ULaaDS

URBAN LOGISTICS AS AN ON-DEMAND SERVICE

Business and operating models in ULaaDS trials

ULaaDS D3.3: Novel business/operating models and mapping to research trial sites

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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, business models, operating models.

Copyright statement

Executive summary

Business and operating models are essential to the success of new initiatives in on-demand and zero-emission urban freight transport. Therefore, the ULaaDS project has a strong focus on identifying successful, developing new, and continuously refining business and operating models related to the solutions and trials it proposes. This process will be reported in three separate deliverables: D3.1 “Benchmarking business/operating models and best practices”, D3.3 “Novel business/operating models and mapping to research trial sites” and D3.5 “Final validated business/operating models”.

The process of defining and pre-validating novel business and operating models for the ULaaDS solutions started off from the state-of-the-art with many examples of sustainable on-demand urban logistics solutions presented in deliverable D3.1, as well as the benchmark for business and operating models presented in the same deliverable. Deliverable 3.3 provides an update on the ULaaDS solutions trialled in the three lighthouse cities and then maps those solutions to the relevant business and operating models described in deliverable D3.1. These updates and mapping result in several new insights into the business and operating model considerations.

In addition, this deliverable presents the latest update on the ULaaDS solutions, including the evolution of the business and operating models thus far for each lighthouse city trials. The overview of the business and operating model considerations for the ULaaDS research trials shows that most attention thus far has been spent on successfully deploying the different ULaaDS solutions and on engaging all important stakeholders. Some questions regarding viable business models for the solutions are still open. Indeed, figuring out what could be successful business models is an explicit part of most trials.

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1. Introduction

This deliverable maps the relevant business and operating models to the ULaaDS solutions. It uses the benchmark and best practices described in D3.1 and serves as input for the planned deliverable D3.5 presenting a validated version of the ULaaDS business and operating models.

Strong business and operating models are essential to the success of new initiatives in on-demand and zero-emission urban freight transport. Indeed, many innovative solutions in recent years have faced reluctant stakeholders, often because of concerns about the benefit to cost ratio, labour unions, a willingness to pay and many other operational constraints. ULaaDS therefore pays close attention to business and operating model aspects throughout the project.

The document is divided in three main chapters, one for each Lighthouse city. For each city, the document first describes the solutions and schemes to be tested—based on the information available in March 2022. It then discusses relevant aspects of the business and operating model for each solution and scheme. Each chapter ends with a brief look ahead, addressing those aspects that are expected to be of interest for further study during the actual trials.

1.1 From Provisional to Validated Business and Operating Models

As part of WP3, ULaaDS will develop and then continuously refine and update the business and operating models related to the research trials. ULaaDS started with a provisional list of novel business and operating models for the two main solutions developed and trialled within the project: (1) collaborative delivery models to enhance logistics efficiency and multimodal mobility in cities and (2) effective integration of passenger and urban freight mobility services and networks. This provisional list served as a basis for further development. As a next step, the project identified an extensive list of best practices in on-demand and zero-emission urban freight transport and linked these to different business and operating models. This is reported in ULaaDS deliverable D3.1 and serves as an elaboration and update of the provision list of business and operating models. D3.1 was used as the ULaaDS trials were further getting shape. This deliverable (D3.3) maps the solutions trialled in the three ULaaDS lighthouse cities to the relevant business and operating models described in D3.1. This mapping is done during the design of the research trials, but prior to their actual start.

After the research trials have started, the business and operating models will be refined to make use of recent advancements in the technological aspects of the solutions and to address different stakeholder needs. This will be done as part of WP4 and with the mobilisation of the entire ecosystem through the local fora established in T2.2. This serves as input for D3.5, which will be delivered towards the end of ULaaDS. D3.5 will present a final, validated version of the business and

operating models—in terms of their efficiency, sensitivity, robustness, and cost effectiveness. It will also analyse the extent to which the trialled business and operating models are scalable within the Lighthouse cities and transferrable to other cities.

1.2 ULaaDS Solutions and Research Trials

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. ULaaDS explicitly considers—and actively involves—the local context and stakeholders of the Lighthouse cities while developing, implementing, and testing the business and operating models of the ULaaDS solutions and schemes. Similarly, the context of Satellite cities (Alba Iulia, Bergen, Edinburgh, and Rome) will be considered when validating the scalability and transferability of the ULaaDS business and operating models.

2. Mechelen trials

Mechelen is a medium-sized European city, with about 90.000 inhabitants, and is characterised by its historic city centre with low car and car free zones. The city is attracting more and more inhabitants, entrepreneurs, employers, visitors, and tourists. In 2020, 29 partners in Mechelen signed a covenant outlining their ambition to reduce urban logistics emissions to 0 by 2030. The two main Mechelen research trials focus on implementation of a city-wide platform for managing urban logistics and the testing of a shared autonomous vehicle. This chapter presents the business and operating model considerations for these two trials.

2.1 ULaaDS solutions in Mechelen

Collectively, the Mechelen trials cover both ULaaDS solutions across two schemes. Trial 1 will focus on collaboration and asset-sharing between one local and two national logistic service providers to improve first mile efficiency: UPS, ECOKoeriers (ECO) and Bpost (BPO). Specifically, they will join forces by consolidating pick-ups at local shops in the inner city, performed by cargo bikes from ECO and consolidated through a network of urban consolidation centres of BPO and UPS. In Trial 2, VIL and the city of Mechelen will trial an autonomous vehicle delivering parcels and transporting passengers at a local business park.

2.1.1 Mechelen Trial 1

In Trial 1, UPS, BPO, and ECO work together with the city of Mechelen in the different business contexts of the companies. Collectively, the different elements of the trial target a collaborative delivery model to enhance logistics efficiency (Solution 1), focusing on the integrated management of multimodal urban freight transport (Scheme 3) as indicated in Table 2.1.

Table 2.1 ULaaDS solution and scheme Mechelen Trial 1

Solution	Scheme
1) Collaborative delivery models to enhance logistics efficiency and multimodal mobility in cities	3. City-wide platform for integrated management of UFT

With the Ecozone of Bpost, Mechelen already has a highly developed zero-emission network for B2C parcel deliveries. Nevertheless, there is room for further improvement. One area that has received less attention thus far is B2B parcel deliveries, which is increasingly used to supply shops and other organizations in the city. Trial 1 is geared towards helping local shopkeepers and entrepreneurs in facilitating zero-emission urban freight transport. The city is primarily thinking of pick-ups and return flows from retailers, which are currently done by different service providers. Due to the small

volumes per shop and service provider, there is ample room for more consolidation, which could also help the transition towards the use of zero-emission vehicles.

2.1.2 Mechelen Trial 2

In Trial 2, where the city of Mechelen and VIL will experiment with the use of an autonomous vehicle, the focus is on the effective integration of passenger and urban freight mobility services (Solution 2) by means of shared vehicle use (Scheme 5) as indicated in Table 2.2.

Table 2.2 ULaaDS solution and scheme Mechelen trial 2

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

The five initial scenarios for using an autonomous vehicle included a focus on (1) express delivery from outside the city to shopkeepers within the city, (2) B2B delivery in the inner city, (3) B2C delivery in the inner city, (4) an autonomously driving parcel locker, and (5) cargo hitching with private logistics on a business park. After stakeholder consultation, the scope of Trial 2 was narrowed down from five potential scenarios to one, namely the testing of an autonomously driving vehicle with a cargo-hitching component.

To reduce the complexity of the trial, the autonomously driving vehicle will be tested outside the city—on a business park. With the narrow streets and complex city traffic, the inner city would result in severe challenges that may hamper the testing of the vehicle. Also, it would increase the length of the route. The vehicle will combine the transport of goods with the transport of passengers from their last bus stop to the working location on the business park. The reason for integrating passengers and goods is that it enhances the utilisation of the vehicle, which may decrease cost and increase revenue. Thus cargo-hitching solution will be facilitated by means of a parcel locker. As part of the trial, a decision will be made whether the parcel locker will be integrated in the autonomous vehicle or whether the passengers will take the parcel from a locker at the bus stop and drop it off at their work location.

2.2 Business and operating model aspects of the Mechelen trials

Deliverable D3.1 presented a broad state-of-the-art and a benchmark of the business and operating models for sustainable on-demand urban logistics solutions. Below, those elements of the state-of-the-art and benchmark that are directly relevant for the Mechelen trials are selected and extended with the most recent information from the trialled solutions.

2.2.1 Business and operating model aspects Mechelen Trial 1

Trial 1 will test a collaborative business model where UPS, ECOKoeriers. and Bpost share assets for B2B parcel deliveries in Mechelen, specifically the pickup of parcels at local retailers. This aim of sharing assets is a typical goal for such collaborative business models, and the assets shared may include vehicles—in this case, for example, the cargo bikes from EcoKoeriers.

Table 2.3 displays the related business model canvas presented and discussed in deliverable D3.1. It focuses on sharing assets from different logistics service providers and consolidating freight flows from multiple suppliers and/or to multiple shopkeepers. Both require consolidation, which can either take place at a corporate hub (i.e., owned by a private company) or a public hub (i.e., owned or subsidised by a public authority). Hence, like Table 6.4 in deliverable D3.1, Table 2.3 below shows aspects specific to a corporate hub in turquoise and those for a publicly owned hub in orange.

