SCALE-UP
User-Centric & Data Driven Solutions for Connected Urban Poles

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D3.2 Final Report on Design of multimodal hubs and network optimization

Disclaimer

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D3.2 – Final Report on Design of multimodal hubs and network optimization			
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List of Acronyms	
Acronym	Meaning
ATR	Antwerp Transport Region
CRTM	Consorcio Regional de Transportes de Madrid
DMOW	Department of Mobility and Public Works
EC	European Commission
EMT	Empresa Municipal de Transportes de Madrid
MaaS	Mobility as a Service
WP	Work Package
P&R	Park & Ride
PPP	Public- private partnership

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1. Executive Summary

Scale Up User-Centric and Data-Driven Solutions for Connected Urban Poles (SCALE-UP) is a four-year Horizon 2020 Innovation Action that started in June 2021. It brings together 23 partners from five different European countries. As part of SCALE-UP, three advanced urban nodes – Antwerp, Madrid, and Turku – team up around one main goal: developing data-driven and user-centric strategies to accelerate the take-up of smart, clean, and inclusive mobility, by means of well-connected and multi-usage urban nodes, and to the level needed to meet EU climate and transport objectives.

Over these almost 45 months the three advanced urban nodes have implemented several measures grouped into the five pillars of interventions: (i) governance, (ii) multimodality, (iii) digitalization of the data, (iv) clean, safe and inclusive transport system and (v) behavioural change.

This document considers amongst others the following main objectives of the WP3 in its development:

1. Design multimodal hubs in the urban areas considering the interaction of multiple transport modes with a special emphasis on Park&Ride solutions and their connectivity with public transport and the integration of shared e-vehicles and active mobility options.
2. Analyse and implement network optimizations, in the understanding that multimodal hubs are not independent elements in the mobility ecosystem but are part of a network in which nodes have to perform jointly.

This deliverable also aims to update the previous report submitted in June 2024 and to describe the final implementation of the measures focused in the second pillar of interventions to achieve a multimodal transport system for passengers and for freight in each of the three urban nodes. The different measures are portrayed focusing briefly on the context, implementation process, barriers and enablers identified, preliminary results analysing their impact in multimodality and network optimization and future plans to scale up:

- Antwerp has defined and implemented a network of multimodal mobility hubs, with different service levels and categories, in collaboration with various stakeholders. The city has also worked on a digital presence of the hubs, including amongst others monitoring the satisfaction/experience and the actual use of multimodal mobility hubs and a P&R use case.

  Additionally, the province of Antwerp has analysed the bike network, resulting in a methodology to predict the chances of bike accidents in the network and a camera analysis for near accidents.

- Madrid has promoted the use of P&R facilities linked with public transport, integrating nine of them into the Aparca-T plan and providing additional services in these facilities. The city has also monitored the use and satisfaction of the P&R users and evaluated the impact on mobility. Moreover, the city has developed a sustainable mobility hub of services, called Canalejas 360, that integrates different modes and services for passengers and freight.
- Turku has carried out different pilots to enhance travel chains and multimodal services at different station areas, involving amongst others city bikes, on-demand bus service, and luggage storage. Furthermore, the city has developed a parking hub platform and tested adaptive parking solutions, as well as created an open interface for ticket combinations and has made advances into integrating services into MaaS.

In addition to the implementation of the measures themselves, the urban nodes have exchanged knowledge and experiences through webinars, workshops and site visits that were held among the 3 cities with the aim to learn from the other's experiences and build up capacity towards a more user- centric transport system.

In conclusion, the cities of Antwerp, Madrid, and Turku have successfully implemented the measures to develop multimodal hubs and network optimization.

2. Introduction

2.1 Content and aim of the deliverable

This deliverable aims to describe the final implementation of the measures focused on the development of designing multimodal hubs and network optimization by the three urban nodes, Antwerp, Turku and Madrid. The three urban nodes have shown different contexts, challenges, but they also share common goals to promote sustainable urban mobility.

To achieve more sustainable, user-centric cities and reduce car dependency, high quality, sustainable, accessible, safe and affordable transport options have to be supplied. Multimodality is key to provide integrated door to door services as an alternative to private cars. Having multimodal facilities in the outskirts of the cities and within the cities to allow seamless comfortable, sustainable and efficient trips will contribute to achieve the aims of WP3.

Furthermore, the mobility ecosystem has evolved rapidly over the last decades. The design of innovative mobility hubs that integrate new services and modes of transportation for passengers and goods is contributing to a more sustainable, safer and efficient urban mobility.

2.2 Relation to other Work Packages & project activities

WP3, as one of the Work Packages among WP2-WP6, is focused on the implementation of the various measures proposed in the different pillars of intervention at each urban node.

