitment level is higher and the time between onboarding as a partner and starting the actual testings, is smaller.

5.2 Stakeholder activation process

The stakeholder activation and involvement process has been changed all over the process of trialling. The overall methodology of stakeholder activation was a theorethical one, that has proven its value as a starting point. But if it would have been deployed exactly as written down, it would mean that each city had to create new stakeholder fora, instead of using the existing stakeholder collaboration channels of the city. In Groningen for example, the Groningen City Club (GCC) is an existing stakeholder collaboration group where the active members know and trust each other's capabilities: this enlarges the willingness to collaborate. And a lot of the trial success factor is depending on the willingness of the trial partners: if they take ownership over the trials, believe in a positive result, the trial will run a lot smoother and have a bigger impact.

In all the trials in all three cities, the city searched and found existing platforms to deploy the methodology of the activation process. This was not an easy task for the lead partner in the stakeholder activation process (IFZ), as it had now seven slightly different methodologies to follow up on, each with its own timeline, instead of one. But they saw the value in this approach, and therefore also were able to let go their initial planning and adapt their own workplans.

5.3 Data-retrievement in real life conditions

The process of data-retrievement was an extremely difficult process. In the beginning, because there was a consensus on what the outcomes of the proposed solutions should bring (diminution of emission, higher safety level, economic viability,…: overall liveability in the inner city, without a

negative influence on the logistics operations), but not a detailed definition of the trials, as well as the role of every trial partner within this solution.

The approach of the consortium was to first ask which data was available. A longlist of KPIs and related data-sources were listed and proposed to the trial partners, to see which KPIs could remain in the end (or where lack of data-sources could form an issue). Afterwards, the KPIs would be feeding a collective target system, which functions as an overall data-management platform, to perform analyses on the trials and linked to the ULaaDS solutions. This longlist of KPIs was shared with all the trial partners, but about all the partners had extreme difficulties with this list. Why exactly did the consortium need this data? How does it correspond with the proposed trial, that was still to be defined in a preparational phase? Bigger private company partners also had an internal policy on data-sharing: basically, it is not done, or only through a certified partner, and no 'raw', unfiltered data can be made available. Smaller companies or testing partners (local businesses, city departments,…) were overwhelmed by the list and feared that they could not provide the information needed. In the end, this longlist, with good intentions, created more aversion of the data-gathering process, as it did create a first overview of possibilities.

The consortium partners that were in the lead for data-retrievement and assessment processes had to create a completely new approach, that was more tailor-made towards the partners and the individual trials, as it was an overall approach. A more bottom-up approach was created, where for every individual trial, KPIs and means for data-requirements were implemented (one year further down the road, the trials were also defined in detail already, or started even). So now, every trial was linked towards an overall objective that the ULaaDS-solutions claimed to contribute towards, and in that objective, certain data-sources or possible pathways were defined in collaboration with the involved stakeholders. Therefore, the stakeholders were in a comfortable situation that they could provide the data, and it also saw the necessary use for providing this data. When needed, an NDA was signed to ensure the data would not be mis-used. Overall, the process of signing the NDA between all partners was quite time-consuming: all stakeholders needed time and to write and re-write some parts in the NDA. For some trials, the trial phase was already finished before the NDA could get signed and the raw data could be transferred. In the meantime, the stakeholder generating the data would hold on to it so it could be shared immediately after signing the NDA.

This approach meant that the collective data monitoring system provided by partner Fraunhofer (IML) had to be re-defined completely, and new types of data-sources had to be defined. Some trials relied a lot less on raw data and a lot more in qualitative data-sources (such as inquiries), while others could not provide the same types of data-sources. Therefore, in the analyses phase, a more individual approach was necessary as well, to compare the trials that created a result on the same theoretical solution.

A useful takeaway would be to not try to pre-define everything for data-retrievement, and to ask for the data you actually need (and you are able to show why you need it, and what you will do with it exactly), instead of asking for all the possible data so you can later make a selection.

6. End note: resilience as a necessary attitude in real life trialling

To end this deliverable, a key learning can be defined for every organisation / individual that will plan real life trials somewhere in the future: it is necessary to keep in mind that things probably will not go exactly as planned, and to deal with the consequences along the way. Every change can create a new opportunity in this process: it depends on the (can do) attitude of the trial partners and willingness to make it a success.

The trial process underwent various difficulties and hurdles in each part of the process: preparation, deployment, result analysis,… The initial work plans described in the proposal were impossible to maintain. Covid-19 broke loose, city logistics and certainly parcel delivery underwent a complete make-over as a result. The project had to adapt to the reality of this new world. Two project partners became bankrupt, other partners saw other priorities as a direct result of the pandemic,… these are not easy changes to deal with. Some projects will create risk management tools to predict changes, yet most of them are not predictable. The best way to deal with these changes is to maintain a 'can do' attitude, stay in touch with the trial partners and create a collaboration environment built on trust, where failing can be an option, yet every partner will help to prevent this from happening. The risk manager should therefore be directly involved in update meetings, if not only to actually understand the trials and possible risks. This task was performed by BAX company in ULaaDS.

In a last note, VIL would like to thank all project (and trial) partners for collaborating within the ULaaDS context, it have been 3.5 exciting years with a lot of lessons to be learned, on city logistics and overall project management / evolvement. These lessons will certainly be deployed in future projects, and shared within the local context of each project partner. The project would also like to thank the European Commission for granting the project, and maintain its confidence throughout the project timeline and providing meaningful input by the hand of the project officers that were appointed to the project throughout its timeline.