Table 2.3 Initial business model canvas for integrated management of urban freight transport from D3.1

<table>
<tr><td colspan="5">Mission statement: To pool resources and freight flows of multiple providers for sustainable urban freight transport</td></tr>
<tr><td rowspan="2">Key partnerships:
1. Local shops and suppliers involved with urban freight flows
2. Logistics providers with potential resources to be shared
3. Company operating the hub</td><td>Key activities:
1. Unlocking information about the current rules and regulations to logistics providers
2. Offer insight into available shared warehouse and vehicle space</td><td rowspan="4">Value proposition:
1. To provide a platform with up-to-date information about rules and regulations in the urban space
2. To enable the use of shared warehouse space
3. To enable the use of shared vehicles</td><td>Buy-in & support:
1. Existing companies with potential shared hub facilities
2. Logistics providers to share their resources</td><td rowspan="2">Beneficiaries:
1. Logistics service providers gain from insight into current state of rules and regulations
2. Citizens and other people staying in the city benefit from improved efficiency (e.g., less vehicles, fewer buildings for logistics)</td></tr>
<tr><td>Key infrastructure and resources:
1. Digital platform accessible to logistics providers
2. Logistics spaces for hub facilities
3. Logistics providers with resources to be shared</td><td>Deployment:
1. Develop tender to purchase platform or capabilities developing the platform
2. Integrate up-to-date regulations (e.g., access restrictions, tolls) into platform
3. Identify locations for hubs and logistics providers for resources</td></tr>
<tr><td colspan="2">Budget costs:
1. Cost involved with developing the platform
2. Subsidy to establish (and operate) hub facility or to help an existing hub to share its facility with others</td><td colspan="2">Revenue streams:
1. Fee for using shared warehouse (e.g., per unit handled) or using a delivery service
2. Membership fee for access to the platform for logistics providers</td></tr>
<tr><td colspan="2">Environmental costs:
1. Energy for operating platform
2. Energy for running hub facilities and logistics resources</td><td colspan="2">Environmental benefits:
1. Reduced greenhouse gas emissions from better utilization of existing logistics resources</td></tr>
<tr><td colspan="2">Social risks:
1. Weaker market position for logistics providers that are not active on the platform</td><td colspan="2">Social benefits:
1. A reduced number of vehicles operating in the city
2. More compliance with rules and regulations due to unlocking of up-to-date information directly to logistics providers</td></tr>
</table>

During the development of the Mechelen trial, it became clear that the scope of the trial includes sharing assets across existing logistics service providers, including their facilities. Consolidation of urban freight hence will take place in corporate hubs. What is more, the focus is on the transport of B2B parcels, and specifically on the pickup of parcels from local retailers. This results in several changes to the initial business model canvas, as presented in Table 2.4

Specifically, the mission statement for the trial is to offer local retailers an option for sustainable urban freight transport, particularly for their outgoing parcels. Due to the limited volume of the flows of outgoing parcels per retailer, there is ample room for further consolidation. Important elements of the value proposition include to facilitate the sharing of vehicles and hub facilities across multiple providers, and in doing so, providing a service for picking up urban freight that is both cost effective and sustainable.

Table 2.4 Updated business model canvas for integrated management of urban freight transport in Mechelen Trial 1

<table>
<tr><td colspan="5">Mission statement: To offer local retailers an option for sustainable urban freight transport</td></tr>
<tr><td rowspan="2">Key partnerships:
1. Logistics providers with potential resources to be shared.
2. Local authorities.</td><td>Key activities:
1. Picking up freight at local retailers.
2. Transporting consolidated shipments to micro hub or urban consolidation centre.
3. Transporting goods from micro hub or urban consolidation centre further into the supply chain.
4. Facilitate information flows between different actors in the network.</td><td rowspan="5">Value proposition:
1. To facilitate the sharing of vehicles and hub facilities across multiple providers.
2. To provide a cost effective and sustainable service for picking up urban freight.</td><td>Buy-in & support:
1. Local retailers for using the shared service.</td><td rowspan="2">Beneficiaries:
1. Local retailers gain from a sustainable urban freight transport solution.
2. Logistics service providers gain from more efficient operations.
3. Citizens and other people staying in the city benefit from improved efficiency (e.g., less vehicles, fewer buildings for logistics)</td></tr>
<tr><td>Key infrastructure and resources:
1. Micro hubs and urban consolidation centres.
2. Cargo bikes & other last-mile vehicles.
3. Vans and trucks for transport further in supply chain.
4. Information system accessible to logistics providers and retailers.</td><td>Deployment:
1. Agreements about different roles of logistics service providers.
2. Identify locations of micro hubs and consolidation centres to be used.
3. Agree on tariff structure for retailers and between logistics service providers.
4. Design information sharing scheme.</td></tr>
<tr><td colspan="2">Budget costs:
1. Fixed and variable cost of the micro hubs and consolidation centres.
2. Cost of operating the cargo bikes, other last-mile vehicles and transport further in the supply chain.
3. Transaction cost of information sharing.</td><td colspan="2">Revenue streams:
1. Fee from local retailers using the service.
2. Tariff structure among logistics service providers involved.</td></tr>
<tr><td colspan="2">Environmental costs:
1. Energy for operating micro hubs and consolidation centres.
2. Energy for operating cargo bikes and other vehicles.</td><td colspan="2">Environmental benefits:
1. Reduced greenhouse gas emissions from better utilization of existing logistics resources.</td></tr>
<tr><td colspan="2">Social risks:
1. Weaker market position for logistics providers that are not active on the platform.
2. More traffic around micro hubs or urban consolidation centres.</td><td colspan="2">Social benefits:
1. Better matching of vehicle size to city context.
2. A reduced number of vehicles operating in the city, potentially leading to reduced congestion and less parking required.
3. Reduced real estate pressure.</td></tr>
</table>

Key activities include picking up freight at local retailers by cargo bikes, transport pickups from multiple local retailers to a micro hub or consolidation centre, and transporting those goods from the hub or consolidation centre to further destinations in the supply chain. To facilitate these processes, information sharing between different provider as well as from the providers to the local retailers is another important activity. This involves using resources such as the vehicles and facilities, but also the information system required to share information. Partnership among the logistics service providers as well as between the logistics service providers and the local authority are critical for the success of the integrated management of urban freight transport. Integrated management requires changing operational processes, ensuring interoperability between operations and information systems of the logistics service providers involved, and thinking about cost and revenue structures that are fair in relation to the initial situation (i.e., prior to the integrated management of urban freight) and tasks in the new situation.

The cost involved with this ULaaDS solution relate to the operations, which include the fixed and variable cost for the micro hubs, consolidation centres, and vehicles used in the operation, as well as the transaction cost involved with sharing information between logistics service providers and local retailers. Similarly, the main environmental costs relate to the assets used in the operation, which depends strongly on the vehicles and hub facilities used. That is, cargo bikes require little energy when electrically assisted or not at all when they are paddle only, whereas delivery vans require considerable energy—even when electric. The network of micro hubs in Mechelen consists of parcel lockers, which require very little energy. Urban consolidation centres on the other hand require considerable energy for heating and internal operations. Important societal risks to consider relate to the position of logistics service providers not involved in the solution, as they may see their volumes dwindle. Perhaps more important is to consider the freight flows around the micro hubs

and consolidation centres. Because of the (extra) transhipment, vehicles may divert to areas that prior to implementing the solution saw no or little traffic. If carefully managed, the overall environmental and social benefits of the solution should easily outweigh its risks.

To make the solution a success, buy-in and support from local retailers is key. They need to start using the service and keep using it to provide freight volumes that suffice for a viable business model. In deploying the solution, agreements between the different logistics service providers about their roles in the operation are key. In Mechelen, pickup of the goods will be done by ECOKoeriers, who will then transport the goods to either a micro hub of Bpost and/or an urban consolidation centre of Bpost or UPS. Bpost or UPS will then take care of the rest of the transportation in the supply chain. The logistics service providers should then agree on a tariff structure among themselves that fits with the role they play in the operation. The key revenue stream comes from local retailers that pay for the service, which can then be redistributed across the logistics service providers according to the tariff structure. Moreover, local authorities should play a role in determining which facilities will be used and how, to avoid increased freight traffic in parts of the city where such traffic is not desired. Lastly, a scheme for sharing information should be agreed and then implemented. If done well, the local retailers, citizens, and visitors of the city become the main beneficiaries as they will see less freight logistics with more sustainable vehicles. The vehicles may also better match the context of the city, that is, smaller-sized cargo bikes are used in the inner city, whereas larger traffic flows are directed further outside the city. The logistics service providers can also benefit, if freight volumes are sufficiently large to result in considerable efficiency gains in the first or last mile.

2.2.2 Business and operating model aspects Mechelen Trial 2

Trial 2 involves an ULaaDS solution with sharing an autonomous vehicle between passenger and urban freight mobility services. Generally, business and operating models exploring the integration between passenger and freight transport do so in an attempt to increase the utilisation of the vehicle, which should result in a shorter payback period for the relatively high initial investment of an autonomous vehicle. Because it is not to be expected that autonomous vehicles will be operational on public roads in large numbers soon, applications with autonomous vehicles are expected to first be deployed on private property or in restricted areas under strict operating rules. These can form excellent environments for further testing the business case and scalability of autonomous last-mile delivery at larger scale. Yet, due to the small scale, the social and environmental benefits will remain somewhat limited. Table 2.5 displays the related business model canvas presented and discussed in deliverable D3.1.