The relation between WP3 and WP1 is quite clear since one of the main objectives of the project is to upscale the measures beyond boundaries and governance level (vertical axe) but also considering all the layers of the multi-layered mobility system. In WP3 some measures are upscaled on a vertical/horizontal level which directly links this WP to WP1.

WP7 evaluates and monitors the implementation and the impact of the SCALE-UP measures, so, there is also a continuous link between the implementation work packages (WPs 2-6) and WP7 which provide a baseline to serve as a starting point and a methodology for process of evaluation and a defined process for the monitoring phase itself.

Moreover, another WP with bidirectional relation with WP3 is WP8. The dedicated knowledge exchange webinars in which partners share their expertise and point of

view with regard to a particular topic/measure let other partners/urban nodes to know the difficulties faced by the others and how they have overcome them.

2.3 Thematic cooperation

To serve as inputs for this deliverable, several workshops were organized in March 2022 as bilateral meeting between the thematic cooperation of the WP3 (ETRA) and each of the urban nodes partners (Turku, Madrid and Antwerp). Also, there was one knowledge exchange webinar carried out the 5th May 2022 to change information and experiences among the 3 urban nodes.

During 2023, additional knowledge exchange webinars were held to continue collaboration between the partners and to progress in the development of the project.

The last knowledge exchange took place in March 2024 and the three urban nodes presented good practices for the development of multimodality and the optimization of networks.

The thematic cooperation has been extremely valuable and insightful for the three nodes. The contexts of the three urban nodes may be different, however, the main goals are the same. Therefore, the transfer of knowledge and sharing specific measures and initiatives have been very positive and fruitful.

3. Context & implementation of the interventions

3.1 A3 – Multi modal mobility hubs and network optimisations in Antwerp Transport Region

3.1.1. Context

Within the Antwerp Transport Region a network of multimodal mobility hubs is defined in the Roadmap 2030, the regional mobility plan. The network of multimodal hubs for passengers will function as the backbone for the region's (public) transport system and the hubs will be central points where different (levels of) networks come together and where travellers can change smoothly and comfortably from one transport mode to another. Their operation, accessibility and service level will be the cornerstone of a more sustainable way of transport, supporting the modal shift to 50% sustainable travel.

This measure especially focusses on three facets of the network of multimodal hubs:

(i) the design and implementation of the hubs, (ii) the digital presence of the hubs and (iii) the connection of the cycle highway network to the multimodal hubs (including an analysis of the cycle network itself).

This measure is a collaboration of the Antwerp Transport Region (ATR), the City of Antwerp, the Department of Mobility and Public Works (DMOW) (all three mainly involved in the design and implementation of multimodal mobility hubs and the digital presence), the Province of Antwerp (mainly responsible for the bike network), Be-Mobile (mainly responsible for the P&R use case/digital presence) and the Port of Antwerp (stakeholder for all facets).

As follows, the implementation process, risks found and corrective actions performed as well as possible continuation of the measures after of the project for all three facets are reported in this deliverable.

3.1.2. Implementation process

For the Transport Region of Antwerp, a network of multimodal mobility hubs has been defined based on workshops with municipalities.

