ULaaDS
URBAN LOGISTICS AS AN ON-DEMAND SERVICE

ECONOMIC IMPACTS, USER EXPERIENCE, ACCEPTANCE AND AWARENESS

ULaaDS D5.4: Economic impacts, user experience, user acceptance, willingness to pay and awareness

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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, impact measurement, socio-economic impact

Copyright statement

Executive summary

This report assesses the economic and social impacts of the different trials that were carried out in the three lighthouse cities of the ULaaDS project.

ULaaDS focuses on two categories of novel on-demand and sustainable urban freight solutions, namely collaborative delivery models and the integration of urban freight and passenger transportation networks. These are further specified in five different logistics schemes: Containerised urban last-mile delivery, Logistical network integration of crowd-sourced bike couriers, City-wide platform for integrated management of UFT, Location and infrastructure capacity sharing and Transport vehicle capacity sharing.

The assessment carried out of the ULaaDS solutions presented a challenge, as pilot projects might not outperform existing solutions that are already seamlessly integrated into larger systems. Instead, pilots may focus on testing specific technologies or delving into particular aspects of a technology or solution. This assessment endeavours to shed light on when, where, and under what conditions ULaaDS solutions can generate a positive impact—both in their current state and in a hypothetical scaling up of the service.

To carry out the assessment, the comprehensive list of 29 KPIs developed in deliverable 5.1 was narrowed down and tailored to each trial based on their objectives and the available data.

The first chapter can be divided into two main topics.

On one side the solution and schemes trialed and the objectives and aim of each trial in the different cities are described to give the reader an overview.

On the other side, to assess the trials, the two fields where the impact is analysed within this document, economic and social, are described from a literature point of view and the methodology used for the assessment is described.

Thus, also the topics of data collection and Key Performance Indicators are part of the first chapter. As the character of all the different trials are very diverse, an approach to classify them is given with the aim to set the way of assessing the trial later.

The following chapters are dedicated to each of the three lighthouse cities Bremen, Mechelen and Groningen, going into detail of the assessment of each of the trials taking place in each city.

Therefore, a short summary of the city and a description of the trial can be found, as well as the objectives that have been defined at the very beginning of the project for each trial.

The next part illustrates for each trial the available data, the Key Performance Indicators related to the described objectives and what is the impact of the trial in an economic and social way. A short conclusion and table of the objectives and KPI´s summarizes each trial.

Final conclusions and take aways for future projects and trials are explained in the last chapter.

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1. Introduction

This deliverable focuses on socio-economic impacts of the different ULaaDs solution that have been trialed in several pilots.

The deliverable builds upon the previous deliverables of the Work package 5, deliverables 5.1, (Framework, methodology and KPI Identification) and 5.2 (ULaaDs: Fact sheets baseline and city profiles), but also on deliverables 3.5 (Final Validated Business Models) and 4.7 (Summary of Practical Research Trials). Further input to this deliverable is the data collected from the individual trials, the questionnaires carried out within the local stakeholder foras for each trial during the project duration, as well as a review of documents and literature relevant for the specific solutions trialed. The impact assessment for all pilots is divided into two deliverables, one focusing on logistic & traffic efficiency, land-use and the environment (D5.5), the other one (this one) with focus on the economic benefits, user experience, acceptance and awareness. Therefore, in some chapters reference to deliverable D5.5 can be found.

The document is divided into 5 chapters- an initial discussion of the impacts measured and the methodology, a chapter for each lighthouse city, and a concluding chapter discussing the findings.

1.1 ULaaDS Solution and schemes

ULaaDS focuses on two categories of novel on-demand and sustainable urban freight solutions, namely (1) collaborative delivery models and (2) the integration of urban freight and passenger transportation networks. These are further specified in five different logistics schemes as shown in Table 1.1. Collaborative delivery models include logistics schemes based on encapsulating goods in standardised and modular containers (1), the integration of crowd-sourced delivery services (2), and the use of city-wide platforms for integrated management of urban freight transport (3). The integration of passenger and urban freight transport services includes logistics schemes based on location and infrastructure sharing (4), and vehicle capacity sharing (5).

Table 1-1. ULaaDS solution categories and logistics schemes

Solution	Scheme
1) Collaborative delivery models to enhance logistics efficiency and multimodal mobility in cities	1. Containerised urban last-mile delivery 2. Logistical network integration of crowd-sourced bike couriers 3. City-wide platform for integrated management of UFT
2) Effective integration of passenger and urban freight mobility services and networks	4. Location and infrastructure capacity sharing 5. Transport vehicle capacity sharing

These solutions and schemes are implemented and tested in three Lighthouse cities: Mechelen, Bremen, and Groningen. A brief introduction will be given in the chapter for each trial, as well as a short description of the city where the trial is located to provide some context.

A more detailed description of each trial, the objectives and timing can be found in deliverable D5.2 ULaaDS: factsheets baseline and city profiles. Deliverable 4.7 provides final reports on all the individual trials.

In addition to the variation inherent in conducting innovative trials in different cities, it has been necessary for the trials to adapt to changing circumstances (both at more global level from events such as the pandemic, but also at a local level due to events such as bankruptcy of ULaaDS Partners, shift of objectives of trial partners or difficulties in collaboration).

As a result, the assessment of each trial was carried out using a flexible approach with the methodology and KPI´s described in deliverable 5.1 (Framework, methodology and KPI identification) used as a starting point.

1.2 Areas of impact

This delivery will analyse the impact of two specific areas for the ULaaDs solutions – 1) Economic Impact and 2) User Experience and acceptance, further referred to as social impact.

In the KPI framework as from D5.1: Framework, methodology and KPI identification, a comprehensive list of 29 KPI´s was defined, which can be found in Appendix 1. Throughout the different stages of each trial, it became clear that each trial produced differing levels of data that we could relate to the initial list of KPIs. Therefore, in each trial and depending on the nature and characteristics of the trial, different KPI´s will be measured for the impact analysis. This has also been described in deliverable 4.1: Framework for effective trialing, ULaaDS 4.1 - Trial experimental plans description repository for effective implementation (and iterations).

The next subchapters will discuss in general what in Literature is defined as economic and social impacts and the approach used in this document to evaluate and assess these subjects.

1.2.1 Economic impact

Economy focuses on the estimation of the effectiveness or benefits derived from a measure in relation to the costs associated with its preparation, implementation, and operation. (CIVITAS)

The cost impact is divided into investment and operational costs.

Operational cost, often referred to as operating cost, is the ongoing, day-to-day expense incurred by a business or organization to maintain its regular operations and produce its goods or services (OpEx). These costs are necessary for the routine functioning of the business and are distinct from expenses related to capital investments, such as purchasing equipment or buildings.

Operational costs typically include a wide range of expenditures, such as:

- **Labor Costs:** Salaries, wages, and benefits paid to employees who are directly involved in the production or operation of the business.
- **Utilities:** Expenses for electricity, water, gas, and other essential services required for operating the facilities.
- **Rent or Lease Payments:** The cost of renting or leasing office space, warehouses, equipment, or machinery.
- **Raw Materials and Supplies:** Costs associated with purchasing materials and supplies needed for production or day-to-day operations.
- **Maintenance and Repairs:** Expenses for maintaining and repairing equipment, machinery, vehicles, and facilities.
- **Insurance:** Premiums paid for various types of insurance coverage, such as property insurance, liability insurance, and worker's compensation.
- **Taxes:** Various taxes, including property taxes, income taxes, and sales taxes that the business is required to pay.
- **Transportation and Travel:** Costs related to business-related travel, shipping, and transportation of goods and personnel.
- **Marketing and Advertising:** Expenditures on advertising campaigns, marketing materials, and promotional activities.
- **Office Supplies and Equipment:** Costs for office supplies, computers, software, and other tools necessary for day-to-day operations.
- **Depreciation:** A non-cash expense that accounts for the wear and tear on assets over time.
- **Utilities and Communication:** Expenses for phone, internet, and other communication services used in the business.

The operational cost has been divided in the evaluation framework 5.1. into last-mile delivery cost and distribution and warehouse cost, which can be evaluated with several different support indicators.

Investment cost, often referred to as capital cost or capital expenditure (CapEx), represents the upfront expenses incurred by a business or individual to acquire or create physical assets, financial assets, or investments with the expectation of generating future income, benefits, or returns. These costs are typically associated with long-term investments that are intended to provide value over an extended period rather than immediate consumption.

Investment costs can encompass a wide range of expenditures, depending on the context, and may include:

- **Purchase of Assets:** The cost of acquiring tangible assets such as real estate, machinery, equipment, vehicles, or technology.

- **Construction and Infrastructure:** Expenses related to building construction, renovation, or infrastructure development.
- **Research and Development (R&D):** Expenditures on research and development activities aimed at creating new products, processes, or technologies.
- **Acquisition of Securities:** Costs associated with purchasing stocks, bonds, mutual funds, or other financial instruments.
- **Business Start-up Costs:** Initial expenses incurred when starting a new business, such as legal fees, permits, and marketing.
- **Software and Intellectual Property:** Expenses for acquiring or developing software, patents, copyrights, and other intellectual property assets.
- **Training and Education:** Investment in employee training, development programs, and education to enhance skills and knowledge.
- **Marketing and Promotion:** Funds allocated for marketing campaigns and promotional activities to expand market reach.
- **Mergers and Acquisitions (M&A):** Costs related to the acquisition or merger of other businesses, including due diligence and legal fees.
- **Environmental and Sustainability Initiatives:** Expenditures aimed at improving environmental sustainability, energy efficiency, or corporate social responsibility.

In this context and defined in the evaluation framework 5.1., the investment cost for the trials refers to the amount of money spent by the local authority on infrastructure and/or to facilitate and support the trial.

Within each trial, some cost numbers have been collected to approach the economic impact, but not in a standardized way to allow a common assessment for all ULaaDS trials. Therefore, in each trial the available data will be discussed and if necessary additional assumptions taken to complete the economic analysis. Due to the nature of each trial, an economic assessment was not always possible.

1.2.2 Social impact

Social impact lacks a common definition and therefore leads to confusion and impedes the ability to study the phenomenon. In the next table an overview of definitions found in Literature is listed to demonstrate the variety of words used in the description as for example “impact”, “outcome”, “effect” or “output” is used.

Table 1-2. Definitions of social impact and related terms in Literature

Term	Definition
Social impact (Burdge and Vanclay 1996)	By social impacts we mean the consequences to human populations of any public or private actions that alter the ways in which people live, work, play,

	relate to one another, organise to meet their needs, and generally act as a member of society.
Social impact **(Latané 1981)**	By social impact, we mean any of the great variety of changes in physiological states and subjective feelings, motives and emotions, cognitions and beliefs, values and behaviour, that occur in an individual, human or animal, as a result of the real, implied, or imagined presence or actions of other individuals.
Impact **(Clark et al. 2004)**	By impact we mean the portion of the total outcome that happened as a result of the activity of the venture, above and beyond what would have happened anyway.
Social Value **(Emerson et al. 2000)**	Social value is created when resources, inputs, processes or policies are combined to generate improvements in the lives of individuals or society as a whole.
Social Impact (Freudenburg 1986)	Social impact refers to impacts (or effects, or consequences) that are likely to be experienced by an equally broad range of social groups as a result of some course of action.
Social Impact **(Gentile 2000)**	Social impacts are the wider societal concerns that reflects and respects the complex interdependency between business practice and society.
Social Impact (IAIA[i] by Wikipedia 2009)	Social impacts are intended and unintended social consequences, both positive and negative, of planned interventions (policies, programs, plans, projects) and any social change processes invoked by those interventions.

In the CIVITAS Framework for impact assessment the category of society "considers people, their characteristics, and mobility mind-sets, as well as the organisation of society" and divided into two sub-categories: people and government.

Society-people "covers all person-related aspects that link to the mobility system (e.g., activity structures, accessibility, health factors, etc.)". Therefore, it is linked to the focuses described in the grant agreement: user experience and acceptance, awareness, and usability.

The impact of acceptance can be divided into awareness and attitude, both that can be measured with the level of each within the society. In the analysis for each trial this has been a question, if possible, within the local stakeholder fora.

The user experience has the objective as described in the deliverable of the KPI´s as same or better service level as existing schemes. This objective was planned to be measured with in two different ways: On-time-in-Full (OTIF) or customer satisfaction. The available data for both KPI´s was not specifically measured within the trials, so a more qualitative approach to measure the impact will be applied here.

The aspect of usability can be related to the impact category of accessibility, considering the physical, operational, and economic accessibility to the service offered by the urban logistics measure implemented. This means that it does not only evaluate physical or operational barriers that can hinder the access to the service, but also the cost of the service offered which then may exclude

financially disadvantaged parts of the population. Also, for this category, data was not collected for every trial, but it was often approached throughout the questionnaires within the local stakeholder foras and will be used if available in this deliverable.

The CIVITAS 2020 process and impact evaluation framework list another type for the society-people category, which is Health, with a focus on the physical activity of the population, measured by average walking or cycling time per week. This category will only be briefly discussed in the section of each trial and in relation also with the environmental impact of air pollution of each trial, which in detail will be analysed within deliverable D5.5 Impacts on logistics and traffic efficiency, land use and the environment.

The second impact area of the category of society is society-government, including "the way society is organised both in terms of land-use and in terms of governance". The aspects considered here are the planning process, measured by the quality of the SUMP or SULP of the city and operational cooperation structures, looking at the quality of cooperation of the stakeholders. The term of land-use is evaluated within deliverable D5.5, therefore no further assessment will be done within this deliverable. The Ecosystem perception and local stakeholder involvement is covered within Work package 2 and its deliverables and therefore not taken into consideration within this deliverable.

1.3 Trials objectives and Key Performance Indicators

1.3.1 Trials objectives

Each trial was described when set up with certain aims that where the goal to be achieved with the trial. In some trials, these objectives have been finetuned or adapted.

In the chapter of each trial, the objectives are listed and how the relate to the areas of impact of this deliverable.

These objectives are important in the assessment process because they govern the definition of KPIs. This deliverable focuses on the trials' objectives that correspond to the two areas of impact addressed in this assessment while other trial objectives are addressed in deliverable 5.5.