2.5 Initial business model canvas for integrating passenger and urban freight transport using autonomous vehicles from D3.1

<table>
<tr><td colspan="5">Mission statement: To enable a better use of an autonomous vehicle capacity by combining passenger and urban freight transport</td></tr>
<tr><td rowspan="2">Key partnerships:
1. Company or campus that wants to adopt an autonomous vehicle on-site.
2. Logistics service provider.
3. Parties doing first and last mile transportation.</td><td>Key activities:
1. Schedule route and service of autonomous vehicle.
2. Organize loading and unloading of the goods from the vehicle.</td><td rowspan="5">Value proposition:
1. To provide a service for urban freight transport using an autonomous passenger vehicle.</td><td>Buy-in & support:
1. Legislators writing rules and regulations or consider statutory exemptions for autonomous vehicles.
2. Passengers need to accept goods in vehicle.</td><td rowspan="2">Beneficiaries:
1. Company using the autonomous vehicle for passenger transport.
2. Receivers of goods.
3. Cities with increased safety and liveability.</td></tr>
<tr><td>Key infrastructure and resources:
1. Autonomous vehicle designed for combined passenger and urban freight transport.
2. Restricted area on which autonomous vehicle is allowed to drive without driver.</td><td>Deployment:
1. Form an alliance of actors (e.g., logistics service provider, autonomous vehicle manufacturer/operator) to deploy the service.
2. Identify tractor on which autonomous vehicle will operate (to reduce need for a level 4 autonomous vehicle and enhance chance at regulatory exemption).</td></tr>
<tr><td colspan="2">Budget costs:
1. Acquisition of autonomous vehicle and cost for preparing its trajectory.
2. Operational costs involved with loading and unloading vehicle.</td><td colspan="2">Revenue streams:
1. Fee per parcel.
2. Passenger transport services fee.</td></tr>
<tr><td colspan="2">Environmental costs:
1. Energy use for manufacturing the vehicle (when using a zero-emission vehicle).</td><td colspan="2">Environmental benefits:
1. Zero-emission last-mile transport of passengers and goods (when using a zero-emission vehicle).</td></tr>
<tr><td colspan="2">Social risks:
1. Safety of other road users where autonomous vehicle operates.
2. Loss of jobs due to no need of drivers.</td><td colspan="2">Social benefits:
1. More flexible parcel delivery by additional service option.</td></tr>
</table>

In the Mechelen trial, the city and VIL will experiment with the autonomously driving vehicle in a business park outside the city centre. A parcel locker will be part of the solution as a means to integrate freight transport within a personal mobility service. It is not yet specified how the locker will be used precisely. Rather, the decision on whether to integrate it into the vehicle or use it in the broader context of the solution (e.g., at the bus stop where the vehicle route originates or at the work location where the vehicle route ends) is an explicit part of the trial. The initial business model canvas did not specify how exactly freight transport is facilitated in the vehicle. Therefore, a few updates to the business model canvas are presented in Table 2.6.

Table 2.6 Updated business model canvas for integrating passenger and urban freight transport using an autonomous vehicle in Mechelen Trial 2

<table>
<tr><td colspan="5">Mission statement: To explore a service that combines passenger and urban freight transport by means of an autonomous vehicle</td></tr>
<tr><td rowspan="2">Key partnerships:
1. Company or campus that wants to adopt an autonomous vehicle on-site.
2. Manufacturers and/or operator(s) of the autonomous vehicle and parcel locker.</td><td>Key activities:
1. Identify an area and route where the autonomous vehicle can be tested.
2. Program route and schedule of the vehicle.
3. Enable loading and unloading of the passengers and goods from the vehicle.</td><td rowspan="5">Value proposition:
1. To provide a service for passenger transport.
2. To provide a service for urban freight transport.</td><td>Buy-in & support:
1. Legislators writing rules and regulations or consider statutory exemptions for autonomous vehicles.
2. Passengers need to accept goods in vehicle.
3. Stakeholders offering goods for transportation.</td><td rowspan="2">Beneficiaries:
1. Company using the autonomous vehicle for passenger transport.
2. Local authority.
3. Company or campus on which autonomous vehicle operates.</td></tr>
<tr><td>Key infrastructure and resources:
1. Autonomous vehicle.
2. Solution for transporting urban freight on autonomous vehicle.
3. Restricted area on which autonomous vehicle is allowed to drive without driver.</td><td>Deployment:
1. Form an alliance of actors (e.g., logistics service provider, autonomous vehicle manufacturer/operator) to deploy the service.
2. Determine on the use of one or more parcel lockers in relation to the service.</td></tr>
<tr><td colspan="2">Budget costs:
1. Operational cost of operating the autonomous vehicle and for preparing its trajectory.
2. Operational costs involved with loading and unloading the vehicle.</td><td colspan="2">Revenue streams:
1. External funding explicitly geared towards trials with autonomous vehicles.</td></tr>
<tr><td colspan="2">Environmental costs:
1. Energy use for manufacturing the autonomous vehicle.
2. Energy use for operating the autonomous vehicle.
3. Energy involved with making Infrastructure changes.</td><td colspan="2">Environmental benefits:
1. Reduced greenhouse gas emissions.</td></tr>
<tr><td colspan="2">Social risks:
1. Safety of other road users where autonomous vehicle operates.</td><td colspan="2">Social benefits:
1. More flexible parcel delivery by additional service option.</td></tr>
</table>

The mission of the ULaaDS solution is not to directly deploy a full-scale operational service with autonomous vehicles. Rather, the trial is aimed at exploring how an autonomous vehicle can be used for both passenger and urban freight transport. In doing so, the main value added is that the autonomous vehicle can actually transport both passengers and freight. Key activities involve identifying an area and route where the autonomous vehicle can be tested, and then to program and schedule this route. After the route and schedule is determined, the loading and unloading of passengers and goods should be organized. In the Mechelen trial, this includes considering how the goods are actually to be transported on the vehicle. One option is that passengers take the parcels that were either collected from a parcel locker at the location where the route originated and/or dropped off in a parcel locker at the destination of the route. Another option is that the parcel locker is integrated in the design of the autonomous vehicle. Important infrastructure and resources hence include the autonomous vehicle, one or more parcel lockers—potentially integrated into the vehicle—and the area on which the autonomous vehicle is allowed to move without a driver. This requires partnerships with that area and with the manufacturer or operator of the vehicle (and parcel locker).

The costs are related to the operation of the autonomous vehicle as well as all organizational costs involved with preparing the area and route for the use of the vehicle. When operational, also cost related to loading and unloading of passengers and especially freight should be considered. Depending on the specific deployment of the solution, the loading and/or unloading of parcels could be a considerable cost element as it may require manual labour. Energy use relates to the manufacturing and use of the vehicle, and potentially to changes required to the infrastructure. The key societal risk is related to safety of others on the route. Due to the small scale of the solution at first, the risk of job loss for drivers will be limited. For the time being, the law—even after exemptions are made—often requires a dummy driver in the vehicle or an operator that watches over one or more vehicles remotely.

To make the ULaaDS solution a success, buy-in and support is needed from legislators that make up the rules for using public road use and may consider statutory exemptions for autonomous vehicles when operated in certain areas. The passengers that make use of the vehicle need to accept the fact that the vehicle is operated autonomously, but also that freight is transported on the vehicle too. This may also require considering legislation, as freight transport may be prohibited from services that also transport people due to safety concerns. Lastly, it is important that there are companies (e.g., logistics service providers, suppliers, or receivers) that offer urban freight that can be transported with the autonomous vehicle. Deploying the solution requires forming an alliance of actors, such as the autonomous vehicle operator, logistics service provider, public transport company, et cetera. Another important aspect of deployment concerns the decision on how to make use of the parcel lockers for freight transport. In its current form, the solution relies on external funding as revenue, and may to a limited extent reduce greenhouse gas emissions by combining passenger and freight transport at low scale. This should benefit several stakeholders directly, and also in terms of experience gained with the usefulness of such a solution. This primarily holds for the companies operating the autonomous vehicle—and possibly the parcel lockers that are part of the solution—as well as the local authorities and other companies involved.

2.3 Important considerations for the trials in Mechelen

From an operating model perspective, Trial 1—where three logistics service providers explore a collaborative service—is challenging but starts to get shape. The overall division of tasks of the logistics service providers in the trial is clear and all required physical assets are lined up. Due to the different contexts of the logistics service providers and because they are competing actors, business model implications are less clear. Firstly, it will be critical to attract sufficient urban freight volumes. A key aspect of the trial, therefore, is to monitor those volumes, assess the extent to which the volume is growing, and extrapolate this growth to estimate future viability of the business model. It is also important to evaluate specific operational choices made during deployment, especially also in relation to information exchanges—both among the logistics service providers, but also from the logistics service provider(s) to the local retailers. Operational choices may be the result of sensitive aspects of the business model implications for the different actors involved. As the trial runs, project partners will aim to determine a tariff structure that makes the ULaaDS solution a viable option for the longer term.

Trial 2 will explore the use of an autonomous vehicle. Here, a priori thoughts about a potential business model are not considered. Also, from an operating model perspective, details are yet to be decided. Rather, the aim is to use the trial to have a first experimentation with these aspects. First and foremost, that holds for the operating model. On which route(s) could an autonomous vehicle operate for passenger transport in the mid-term? What is required to make that happen? Then, how can freight transport be integrated onto that service? Based on insights on these essential operational questions, and experience gained from trying it out during the trial, first ideas about a potential business model can be generated and discussed.

3. Bremen trials

Bremen is a harbour city in the Northwest of Germany with about 566.000 inhabitants. It has a long history in logistics, mostly in terms of maritime trade and logistics. Also in urban mobility, Bremen has an outstanding track record, for example, introducing a car sharing action plan in 1990 and, more recently, an urban sustainability plan in 2014. The two Bremen research trials focus on expanding the fleet of cargo bikes and micro hubs in combination with containerised last-mile delivery, introducing sharing options for cargo bikes, and combining passenger and freight transport. This chapter presents the business and operating model considerations for these three trials.