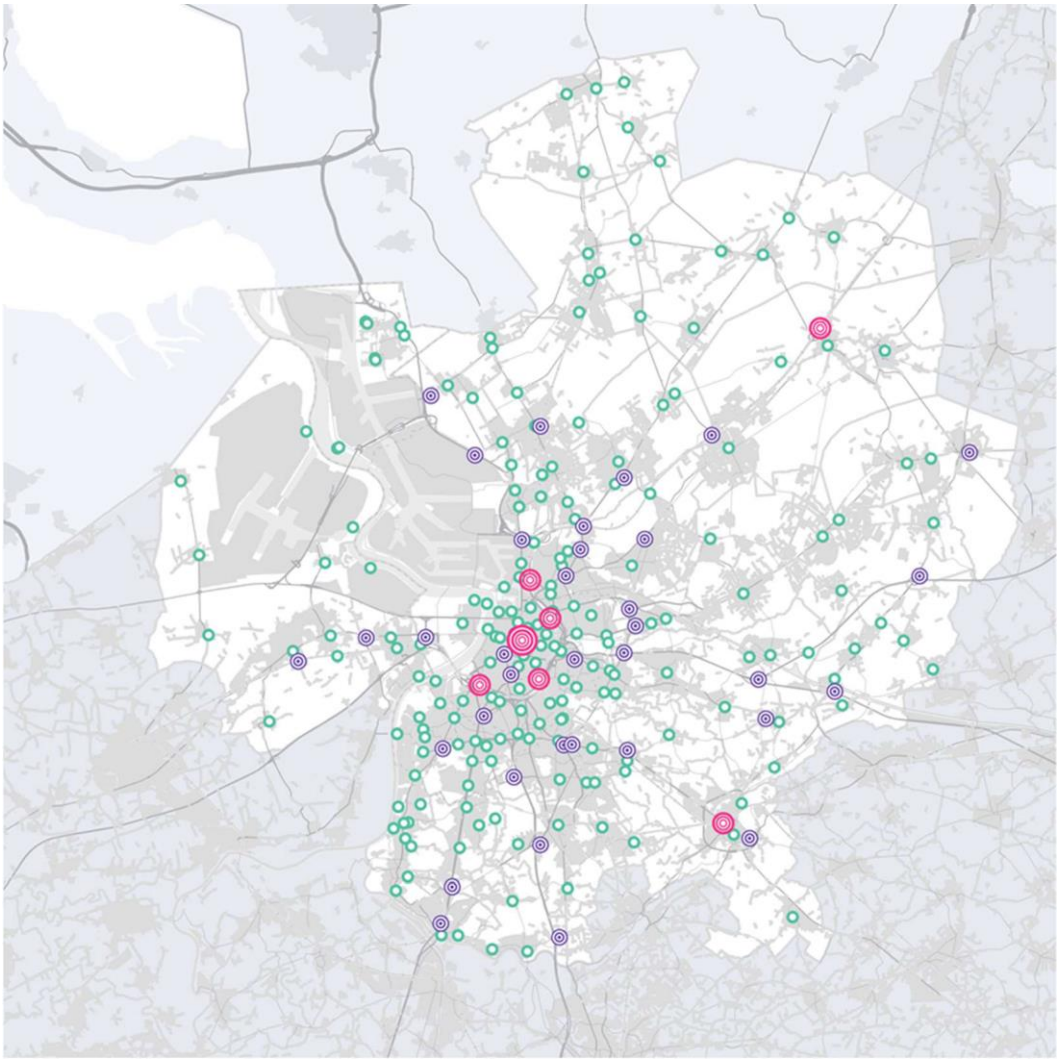

Figure 1 Multimodal mobility hubs of the Antwerp Transport Region

In this network, multimodal mobility hubs are defined as inter-regional hubs, regional hubs, local hubs or neighbourhood hubs according to the functions they serve and based on the "Hoppin" methodology[1] of the Flemish region.

Inter-regional Hoppinhubs: Hoppinhubs with generally a wide mobility offer of frequent interregional, regional, and local connections, from which journeys between different transport regions are possible. These Hoppinhubs include at least high-quality interregional public transport connections of the train network.

Regional Hoppinhubs: Hoppinhubs that are served by a frequent regional connection of the core net or train network. These Hoppinhubs are aimed at users with a supra-local origin and destination.

Local Hoppinhubs: Hoppinhubs which are determined by the municipalities and which are aimed at users whose origin or destination is close by. These hoppinhubs

[1] https://hoppin.be

are at least served by a cadence line (line according to a certain schedule) within the supplementary network.

Neighbourhood Hoppinhubs: Hoppinhubs that are only served by functional lines of the complementary network or by transport on demand/flex transport (network logic). If they are not served by public passenger transport, shared vehicles form the basis of the transport offer. The recruitment radius of these Hoppinhubs is limited to the immediate surroundings and to travellers who live nearby.

Furthermore, service levels for the hubs in the Antwerp Transport Region / Flanders have been defined for each of those hub categories.

The quality requirements for the Hoppinhubs are:

- Accessibility
- Minimal equipment
  - Parking (if needed, with adjusted and reserved places for disabled people)
  - Bicycle sheds (with space for outsized bikes)
  - Information carriers
  - Infrastructure for data exchange

The city of Antwerp even goes a step further in their service levels and adds the layer of context and identity of the user to its scheme. For instance, a smaller, residential located hub will have a different kind of user than a hub located in a city center where different modes of transport come together and will therefore have different needs.

Based on the proposal for multimodal hubs in the transport region, they are implemented by the different stakeholders (e.g. municipalities, Flemish Agency for Roads and Traffic), depending on the location of the hub. In order to be able to monitor the implementation of the hubs, a good view on the responsible stakeholder is necessary as well as the expected implementation time. For this, information has been collected from municipalities as well as the Flemish Agency for Roads and Traffic. The Antwerp Transport Region does not have a budget on its own for the realisation of the multimodal mobility hubs and they mostly have to be implemented by other government entities, which often have other priorities or time-lines and the implantation of the point. Therefore, the ATR decided to focus on informing the municipalities about the requirements and subsidies for the multimodal mobility hubs as well as encouraging them to start with the implementation of the multimodal mobility hubs. However, it was also seen that this was not enough to increase the speed of implementation. Especially municipalities often do not have the capacity and people. Therefore, within the service centre (see also A1), Lantis decided to

support ATR. The first step was to detect and map the needs of municipalities. Afterwards, a strategy to support the municipalities in implementing the Hoppin points was set up. Focus of this strategy is to support the municipalities with in the design and implementation process of the hubs with medium and low priority but also finance the design of the multimodal hubs with the highest priority itself.