1.3.2 Key Performance Indicators (KPIs)

In Deliverable 5.1, an initial and comprehensive catalogue of 29 Key Performance Indicators (KPIs) was established to assess and compare the trial impacts. Deliverable 5.1 marks the outcome of the initial phase of the impact assessment framework. Subsequently, as the trials were executed and data was gathered, a second iteration of the framework was undertaken, which involved the refinement and adaptation of the KPIs. This iteration has resulted in a more refined list of KPIs that are customized to the specific objectives of each trial and are more aligned with the available data. The initial extensive list of KPIs was narrowed down and tailored for each trial, as we will explain in more detail below. The final set of KPIs is presented within the respective chapters dedicated to each trial and can also be found in Table 1-3 for easy reference.

Table 1-3: Reviewed list of KPI´s related to the areas of impact: Social and Economical

Area of Impact	Key Performance Indicator
Economical	Land use efficiency
	Space use efficiency
	Area occupied by vehicle in traffic
	Land use of hub
Social	Time per delivery
	Vehicle load factor
	Deliveries per tour per vehicle
	Time in operation per vehicle
	Days in operation per vehicle

1.4 Available data

Data collection for the trials was an ongoing process, spanning various phases of the project, with some trials taking place over relatively short durations and others extending over multiple years. The dynamic nature of on-the-ground conditions and evolving trial objectives at times posed challenges to data collection, particularly in terms of establishing a robust baseline. In certain instances, data had to be estimated due to these challenges. The absence of solid baseline data can be attributed to several factors, including the impact of the pandemic, unexpected alterations to trial plans, the project's limited scale, the absence of pre-existing data collection systems in the trial cities, and reluctance from non-project partners to share pertinent data.

Furthermore, it's important to note that the impact of small-scale pilot studies, technological demonstrations, and simulations may not yield substantial measurable impacts on logistics and traffic efficiency, even at a neighbourhood level. Therefore, it was deemed crucial to contextualize these trials and consider their contribution as part of a broader body of research concerning trials and pilots focused on innovative urban logistics solutions. To achieve this, an examination of literature, reports, documents, and other EU projects was carried out.

Similar projects and studies that shared the same core concept as each trial, such as containerized cargo bike logistics in the Rytle trial in Bremen, served as baselines for comparing the trials to similar initiatives across Europe. Beginning with Deliverable 3.1, an ongoing review of more recent publications and other EU Horizon projects allowed for the continual updating of the projects overview. Projects like MOVE21 and SPROUT, with their emphasis on cargo hitching, were closely monitored. This approach facilitated the collection of pertinent data and information for comparative purposes, enriching and validating the impact assessment of the ULaaDS trials.

1.5 Approach to assessing the impact of the trials

As cited in "Civitas Process & Impact Evaluation Framework, an "impact evaluation consists of the assessment of the changes attributed to a specific measure or integrated package of measures. Both intended and unintended impacts of the measure are examined."

There can be various influences that cause certain effects and side-effects. You want to know how to show the real impact of a measure in a structured way? So let us start with the basics of evaluating an impact of a measure. Impact evaluation illustrates changes which are attributed to an intervention such as a project, measure or policy which was planned and implemented to reach a formulated goal. In contrast to outcome monitoring, which examines whether targets have been achieved, impact evaluation is structured to answer the question: How would outcomes such as participants' well-being have changed if the intervention had not been undertaken? [1]

To be able to evaluate any measure within the complex situation of a city, it is important to have a good understanding of its context, the characteristics and to have basic knowledge about the general mobility situation.

It is good to have a baseline situation described and optimally measured with the same indicators that then will be used for the assessment of any impact. This enables you to compare both situations and draw conclusions. A central question to answer is: What was the situation before I implemented the measure and what changes can be attributed to the measure?

Within the different trials in ULaaDS it was not always easy to have this baseline situation clearly described and data collection throughout the trials has not been always consistent. Therefore, assumptions will be made if necessary, or the comparison and impact measurement only be carried out for some topics.

1.5.1.1 Theory about social and economic Impact measurement methodologies

There has been a lack of standardisation in methods used to monitor and evaluate transport measures, at regional, national and EU level. This applies to SIA (Social Impact Analysis). In larger transport measures SIA may form an integral part of the planning process. In such cases, Cost Benefit Analysis (CBA), Multi Criteria Analysis (MCA) or a combination of the two have been used. These are described in brief, but both have serious shortcomings when used in this context. Cost Benefit Analysis (CBA) can be used to quantify the costs and benefits of a project (over a certain period), and those of its alternatives, usually in monetary terms, in order to have a single scale of comparison. The economic viability of a project can be assessed and expressed by viability indicators such as benefit to cost ratio (BCR), internal rate of return (IRR) or net present value (NPV). Where environmental and social issues can be monetized, they are also included. However, communication and prioritization of

[1] Dziekan, K., Riedel, V., Müller, S., Abraham, M., Kettner, S., Daubitz, S., (2013). Evaluation matters. A practitioners' guide to sound evaluation for urban mobility measures, chapter 2, page 23

results can be dominated by a few, easily monetizable indicators and focus on direct benefits such as measures of reliability and reductions in travel times. The benefits derived from sustainable transport in terms of social equity, urban regeneration and improvements in visual quality require more qualitative approaches, and as such may be overlooked. As such, CBA on its own is not suitable as a means of performing SIA. Multi Criteria Analysis (MCA) enables the simultaneous quantitative and qualitative measurement of impact, not necessarily in monetary terms. It is more participatory and holistic but can be subjective leading to bias. Socio-economic Impact Assessment (SEIA) provides a measure of the expected benefits and costs to different groups. This approach shows the impact of accessibility and mobility on socio-economic well-being of the urban poor. It uses household survey data to derive indicators of accessibility, mobility, and socio-economic well-being. The indicators are then aggregated into indices of accessibility, mobility, and socio-economic well-being. The change in indicators and indices in before and after project scenarios is used to assess the significance of the impact of the project on the urban poor.

Apart from relating to the work of previous deliverables, this impact assessment considers the CIVITAS Process & Impact Evaluation Framework, as it´s "main objective of the CEF is to understand the process and impact of mobility-related measures that have been implemented by projects in cities or sites. Understanding both successes and failures is crucial to enable replication and to build up evidence-based European knowledge."[2] (citation from ELEVATE_CEF Readers' Guide final)

This is considered as well, as the characteristics of each trial differ from each other and one standard approach is neither appropriate nor feasible. Therefore, in the next two sections a classification of the trials in two tiers is done and the methodology of the assessment described.

1.5.2 Classification of the different trials

Due to the variation of all the trials within the ULaaDS project, the trials have been classified to carry out an adjusted assessment for each trial. This classification was elaborated together with deliverable 5.5 and is described in this section.

The ULaaDs solutions differ in scale, complexity, and purpose, focusing on collaborative delivery models as well as the integration of freight and passenger transport. Within these two broader categories of solutions, the trials aim to test five different schemes (see chapter 1.1 ULaaDS Solution and schemes), with some trials testing a single solution and scheme and others testing several at once.

Some trials had to adapt their initial objectives due to unforeseeable factors such as bankruptcy, cooperation breakdowns, or technical and regulatory issues (these issues are covered in depth in the final trial report, deliverable 4.7) and the execution of the trial therefore was adapted. In addition to the relative diversity of the trials at the outset of the project, it has also been necessary for the trials

[2] CIVITAS. (April 2023). CIVITAS Process & Impact Evaluation Framework: a readers' guide. https://civitas.eu/resources/civitas-process-impact-evaluation-framework-a-readers-guide

to adapt to changing circumstances (such as the pandemic or bankruptcy of trial partners) which has also led to alterations to their original design and objectives, resulting in limitations in how the trials were conducted. And as developed in section 1.4, available data was limited, particularly for some trials.

For these reasons, not all trials were formally assessed according to the final list of KPIs, some were instead examined through a more theoretical and/or conceptual lens. Trial 1 in Mechelen was not assessed as the trial did not occur and there was no collected data. Trial 2 in Groningen has developed a framework but not yet implemented the white label parcel locker so there was no available data from which to perform an assessment. Despite (and sometimes because of) the various challenges, the trials still provided interesting results and valuable insights in terms of their impacts on aspects such as cooperation between actors, building acceptance for new technologies, operational implementation and developing regulatory frameworks.

The trials are separated into two tiers of assessment:

1) Full assessment based on KPIs,

2) Partial assessment based on trial objectives and discussion about potential.

Table 1-4 shows how the different trials are spread among the two tiers.

Table 1-4- Overview of ULaaDS trials and assessment tiers

	BREMEN			GROINGEN		MECHELEN	
Trial	**BRE.01**	**BRE.02**	**BRE.03**	**GRO.1**	**GRO.2**	**MEC.01**	**MEC.02**
Full assessment	X	X		X			
Partial assessment			X				X

1.5.3 Description of the methodology to analyse the socio-economic impact for each trial

The approach is the same as the trial assessment of deliverable D5.5.

For each trial, a brief trial description can be found in the next chapter, pointing out the scheme and solution trialed and what have been the objectives defined at the beginning of the project and what was finally trialed.

Then the section of KPI´s will show the selected indicators in relation to the objectives for the trial and how this indicator was measured: data collection, survey, or estimation.

Finally, an analysis on a very high-level will conclude the impact of the trial on possible economic benefits, as for the trial´s ability to stand alone and social benefits, as for the acceptance and awareness of society.

Table 1-5: Definition and explanation of different assessment outcomes

PI		**Positive impact**	Trial had a positive impact on this KPI
NC		**No change**	There was no change noted for this KPI, due to lack of data or the trial not affecting this KPI at all
NI		**Negative impact**	Trial had a rather negative impact on the KPI
NC	NI	**Conditional**	The impact assessed is somewhat negative with certain restrictions, or not very clear but with a negative trend
NC	PI	**Conditional**	The impact assessed is somewhat positive with certain restrictions, or not very clear but with a optimistic trend

Thereby, for each assessed KPI, the assessment results in a colour assigned depending on whether the trial has had a positive impact (green), a negative impact (red) or no impact (yellow). When the impact can differ depending on the circumstances, multiple colours can be assigned to one KPI (see Table 1-5).

Table 1-6: Example of an assessment table

Trial Objective	KPI	Assessment
Area of impact		
Trial objective 1	KPI 1	
	KPI 2	
Trial objective 2	KPI 3	
	KPI 4	
	KPI 5	

The assessment approach used is summarized in Table 1-6: based on the trial objectives, we selected the relevant KPIs to assess each trial. Each of these KPIs were then assessed following our qualitative scale. When it comes to trials belonging to tier 2, the assessment consists in a discussion on their potential impacts, depending on the conditions of implementation.

Another adaptation of the methodology concerns the comparability of the different trials in terms of impacts. As the trials were developed and carried out, it became clear they were not always directly comparable, especially as several of them changed their original objectives and scope in reaction to operational or organizational challenges. For example, there was little perceived value in comparing a shared cargo bike trial focused on personal transport with a trial using cargo bikes to replace pallet deliveries by truck in city centres, despite both trials using cargo cycles. The objectives of the trials are too different to easily compare. The same principle extends to the other trials, which implement and test solutions using diverse and innovative technologies, from autonomous vehicles to shared

vehicle sharing platforms for businesses, limiting the usefulness of a direct comparison. Consequently, trials are assessed individually.

2. Bremen Trials

Bremen is a harbour city in the Northwest of Germany, the larger of two cities that together form the Free Hanseatic City of Bremen, Germany's smallest federal state. Two cities forming one state („Zwei Städte, ein Bundesland - Bremen und Bremerhaven") make for a unique configuration in Germany's federal system.

Initially, three trials were planned in Bremen, but due to changes during the project, one of the trials could not take place physically and was instead carried out as a simulation of different cargo hitching scenarios.

2.1 Trial: BRE.01 – Containerized urban last mile (micro hubs and dedicated cargo-bikes) Solution 1, Scheme 1

Bremen is testing containerised urban last-mile delivery in this trial by grouping together parcels and general cargo heading towards the same city area. These will be sorted according to the delivery zone already at the warehouse. Then, containers heading to the inner city will be delivered at micro hubs and collected by cargo bikes for the final stretch.

Table 2-1. Solution and schemes trialed in Bremen trial 01

Solution	Scheme
1) Collaborative delivery models to enhance logistics efficiency and multimodal mobility in cities	1. Containerised urban last-mile delivery

2.1.1 Trial objectives defined and finally trialed

Focus on general cargo instead of courier express freight itself and on expanding the number of micro hubs within the city (as D.5.2 ULaaDS factsheets baseline and city profiles):

1. Reducing the number of polluting vehicles entering the city centre
2. Improving space management thanks to last-mile delivery by cargo bikes
3. Increasing the efficiency in the interaction between long distance freight transport and urban freight transport

2.1.2 KPIs and available data

From the KPI´s defined in Deliverable D5.1, the following have been chosen for the impact calculation on this trial in the economic and social field. The selection was made based on available data and to cover as best as possible the impact assessment field and is listed in table 2-2 below.