3.1 ULaaDS solutions in Bremen

Collectively, the Bremen trials cover both ULaaDS solutions across two—or possibly three—schemes. There will be two trials. Trial 1 relies on containerised urban logistics in the last mile to further expand the number of micro hubs and cargo bikes. Trial 2 focuses on private micro-logistics. It further develops a sharing system for (e-)cargo bikes, aimed at reducing the use of cars for household logistics.

3.1.1 Bremen Trial 1

In Trial 1, the city of Bremen (BRE) and Rytle (RYT) will continue their ongoing collaboration and is to operate two new micro hubs—in addition to the existing one. The locations identified for the new micro hubs are the "Viertel" (an area neighbouring the inner city) and another neighbourhood (either in Findorff or Neustadt). Micro hub 1 has already been operational since 2019; micro hub 2 in Viertel since July 2021; and micro hub 3 will become operational in the first half of 2022. These will be used as locations for rolling out containerized last-mile logistics, addressing ULaaDS Solution 1 and Scheme 1, as indicated in Table 3.1.

Table 3.1 ULaaDS solution and scheme Bremen trial 1

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

The trial will focus on the use of containerised logistics for general cargo mainly in a B2B setting, in addition to prior insights and know-how about containerized logistics for courier express freight. Specifically, general cargo heading toward the inner city is planned to be grouped with parcels for

the courier express service in the same area. The containers are pre-sorted according to the delivery area at the warehouse, so that they can be loaded directly onto the cargo bikes at the micro hubs, from which the last mile will be covered.

3.1.2 Bremen Trial 2

In Trial 2, the City of Bremen and ADFC will operate a cargo bike sharing system. Other than in Trial 1, the solution here mainly targets private micro-logistics (which relates to the transport of goods by individual citizens, such as transporting shopping or furniture items), with an aim to reduce car trips by familiarising users with cargo bikes without a need to buy one themselves. In doing so, the trial addresses ULaaDS Solution 2, Scheme 4, as indicated in Table 3.2

Table 3.2 ULaaDS solution and scheme Bremen Trial 2

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 trialled solution focuses on adding five dedicated cargo bikes to the (existing) ADFC renting scheme, called Fietje, extending the possibility to manage private micro-logistics by cargo bike. When renting, the Fietje bikes can be collected from “hosts”, typically small local stores partnering. The use of the bikes is basically free, but there is the option for donations. ADFC and its partners are taking care of the maintenance and other functionalities of the cargo bikes. The bikes themselves are acquired via external funding possibilities. For the near future, there is a plan to align the ADFC renting procedure/platform with other cargo bike rental schemes hosted by district initiatives in the city of Bremen.

In a potential second part of Trial 2, the city of Bremen and VIA Technologies Europe (formerly ViaVan) are to test a cargo-hitching scheme, where freight transport is combined with on-demand mobility. This then would also address ULaaDS Solution 2, but would further focus on Scheme 5, as indicated in Table 3.2 (between parenthesis).

3.2 Business and operating model aspects of the Bremen trials

Deliverable D3.1 presented a broad state-of-the-art and a benchmark of the business and operating models for sustainable on-demand urban logistics solutions. Below, those elements of the state-of-the-art and benchmark that are directly relevant for the Bremen trials are selected and extended with the most recent information from the trialled solutions.

3.2.1 Business and operating model aspects Bremen Trial 1

Trial 1 will expand the containerised last-mile solution in the city of Bremen by adding two new locations for micro hubs and focusing on general cargo in addition to express freight. Generally, containerised last-mile solutions introduce standardised and modular loading units that enable fast and efficient transhipment of freight. This in turn can limit the handling cost involved with additional transhipment and thereby rendering the use of smaller vehicles in the last mile more economically attractive.

Table 3.3 displays the related business model canvas presented and discussed in deliverable D3.1. Specifically, the table addresses the business and operating model where the containerised urban last-mile solution is implemented by a single carrier and using transhipment points for mobile depots or containers rather than fixed urban consolidation centre facilities.

Table 3.3 Initial business model canvas for containerised urban last-mile delivery from D3.1

<table>
<tr><td colspan="5">Mission statement: To facilitate a quick uptake of small-sized, zero-emission vehicles in the last mile</td></tr>
<tr><td rowspan="2">Key partnerships:
1. Manufacturer of standardized loading units and/or containers.
2. Manufacturer of cargo bikes and/or light commercial vehicles.
3. Municipality for location of container/mobile depot.</td><td>Key activities:
1. Load goods into standardized loading units in terminal.
2. Load loading units into container.
3. Transport loading units/container(s) towards city.
4. Position mobile depot in city.
5. Operate last-mile delivery routes.</td><td rowspan="5">Value proposition:
1. To enable the integration of smaller zero-emission vehicles into urban last-mile delivery network.
2. To provide transhipment for last-mile delivery.
3. To enable sustainable last-mile transportation with (zero-emission) vehicles of the best size.
4. To optimise and homogenize loads and vehicle capacities.</td><td>Buy-in & support:
1. Local authority for finding appropriate location and providing permits for transhipment points, as well as appropriate road infrastructure for cargo-bikes.
2. Courier willingness to operate cargo-bikes and/or light commercial vehicles.</td><td rowspan="2">Beneficiaries:
1. Carrier by enabling more cost-effective transport.
2. City visitors and residents by more sustainable last-mile delivery process.
3. Local authorities and all stakeholders due to reduced environmental, safety- and health-related costs.</td></tr>
<tr><td>Key infrastructure and resources:
1. Standardized loading units.
2. Containers/mobile depots.
3. Cargo bikes and/or light commercial vehicles for last-mile deliveries.</td><td>Deployment:
1. Changes to operational processes to enable integration of loading units and containers.
2. Planning of feeder routes towards city and last-mile routes.</td></tr>
<tr><td colspan="2">Budget costs:
1. Rent or depreciation of standardized loading units and/or containers.
2. Rent or depreciation of container/mobile depot.
3. Total cost of ownership (acquisition, operational, maintenance, etc.) costs involved with cargo bikes and/or light commercial vehicles.</td><td colspan="2">Revenue streams:
1. Cost reduction in last-mile delivery routes.
2. End-receiver of goods willing to pay more for sustainable last-mile delivery, and/or willing to wait so that last-mile delivery efficiency can be improved.</td></tr>
<tr><td colspan="2">Environmental costs:
1. Energy use involved with the manufacturing of the container/mobile depot.
2. Energy use of cargo bikes and/or other light commercial vehicles.</td><td colspan="2">Environmental benefits:
1. Reduced total greenhouse emissions involved with last-mile delivery due to consolidation on-route to transhipment point.
2. Reduced greenhouse gas emissions and noise pollution in last-mile delivery route by enabling the use of smaller zero-emission vehicles.</td></tr>
<tr><td colspan="2">Social risks:
1. Attracting additional freight flows and/or larger vehicles because of transhipment operation.
2. Low paid work for material handlers.
3. Use of parking space for container/mobile depot that could otherwise be used for car, café terraces, etc..</td><td colspan="2">Social benefits:
1. Smaller (zero-emission) vehicles in city centre and streets.
2. (Low skilled) jobs for citizens in the area.
3. Safer streets due to reduced number of large freight vehicles.</td></tr>
</table>

During the development of the Bremen trial, it became clear that the focus would be on facilitating sustainable urban logistics of general cargo. As opposed to express freight, which is often small in size but time critical, general cargo is often less time sensitive but can be relatively heavy and voluminous. This may result in fewer stops per route of the zero-emission vehicle covering the last mile—either because few shipments fill up the capacity of the vehicle and/or because there is more time to bundle deliveries to a single receiver in a single shipment. This makes that a transhipment location close to the delivery area becomes even more important. Otherwise, the vehicles would frequently spend a relatively large distance traveling from and to the delivery area. Therefore, the trial includes the search for and addition of two new transhipment locations. To ensure sufficient

volume and to exploit the zero-emission vehicles in the last mile as best as possible, general cargo shipments can be combined with express freight, likely with a local/regional CEP service provider.

Overall, the current focus of the trial results in a few changes to the initial business model canvas, as presented in Table 3.4. Specifically, the mission statement for the trial is to facilitate the use of small-sized, zero-emission vehicles in the last-mile delivery of general cargo. The main value proposition is that the solution enables the integration of smaller, zero-emission vehicles. It does so by making use of more efficient transhipment at multiple locations close to the delivery area resulting from purpose-designed, standardized modular containers. Combining different types of shipments into these standardized and modular containers should make it possible to use the available vehicle capacities—both from the warehouse to the transhipment points and the last mile.