Furthermore, during the project ATR (or rather Lantis) improved a number of existing P&Rs where possible: a marketing campaign has been set up to improve utilization of the 3 P&Rs closest to Antwerp. Also, the e-bike system has been integrated in those P&Rs (see also A7). On a number of P&Rs, enclosed bicycle racks have been built and one P&R in the wider area of Antwerp (Zoersel) has been upgraded as multimodal mobility hub.

As one of the stakeholders responsible for implementing multimodal hubs, the city of Antwerp has been preparing the implementation of hubs in 13 locations in the city. For those locations the research and design proposals were discussed with and approved by all stakeholders. Furthermore, the concept designs for the first 13 locations were approved by the city council and are being discussed with the councils on district level. Also, a cooperation agreement with the Flemish Agency for Roads and Traffic for the design process of multimodal mobility hubs located on regional roads is set up. The city has been spending quite some effort to organize the operational design of the hubs and providing them with different equipment: the development of wayfinding signs for the hubs, a design competition for shelters to place at public transport stops, preparation of locked bike racks, preparation of public lockers where users can charge their electric bike battery, provider of public bike pumps and further implementation of drop zones for shared mobility.

In total 12 multimodal mobility hubs have already been realized in the city of Antwerp.

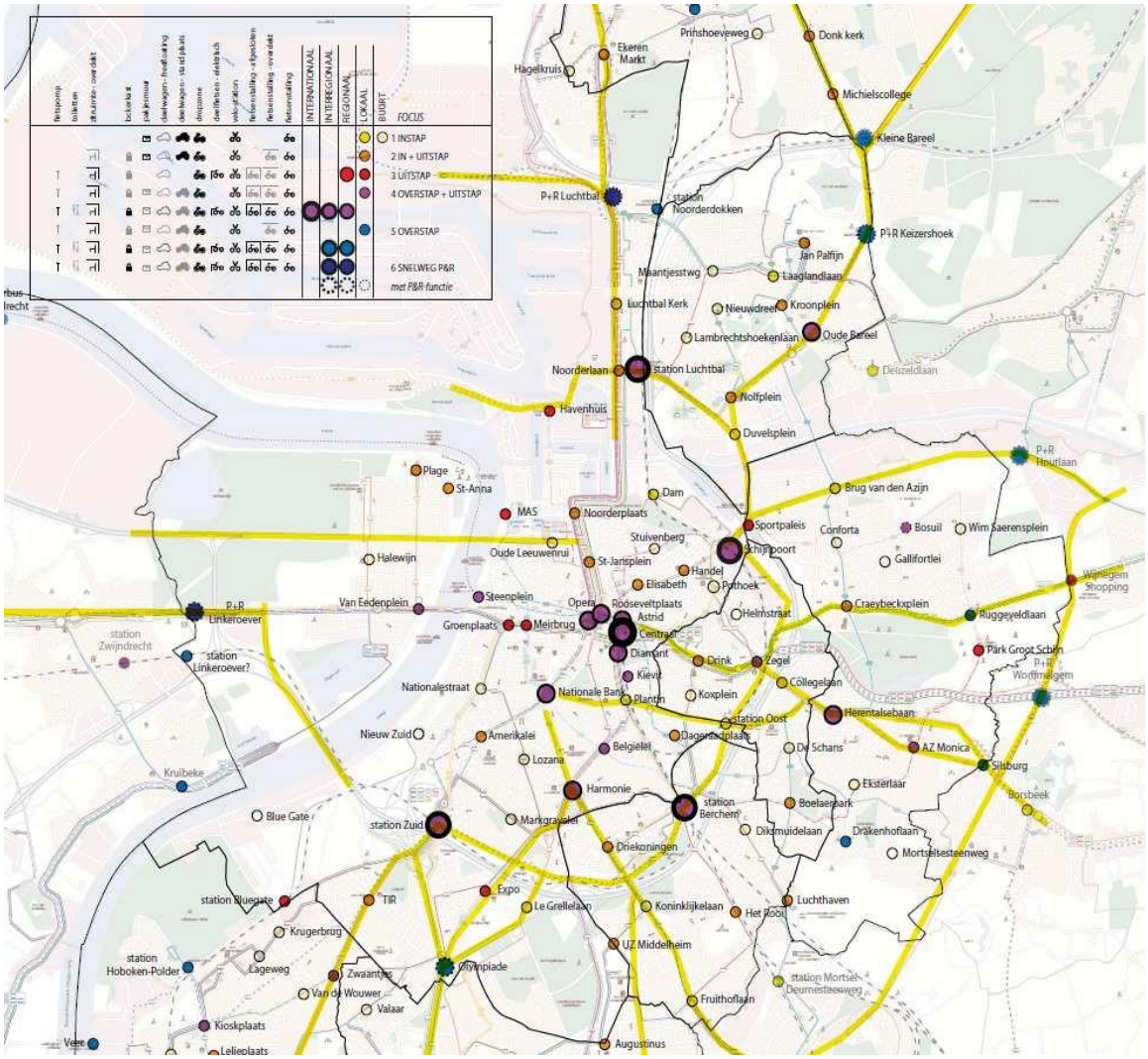

Figure 2 Multimodal mobility hubs in the city of Antwerp

During the second part of the project, the work in the city of Antwerp has focused on wayfinding. At four sites the wayfinding has already been realized: Bist (Wilrijk), Mediaplein, Antwerp-Central station and Opera. In the near future, one more location will be added: Olympiade. The design for this hub has already been finalized, but implementation of the wayfinding was delayed due to necessary infrastructure adjustments such as a shared-bike station that had to be completed first. In addition, the designs for National Bank, Rooseveltplaats, P+R Luchtbal and P+R Linkeroever are textually ready and are currently being designed. 6 follow-up locations are also planned. In addition to analogue signalling, a pilot project for digital 'smart' wayfinding providing real-time information on the availability of sub-systems is underway, although this project is experiencing some delays. Finally, an evaluation process has been set up to assess the effectiveness of wayfinding and make adjustments where necessary, both on-site and digital. The evaluation shows that the wayfinding was received positively. Most people do not need it themselves but recognize that it can sometimes help others. There were only few comments regarding the current

design, so the city will continue with the current layout. Based on the first experience, the guidebook for the multimodal hubs in Antwerp was also updated, although it was more about fine-tuning the iconography, etc., rather than needing to incorporate user feedback.

3.1.3. Risks found and corrective actions performed