Table 2-2: List of KPI and data to assess Bremen trial 1

Field of impact/ Trial Objective	Which KPI	Support Indicator	Method (Data collection – Estimation – Survey)
Economic			
Increasing the efficiency in the interaction between long distance freight transport and urban freight transport (Objective 3)	Delivery and operational costs	Operating costs	Estimation from trial participants
		Maintenance costs	Estimation from trial participants
	Investment costs	Amount of money spent by the local authority to invest in infrastructure	Estimation from trial participants
		Amount of money spent to facilitate and support trials, and / or enforce regulation / legislation	Estimation from trial participants
Social			
Improving space management thanks to last-mile delivery by cargo bikes (Objective 2)	Level of acceptance	Recipient acceptance	Survey / Interview
Reducing the number of polluting vehicles entering the city centre (Objective 1)	Awareness	Awareness	Survey / Interview

2.1.2.1 Economic field of impact

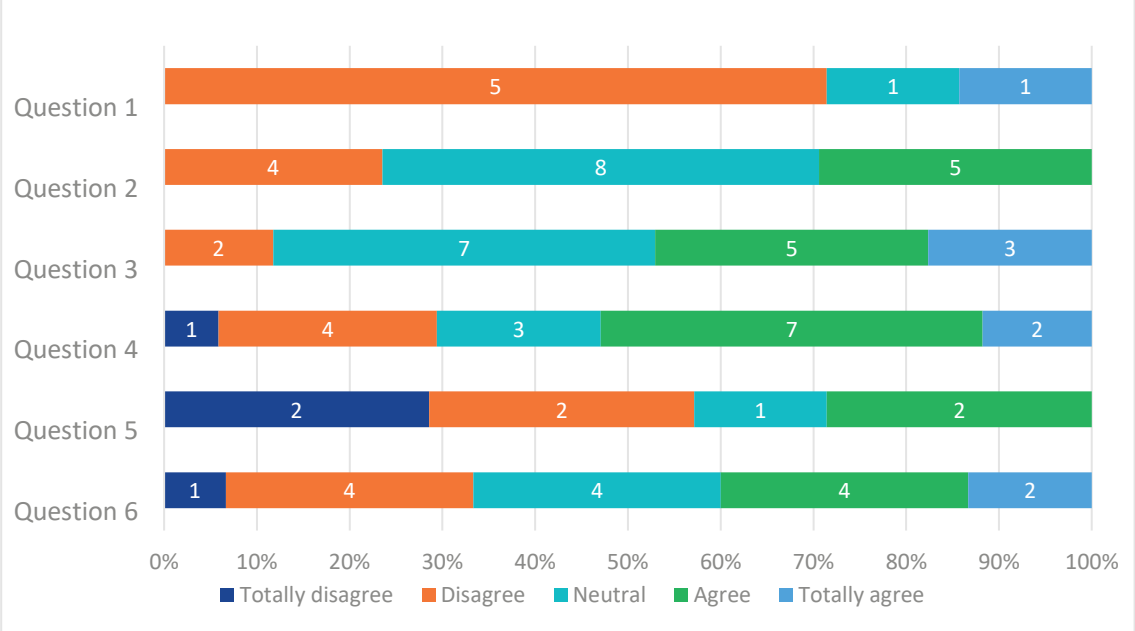
The costs for operation and maintenance are approximately 4.000 €/year per bike as indicated from one of the persons involved in the trial. Which cost exactly are included within the operational costs is not clear. The employee cost per hour and bike driver is about 25 €, but it was not possible during the trial obtain exact information about the amount of time spent by each driver with deliveries related to the microhub (estimated about 4 hours per hub). Also, the location cost, for one Hub private parking lots were occupied and rented, for the other one its subsidized by the city. Another cost aspect is the truck and its driver.

The Investment cost depends much on the type of bike, as there were two different models in use during the trial. Bikes 1. Series - 15.500,00 € (ULaaDS) / Bikes 2. Series - 19.950,00 € / Hub approx. 17.000,00 €.

Another investment is the hub itself and the equipment used, especially in the scenario with the pallet delivery (pallet truck, etc.).

A survey was conducted in relation with a stakeholder forum and the relevant questions related to the economic impact field and their answers are displayed here (Figure 2-1). In total 19 persons answered the survey, 40% of them belonging to the stakeholder group Logistic Service Provider (CEP or freight forwarder), 20% to the public sector and 40% related to Other.

Figure 2-1: Economic aspects of Micro Hub concepts, Source: Questionnaire Stakeholder Fora, 2023



Question 1	Additional personnel costs that may arise from the use of cargo bikes are negligible or can be easily covered.

Question 2	From an economic perspective, larger transshipment points/warehouses (midi hubs) would be better suited for a climate-neutral last mile.
Question 3	Micro hub concepts are only economically interesting if the (e.g. political or traffic) framework conditions in Bremen change.
Question 4	Micro hub concepts can only be implemented in a financially viable manner if they can be built on public land at reduced costs.
Question 5	The use of micro hubs has no impact on the quality of delivery, e.g. in terms of timely deliveries.
Question 6	Using the Micro Hub system results in economic benefits for my organization.

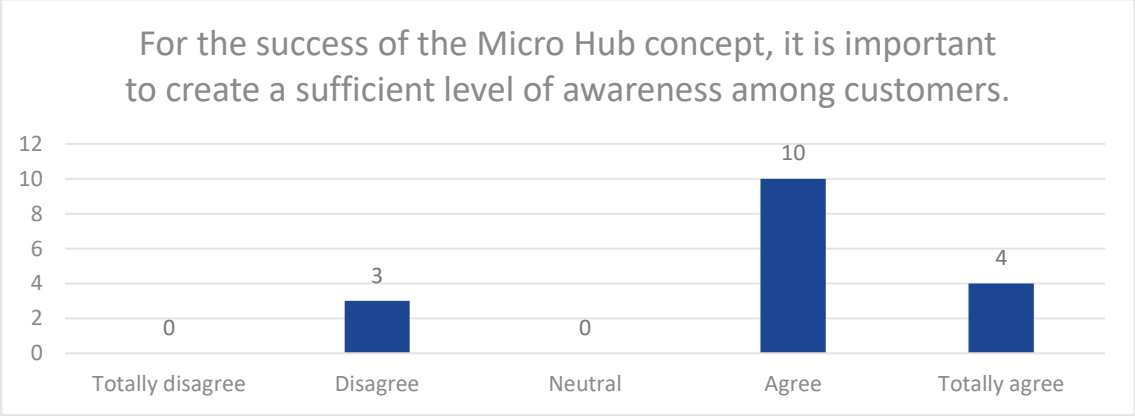
The questions in the table above have been elaborated together with other ULaaDS partner to get a perception of the opinion of different stakeholder groups in relation to Micro Hubs. The aim is to discover the main obstacles for Micro Hubs, mostly in relation to economic barriers.

However, the results must be looked at carefully, as the number of samples is low and the belonging to a concrete stakeholder group of some respondents is not clear (defined as “Other”).

2.1.2.2 Social field of impact

One of the mayor inputs for the social field is an interview that was carried out with the bike drivers and multiple meetings with Rytle to better understand the context of their operations. The above-mentioned survey also included some questions related to the awareness of Micro Hubs and the impact for public space and are displayed in the following section.

Figure 2-2: Awareness and success of Micro Hub concepts, Source: Questionnaire Stakeholder Fora, 2023



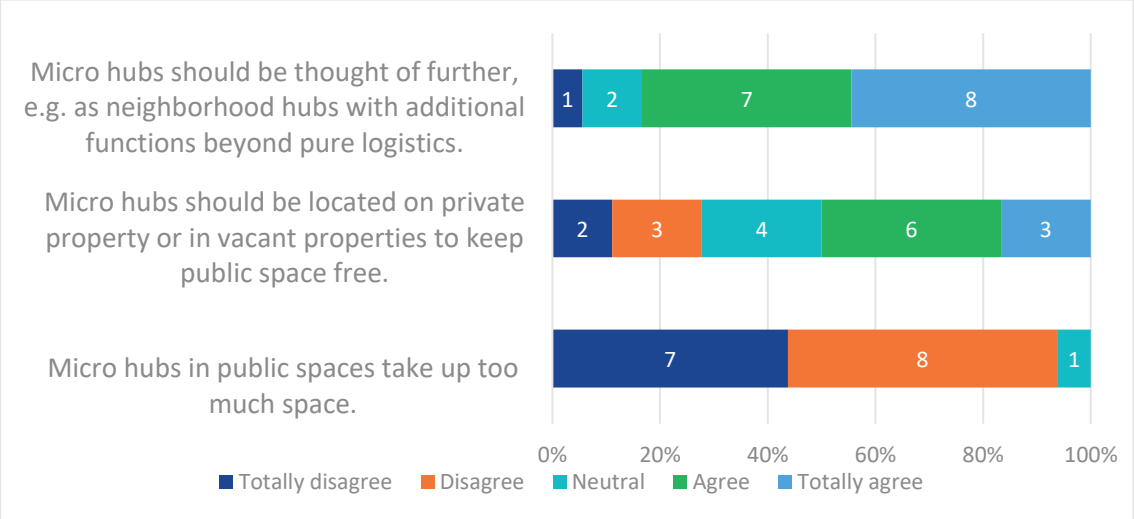
When asked, how important the awareness of the final customer is seen, the large majority sees it as a key element for success. Nevertheless, in our interview with the drivers of the cargo bikes, they didn´t perceive a striking reaction from the customers, although reactions in general where more positive in relation to the bike delivery instead of a truck.

Several other questions were more related to the concept of Micro Hubs itself and how they are seen within public space.

Most of the participants see them as an opportunity to offer other services like for example return logistics, but also functions beyond logistics within the neighbourhood.

When it comes to the space occupied by the Micro Hub, the opinions diverge. On one side, Micro Hubs on public space is seen as an advantage related to costs, on the other side they are seen as a disturbance by occupying public space.

Figure 2-3: Public space and Micro Hub concepts, Source: Questionnaire Stakeholder Fora, 2023



2.1.3 Impact assessment and benefits of the trial

2.1.3.1 Economic benefits

From our experience in general and a clear result from the participants of the questionnaire as well (see results for question 6, Figure 2-1), the addition of another handling activity (transshipment to the cargo bike) results in extra costs and is therefore most of the times a hindrance for companies to go for more sustainable solutions that imply additional handling. This can only be faced by counting with large volume so the cost impact of cost per parcel is reduced. This is also a conclusion the participants of this trial have indicated to us.

Another obstacle can be the location of the micro hub in financial terms. Available space is mostly rare in cities and a high demand result in higher prices. Competing with other use of the available space (like parking for private persons, public transport or city service) can also lead to a harder acceptance for this type of solution from all involved stakeholder groups.

The only other driver we receive also from other similar projects is the changing conditions of the framework, like strict access regulations (as it has happened in Groningen) or other control mechanism that result in additional cost for the company that can be avoided using cargo bikes. Then this solution can bring economic benefits as it entails a cost avoidance on one side and a slight cost increase on the other side. The results of the survey indicate similar conclusion, see Question 3, Figure 2-1.

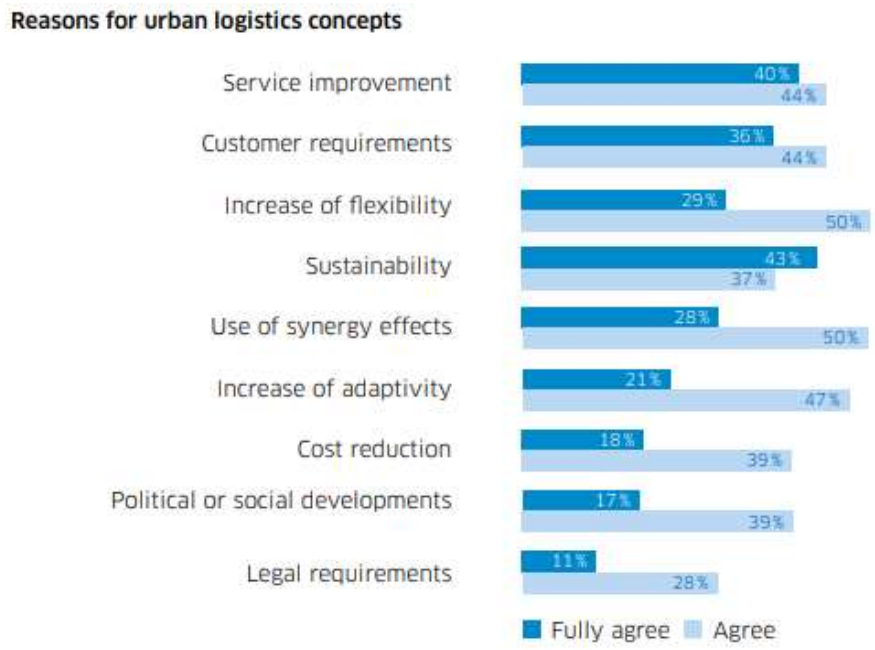
Miebach Consulting, together with JLL and the Research Lab Urban Transport (ReLUT) of Frankfurt University of Applied Sciences, conducted a study at the beginning of 2022 with the aim of identifying and examining new trends in the field of urban logistics. In particular, the concepts of the “Urban

Consolidation Center" and the "Micro Hub" were considered in the study. As part of an empirical expert survey, managing directors, production and logistics managers from various players in urban logistics like manufacturers, retailers, and logistics service providers were asked how they assess the trend toward urban logistics, what strategies they are currently pursuing and what changes are expected in the future. In all, the study received 284 responses from the sectors manufacturers, retailers, and logistics service providers and two key messages were taken as output from the survey:

- Urban Logistics concepts are in trend
- Urban logistics concepts as a competitive advantage

The results of the study conducted by Miebach show that in order to be successful, new concepts should be applied to meet the everchanging cities and their related challenges. The competitiveness of companies will benefit if the supply chain is improved in terms of sustainability and meeting increasing customer demands to deal with the current trend in urban populations in a meaningful way. As can be observed in Figure 2-4, main reasons for Urban logistics concepts like Micro Hubs are to achieve service improvement, meet customer requirements, increase flexibility and meet sustainability goals.

Figure 2-4: Reasons for urban logistics concepts. Source: Miebach study (2022)



When asked in particular about Micro Hubs, almost 70% of the companies surveyed can imagine using a Micro Hub in the near future.

One of the mayor barriers for urban logistics concepts is the coordination effort. Any solution always implicit a huge variety of stakeholders involved, even sometimes with contrary objectives. This has been confirmed also within the different trials of ULaaDS project. Another risk as for implementation and good running solution of UL concepts is the cost factor (see Figure 2-5). Lack of ability of

standardization and high amount of manual handling tasks raise the costs per freight unit. Here the trial in Bremen is example as well, as without subsidies from city government side and companies willing to bear costs on their side, there is no positive business case.

Figure 2-5: Risks for urban logistics concepts. Source: Miebach study (2022)

2.1.3.2 User experience, acceptance and awareness

In general, a positive experience, people like the idea of avoiding trucks going into the city. Also, there is no negative impact in service level in terms of delivery time.

There overall impression is very positive about the perception of the bikes delivering parcels or pallets. For parcel delivery either ambivalent or see it as a positive that deliveries come by bike.