Table 3.4 Updated business model canvas for containerised urban last-mile delivery in Bremen Trial 1

<table>
<tr><td colspan="5">Mission statement: To facilitate the use of small-sized, zero-emission vehicles in the last-mile delivery of general cargo</td></tr>
<tr><td rowspan="2">Key partnerships:
1. Manufacturer of standardized loading units and containers.
2. Manufacturer of cargo bikes.
3. Suppliers delivering goods for delivery via the containerised urban last mile.</td><td>Key activities:
1. Load goods into standardized loading units at the warehouse.
2. Load loading units into container.
3. Transport container with loading units towards delivery area.
4. Position container at location near delivery area.
5. Operate last-mile delivery routes.</td><td rowspan="3">Value proposition:
1. To enable the integration of smaller zero-emission vehicles into urban last-mile delivery network.
2. To provide efficient transhipment for last-mile delivery.
3. To optimise vehicle capacity utilisation.</td><td>Buy-in & support:
1. Local authority for finding appropriate location and providing permits for transhipment points, as well as appropriate road infrastructure for cargo-bikes.
2. Courier willingness to operate cargo-bikes.</td><td rowspan="2">Beneficiaries:
1. Carrier/suppliers by enabling more cost-effective transport.
2. City visitors and residents by more sustainable last-mile delivery process.
3. Local authorities and all stakeholders due to reduced environmental, safety- and health-related costs.</td></tr>
<tr><td>Key infrastructure and resources:
1. Warehouse location.
2. Transhipment location.
3. Standardized loading units.
4. Containers.
5. Truck/van and driver for transporting containers.
6. Cargo bikes and couriers for last-mile deliveries.</td><td>Deployment:
1. Changes to operational processes to enable integration of loading units and containers.
2. Planning of feeder routes towards city and last-mile routes.</td></tr>
<tr><td colspan="2">Budget costs:
1. Total cost of ownership (manufacturing/acquisition, operational, maintenance, etc.) involved with the standardized loading units.
2. Total cost of ownership involved with containers.
3. Total cost of ownership involved with cargo bikes, including wages of couriers operating the bikes.</td><td colspan="2">Revenue streams:
1. Last-mile delivery fee for user of the solution.
2. End-receiver of goods willing to pay more for sustainable last-mile delivery, and/or willing to wait so that last-mile delivery efficiency can be improved.</td></tr>
<tr><td colspan="2">Environmental costs:
1. Energy use involved with the manufacturing of the standardized loading units, containers, and vehicles.
2. Energy use of cargo bikes and the vehicle transporting the container from the warehouse to the transhipment location.
3. Energy use of the warehouse.</td><td colspan="2">Environmental benefits:
1. Reduced total greenhouse emissions involved with last-mile delivery due to consolidation on-route to transhipment point.
2. Reduced greenhouse gas emissions and noise pollution in last-mile delivery route by enabling the use of smaller zero-emission vehicles.</td></tr>
<tr><td colspan="2">Social risks:
1. Use of parking space for container if that would otherwise be dedicated to public usage (e.g., café terraces).
2. Low paid work for material handlers.
3. Attracting additional freight flows from/to the transhipment point due to smaller-sized vehicles.</td><td colspan="2">Social benefits:
1. Smaller (zero-emission) vehicles in city centre and streets
2. (Low skilled) jobs for citizens in the area.
3. Safer streets due to reduced number of large freight vehicles.</td></tr>
</table>

Key activities include loading goods (general cargo and express) into standardized loading units according to their delivery zone and timing at the warehouse, place the loading units in a container, transport the container to one of the three locations close to the delivery areas, and operate the small-sized and zero-emission vehicles from those locations into the last mile. Project partner Rytle works with several important resources to facilitate these activities, namely the standardised loading units (called BOX), the containers that have space for 9 BOXes (called HUB), a vehicle that can transport cargo from the warehouse to a transhipment location, and the cargo bikes (called MOVR) that transport a BOX or cargo on a euro-pallet for the last mile. Key partnerships for this solution are with the manufacturer(s) of the standardized loading units, containers, and cargo bikes

as well as with the suppliers—and possibly also the receivers—of the goods that are to be delivered via the containerised urban last-mile solution.

The solution's cost relates directly to the production or acquisition and use of the key resources, namely the standardized loading units, containers, and cargo bikes—including the wages of the workers operating the vehicles and warehouse. Similarly, the environmental costs relate to the manufacturing of those resources as well as the energy required to operate the vehicles (i.e., electricity for the cargo bikes and fuel for the vehicle transporting the containers) and warehouse (e.g., heating and powering of the facility and its interior resources). From a societal perspective, there is a risk that the solution consumes public space that could otherwise be used for things like café terraces. The transhipment locations may also attract freight flows to parts of the city that—prior to the implementation of the solution—did not see much freight flows. On the one hand, this is mitigated by the use of smaller, less congesting vehicles. On the other hand, precisely because the vehicles are small, the solution may result in more vehicles and/or vehicle movements compared to a situation with a larger truck delivering goods. Lastly, workers in the logistics sector do not always enjoy a large salary or good working conditions. This should be considered when implementing the solution.

Prior to deployment, buy-in of the local authority is critical for finding appropriate locations for the transhipment points and providing the necessary permits for placing the containers. In Bremen, this buy-in is strong and already resulted in the identification of locations and regulatory solutions for using them. Also, couriers are typically used to operating vans. Their buy-in for operating cargo bikes is critical for the success of the solution. Reversely, the use of cargo bikes may attract employees that would otherwise not have considered working in logistics—or were not allowed, for example because they have no driver's licence. Deployment itself requires considerable changes to the operational processes of the users of the solution. Instead of delivering directly to the receiver, goods are dropped off at the warehouse, from where goods for multiple receivers (and from multiple suppliers) are grouped per delivery area into loading units. The loading units are consolidated into a container which has to be transported to the transhipment point, from where the cargo bikes operate the last mile. After deployment, the stakeholders using the solution (e.g., carriers or suppliers) should benefit from more cost-effective transport as a result of the additional consolidation. They may also benefit from an improved image. City visitors, residents, and others with a stake in a liveable and pleasant city benefit from more sustainable last-mile delivery. The solution receives revenues from its users when they drop off goods at the warehouse for last-mile delivery. Another potential source of revenue could be the receivers of goods that are willing to pay for more sustainable delivery.

3.2.2 Business and operating model aspects Bremen Trial 2

Trial 2 involves an ULaaDS solution where private citizens in Bremen can rent a cargo bike for their household logistics. Generally, such solutions are aimed at reducing the dependence on cars for trips to, for example, the supermarket, do-it-yourself shops, or for trips with the family. In the state-of-the-art described in deliverable D3.1, a distinction was made between city-driven, commercially-driven, and community-driven platforms offering cargo bike services. The benchmark for operating and business models then zoomed in at a commercially driven solution, offering cargo bike services

at a public transportation hub. Table 3.5 displays the related business model canvas presented and discussed in deliverable D3.1.

3.5 Initial business model canvas for cargo bike services at public transportation hub from D3.1

<table>
<tr><td colspan="5">Mission statement: To provide a sustainable delivery method for users that would otherwise use their polluting vehicle.</td></tr>
<tr><td rowspan="2">Key partnerships:
1. Public transport authority.</td><td>Key activities:
1. Provide a parking place for cargo bikes.
2. Design, implement and operate an app or other solution for access to cargo bikes.
3. Maintain cargo bikes.</td><td rowspan="5">Value proposition:
1. To provide easy access to free cargo bikes at convenient locations.</td><td>Buy-in & support:
1. Local authority for finding appropriate location and providing permits.</td><td rowspan="2">Beneficiaries:
1. City visitors and its residents by less unsustainable vehicles in the city.
2. Local shops and repairmen maintain their access to the city that is closed off for polluting vehicles.
3. Citizens can rent cargo bike for own needs (weight and load issues) with no need to possess a car or similar.</td></tr>
<tr><td>Key infrastructure and resources:
1. Space on public transport hub.
2. Cargo bikes.
3. App and/or webservices for managing the fleet of cargo-bikes.</td><td>Deployment:
1. Making public space ready for parking of cargo bikes.
2. Integrate cargo bikes in existing app for renting, or develop the app.
3. Notify potential users about the existence of the cargo bike rental system.</td></tr>
<tr><td colspan="2">Budget costs:
1. Investment in cargo bikes.
2. Maintenance costs for keeping cargo bikes operational.
3. Development of platform to access cargo bikes.</td><td colspan="2">Revenue streams:
1. Rental fee for use of cargo bikes.
2. Membership fee for use of cargo bikes.
3. Advertisement fee for display at cargo bike station and/or on the cargo bikes themselves.</td></tr>
<tr><td colspan="2">Environmental costs:
1. Energy use for manufacturing the cargo bikes.</td><td colspan="2">Environmental benefits:
1. Reduced greenhouse emissions involved with transport due to use of cargo bikes instead of delivery vans.</td></tr>
<tr><td colspan="2">Social risks:
1. Lack of use, because small and medium companies cannot afford the rental system.
2. Disappearance of small and medium sized repairmen and other services in the city centre.</td><td colspan="2">Social benefits:
1. Smaller (zero-emission) vehicles in city centre and streets.</td></tr>
</table>

The trial in Bremen, however, can better be classified as a community driven platform. ADFC is an association—not a private, for-profit company—and relies on external funding and donations for revenue. This has severe implications for the business model canvas as indicated in the updated version in Table 3.6. Its mission and value proposition focuses on enabling citizens to use a cargo bike, rather than their car, by providing free and easy access to cargo bikes. Important activities include the identification of individuals or small companies that are willing to act as a host or "renting station", that is, locations where the cargo bikes are temporarily stalled. After a few weeks, the cargo bike is moved to a next individual or company that serves as renting station. In addition, important activities concern the design, implementation, and operation of the website through which the cargo bikes can be reserved. Lastly, the cargo bikes need to be maintained. Key resources include the cargo bike and the website.