One of the largest risks/challenges concerning the overall implementation of the multimodal mobility hubs was the involvement of and coordination with a large number of stakeholders (City of Antwerp, Agency for Roads and Traffic, Antwerp Transport Region, Department of Mobility and Works, NMBS, De Lijn, Lantis, providers of shared mobility…). Furthermore, ATR cannot implement the hubs themselves; other partners as municipalities and the Agency for Roads and Traffic are responsible for the actual implementation. To remedy both challenges, the team of the transport region with support from Lantis tries to coordinate between the different stakeholders and especially support and motivate the municipalities as much as possible with the implementation. During the second part of the project, Lantis also looks into possible ways to accelerate the role out of multimodal hubs, which will be part of the Service Centre (see A1). Furthermore, all multimodal hubs are unique and the implementation as well as the needed service levels have to be analysed on a case-by-case basis.

Concerning the operational implementation one of the largest difficulties is to find free space for all the infrastructure/services at the locations of multimodal hubs as often the space at the location is limited. This also means that the theoretical framework the city uses to design mobility hubs cannot always be implanted 100%. Sometimes the context doesn't allow for certain objects or facilities to have its place in the public space. The city of Antwerp also had to deal with the overall challenges as described above: Often a lot of actors are involved (the more important the hub, the more actors), so realizing changes asks for a lot coordination effort as well as involvement and time from each of these actors. Furthermore, at times, capacity can be limited for the implementation of the hubs, be it because of other priorities or lack of personnel.

Participation of certain user groups is key to really make a difference. A site visit with a group of disabled persons in wheelchairs provided a different image on the definition of accessibility. Their input is crucial if the ambition is to make mobility hubs accessible for everyone. This knowledge is currently being implemented in the design process for different locations. It makes the design process more complex but definitely has an added value.

It is quite a challenge to make hubs that are fitted to the needs of the users/customers

(the demand) AND the actual mobility modes and operators (the supply), as both tend to shift rather fast these days.

It has been quite the exercise to communicate in a way the average person understands the goal of the mobility hubs project. Travelers are not yet accustomed with terms like multimodal mobility hubs. It is a barrier for a high percentage of engagement. Also, some new additions take time and active communication in order to be trusted and adopted by the users. The enclosed bikes sheds for example had some initial flaws, were not opened with a very big campaign, and now it seems more difficult to convince the potential users to try this new product.

3.1.4. Results

Digital presence

With regards to the digital presence in multimodal mobility hubs, different actions have been carried out during the project.

At the moment there is already data on how many people take the bus at a multimodal mobility hub. However, there is no data yet on the user satisfaction/experience and the actual use of multimodal mobility hubs. In order to get a better view of the user experience and satisfaction on multimodal mobility hubs, the city of Antwerp has rolled out a digital questionnaire for 30 locations. The first questionnaire gave decent feedback that was used in the further design process. The capacity to engage citizens was limited but 300 people filled in the questionnaire. The focus was mostly on things the city can control like placing more benches and trash cans or providing more safe options for storing a bike. Other aspects like how public transport is organized the city has less control over.