For pallet delivery, some customers are used to having drivers take the pallet inside (despite the contract saying to the front door). Pallet mover on the bikes attaches to the outside of the pallet which means it can be too wide to take the pallet inside in some instances. Other customers like that goods are delivered by bike. Even if there is a first resistance at the beginning, users get convinced at the end.

The perception of the participants of the questionnaire is in general that awareness among the end-customer is a crucial factor for the success of a Micro Hub and measures like campaigns to increase this awareness are important.

Regarding the use of public space, the opinion of Micro Hub occupying this space is more divided, but it is welcomed if a Micro Hub offers further functionalities to the neighbourhood that are not linked only to logistics activities. In general, this is a complicated topic as several different stakeholder groups have distinct objectives of how to use public space.

2.1.4 Conclusions

As discussed in the previous chapter, achieve a better efficiency of the interaction between long distance freight and urban distribution is a crucial point for this type of trials to be independent from subsidies. The daily freight volume plays an important role to minder the cost increase impact of the solution.

While we see that the economic benefits may have been limited, the trial results suggest important social benefits achieved be using smaller, less polluting vehicles to carry out deliveries in the city centre. This contributed to a high level of acceptance for the solution, with the concept being positively received by customers.

In general, a positive experience, people like the idea of avoiding trucks going into the city. Also, there is no negative impact in service level in terms of delivery time.

Table 2-3 Assessment of trial objectives by evaluation of related KPIs of BRE.01

Trial Objective	KPI	Assessment
Economic		
Increasing the efficiency in the interaction between long distance freight transport and urban freight transport (Objective 3)	Delivery and operational costs	NI
		NI
	Investment costs	NI
Social		
Improving space management thanks to last-mile delivery by cargo bikes (Objective 2)	Level of acceptance	PI
Reducing the number of polluting vehicles entering the city centre (Objective 1)	Awareness	PI

2.2 Trial: BRE.02 – Private micro-logistics (network of cargo-bike rental stations) Solution 2, Scheme 4

The second trial in Bremen distinguishes itself from the other trials as it focuses on private logistics. Within the ULaaDS project and together with ADFC, 5 cargo bikes are made available for private users at certain locations (shops, coffee places, supermarkets or public institutions) to book online for one day and free of charge.

Table 2-4. Solution and schemes trialed in Bremen trial 02

Solution	Scheme
2) Effective integration of passenger and urban freight mobility services and networks	4. Location and infrastructure capacity sharing

2.2.1 Trial objectives defined and finally trialed

The first aim set was a City-wide sharing network of cargo bikes to be offered for little monetary compensation focusing on private logistics. Finally trialed was this sharing network but without a monetary compensation (as D.5.2 ULaaDS factsheets baseline and city profiles):

1. Avoid car trips for private logistics, thus reducing pollution and congestion.
2. Offer users the possibility to familiarize with cargo bikes without having to invest in purchasing a privately owned one.

Focus was more on objective Nº2, allthough the survey carried out by Fitje Bikes gave positive feedback also on objective Nº1 (as this is related to environmental impact assessment, this is further analyzed in deliverable D5.5).

2.2.2 KPIs and available data

From the KPI´s defined in Deliverable D5.1, the following have been chosen for the impact calculation on this trial in the economic and social field. The selection was made based on available data and to cover as best as possible the impact assessment field and is listed in table 2-9 below.

Table 2-5: List of KPI and data to assess Bremen trial 2

Field of impact	Which KPI	Support Indicator	Method (Data collection – Estimation – Survey)
Economic			
Offer users the possibility to familiarize with cargo bikes without having to invest in purchasing a privately owned one (Objective 2)	Delivery and operational costs	Operating costs	Survey with trial members
		Maintenance costs	Survey with trial members
	Investment costs	Amount of money spent by the local authority to invest in infrastructure	Estimation / Survey with trial members
		Amount of money spent to facilitate and support trials, and / or enforce regulation / legislation	Estimation / Survey with trial members
Social			
Offer users the possibility to familiarize with cargo bikes without having to invest in purchasing a privately owned one (Objective 2)	Awareness	Awareness	Survey by ADFC
	Service Level	Service Level	Survey by ADFC

2.2.2.1 Economic field of impact

Regarding investment costs, the purchase price for an e-cargo bike is between 2.000 € and 5.000 € (Carracedo and Mostofi 2022). When it comes to the 5 bikes involved in the trial (two of them are electric bikes), they have been financed by ULaaDS project. In addition, there are also maintenance costs, which are approximately 1.300 € per cargo bike and per year, according to ADFC (exact cost breakdown in Table 2-6 below). Another cost is the operation and maintenance of the renting webpage and all activities related to communication with the location of the bikes, like shops, cafés,

etc. During the trial period, cargo bikes were rented for free, which means that the system currently works thanks to public subsidies.

Table 2-6: Cost breakdown for operating costs. Source: ADFC

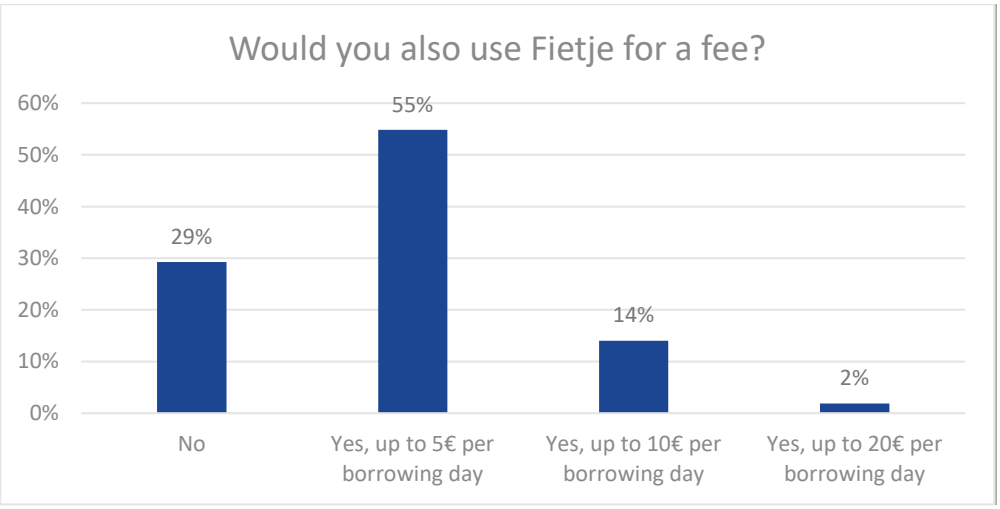
List of costs related	Fietje	E-Fietjje
Operating costs	1.286 €	1.567 €
Service	120 €	
Average repairs	154 €	284 €
Advertising material (flyer / beach flag)	90 €	
Insurance	122 €	273 €
Support incl. public relations (staff hours)	800 €	

A survey was conducted by ADFC in November 2022 among people registered on their website. In total 351 answers were collected from almost 3.700 registered users. But among them, 30 respondents seem never to have had the opportunity to borrow a Fietje cargo-bike. The questions were related to the service in general, not to specific trips, and the following have relation to the monetary part of the service:

- Would you also use Fietje for a fee?
- Relate to the statement «I already donate regularly so that Fietje can continue»

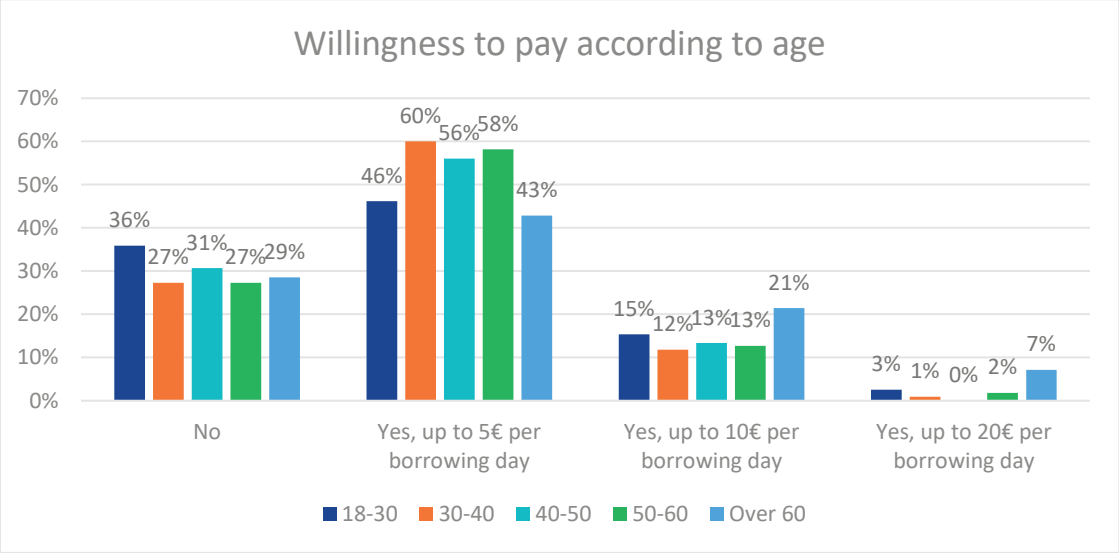
The data from the survey was analyzed and combined and is shown in the following figures.

Figure 2-6: Willingness to pay in general. Source: ADFC survey, 2022; several answers possible



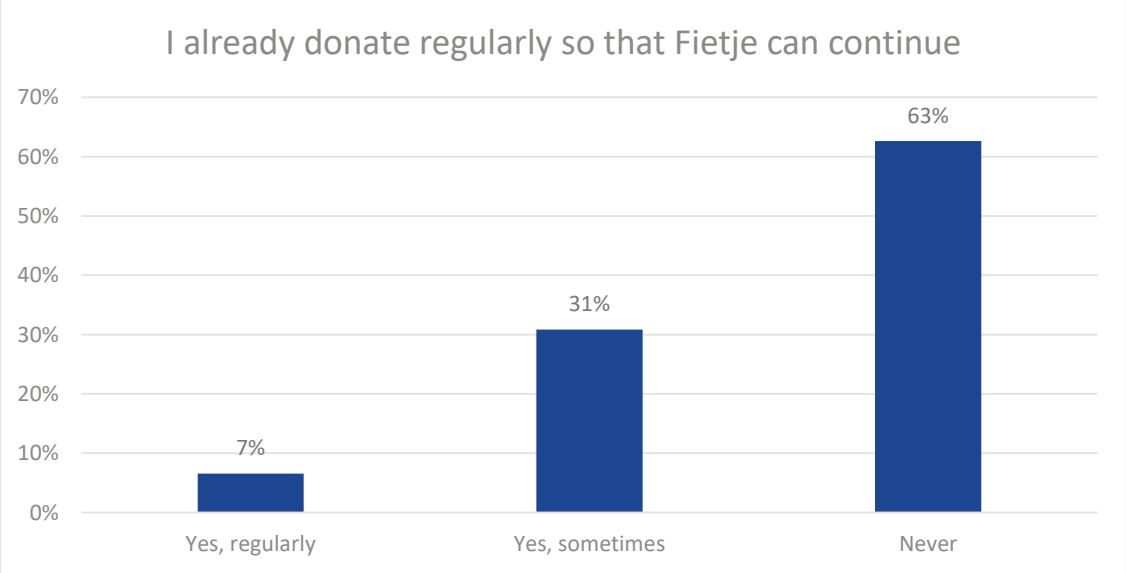
In figure 2-6 we see the users who would be willing to pay for the solution. 71% would be willing to pay at least 5€, but we see that the willingness to pay falls off quickly and that when moving from 5€ to 10€, the willingness to pay falls from 55% to just 16 (14+2)%.

Figure 2-7: Survey results regarding willingness to pay combined to age of user. Source: ADFC survey, 2022; several answers possible



As the survey covered as well general questions related to user's specifics, in Figure 2-7 this could be combined to divide the answers and users per age. Younger users are slightly less inclined to pay for the service, but still more than 64% would pay at least 5€.

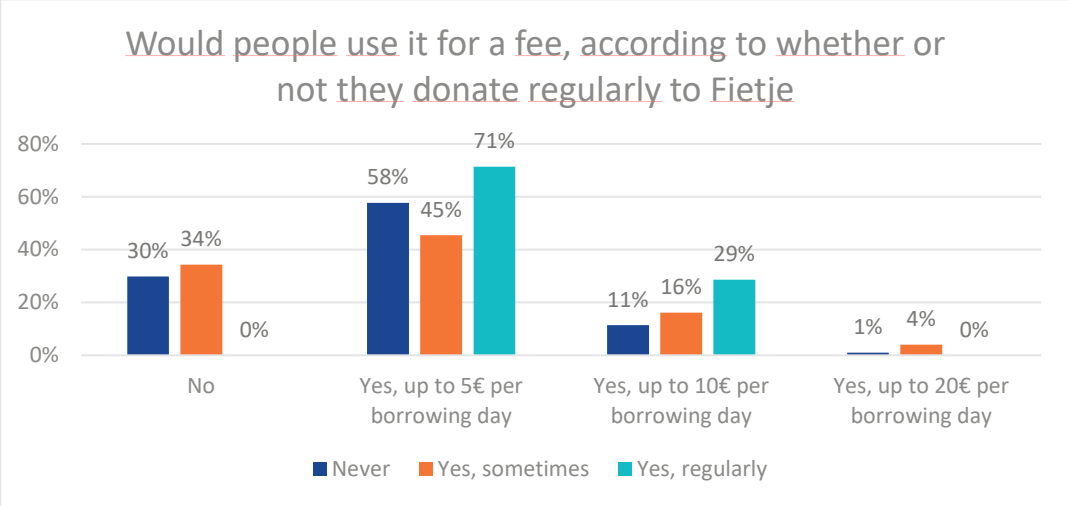
Figure 2-8: Motivation to donate to the project. Source: ADFC survey, 2022; several answers possible



When it comes to supporting voluntarily the service offered, more then 60 % of the answers don´t have a motivation to donate. This indicates that to have a positive business case and for the trial to

keep on without subsidies, a system based on free willingness to contribute wouldn't work on the long run.