Because the cargo bikes are rented via a community driven platform, partnerships with individuals and organizations that act as host (renting station) are crucial—and so too are organizations or individuals that are willing to donate. Because borrowing a cargo bike is free of charge, these donations or external funding are needed to cover expenses related to acquiring the cargo bikes (main budget cost), maintaining them, and developing and hosting the website for reservations. Energy use and social risks are limited. Of course, the cargo bikes need to be manufactured and transported to the place of use, resulting in greenhouse gas emissions. Also, there are some emissions related to hosting a website. In terms of societal risks, a small risk is associated with inconvenient parking locations due to users being unfamiliar with cargo bikes. However, this is a small risk. Indeed, a larger risk is that few citizens realize that the cargo bikes are a viable alternative to their car—for example, because the cargo bikes are not available nearby, they are generally unaware of the ADFC, or because too few bikes are available to cover demand.

Table 3.6 Updated business model canvas for community driven cargo bike platform in Bremen Trial 2

<table>
<tr><td colspan="5">Mission statement: To provide a sustainable alternative for household logistics that would otherwise include the use of a private car</td></tr>
<tr><td rowspan="2">Key partnerships:
1. Individuals or small companies that are willing to act as temporary “renting station”
2. External funding bodies or donating organizations or individuals.</td><td>Key activities:
1. Identify suitable “renting stations” for the cargo bikes.
2. Design, implement and operate a website through which cargo bikes can be reserved.
3. Maintain cargo bikes.
4. Move cargo bikes from one “renting station” to the next.</td><td rowspan="4">Value proposition:
1. To provide easy access to cargo bikes for household logistics at convenient locations.</td><td>Buy-in & support:
1. Members for using the cargo bikes
2. Local authorities for stimulation use.</td><td rowspan="2">Beneficiaries:
1. City visitors and its residents by less unsustainable vehicles in the city.
2. Citizens can rent cargo bike for own needs (weight and load issues) with no need to possess a car or similar.</td></tr>
<tr><td>Key infrastructure and resources:
1. Cargo bikes.
2. Website through which cargo bikes can be reserved.</td><td>Deployment:
1. Integrate cargo bike system into existing scheme
3. Notify potential users about the existence of the cargo bike rental system.</td></tr>
<tr><td colspan="2">Budget costs:
1. Investment in cargo bikes.
2. Maintenance costs for keeping cargo bikes operational.
3. Cost for hosting and maintaining website for reservation</td><td colspan="2">Revenue streams:
1. Donations and/or external funding.</td></tr>
<tr><td colspan="2">Environmental costs:
1. Energy use for manufacturing the cargo bikes.
2. Energy for hosting the website</td><td colspan="2">Environmental benefits:
1. Reduced greenhouse gas emissions involved with transport due to use of cargo bikes instead of polluting vehicles.</td></tr>
<tr><td colspan="2">Social risks:
1. Temporary parking in public space when in use.
2. Lack of use, because availability of cargo bikes is limited, locations are inconvenient, or the initiative is not sufficiently known.</td><td colspan="2">Social benefits:
1. Smaller (zero-emission) vehicles in city centre and streets.
2. Increased visibility for cycling and active travel.</td></tr>
</table>

For a community-driven cargo bike scheme to become a success, buy-in from its members that will use the cargo bikes is key. Local authorities can help spread the word. They can use local campaigns and other communication channels to let citizens know free cargo bikes are available for borrowing. During deployment, focusing on promotional events and notifying potential users is thus key. Another aspect to consider is integration with other cargo bike systems available in the city. Citizens and visitors are the main beneficiaries of the solution. They should see less unsustainable vehicles in the street scene and get an alternative for using their car when they need to transport things that do not fit a normal bike.

3.3 Important considerations for the trials in Bremen

The operating models for the ULaaDS solutions trialled in Bremen are generally clear. That is, the locations for the warehouse and transhipment in Trial 1 are known and the equipment is ready and has been used for other purposes in the same city before. Trial 2 already identified the areas in which the cargo bikes will be used. Moreover, both trials build upon previous initiatives. However, several business model considerations are still open questions.

The containerised last-mile service in Trial 1 requires customers that are willing to pay for the hardware and software. Even when the last-mile delivery operations become more efficient, prior projects have shown that it is not always trivial to exploit those efficiency gains into an economically viable and sustainable business model for the service provider. Receivers of goods are generally enthusiastic about the use of cargo bikes in the last mile but are not used to paying for transportation. It is usually the supplier who pays the transportation cost, but also the one that is used to organizing it from factory to final delivery—be it via their own transport or by involving logistics service providers. Due to owning assets with a long deprecation time and/or longer-term contracts with traditional logistics service providers, short-term changes to the last-mile delivery process do often not immediately translate into savings that could be transferred to the provider of a new service, such as the one providing the containerised last-mile services.

The community-driven cargo bike scheme as part of Trial 2 does not require an explicit business model, as it relies on donations and external funding to cover expenses. Nevertheless, further expansion of the scheme may require additional funding to acquire the cargo bikes and maintain them as well as extra volunteer work to include more hosts and do minor repairs. During the ULaaDS trial, it would hence be of interest to explore complementary sources of funding and effort.

4. Groningen trials

With about 230.000 inhabitants, Groningen is the largest city in the North of the Netherlands. It is known for its progressive mobility strategy, for example, by banning cars largely from the city in its 1977 "traffic circulation plan". More recent examples include the Green Deal city logistics (2014) and the Sustainable Urban Logistics Plan (2021). The two Groningen research trials focus on the implementation of a shared platform for logistics and urban logistics as a service for commuters. This chapter presents the business and operating model considerations for these two trials.

4.1 ULaaDS solutions in Groningen

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

4.1.1 Groningen trial 1

In Trial 1, the municipality of Groningen (GRO) and the Groningen City Club (GCC) organize the development, implementation, and promotion of a platform for the on-demand supply of shops and delivery to consumers in the city of Groningen. Trial 1 addresses both ULaaDS solutions across at least three schemes as indicated in Table 4.1.

Table 4.1 ULaaDS solutions and schemes Groningen trial 1

Solution	Scheme
1) Collaborative delivery models to enhance logistics efficiency and multimodal mobility in cities	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

The platform enables local shopkeepers and other entrepreneurs to access different types of shared zero-emission vehicles. The vehicles will be available at different locations throughout the city. This concerns the integration of mobility networks (Solution 2), with location and infrastructure capacity sharing (Scheme 4) and vehicle sharing (Scheme 5). The shopkeepers and entrepreneurs can use the shared vehicles for supplying their shops and/or delivering to their customers in the city and its peri-urban and rural region. The platform can also be used for organizing the delivery of orders from

multiple participating shopkeepers. It links to the second trial in that these deliveries can be made to parcel lockers located at mobility hubs, parking garages, offices, hotels, etc. This facilitates the design and use of collaborative delivery models (Solution 1), with a city-wide platform for the integrated management of urban freight transport (Scheme 3).

The other two schemes as part of Solution 1, namely the integration of crowd-sourced bike couriers (Scheme 2) and containerisation (Scheme 1) may be considered as the trial continues. The trial design allows for the integration of those two schemes but starts with a focus on making zero-emission vehicles available to local shopkeepers and entrepreneurs, while building towards an integrated management of urban freight transport in Groningen and its surrounding peri-urban and rural regions.

4.1.2 Groningen Trial 2

In Trial 2, the municipality of Groningen (GRO) and the public transport organisation of the provinces Groningen and Drenthe (OVB) will experiment with the addition of logistics services to multi-modal mobility hubs for commuters. Trial 2 addresses both ULaaDS solutions across two schemes as indicated in Table 4.2.

Table 4.2 ULaaDS solutions and schemes Groningen trial 2

Solution	Scheme
1) Collaborative delivery models to enhance logistics efficiency and multimodal mobility in cities	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

The addition of logistics services is centred around the instalment of a parcel locker system at the Park and Ride (P&R) location Hoogkerk, just outside the city of Groningen. This location attracts many commuters parking their car or arriving by bus, to travel their final leg towards the city of Groningen by bike, bus, or taxi. The parcel locker system is integrated into the public transport system (Solution 2) sharing its location and available infrastructure capacity (Scheme 4). Commuters can use the parcel locker for returning parcels they received before (reverse logistics) or collect parcels they received in the parcel locker.

The parcel locker system can also be used by shopkeepers and entrepreneurs in the city. This is facilitated by means of a collective service (Solution 1, Scheme 3) focusing on reducing the dependence of shopkeepers and entrepreneurs on their car or van. Specifically, shopkeepers and entrepreneurs can drive from home to the mobility hub, where they can drop off their goods and travel to their shop by means of bike of public transport. Goods are then bundled and delivered to the shops from the mobility hub. Reversely, the parcel lockers can also be used for the “first mile”—that is, e-commerce deliveries can be taken from the shop to the parcel lockers at the hub.

4.2 Business and operating model aspects of the Groningen trials

Deliverable D3.1 presented a broad state-of-the-art and a benchmark of the business and operating models for sustainable on-demand urban logistics solutions. Below, those elements of the state-of-the-art and benchmark that are directly relevant for the Groningen trials are selected and extended with the most recent information from the trialled solutions.

4.2.1 Business and operating model aspects Groningen Trial 1

Trial 1 will test a platform for the on-demand supply of shops and delivery to consumers in the city of Groningen. Generally, the aim of such platforms is to pool resources and freight flows from different actors in the city. The pooled resources may include either vehicles or facilities—or both, and can be owned by local shops, suppliers, or logistics service providers. The platform can help to meet the regulatory framework of a city, such as time-access restrictions and emission zones.