To improve the survey and to get feedback from stakeholders in the region, a workshop on the topic of monitoring of multimodal mobility hubs has also been organized by the Antwerp Transport Region in September 2022. This has been the basis for the development of a methodology concerning the user experience and the use of multimodal mobility hubs in the Antwerp Transport Region.

The focus was twofold:

- Methodology for measuring User Satisfaction of Hoppin Points: This involves developing a methodology/strategy to measure the user satisfaction of mobility hubs (Hoppin points).
- Methodology for measuring Effective Use of Hoppin Points: This involves developing a methodology/strategy to map the effective use of mobility hubs

(Hoppin points). The proposed methodology aims to map the most used combination of transport modes, transfer movements, and the first and last mile.

For the various research questions, two methodologies were applied: online panel and face to face fieldwork. These two methodologies were tested on one Hoppin point, namely P+R Merksem, to see if we can measure the satisfaction and use of Hoppin points and what lessons we can learn from this for the methodology. Following table lists for which research questions each methodology is suitable:

Research Question	ONLINE PANEL	FIELDWORK(F2F)
Usage & Frequency of Use	x	
Usage Combinations (combi-mobility, first & last mile)	X	X
User Satisfaction (general, specific offerings, satisfaction aspects, etc.)		X
Opportunities (missing links, improvement points)		X
Stratification (personal details, place of residence, workplace, etc.)	X	X

In conclusion we can say that there is no difference in gender between the two research methods, but there are significant differences in terms of stratification in age, education, and employment status. The online sample needs to be targeted better to be representative for this mobility hub.

F2F fieldwork is methodologically measurable and a good methodology, but more respondents are needed for reliability within the sub-questions. Additionally, more spread throughout the year is desired to improve representativeness, validity, reliability, and benchmarking. However, this is too expensive and labour-intensive to apply on a large scale.

The online panel survey is not recommended because the sample is not representative. More respondents are also needed here and better spread throughout the year. There is a need for more targeted recruitment for an online panel, i.e., samples from people who actually use the relevant Hoppin point. This is in function of representativeness and cost-efficiency.

Questions regarding the used Hoppin points need to be formulated differently/better.

To measure the use of Hoppin points, online panels are not a reliable option unless very large or multiple online panels are used.

The respondent is not always familiar with the concept of "Hoppin point" and therefore finds it difficult to assess (e.g., is it a Hoppin point or just a bus station?). The complex question structure of which Hoppin point was visited is also not evident. An alternative question formulation is needed here.

To extend the benefits of our research beyond the current project, we will develop a long-term strategy that includes recruiting a diverse panel of public transport, shared mobility, and mobility hub users. This will involve on-site advertising and in-person recruiting to ensure a more affordable and representative survey. The panel will serve multiple purposes, providing valuable insights for various applications. We will also improve the questionnaire by adding relevant open-ended comments and enhancing trip origin-destination data entry options. Prioritizing surveys for regional mobility hubs and collecting data for other hubs as a byproduct will refine our data collection. Finally, we will validate the survey's representativeness through onsite face-to-face interviews, ensuring reliable and accurate data.

On the Flemish level, a data standard for multimodal mobility hubs was defined in order to be able to share data more easily. In order to define this data standard, sessions with different stakeholders have been carried out. Different initiatives concerning the digitalization of information were also set up.

Furthermore, a databank and comprehensive map of the Multimodal Mobility hubs was created and updated regularly. The map can be found online. It is also available in WFS format which makes it machine readable. During the project the databank was also further developed to save information in a more efficient way. Also, some data connections with external information providers were developed.

For the P&R use-case, an extension of the Flitsmeister app was developed. The extension nudges drivers that navigate to Antwerp to leave their car at the P&R and take public transport to continue their journey. After a functional design has been developed and the different paths for development have been discussed, the extension was released. Flitsmeister users who entered a destination within “the city” were offered an alternative route, via the most efficient P&R. The choice of P&R was automatically calculated, and the proposal was made only if sufficiently useful for the user.

By “the city” as a destination area, we mean here a (rather naive) defined area that was plotted by the city of Antwerp:

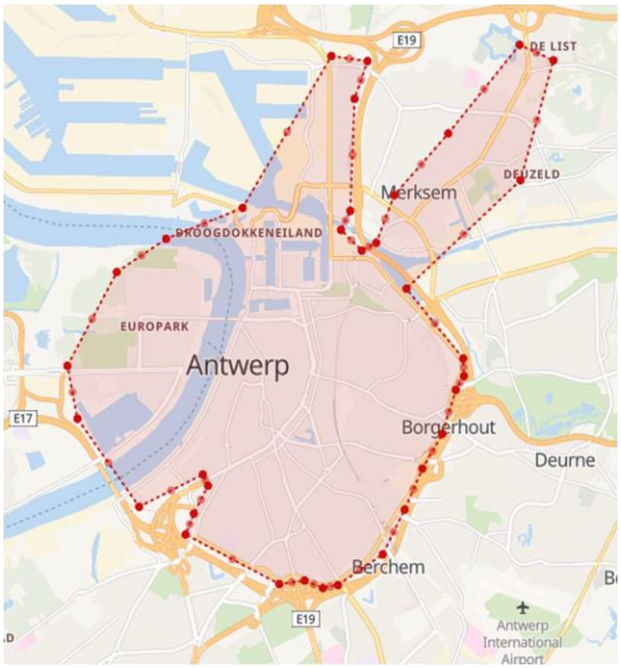

Figure 3 City of Antwerp as a destination area for testing P&R

Within this use case, 9 P&Rs were included, as shown on the map below:

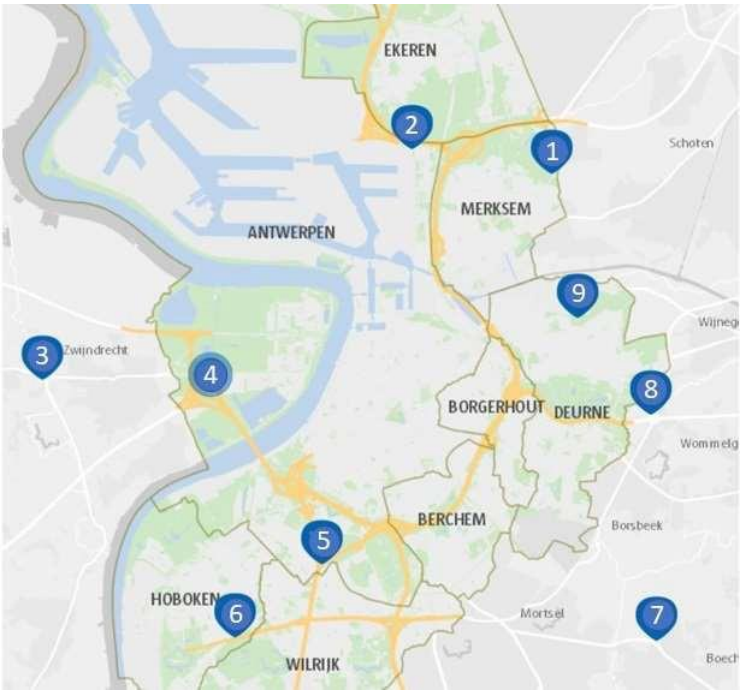

Figure 4 P&R tested in Antwerp

The P&R use-case was tested during a live test period, which took place between 25/09/2023 and 22/03/2024. We could see that the acceptance rate, averaged across the 2 platforms iOS and Android, was about 9% (85 out of 940 drivers) which is quite high.

The P&R locations involved in accepted route suggestions were:

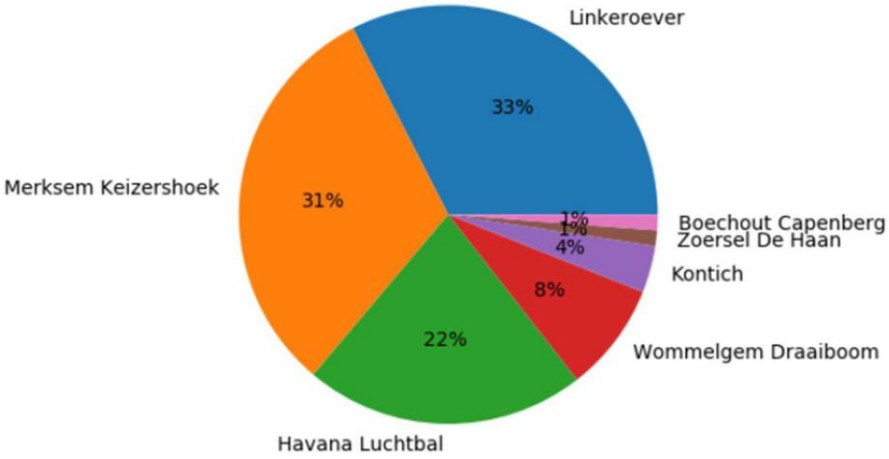

Figure 5 Accepted P&Rs

It is clearly noticeable here that the most accepted P&Rs are the new, large (and paying) sites (Merksem Keizershoek, Havana Luchtbal and Linkeroever), which were built fairly recently by Lantis (more information can be found on the Lantis website). It is not possible to conclude from this what the reason for this is, this could be purely due to their good location, for example.

To do more research on the P&R locations themselves, and their user experience, a survey was also conducted upon arrival at the P&R (for all Flitsmeister users who drove with route navigation). The survey revealed several insights. When asked if they were offered a route via a P+R, 83.8% of respondents said no, 8.5% said yes but declined, and 7.7% accepted the option. It is interesting to note that the majority of respondents did not receive a P&R option. This means they did not enter a destination within the designated area (see above). It is likely that they navigated directly to the P&R after looking up the address themselves.