Figure 2-9: Survey results regarding willingness to pay. Source: ADFC survey, 2022; several answers possible

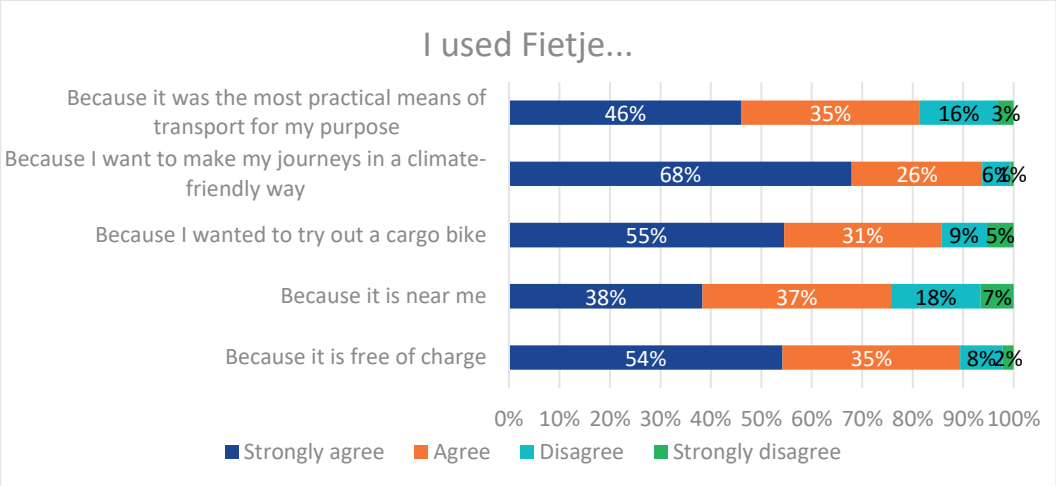


The graphic in Figure 2-9 combines the results from the question if people already donating to the project and if they would pay for the service. It comes clear that the user of the service that aren´t already contributing to it, also wouldn´t pay more then 5 Euro for the use of the bikes. In general throughout the three groups, an amount up to 5 Euro would be acceptable.

2.2.2.2 Social field of impact

The questions of the survey carried out by ADFC also asked the participants, what their intention of using the cargo bike was and why they used it. It must be considered that several answers were possible for the questions.

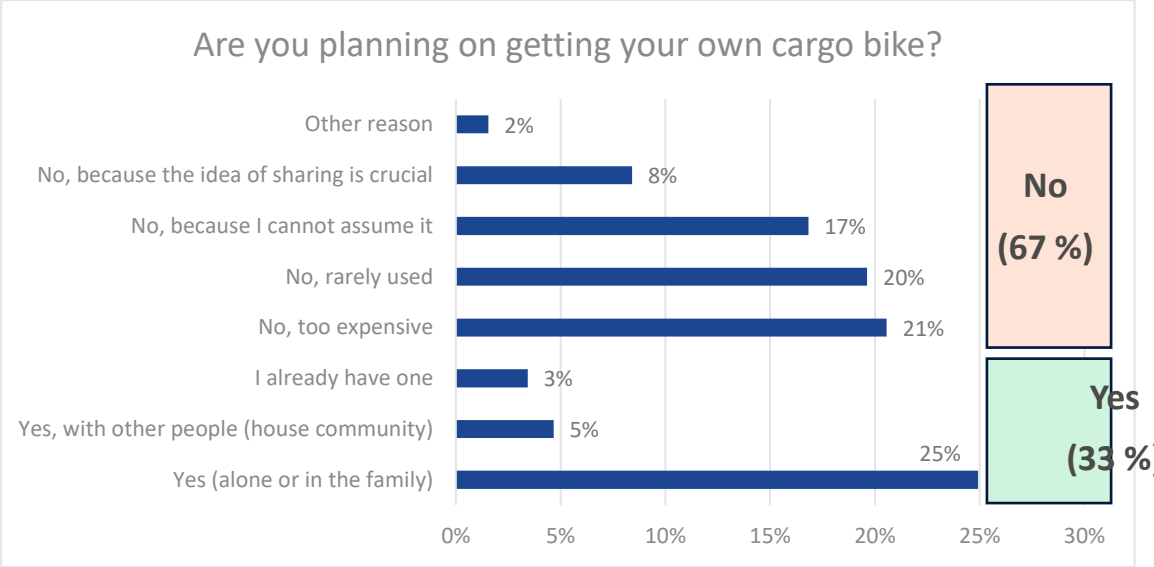
Figure 2-10: Intention of use of cargobike. Source: ADFC survey, 2022; several answers possible



The mindset of using cargo bikes as a sustainable mean of transport is clear (almost 70%) and it is seen as practical (about 70%). The majority of user´s that answered the survey also indicate, that the service offered free of charge is a driver to use it (almost 90%) and an incentive to try out a cargo bike (more than 80%).

Another question related to the general idea of using cargo bikes, the related investment of possessing one and the possibility of the shared access.

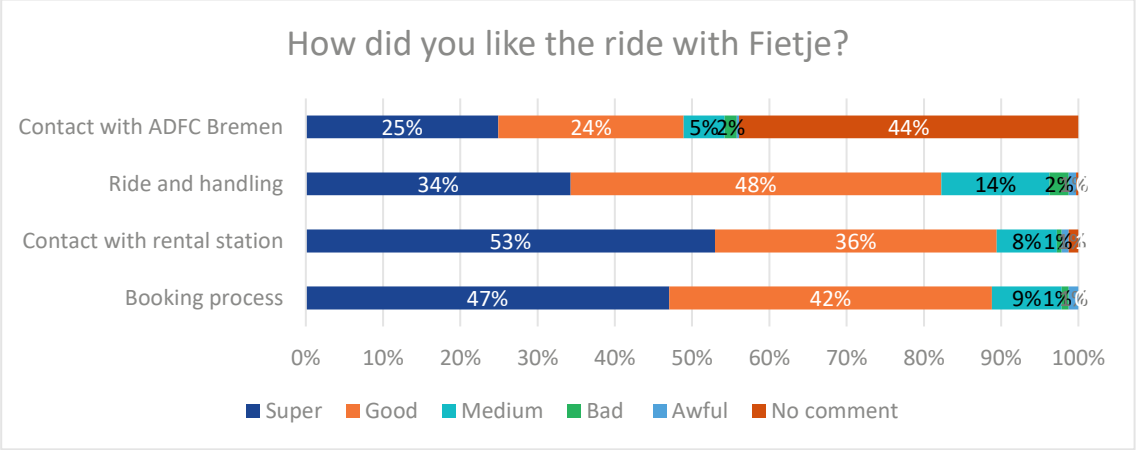
Figure 2-11: Ownership of the cargo bike. Source: ADFC survey, 2022; several answers possible



Almost 70% of the participants don´t have any intentions to purchase an own cargo bike and therefore rely on somehow on this kind of service being offered.

In addition, the users were asked about their perception of the survey and their satisfaction. The operational part including the booking process and contact with the rental station to retrieve and return the bike is perceived very positive, as well as the use itself of the bike.

Figure 2-12: Satisfaction with the service. Source: ADFC survey, 2022; several answers possible



2.2.3 Impact assessment and benefits of the trial

2.2.3.1 Economic benefits

The initial objective to offer the bikes for a low monetary compensation to try out the renting scheme finally kept on being free for use. Therefore, there is no positive economic benefit but the remaining operational and maintenance cost that are subsidized by the city or similar projects to ULaaDS.

In the survey carried out by ADFC in November 2022, users were asked about their willingness to pay and 70% of them are willing to use Fietje cargo bikes for a fee (5€, 10€ or 20€ per borrowing day) as displayed in Figure 2-1.

Willingness to pay is different according to age since young people are more reluctant than older people to pay a fee (see Figure 2-6). This raises the issue of social justice: in order for the cargo bike sharing system to offer a transportation solution to less privileged persons, use needs to be free or cheap (Becker and Rudolf 2018b). There is a balance to find here between viability and social justice. It was a clear result from this trial, that without receiving subsidies from the city, the service could no longer be offered for free, as at least operational costs like maintenance of the bikes and the renting system has to be covered.

Although user of the renting scheme would in general also pay for the service, their motivation of supporting offers like this in their city by donating money for it, is quite the opposite (see Figure 2-8). They rather prefer paying for it only if they are using it (see Figure 2-9).

The calculation of a minimum fee per use is quite simple. The total cost of the service is estimated about 19.000€ per year, consisting in the maintenance fee per bike (the project counts a total of 14 bikes, 5 of them having been acquired throughout ULaaDS) and an estimate cost for the webpage. Resulting from the survey, the bikes are booked almost 100% of the available days (220 working days approx., as they can only be rented during opening hours of the location). This results in a cost of 5,90 € per bike per day that should be the minimum fee.

Parting from this minimum fee, several actions could be taken to reduce the fee, depending on the business model that is chosen for the service. Offering the possibility to rent the bike only for half of the day increases the overall availability of the bikes (which was mentioned quite a lot as an improvement point in the survey) and would reduce the fee per rent. Another option is to charge a one-time fee for registering or an annual inscription to the service to cover part of the maintenance cost.

2.2.3.2 User experience, acceptance and awareness

As a result from the survey, it becomes clear that the service is a good solution for people who have intentions to reduce emissions also for the private logistic (almost 70%) and to try out something, which without this project would be not accessible for them: 55% wanted to try out a cargo bike and as it is free of charge it is more appealing.

So, offering the possibility to familiarize with cargo bikes without having to invest in purchasing a privately owned one was accomplished (almost 80%).

It also becomes clear, that almost 70% wouldn´t purchase their own cargo bike (see Figure 2-11), rather because of the frequency of usage of one or due to the investment costs that come along. They rely on the possibility of a renting scheme which gives them more choice in how they perform trips.

In relation to the acceptance and satisfaction of the users of the cargo bikes, they were asked in the survey about their satisfaction about the ride with the bike and what they liked and where they see improvement.

The majority are very positive about the booking process, the interaction with the rental station and the ride and handling of the cargo bike. They also mentioned as positive that it is free of charge, offers the possibility to try out, practical and non-complicated use and vicinity.

As points to be improved, the duration of the renting was mentioned to be shorter to also offer more availability, which also was one of the main stated points. In general, more bikes available also on more locations would also offer a shorter term and spontaneous rent of the bikes. Even though the interaction with the rental station was pointed out as positive, the obstacle that therefore the available hours a bound to the opening hours of the location was seen as negative and to be improved.

2.2.4 Conclusion

The major benefit of this trial is the possibility for private persons to get access to a substitute vehicle that is environmentally friendly for their private logistics activities. Cargo bikes may not count as new technology solutions, but the possibility to try it out without any further requirements then to register, is a huge positive impact and results in a positive awareness KPI. Consequently, the low availability speaks for a high demand of the cargo bikes and can give the motivation to continue with offering this service and not only spread the network of where these cargo bikes can be rented but increase the available quantity. Therefore, the service level has a positive impact but under the condition of the availability.

However, as the service is currently offered free of charge, a clear result is also that this is not feasible on an economic aspect without further subsidies from private or governmental side. In addition to that, the rental scheme set-up daily may not be the optimal solution, as it clearly reduces the flexibility of the system itself and reduces the availability of the bikes. As a result from the survey conducted by ADFC, the user´s would be willing to pay a small amount and costs like maintenance could be covered or even an extension of the fleet could be considered. Considering this would be an important point for future similar trials and for the continuity of this trial itself. Based on this, the KPI´s related to costs somehow only have a conditional positive impact.

Table 2-7: Assessment of trial objectives by evaluation of related KPIs of BRE.02

Trial Objective	KPI	Assessment

Economic			
Offer users the possibility to familiarize with cargo bikes without having to invest in purchasing a privately owned one (Objective 2)	Investment costs	NC	PI
	Delivery and operational costs	NC	PI
Social			
Offer users the possibility to familiarize with cargo bikes without having to invest in purchasing a privately owned one (Objective 2)	Awareness		
	Service Level	NC	PI

2.3 Trial: BRE.03 – Cargo-hitching (combined passenger and parcel transport) Solution 2, Scheme 4 and 5

The third trial in Bremen was set up to test the combination of passenger and freight transport, also known as cargo-hitching. The trial was supposed to build upon an existing operation of a passenger transport shuttle within a big automotive plant, adding the option within of on-demand transport for cargo.

Table 2-8. Solution and schemes trialed in Bremen trial 03

Solution	Scheme
2) Effective integration of passenger and urban freight mobility services and networks	4. Location and infrastructure capacity sharing 5. Transport vehicle capacity sharing

This trial finally due to several circumstances only could take place in a virtual simulation. Further information to this can be found in the trial report “Cargohitching: An On-Demand Digital Pilot Combining Passenger and Goods Movement Conducted by Via Technologies Europe B.V.”.

Therefore, in this deliverable, the impact analysis is based on the generated data within the simulation, the hypothesis formed as takeaways from the simulation and can give only a hint for an impact in the real world.

2.3.1 Trial objectives defined and finally trialed

This trial aims for the reduction of freight transport traffic within the industrial test site by taking advantage of other passenger trips that take place simultaneously. In this trial shared mobility and MaaS (Mobility as a Service) functionalities offer a dynamic solution that increases the level of service provided to businesses and private recipients in the industrial test site (as D.5.2 ULaaDS factsheets baseline and city profiles):

1. Increasing network efficiency as a result of higher load factors
2. Increasing synergies with other spatial developments
3. Limiting environmental emissions
4. Increase flexibility and service availability
5. Keeping people transportation and freight transportation at socially acceptable levels in an economically viable way

As mentioned before, the trial didn´t take place in real but was converted together with ViaVan into a simulation. The goal of the Via pilot was to explore the potential impact of a cargohitching service in Bremen, Germany.

Via conducted simulations for both Bremen and a comparison city. The comparison city was a German city similar in characteristics to Bremen with an existing Via service. Four scenarios were simulated for each city:

- **Scenario 1:** Passenger-only demand to determine the quality of service and vehicle supply required to meet demand. All trips use the passenger parameters.
- **Scenario 2:** Cargo-only demand to determine the quality of service and vehicle supply required to meet the estimated delivery demand. All trips use the cargo delivery parameters.
- **Scenario 3:** Passenger and cargo demand from Scenarios 1 and 2 are combined to determine the quality of service and vehicle supply required to meet the estimated passenger and package demand. Passenger parameters apply to the passenger trips and the cargo delivery parameters apply to the package deliveries.
- **Scenario 4:** Scenario 1 passenger demand and vehicle supply are used, with an incremental volume of packages added that can be transported without increasing the vehicle supply. Passenger parameters apply to the passenger trips and the cargo parameters apply to the package deliveries.