Table 4.3 displays the related business model canvas presented and discussed in deliverable D3.1. It focuses on bundling freight flows from multiple shopkeepers and pooling vehicles from different logistics service providers. In that situation, a central question becomes where—that is, at what location—freight flows related to different shopkeepers can be consolidated for shipment to consumers (i.e., from multiple shops) or to the shops (i.e., from multiple suppliers). The business model of such a solution differs considerably when using a corporate hub, owned by a private company, or a public hub, owned or subsidised by a public authority. Hence, Table 4.3 (or Table 6.4 in D3.1) shows aspects specific to a corporate hub in turquoise and those for a publicly owned hub in orange.

Table 4.3 Initial business model canvas for integrated management of urban freight transport from D3.1

<table>
<tr><td colspan="5">Mission statement: To pool resources and freight flows of multiple providers for sustainable urban freight transport</td></tr>
<tr><td rowspan="2">Key partnerships:
1. Local shops and suppliers involved with urban freight flows
2. Logistics providers with potential resources to be shared
3. Company operating the hub</td><td>Key activities:
1. Unlocking information about the current rules and regulations to logistics providers
2. Offer insight into available shared warehouse and vehicle space</td><td rowspan="4">Value proposition:
1. To provide a platform with up-to-date information about rules and regulations in the urban space
2. To enable the use of shared warehouse space
3. To enable the use of shared vehicles</td><td>Buy-in & support:
1. Existing companies with potential shared hub facilities
2. Logistics providers to share their resources</td><td rowspan="2">Beneficiaries:
1. Logistics service providers gain from insight into current state of rules and regulations
2. Citizens and other people staying in the city benefit from improved efficiency (e.g., less vehicles, fewer buildings for logistics)</td></tr>
<tr><td>Key infrastructure and resources:
1. Digital platform accessible to logistics providers
2. Logistics spaces for hub facilities
3. Logistics providers with resources to be shared</td><td>Deployment:
1. Develop tender to purchase platform or capabilities developing the platform
2. Integrate up-to-date regulations (e.g., access restrictions, tolls) into platform
3. Identify locations for hubs and logistics providers for resources</td></tr>
<tr><td colspan="2">Budget costs:
1. Cost involved with developing the platform
2. Subsidy to establish (and operate) hub facility or to help an existing hub to share its facility with others</td><td colspan="2">Revenue streams:
1. Fee for using shared warehouse (e.g., per unit handled) or using a delivery service
2. Membership fee for access to the platform for logistics providers</td></tr>
<tr><td colspan="2">Environmental costs:
1. Energy for operating platform
2. Energy for running hub facilities and logistics resources</td><td colspan="2">Environmental benefits:
1. Reduced greenhouse gas emissions from better utilization of existing logistics resources</td></tr>
<tr><td colspan="2">Social risks:
1. Weaker market position for logistics providers that are not active on the platform</td><td colspan="2">Social benefits:
1. A reduced number of vehicles operating in the city
2. More compliance with rules and regulations due to unlocking of up-to-date information directly to logistics providers</td></tr>
</table>

During the development of the Groningen trial, the ULaaDS Local Forum resulted in a strong focus on assisting local shopkeepers and entrepreneurs in meeting the future regulatory frameworks of Groningen. Specifically, Groningen will extend the geographical zone to which time-access restriction will apply in 2022—and that zone is also designated to become a zero-emission zone by 2025. In between 2022 and 2025, parties entering the city can get a waiver for the time-access restriction, allowing them to enter also outside the time window, if they use a zero-emission vehicle. Especially for smaller-sized vehicles (e.g., light electric freight vehicles and vans), concerns about the lack of availability and higher total cost of ownership are alleviated due to changes in the market. Nevertheless, many local shopkeepers and entrepreneurs are not able or willing to invest in a new vehicle, which hampers their access to the city in which they operate. What is more, local authorities see an opportunity to limit the number of vehicles used in the city. Combined, these observations resulted in a trial design where the focus is on rolling out a platform where local shopkeepers and entrepreneurs can organize using shared electric vehicles.

The focus of the platform on sharing vehicles has implications for the business and operating model. Therefore, an updated version of the business model canvas is presented in Table 4.4. Specifically, the mission statement becomes to pool zero-emission vehicles (as resources) and freight flows of multiple local shopkeepers and entrepreneurs. The value proposition focuses on the use of shared, zero-emission vehicles, which on the one hand should facilitate shopkeepers in exploring how these vehicles can be used in their operation, while on the other hand ensuring they keep their access to the city as the regularly framework becomes increasingly stringent.

Table 4.4 Updated business model canvas for integrated management of urban freight transport in Groningen Trial 1

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

In terms of key activities, the platform should provide an overview of where and when the vehicles are in use and when they are available. The platform should also provide an easy booking system through which vehicles can be reserved and paid. The vehicles are of course a key resource, as are the locations where the vehicles can be parked. In this trial, different types of zero-emission vehicles

will be used, namely a zero-emission van, a light electric freight vehicle, and an electric cargo bike. The vehicles will be assigned to a fixed parking location. Shopkeepers and entrepreneurs need to collect and return the vehicle to that location. Key partnerships involve the vehicle provider, the platform provider, and local authorities. In this trial, the vehicle and platform provider are the same party. Local authorities need to approve the use of the vehicles, their parking location and potential changes to the charging infrastructure to enable recharging of the vehicles.

The main costs are involved with the vehicles. In this trial, the vehicles are owned by a service provider that also provides that platform through which the vehicles can be reserved. Based on the usage of the vehicles during the trial, important lessons can be learned about a viable business model for both the user and provider of the vehicles. Specifically, different types of local shopkeepers and entrepreneurs can be determined based on their usage, for example, in terms of frequency, duration, and the moments at which the use the vehicles. This information can feed into a rental cost structure with some form of dynamic pricing to accommodate different user types. The service provider needs to be able to receive a return on investment on the vehicles as well as cover the cost of operating the platform. While being without exhaust pipe emissions—that is tank-to-wheel emissions—the vehicles do use energy. At the current energy mix in the EU, this will involve well-to-wheel emissions related to generating the required energy. Potential infrastructure changes and the platform will also require energy. A social risk of the platform is that not all shopkeepers and entrepreneurs find out about the availability of the shared vehicles, or that they have operating models that are not well suited for the use of those vehicles. Because the platform is seen as a mitigation strategy for more stringent access regulations of the city, those shopkeepers and entrepreneurs may need to buy their own zero-emission vehicles to avoid limiting their access to the city. In order to make the vehicles visible and attractive in use, they will need to be parked in visible and convenient locations, which will consume public space that is particularly scarce in those locations.

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

The main source of revenue for the platform will be the fee for using the vehicles. In this trial, the fee will initially not apply to users to first explore how the vehicles can be used. But, based on the

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

4.2.2 Business and operating model aspects Groningen Trial 2

Trial 2 will test the addition of logistics services to a multi-modal mobility hub for commuters. The logistics services centre around the placement of a white label parcel locker system at the mobility hub in Hoogkerk, just outside the city of Groningen. Logistics services can relate directly to the of use of the parcel locker, for example as commuters pick up parcels that are bought at a webshop, or indirectly, for example when the parcel locker enables local shopkeepers to use a (cargo) bike instead of their car to enter the city centre. Table 4.5 displays the relevant business model canvas presented and discussed in deliverable D3.1.

Table 4.5 Initial business model canvas for parcel lockers at public transit hubs from D3.1

<table>
<tr><td colspan="5">Mission statement: To enable a sustainable parcel delivery service on top of traditional home delivery</td></tr>
<tr><td rowspan="2">Key partnerships:
1. Public transport authority
2. Logistics service provider(s) and other suppliers</td><td>Key activities:
1. Accept parcels from logistics service provider(s) and other suppliers
2. Accept return parcels from customers
3. Enable pick up and drop off by customers</td><td rowspan="5">Value proposition:
1. To provide pick up and drop off services for parcels
2. To provide an additional delivery method to local shops</td><td>Buy-in & support:
1. Local authority for finding appropriate location and providing permit for locker placement
2. Logistics service providers and other suppliers for using the locker system</td><td rowspan="2">Beneficiaries:
1. Customers gain access to another delivery option with high on-demand aspect
2. Local shopkeepers gain access to an open delivery service
3. Logistic service providers can save route distance</td></tr>
<tr><td>Key infrastructure and resources:
1. Parcel locker
2. Public space with access to power
3. Digital infrastructure to alert customer when parcel is available and for accessing locker box</td><td>Deployment:
1. Install parcel locker
2. Integrate it into existing delivery processes
3. Offer easy integration into delivery processes of third-party logistics providers and suppliers</td></tr>
<tr><td colspan="2">Budget costs:
1. Investment cost of installing locker system
2. Operational cost (power) and maintenance</td><td colspan="2">Revenue streams:
1. Cost saving from shorter delivery routes
2. Fee per parcel
3. Membership fee for third-party users
4. Revenue from advertisement on locker system</td></tr>
<tr><td colspan="2">Environmental costs:
1. Energy use of manufacturing and operating the locker system
2. Greenhouse gas emission from customers traveling to parcel locker in polluting vehicle</td><td colspan="2">Environmental benefits:
1. Reduced greenhouse emissions involved with transport by logistics service provider</td></tr>
<tr><td colspan="2">Social risks:
1. Reduced service for attended home delivery because easy alternative exists (e.g., logistics service provider not willing to make second attempt at home delivery)
2. Increased number of trips (in polluting vehicles due to heavy parcels) to the public transport hubs for pick-up or drop-off matters only</td><td colspan="2">Social benefits:
1. Alternative for attended home delivery for customers
2. Less vehicles in the city
3. Possibility to trip chain</td></tr>
</table>

The table distinguishes white label from private label lockers, where the main difference is that a white label locker system is operated by an independent company and requires interaction between different potential user groups. In terms of the business model, this has implications for the revenue streams. If a white label parcel locker is placed, the initial investment is usually not made by the main users of the locker system. The main users pay a fee according to their use of the locker, which should not only cover the initial investment and operational cost associated with the parcel locker, but also a profit margin for the parcel locker operator. A white label parcel locker system does allow

for a larger pool of users. That is, it is not limited to the logistics service company owning and operating the parcel locker, but open to multiple logistics service companies as well as other sellers of goods and providers of services. If a private label parcel locker is placed, the investment and use decision is purely an internal, corporate decision, based on the associated cost and benefits of the locker system. The main benefit for a logistics service provider resides in reduced route length and time of their delivery vehicles.