2.3.2 KPIs and available data

As mentioned in section 1.3.2, this trial belongs to the tier partial assessment. Final major focus was to explore the potential impact of a cargo hitching service in Bremen. Therefore the focus on the

assessment for this trial will lie on the economic impact, as there was no real interaction with endusers.

2.3.2.1 Economic field of impact

As stated in the trial report of Via, "operating service costs for a passenger service could range from €70 - €100 per revenue hour. This estimate considers labour (drivers, cleaners, dispatch, etc.), electricity, vehicle cost (depreciation, maintenance, etc.), overhead (management), and technology costs. Actual costs will depend on vehicles selected, service model, hours of operation, and many other factors."

The estimation of the cargo services is based on a cost of €8 - €12 per package, a conservative estimate of the cost per trip for app-based small package delivery services in Germany and comparable countries, which are often operated using independent contractors driving their own personal cars.

One of the main differences in between the two services is that on-demand transport passenger services are usually subsidized, whether many cargo-only services rely on independent contractors who are paid by the trip and use their personal vehicles for deliveries, rather than a fleet of vetted drivers that are paid by the hour.

The cost table of figure 2-13 displays an estimated annual cost for each scenario.

Figure 2-13: Overview of annual cost per scenario. Source: ViaVan Final Report

Cost of service	Annual cost (in millions €)			
Demand Scenario	Scenario 1. Passenger-only	Scenario 2. Cargo-only	Scenario 3. Passengers + Cargo	Scenario 4. Passengers + Cargo Incremental (limited to supply of passenger-only scenario)
Bremen	€0.8 - €1.1	€0.4 - €0.6	Expected: €1.2 - €1.7, Actual: €1.9 - €2.8, Additional cost: ~€0.9 (+60%)	Expected: €0.9 - €1.3, Actual: €0.8 - €1.1, Savings: ~€0.1 (-13%)
Comparison City	€1.9 - €2.8	€1.1 - €1.5	Expected: €3 - €4.3, Actual: €4.6 - €6.6, Additional cost:: ~€2.0 (+55%)	Expected: €2.2 - €3.2, Actual: €1.9 - €2.8, Savings: ~€0.3 (-30%)

Both Bremen and the comparison city have an implied cost per passenger of 28€ up to 41€ under Scenario 1, which would be considered high for an urban service but is a reasonable rate for less dense environments.

Scenario 3 results in increased costs due to the transition from the cargo-only delivery model to the passenger delivery model for packages. For Bremen, this would result in a 0,9 Mio€ annual increase to the cost compared to keeping the services separate.

Scenario 4 results in a decrease of 0,1 Mio€ in total costs due to efficiencies gained from commingling.

Scenario 4 with incremental demand is most appealing for overall cost reduction. If the service could charge 8€ to 12€ per package, this would lead to a 4€ to 5€ reduction in cost (and therefore required subsidy) per passenger, with an annual savings of about 14%.

2.3.3 Impact assessment and benefits of the trial

2.3.3.1 Economic benefits

The result of the simulation makes it clear, that a cargo hitching model has a meaningful impact on service finances. Combining high levels of passenger and package demand increased the cost compared to running two separate services, because packages alone can be delivered with a lower-cost model than passengers.

However, a cargo hitching model where package delivery only occurs during off-peak hours of a passenger service can yield a meaningful cost reduction compared to running both services separately.

It is difficult to optimize for both passenger and cargo transport; usually one will need to be prioritized. The logistics experts as well as representatives from the freight village, that were consulted for the simulation, all indicated that cargo transport is complex to optimize and requires bespoke approaches focused on the specifics of a service, whether it be hub-to-destination or in-neighbourhood on-demand cargo transport. Optimizing would be most effective if packages and passengers have peak demands at different times, or if packages can be delivered at any time during the day.

2.3.4 Conclusions

A part of the business model to make cargo hitching viable, some other points must be considered to ensure a smooth functioning of the service and a positive impact.

The primary sources of challenges that must be anticipated and addressed in both on-demand passenger services and cargo services revolve around pickup and drop-off operations. These issues encompass various aspects that can complicate the process for passengers and cargo alike. Passenger-related challenges consist of instances such as no-shows, delays on the part of either passengers or drivers, drivers encountering difficulties in locating an address, passengers struggling to locate their designated vehicle, and time consumption during the loading and unloading process.

Cargo services encounter their own set of difficulties, including situations where the cargo is not prepared for pickup when the driver arrives, challenges in finding the correct address, the recipient of a package not being present at home to accept the delivery, drivers needing to walk substantial distances to deliver packages within large buildings, the necessity for drivers to find suitable parking for pickups or deliveries, and potential complications or limitations for drivers when handling packages.

The coexistence of passengers and cargo within the same vehicle may not always be feasible. In many cases, a service will likely opt to avoid situations where both passengers and cargo are present in the vehicle simultaneously during pickup or drop-off. Similarly, certain types of cargo may not be well-suited to share a vehicle with passengers. For instance, larger cargo items that necessitate folding down seats or cargo with strong odour, such as food items, may pose challenges when combined with passenger transportation.

In summary, combining freight and passenger transportation flows to optimize not only occupancy levels and utilization of means (driver and vehicle) but also divide fix costs in between both flows seem logical on a theoretical basis. However, when it comes to practice, the different challenges like maintaining service levels (impacted by waiting times in between the two processes), pick-volumes at the same time make a successful implementation challenging.

Table 2-9: Assessment of trial objectives by evaluation of related KPIs of BRE.03

Trial Objective	KPI	Assessment	
Economic			
Explore the potential impact of a cargo hitching service	Investment and operating costs	NC	PI

3. Mechelen Trials

Mechelen is a medium-sized typical European city and municipality in the province of Antwerp, Flanders, Belgium. It has almost 88.000 inhabitants and estimated to count 100.000 inhabitants by 2030. In Mechelen, two different trials have been set up at the beginning of the project. Due to collaboration issues and other specific setbacks during the initial set-up phase of the trials, only one trial reached implementation stage and will be analysed within this deliverable.

3.1 Trial: MEC.01 – Mechelen Inner City Trial – Solution 1, scheme 3

First version was a trial with existing city hubs that will act as consolidation points that will function together with decentralized warehouses in the form of smart lockers. Within this trial, three different pilots would have been taken place. During the period of the project, specific setbacks within each pilot made it reasonable to establish a joint trial. With time going by, the interests and needs of the different stakeholders involved changed and three different versions of how the joint trial can look like, have been defined. At the time of this deliverable, lack of progress and time consumed for defining the trial has led to stall the whole project. Therefore, within this deliverable, it is not possible to analyse any possible impact on economic and social side but take note on the importance of collaboration and compromise of each stakeholder and participant of a trial to get take aways. Further details and the story behind this trial can be found in the final report deliverable D4.7 – Mechelen ULaaDS practical research trials.

3.2 Trial: MEC.02 – Cargo-hitching with autonomous vehicle – Solution 2, scheme 5

This trial represents a clear case of cargo-hitching with the help of a semi-autonomous shuttle and lockers for the integration of freight and passenger transport. For the first time an autonomous vehicle drove on public roads in Belgium. In the first phase of the pilot, only passenger transport was tested, then in a second phase, a locker system was installed inside the vehicle to test the cargo-hitching scheme within the business park Mechelen Noord at the city boarder, on open accessible public roads.

Table 3-1. Solution and schemes trialed in Mechelen trial 02

Solution	Scheme
2) Effective integration of passenger and urban freight mobility services and networks	5. Transport vehicle capacity sharing

3.2.1 Trial objectives defined and finally trialed

The aim of this trail was to test the concept of "cargohitching" i.e., the combination of freight and public transport. Furthermore, to increase the level of service, the combination with an autonomous shuttle was made to carry out this trial (as D.5.2 ULaaDS factsheets baseline and city profiles):

1. Testing of an autonomous driving parcel locker with a cargo-hitching component
2. Minimizing of cost by optimal use of vehicle for passenger and freight transport

3.2.2 KPIs and available data

As mentioned in section 1.3.2, this trial belongs to the tier partial assessment. Final major focus was on objective Nº 1 of testing an autonomous vehicle on public streets.

From the beginning it was clear, that it was going to be a one-time trial, on a 4 km route. Though detailed trial cost (renting of the vehicle, installation cost of the locker inside the vehicles, permits, prepration and programming costs, etc.) have been provided, they are not representative for implementation or trials in other places. An important factor here is the duration of such a trial, as well as local factors.

The outcome of this trial focussed more on testing of a new techonolgy and the challenges and barriers this can bring with for example on legal and operational level. Therefore the focus on the assessment for this trial will lie on the social acceptance of the users and the readiness of the technology.

3.2.2.1 Social field of impact

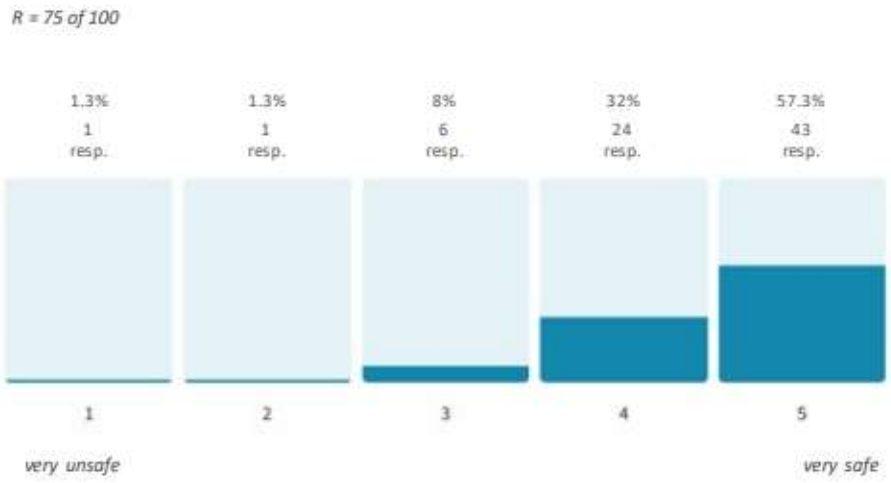
It was a major focus of this trial to gather opinions and views from the pilot. Hence, workshops, questionnaires or interviews were conducted with several stakeholder groups. One specific stakeholder group was the Residents' panel, a combination of members of older people's organisations and representatives of people with less mobility.

With the aim of raising the awareness of the pilot, social media posts, posters and flyers with a guideline how to use the parcel locker have been promoted.

Also, an online survey was conducted asking the opinion about autonomous shuttles and the use of parcel lockers on the shuttle. The survey was firstly set up for people who had used the shuttle and was spread by means of the city of Mechelen website, flyers in the shuttle, flyers at the physical setup and on social media. 100 people took part in the survey, 75 of whom also took a ride on the shuttle.

In the following figures, the answers to the questions about the safety during the ride, the purpose of the ride and the general field of use of driverless transport are displayed.

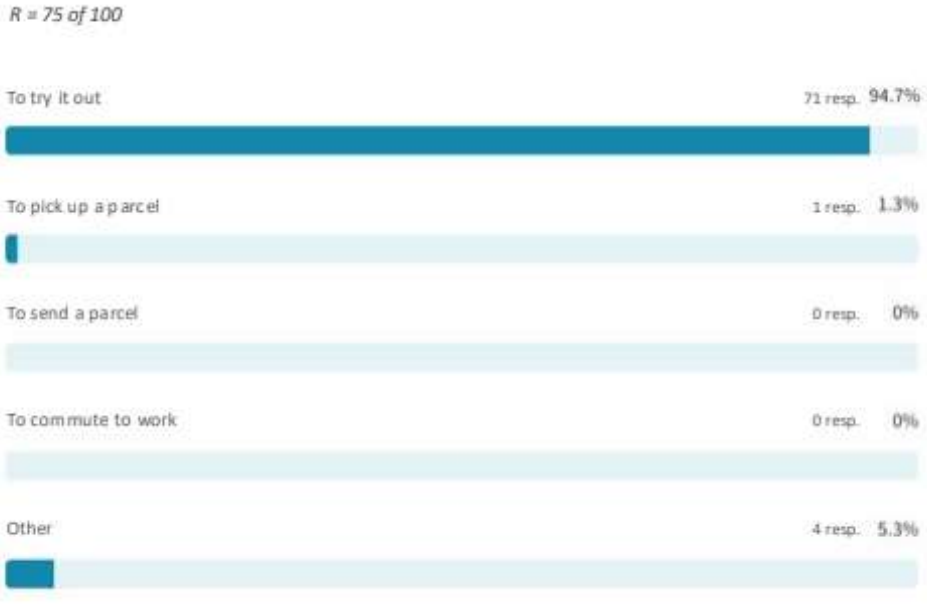
Figure 3-1: How safe did you feel while riding? Source: Question from the Digital Survey, Studio Dott



In general, people felt safe during the ride (see Figure 3-1). This is important because the first barrier of new technology can be safety of the final user.

The mayor intention of using the shuttle, was the curiosity to try it out as it is a complete new technology, not very present yet in general in cities (see Figure 3-2).

Figure 3-2: Why did you use the shuttle? Source: Question from the Digital Survey, Studio Dott



When asked the question, what should be the purpose of autonomous vehicles, several answers were possible, so also a combination of the answers is possible. In general, it is considered as well suited for shuttle service in between two or more concrete destinations, rather than as public transport with much more stops. Also, a use in a more controlled environment like hospitals or airports with less external factors influencing the route is seen as a possibility (see Figure 3-3).

Figure 3-3: What do you think driverless transport (like this) would be good for? Source: Question from the Digital Survey, Studio Dott

3.2.3 Impact assessment and benefits of the trial

3.2.3.1 User experience, acceptance, and awareness

The result of the online survey states that 89% of people who took a ride had a positive experience. They described it as surprising, fun, educational and inspiring. An often-mentioned drawback was the low speed of the shuttle (for safety reasons, the shuttle´s maximum speed was limited to 15 km/h).

The people participating in the online survey perceived the use of the shuttle as safe and would use it again or recommend it to others (see in Figure 3-1).

When asked, why they did use the shuttle, the majority indicated their curiosity in trying a new technology (see Figure 3-2). People were very positive about the fact that Mechelen is considering an autonomous shuttle and prepared to experiment.

The most frequently chosen applications are transport in a business context, transport as a shuttle service to the town centre and to amenities (see Figure 3-3). However, comments were made in relation to the route, which a lot of people considered useless: “Nice test, but unrealistic given that the environment is too safe: parking ban, traffic travelling at 30 km/h maximum, light traffic, no cyclists. In other words: an overly controlled environment.”

In general, the survey participants stated the opinion that in the future, autonomous shuttles will have a part within the mobility and logistics systems. Nevertheless, a certain barrier of handing over control of machines is still present, even though this could improve problems like bottlenecks in public transport. Main concerns were based on technical failures operator intervention, slowness, and congestion due to frequent stops. Clearly there is an uncertainty regarding the possibilities of the vehicle of participating in city centres, interacting with other road users. The conclusion of the survey states that “*people were positive about the city's willingness to experiment with this new type of technology. Although they think the pilot should be on a more useful route and in a less congested area.*”

One point discussed within the Experts panel (experts from different European cities who visited for a study day on the topic of logistics) was the level of service of an autonomous vehicle combining goods and passengers. Similar to the findings in the Bremen Trial 3 (Simulation of ViaVan), the waiting times in between the flows can have important impact on the service levels.

The major concern within the stakeholder group of city council was that an autonomous vehicle replaces the usage of bicycles and not the car.

The conclusion of the resident's stakeholder group was the limited flexibility of the service that makes it difficult to have as a solution for the major group of users, but though a potential solution to substitute taxi rides of short distances for people with less mobility.

Even though within the online survey the participants indicated to have felt safe while traveling with the autonomous vehicle, the participants of the business and industry panel were more critical about the capabilities of the shuttle, mainly within the sense of safety. Not being able to avoid obstacles was seen as a minus, but they also acknowledge that the technology has come a long way and believe that it would be feasible to deploy driverless vehicles in the short term (less than 5 to 10 years).

3.2.4 Conclusions

This trial truly shows the importance of pilots like this for testing new technology solutions and their implications and repercussions in society. The panels and questionnaires conducted during the trial give important feedback not only where society and end-users have their doubts and concerns, but also other stakeholders like Industry and Business and the City Government can define together a roadmap for this new solution to convert it from a futuristic scenario into a working model in everyday life. This sets the framework conditions for a successful implementation of a solution as the level of acceptance and awareness will be high from the beginning.

Another opportunity given by this trial is that throughout the panel discussions and the trial taken place different stakeholder groups get together at the same table and interact. This does not only raise the awareness of the technology itself of all the groups but also their needs and interests related to the technology are displayed to each other.

Awareness of autonomous passenger and parcel transport solutions was increased with this trial, although it also made clear, that for a better acceptance and fulfilment of high level of service, advanced expectations like velocity and the technical capability of the solution must be met.

Table 3-2: Assessment of trial objectives by evaluation of related KPIs of MEC.02

Trial Objective	KPI	Assessment
Social		
	Level of acceptance	PI
	Awareness	PI

Testing of an autonomous driving parcel locker with a cargo-hitching component (Objective 1)		
	Level of service	NI

4. Groningen Trials

Groningen is the 6th biggest city in the Netherlands and the biggest city in Northern Netherlands. About 1.6 million people live in North-Netherlands and the daily urban system of Groningen counts around 500.000 people.

The city of Groningen has set goals towards a zero-emission Zone by 2025 for Logistics.

Redirecting public transport of buses to create more space in the inner city and a traffic circulation plan are just some of the measurements that are taken place in Groningen. At a similar time as the start of the trial, a strict time delivery window for urban freight was put in place as another measure of the city to achieve the zero-emission goal.

4.1 Trial: GRO.01 – Sharing platform for logistics – all solutions and schemes

The city of Groningen (GRO) together with the Groningen City Club (GCC) has developed a platform for shared zero-emission vehicles for the shop-owner of the city for their logistics activities.

Table 4-1. Solution and schemes trialed in Groningen trial 01

Solution	Scheme
1) Collaborative delivery models to enhance logistics efficiency and multimodal mobility in cities	1. Containerised urban last-mile delivery 2. Logistical network integration of crowd-sourced bike couriers 3. City-wide platform for integrated management of UFT
2) Effective integration of passenger and urban freight mobility services and networks	4. Location and infrastructure capacity sharing 5. Transport vehicle capacity sharing

4.1.1 Trial objectives defined and finally trialed

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 centre to consumers in the city and its neighbouring peri-urban and rural areas. The deliveries may include possibilities to deliver via Mobi hubs/parcel lockers, parking garages, offices, hotels etc.

- provides access to multiple zero-emission vehicles for shared use by local shopkeepers and entrepreneurs.

Therefore, the following objectives have been defined (as D.5.2 ULaaDS factsheets baseline and city profiles):

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

4.1.2 KPIs and available data

From the KPI´s defined in Deliverable D5.1, the following have been chosen for the impact calculation on this trial in the economic and social field. The selection was made based on available data and to cover as best as possible the impact assessment field and is listed in table 4-2 below.

Table 4-2: List of KPI and data to assess Groningen trial 1

Field of impact	Which KPI	Support Indicator	Method (Data collection – Estimation – Survey)
Economic			
Increasing the use of cargo bikes and other zero emission vehicles (and decreasing the use of polluting vehicles) (Objective Nº 1) Increasing the efficiency/use of transport vehicles (Objective Nº 2)	Delivery and operational costs	Operating costs	Data collection from deliverable D3.5
		Maintenance costs	Data collection from deliverable D3.5
	Investment costs	Amount of money spent by the local authority to invest in infrastructure	Data collection from deliverable D3.5
		Amount of money spent to facilitate and support trials, and / or enforce regulation / legislation	Data collection from deliverable D3.5
Social			
Increasing liveability and safety because of	Level of acceptance	Recipient acceptance	Survey & Interview with shop owners

the use of smaller, silent, and clean vehicles (Objective 3)			
Giving more target groups the opportunity to use electric vehicles. (Objective 4)	Awareness	Awareness	Survey & Interview with shop owners
	Service Level	Service Level	Survey & Interview with shop owners

4.1.2.1 Economic field of impact

In the deliverable D3.5 (Final validated business/operating models) a detailed analysis of the different cost components in relation to the usage of the vehicle (in terms of km) was carried out and is displayed in Figure 4-1. The purpose of the analysis was to validate, which pricing scheme would be the most accepted one to ensure the capability of the pilot to endure even once it´s trial status from ULaaDS was finished. Focus was on the electric vehicle (ID. Buzz), as it was the most used one.

Figure 4-1: Fixed and variable cost of the ID. Buzz. Source: Deliverable D3.5

Fixed cost component	Cost per month
Vehicle	
Investment*	
Financing	
Charging Infrastructure	€ 625,00
Additional cost	
Cleaning services	
Parking permit	
Sharing platform	
Insurance	
Waiver for time-window access restriction	€ 325,00
Commercial profit surcharge (25%)	€ 237,50
Total fixed cost per month	**€1.187,50**

Variable cost component		Cost per km
Maintenance		€ 0,06
Energy		
Estimated electricity consumption ID. Buzz (kWh/km)	0,30	
Electricity price (€/kWh)	€ 0,60	€ 0,18
Commercial profit surcharge (25%)		€ 0,06
Total variable cost per km		**€ 0,30**

** Considering depreciation and scrap value*

The largest cost component concerns the fixed costs involved with acquiring the vehicles, including financing, followed by other fixed costs, such as for developing and operating the online platform and keeping the vehicle clean.

The percentage split of the additional cost was provided and is displayed in table 4-2.

Table 4-2: Distribution of additional cost. Source:

Cost Component	Percentage
Purchase, Financing and Depreciation	48,5%
Profit Surcharge	20,0%
Insurance	10,9%
Cleaning	8,4%
Waiver	8,4%
Charging infrastructure	1,5%

Sharing platform	1,4%
Parking	0,8%
	100,00%

There are also variable costs associated with the use of the vehicle, mainly consisting of energy cost and maintenance, which are displayed per kilometre, in Table 4-1.

4.1.2.2 Social field of impact

This trial had active involvement of all stakeholders throughout his whole process. The communication and participation of the users (represented by the Groningen City Club) as well as the City itself and private companies involved (Century as owner of the vehicles) was key to a successful execution of the trial.

A questionnaire was carried out prior to the first local Stakeholder Fora, where 16 respondents stated their opinion on trial aspects related to economic, environmental, social, and required service level.

When it comes to sustainable solutions the participants state clearly that awareness of this solution is important (see Figure 4-3). Another indication of the results of the questions is that sustainability is getting higher level of acknowledgement within organisations and their activities.

However, they are not really seen as a solution to the problem of traffic safety or the available space in public.

Figure 4-3: Sustainable solutions. Source: Questionnaire 1st Fora

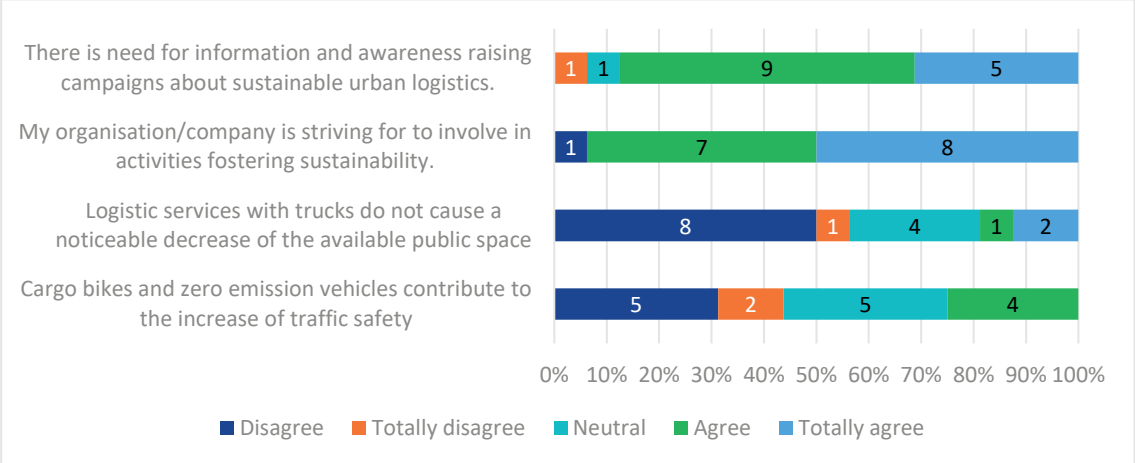
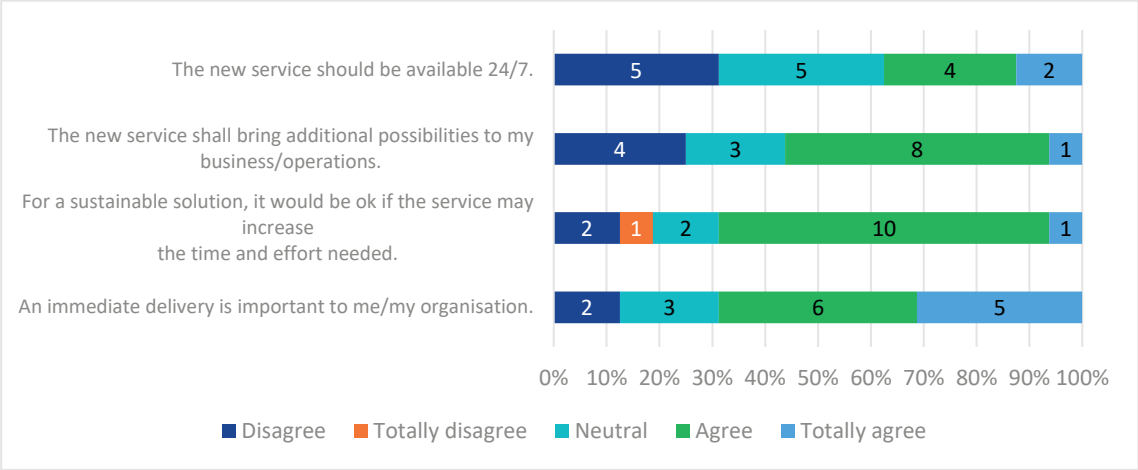


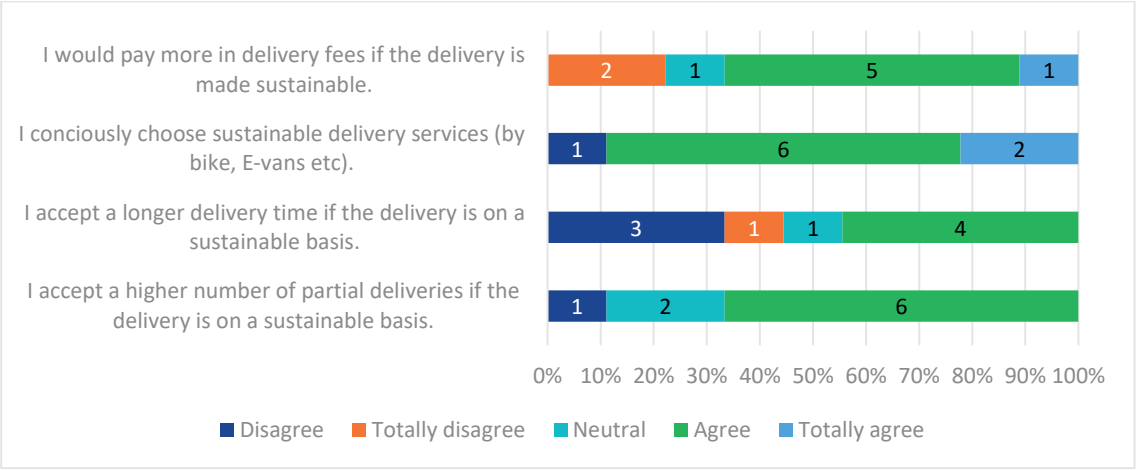
Figure 4-4: Service level. Source: Questionnaire 1st Fora



When it comes to the service level offered by this trial, a clear message from the participants is that it must be fast, but not necessarily available all the time (see Figure 4-4). But the majority also indicate that they would accept, that time and effort needed can be higher than the traditional solution. This is a bit contradictory and should be analysed further if there are variations between the stakeholder groups or among them.