The ULaaDS Local Forum in Groningen resulted in a strong preference for a white label parcel locker system, because it unlocks opportunities for other logistics services. That is, local shopkeepers and entrepreneurs in the city can use the parcel locker to reduce their dependence on a car or delivery van for going into the city. Specifically, they can pick up and/or drop off their goods in the parcel locker at the mobility hub and continue their trip into the city by bike or public transport. In addition, goods from multiple shopkeepers and entrepreneurs can be consolidated—either in the last mile (i.e., from the hub to multiple shops in the city) or the first mile (i.e., from multiple shops in the city to the hub). The choice for the white label parcel locker system has implications for the business and operating model. Therefore, an updated version of the business model canvas is presented in Table 4.6.

Table 4.6 Updated business model canvas for parcel lockers at public transit hubs in Groningen Trial 2

<table>
<tr><td colspan="5">Mission statement: To reduce dependence on cars and vans for last-mile and first-mile logistics</td></tr>
<tr><td rowspan="2">Key partnerships:
1. Public transport authority
2. Logistics service providers
3. Other suppliers such as local shopkeepers and entrepreneurs</td><td>Key activities:
1. Accept goods from logistics service providers and other suppliers (e.g., local shopkeepers)
2. Accept return parcels from commuters
3. Enable pick up of goods</td><td rowspan="5">Value proposition:
1. To provide pick up and drop off services for parcels for commuters
2. To provide an additional delivery method to local shops
3. To reduce the need for going to/from the city by car or van</td><td>Buy-in & support:
1. Local authority for finding appropriate location and providing permit for locker placement</td><td rowspan="2">Beneficiaries:
1. Commuters and other customers
2. Local shopkeepers
3. Logistic service providers</td></tr>
<tr><td>Key infrastructure and resources:
1. Parcel locker
2. Public space with access to power
3. Digital infrastructure to alert suppliers and commuters when parcel is available and for accessing locker box</td><td>Deployment:
1. Install parcel locker
2. Offer easy integration into delivery processes of third-party logistics providers and suppliers</td></tr>
<tr><td colspan="2">Budget costs:
1. Investment cost of installing locker system
2. Operational cost (e.g., power and transaction costs) and maintenance</td><td colspan="2">Revenue streams:
1. Fee per parcel
2. Membership fee for third-party users
3. Revenue from advertisement on locker system</td></tr>
<tr><td colspan="2">Environmental costs:
1. Energy use of manufacturing and operating the locker system
2. Greenhouse gas emission from logistics service providers and suppliers traveling to parcel locker in polluting vehicle as well as from consumers that otherwise would not have travelled to the public transit hub.</td><td colspan="2">Environmental benefits:
1. Reduced greenhouse gas emissions involved with transport by logistics service provider
2. Reduced greenhouse gas emissions involved with travel into and out of the city by local shopkeepers and entrepreneurs</td></tr>
<tr><td colspan="2">Social risks:
1. Reduced service for attended home delivery because easy alternative exists (e.g., logistics service provider not willing to make second attempt at home delivery)
2. Increased number of trips (in polluting vehicles due to heavy parcels) to the public transport hubs for pick-up or drop-off matters only</td><td colspan="2">Social benefits:
1. Alternative for attended home delivery for customers
2. Less vehicles in the city</td></tr>
</table>

The updated version of the business model canvas in Table 4.6 does not deviate from the original one in Table 4.5 in many aspects. The mission statement did change its focus from parcel delivery towards reducing the dependence on cars and vans for last-mile and first-mile logistics. That is, offering logistics services at the public transit hub is done with the aim to reduce vehicle movements in and out of the city. For the other building blocks of the business model canvas, the updated version builds on the version with the white label parcel locker aspects. An important value proposition of the parcel locker is that it enables commuters to pick up and drop off their parcels at the public transit hub. In addition, it provides local shops in the city of Groningen with additional

delivery services—both in supplying their shops and in delivering to their customers. In doing so, it should also add value by obviating the need to go from and/or to the city by car.

Key activities include accepting parcels from logistics service providers, other suppliers and return parcels from commuters. The parcel locker should also enable commuters, logistics service providers and other suppliers to pick up their goods (e.g., via a portal). Of course, the parcel locker itself is an important resource, but so is the public space on which it is located, including the required permits and access to power. Important partnerships are required with the public transport company, to promote the use of the parcel locker, as well as with different logistics service providers and other suppliers, so that the parcel locker is used as much as possible. The main cost involve the investment required for the parcel locker as well as operational costs and maintenance. Operations and maintenance also result in environmental cost. Other than that, environmental costs stem from logistics service providers and suppliers traveling to parcel locker in polluting vehicle as well as from consumers that otherwise would not have travelled to the public transit hub. While the mission of the solution is to reduce the number of trips from and to the city, a parcel locker may attract additional trips to the public transit hub—that is, by consumers traveling to the hub for the sole purpose of picking up or dropping off a parcel and by suppliers that would otherwise not have visited the hub.

Buy-in of the local public authority is required to ensure a permit for using the parcel locker. In terms of deployment, the parcel locker needs to be installed and should operate well with the systems and operations of logistics service providers and other suppliers, such as local shopkeepers. Key beneficiaries are commuters (and potentially other customers) that get another option for parcel delivery, local shopkeepers that can use the parcel locker for picking up and dropping off goods, and logistics service providers that can save route length. Revenue streams go to the third-party company that owns and operates the white label parcel locker. Chiefly, these include a fee per time a locker is used, and may also cover a membership fee and income from advertisement. Environmental benefits are mostly related to reduced route length of the logistics service providers using the locker system as well as of other suppliers that would otherwise have gone into and out of the city with their own vehicle. Social benefits stem from reduced vehicles and trips into and out of the city.

4.3 Important considerations for the trials in Groningen

The general business and operating models for the ULaaDS solutions trialled in Groningen are clear. At a more precise level, the operating models for both solutions are also clear. Yet, in terms of the business model, both trials are aimed at better understanding the precise fees, possible membership structures and advertisement revenue.

A key reason for not fixing this prior to the start of the trials is that these fees and other revenue streams depend strongly on the usage of the solutions. Specifically, the fixed investment costs in both solutions are clear and make up the majority of the total cost. In Trial 1, these investment costs concern the purchasing price of the zero-emission vehicles; in Trial 2 the cost associated with installing the parcel locker system. The depreciation period for these assets is also given in advance. In order to have a viable business model, the total revenue stream should cover the initial fixed investment costs as well as the variable operational costs and a profit for the provider of the vehicles

(Trial 1) and parcel locker services (Trial 2). This is largely determined by the usage of the vehicles and parcel locker. The more frequent the use, the lower the fee per use could be.

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

Conclusions

ULaaDS has a strong focus on identifying successful, developing new, and continuously refining business and operating models for on-demand and zero-emission solutions for urban freight transport. The evolution of important insights in business and operating model is document in three separate deliverables: D3.1 “Benchmarking business/operating models and best practices”, D3.3 “Novel business/operating models and mapping to research trial sites” and D3.5 “Final validated business/operating models”. This deliverable (D3.3) maps the relevant business and operating models to the ULaaDS solutions at the beginning of the research trials. In doing so, it selects those examples mentioned in the state-of-the-art (D3.1) that fit with the solutions to be trialled in the three Lighthouse cities and updates insights on their business and operating models.

The solutions to be trialled in the Lighthouse cities make use of many different elements presented in the state-of-the-art in deliverable D3.1. Mostly, the ULaaDS solutions focus on novel vehicle technology—using smaller, zero-emission, and even autonomous vehicles—and collaborative models to use vehicles, facilities, and infrastructure more efficiently. In designing and setting up the trial sites and specific solutions, several important points were learned. First, stakeholders across the different Lighthouse cities are very curious and willing to experiment with the use of smaller, zero-emission vehicles. Indeed, the city of Groningen shows how experimentation with these vehicles can even serve as a means to flank more restrictive policy implementations towards low-car, emission free zoning in the city centre. Second, when focusing on the sharing of vehicles—or even facilities and infrastructure—solutions require active embedding of (potential) stakeholders, which complicates the design, testing, and implementation of those solutions. The ULaaDS project has shown that embedding stakeholders early on strengthens the solutions that are to be trialled.

In the evolution from the state-of-the-art and benchmark in deliverable D3.1 towards the validated business and operating models to be discussed in D3.5 at the end of the project, the focus thus far has been on successfully deploying the different ULaaDS solutions and on engaging all important stakeholders. As a result, the operating models of the ULaaDS solutions to be trialled are refined and the Lighthouse cities have developed a vibrant context for trialling those solutions. For most ULaaDS solutions, ideas about potential business models have been collected while the trials are designed such that different aspects of the business models can still be explored. One explicit purpose of the trials is thus to result in tangible insights in elements for successful and sustainable business models.

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
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