Also in relation to the speed of delivery, half of the participants would accept longer leadtime, not consolidated deliveries and even pay more for a sustainable delivery (see Figure 4-2).

Figure 4-2: Willingness to pay and acceptance of service level. Source: Questionnaire 1st Fora



4.1.3 Impact assessment and benefits of the trial

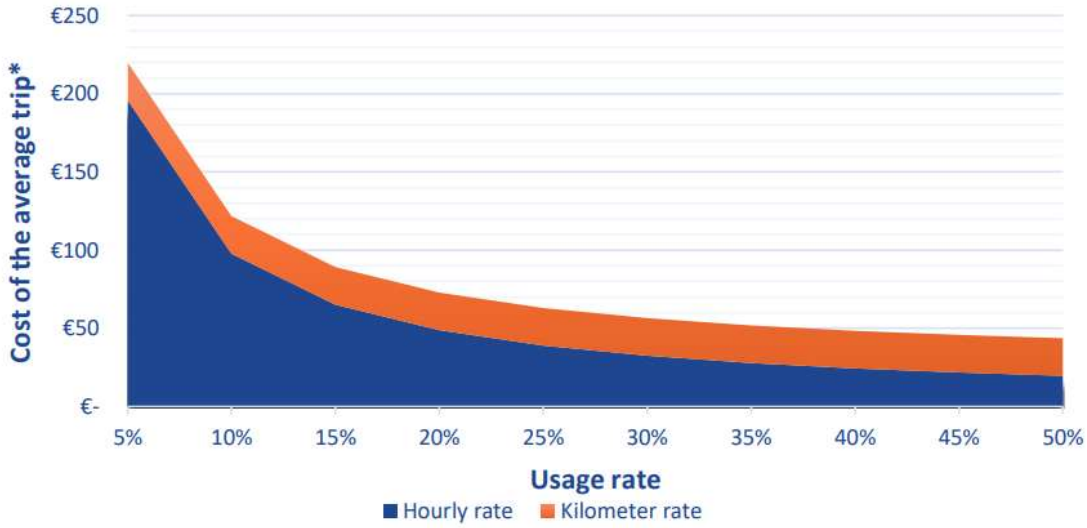
4.1.3.1 Economic benefits

There are several benefits that this trial has displayed throughout the performance stage, such as the reduction of the number of different vehicles in the city. Although there was no data measuring the impact, sharing a vehicle clearly reduces the amount of vehicles existing in the city. Another benefit is that a platform for shared zero-emission vehicles supports local business activity throughout the

rollout of more stringent regulations. From an economic perspective it is very important to choose the right business model that cover ongoing cost and the optimum number of vehicles part of the renting scheme is calculated to offer the most availability to the final user. This is discussed more in detail in deliverable D3.5 (Final validated business/operating models).

Regarding the operating model detailed in deliverable D3.5, the importance of the trade-off between cost and availability becomes very clear. The more a vehicle is used, the more the fixed costs can be shared amongst its users, ultimately lowering the price per use (see Figure 4-6).

Figure 4-6: The trade-off between usage rate and price per use. Source Deliverable D3.5



However, increasing the usage rate directly implies reducing the availability rate. As a result, the probability of the vehicle being unavailable when users want to reserve it increases. This invokes a trade-off, where some of the shopkeepers indicated during their second interview that they favoured availability (i.e., a high probability that the vehicle is available when needed) over price, whereas others indicated that price was the most dominant factor deciding interest in the vehicle.

When asked in the questionnaire rather they would pay even more for a sustainable delivery and therefore chose a different type of service, the majority is ok with this, even accepting a slight increase in the delivery time or the quantity of deliveries per day (see Figure 4-5).

The trial showed the potential for a positive business case, including a profit margin for the mobility service provider. It details a pricing scheme that would result in a single rate consisting of two elements: the hours used, and kilometres driven. Discussions with the trial user group suggested a membership fee would be another interesting revenue to explore. A challenge is that different users would value different things from a membership. Ad hoc users would mostly pay for ensured availability, while planned use benefits from a discounted price for longer use or for reserving ahead of time. In any case, the revenue from the membership could reduce the fee per use as indicated in the beginning of this sub-section. Advertisement was not considered during the trial but could principally be another way of lowering the price per use.

4.1.3.2 User experience, acceptance and awareness

In general, perception of the final users (shopkeepers) was positive, coming also from the fact, that the city of Groningen had changed the legislation of access to the inner city and they see a viable solution in the renting of the ZEV to carry on their business.

When asked about the general opinion of sustainable urban logistics solution, a clear majority is in favour of them and looking forward to including them within their business. A certain awareness is existing, but further information and promotion of this types of solution seen as necessarily.

However, there is no clear relation seen by the fora participants in between logistics activities with a truck and public space. Even if these activities are done by a ZEV, space is still required.

In relation to the service level required from the renting of a ZEV, it comes clear that availability is key, but the time and effort from user side in using this service is accepted to be higher (see Figures 4-4).

4.1.4 Conclusions

The benefits of the trial are clear, as due to changing regulations related to the accessibility of the inner city, the solution offered by the trial was somehow the only viable option for the shopkeeper to keep their activities running without mayor obstacles. Also, the familiarization of the end-user with zero-emission vehicles was given in this trial

In conclusion, the trial of shared zero-emission vehicles has highlighted several significant benefits during the performance stage. One noteworthy advantage is the evident reduction in the number of different vehicles present in the city, although precise impact data is lacking. This reduction not only contributes to a more sustainable urban environment but also aligns with the city's goals of minimizing vehicle congestion.

Furthermore, the platform for shared zero-emission vehicles has positively influenced local business activity, particularly in the context of increasingly stringent regulations. The choice of an appropriate business model is critical to cover ongoing costs and determine the optimal number of vehicles within the rental scheme to maximize availability for end-users, a subject further explored in deliverable D3.5 (Final validated business/operating models).

Within this operating model detailed in deliverable D3.5, the trade-off between cost and availability becomes evident. Higher usage rates allow for the distribution of fixed costs among users, ultimately reducing the price per use, as illustrated in Figure 4-6. However, an increase in usage rate is associated with a decrease in availability, potentially affecting the likelihood of vehicles being unavailable when users need them. This presents a trade-off, where some stakeholders prioritize availability, while others emphasize price as the key factor influencing their interest in the vehicle.

The trial has also demonstrated the potential for a flexible pricing scheme that combines hours used and kilometres driven, with the addition of a membership fee as an additional revenue source. Different users may value distinct features of membership, such as ensured availability for ad hoc

users or discounts for planned use. Advertising, although not explored during the trial, could potentially further reduce the price per use.

In terms of user experience, acceptance, and awareness, the feedback from shopkeepers, the final users of the service, has generally been positive. They perceive shared zero-emission vehicles as a viable solution, especially given the changes in inner-city access legislation in Groningen. While there is existing awareness and a favourable view of sustainable urban logistics solutions, there is room for improvement in information dissemination and promotion of these solutions.

Table 4-3 : Assessment of trial objectives by evaluation of related KPIs of GRO.01

Trial Objective	KPI	Assessment
Economic		
Increasing the use of cargo bikes and other zero emission vehicles (and decreasing the use of polluting vehicles) (Objective Nº 1) Increasing the efficiency/use of transport vehicles (Objective Nº 2)	Delivery and operational costs	PI
	Investment costs	PI
Social		
Increasing liveability and safety because of the use of smaller, silent, and clean vehicles (Objective 3)	Level of acceptance	PI
Giving more target groups the opportunity to use electric vehicles. (Objective 4)	Awareness	PI

4.2 Trial: GRO.02 – Urban Logistics as a Service for commuters – Solution 2, schemes 4 and 5

This trial consists of adding urban logistics services to a Park & Ride Location in the outsides of the city. The initial scope of the ULaaDS trial 2 was the placement of a parcel locker at one public transit hub in Groningen, where there was a strong preference for a white-label system so that all logistics service providers and local entrepreneurs could principally use it.

Table 4-4. Solution and schemes trialed in Groningen trial 02

Solution	Scheme
2) Effective integration of passenger and urban freight mobility services and networks	4. Location and infrastructure capacity sharing 5. Transport vehicle capacity sharing

The implementation of the trial faced several challenges, which can be found explained more in detail in deliverable D4.7. Regardless, important learnings have been taken with for all parties involved and the municipality of Groningen expanded the scope of the trial by looking at parcel locker systems more broadly. The municipality of Groningen decided along with the Together with the ecosystem of local stakeholders to work towards a policy framework for parcel locker placement in the city, that is discussed in Deliverable D6.6.

Therefore, within this deliverable, it is not possible to analyze any possible impact on economic and social side but we can highlight some of the key findings that the trial has brought so far:

- Density of network. The shorter the distance that must be traveled to the pick-up station, the more likely it will be done by foot and not by car.
- Preference for private-label solutions, as technology and responsibilities (for example in case a parcel gets lost) is much easier.

5. Conclusions

ULaaDS has a clear focus on identifying and assessing impacts of on-demand services demonstrated throughout the ULaaDS trials in the lighthouse cities Bremen, Mechelen and Groningen. To define the appropriate evaluation framework and KPIs and assess both how well the ULaaDS trials perform as well as the socio economic, costs, benefits and environmental effects was objective of Workpackage 5 and was divided into several deliverables: D5.1 Framework, methodology and KRI identification, D5.2 ULaaDS: factsheets baseline and city profiles, D5.4 Economic impacts, user experience acceptance and awareness and D5.5 Impacts on logistics and traffic efficiency, land use and the environment.

This deliverable together with D5.5 is an important base for the replication of the trials within the satellite cities, as is planned with the following deliverables: D5.3 Replication strategy and training and D5.6 Implementation roadmaps for Satellite cities.

The ULaaDS solutions that have been put into practice place a strong emphasis on innovative vehicle technologies, employing smaller, zero-emission, and even autonomous vehicles, alongside collaborative models that maximize the utilization of vehicles, facilities, and infrastructure. The diverse stages of development across the various trials have offered distinctive perspectives on the relevance and efficacy of the suggested operating and business models. While certain trials have illuminated a well-defined route to sustainable business models, others have indicated a heightened necessity for technological advancements in order to attain commercial viability.

Two key learnings can be taken from the whole process and the attempt of assessing the trials in the social and economic field. A clear definition of the objectives at the beginning and how they can be measured is crucial to analyze and evaluate a trial in any aspect, not only on social and economic level. A clear awareness and analysis of the situation before a trial is started is also very important, as it offers then the opportunity to compare the happening of the trial against it and the impact assessment can be done on a very detailed level.

Another key learning that has also been discussed in several sessions within ULaaDS is availability of data and its collection. It is a fundamental element for enabling a successful trial and a valuable assessment. It also can be taken as an opportunity to engage different stakeholder groups from the beginning and align on the expectations from the trial.

In conclusion, this deliverable as part of the assessment of all trials, focuses on the social and economic field and how each trial had an impact there. It highlights the importance of clear objectives together with data collection and measurement also with the focus of replicating and upscaling trials. To get an overall idea of the output and successfulness of each trial, it is important to consider also the assessment taken place in deliverable D5.5.

Acronyms

Acronym	Meaning
AI	Artificial Intelligence
AV	Autonomous Vehicles
D	Deliverable
EC	European Commission
GA	Grant Agreement
ICT	Information and Communication Technology
LF	Load Factor
LSP	Logistics Service Provider
MaaS	Mobility as a Service
O	Objective
ODD	On-demand Delivery
P	Product
PPP	Public Private Partnership
PM	Person Month
SUMP	Sustainable Urban Mobility Plan
SULP	Sustainable Urban Logistics Plan
T	Task
UC	Use Case
UCC	Urban Consolidation centre
UFT	Urban Freight Transport
ULaaDS	Urban Logistics as an on-Demand Service
WBS	Work Breakdown Structure
WP	Work Package
VUR	Vehicle Utilisation Rate
ZEV	Zero Emission Vehicle

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Annexes

List of KPI´s defined in D5.1

Objective	Key Performance Indicator (KPI) (unit of measurement)	Support indicator
	Days in operation per vehicle (Percentage (%))	Days in operation per facility
ECONOMIC IMPACTS		
Economically sustainable business models	Last mile delivery cost per delivery / pick up (Percentage (%))	Cost per person/day
		Hour worked/day
		Absenteeism
		Cost/vehicle/day
		IT cost/delivery
	Distribution and warehouse cost per delivery / pick up (Percentage (%))	Depreciation costs of investment
		Operating costs
		Maintenance costs
		No. of deliveries / pick-ups
	Investment costs for the city (Percentage (%))	Amount of money spent by the local authority to invest in infrastructure.
		Amount of money spent to facilitate and support trials, and / or enforce regulation / legislation
USER EXPERIENCE AND ACCEPTANCE		
Same or better level of service as existing schemes and increased acceptance	On time in full (OTIF) (Percentage (%))	No. of deliveries / pick-ups on time
		No. of errors (loss, theft, damaged)
		ETA (expected time of arrival)
		Total no. of deliveries / pick ups
	Customer satisfaction (Index)	Satisfaction with services
		Loyalty
		Likelihood of recommending to others
		Information availability, visibility and accessibility (real time updated)
	Level of acceptance (Percentage (%))	Understanding level
		Willingness to change
AWARENESS		
Increased awareness of	Level of awareness of sustainable delivery (index)	Recipient awareness of sustainable delivery options

AWARENESS		
Increased awareness of	Level of awareness of sustainable delivery (index)	Recipient awareness of sustainable delivery options

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Objective	Key Performance Indicator (KPI) (unit of measurement)	Support indicator
sustainable delivery solutions	Willingness to pay for sustainable delivery (index)	Recipient willingness to pay for sustainable delivery