Among those who chose the P+R option, 44.4% did so to avoid parking stress, 22.2% found it more convenient, and another 22.2% were simply curious, although very few people answered this question. Regarding the number of passengers in the car, 53.8% were alone, while 26.5% had two people. The clarity of the route and entrance to the P+R was affirmed by 66.7% of respondents, whereas 33.3% found it unclear. Additionally, 70.9% reported sufficient parking space at the P+R, while 29.1% did not. Despite the low response rate to the satisfaction question, all who answered were

pleased with their decision to use the P+R option.

During the design and implementation of the P&R use case, the following challenges have been detected and should be considered when potentially replicating the use case

- The biggest challenge is to convince the user to effectively use the P&R route. A possible remedy would be to offer a free (or reduced) ticket for public transport. However, due to limited funding, this could not be organized during the Scale-Up project.
- It is very important to obtain occupancy rates to the participating P&Rs in order to avoid sending the drivers to full P&Rs. Therefore, during the Scale-Up use case, a selection of P&Rs has been made. Only P&Rs were included where ATR has the occupancy rates or where the risk that car users are lead to the P&R and does not find a space is limited.
- There are also extra challenges if the P&R is not free (new P&Rs). If the costs of the P&R is integrated as an incentive and parking would be offered for free, an extra feature would have to be integrated in the app so that users can access the P&R. Due to financial and operational restrictions this option was not used.

Bike analysis

A first analysis for a 'bikeability index' has been concluded by the Antwerp Transport Region, mainly based on data from the measuring bike (Fietsersbond). The results of the analysis show where bicycle infrastructure is too narrow, relative to the speeds of motorized traffic and where surface flatness is inadequate. Additionally, data from traffic accidents was used to identify high-risk intersections. Parts of the network where you cannot cycle today were classified as 'a missing link'.

The province of Antwerp built further on this first analysis for the duration of the SCALE-UP project. For a risk analysis, the province of Antwerp first looked at other types of data sources that are available on a larger scale and could point us to today's blind spots as for example OpenStreetMap, terrain models, and traffic information.

The next step of the analysis consisted of a brainstorm session with a multidisciplinary team (traffic engineers, mobility planners and site managers with expertise on bicycle highways). This resulted in a broad overview of situations that may indicate a potentially dangerous location and on the other hand factors that increase the accident risk at these locations. The input from this session was incorporated into a model that identifies risk situations and influencing risk factors and translates them into the data needed for analysis. The brainstorm session was supplemented by literature review and input from similar analyses.

Basic data such as the road network and a first analysis to identify intersections were visualized in a web tool (ArcGIS Online Experience Builder[2]. This practice makes it easier to share interim results with colleagues for further discussion and refinement.

After the identification of the intersections with the cycle highways, the province of Antwerp added parameters such as speed limit, road category, traffic lights with the degree to which they are conflict-free and the waiting time for cyclists. In addition the province of Antwerp developed a visibility analysis for the intersections. They combined the parameters to calculate a first estimation for the safety risk for each intersection.

The list of risk situations and factors that influence the accident risk is large, some factors are difficult to relate to data. The risk was that we lack focus and put too much effort in being as complete as possible and the search for very specific data. Therefore, the plan was abandoned to be as complete and detailed as possible but a more pragmatic step-by-step approach was chosen, starting first with basic parameters that are readily available (and therefore easier to scale up to other regions) and from there gradually adding more detail.

In the first part of the data-analysis the province of Antwerp focused mainly on infrastructural design parameters and how they determine the safety risk. In a second part, the actual registered accidents were included in the analysis. For this the AVOC (Approach to Traffic Accident Concentration Points) score has been included which weighs accidents based on severity and involvement of active road users over the past three years. This is similar to the score used by 'The roads and traffic agency' (AWV) so calculate the list with dangerous crossroads. The province analysed how to improve the effectiveness of this score on longer road sections.

The webtool with initial results was then converted to a dashboard view to more easily explore and monitor the results. Following indicators have been included: the quality of bike paths, missing links, whether they are absent, under study, or in execution, the risks at intersections and an additional risk analysis on the infrastructure of the cycle highways has been integrated into the dashboard. Emphasizing safety over comfort, with parameters like speed limits, bike path width, and buffer zones between bike paths and roads. Discussions with the Ministry of Mobility and Public Works (MOW) have also taken place, focusing on traffic models and the need to consider road congestion, which is not always reflected by road categorization.

The dashboard is publicly available via this weblink: https://experience.arcgis.com/experience/61ed71f8ebf745ad95221a25a992ff82

[2] https://www.esri.com/en-us/arcgis/products/arcgis-experience-builder/overview

In addition to the data analysis, it also contains a detailed description of the full data analysis, the parameters, assumptions and the calculation method for the risk indicator. A description of the used data sources and their quality.

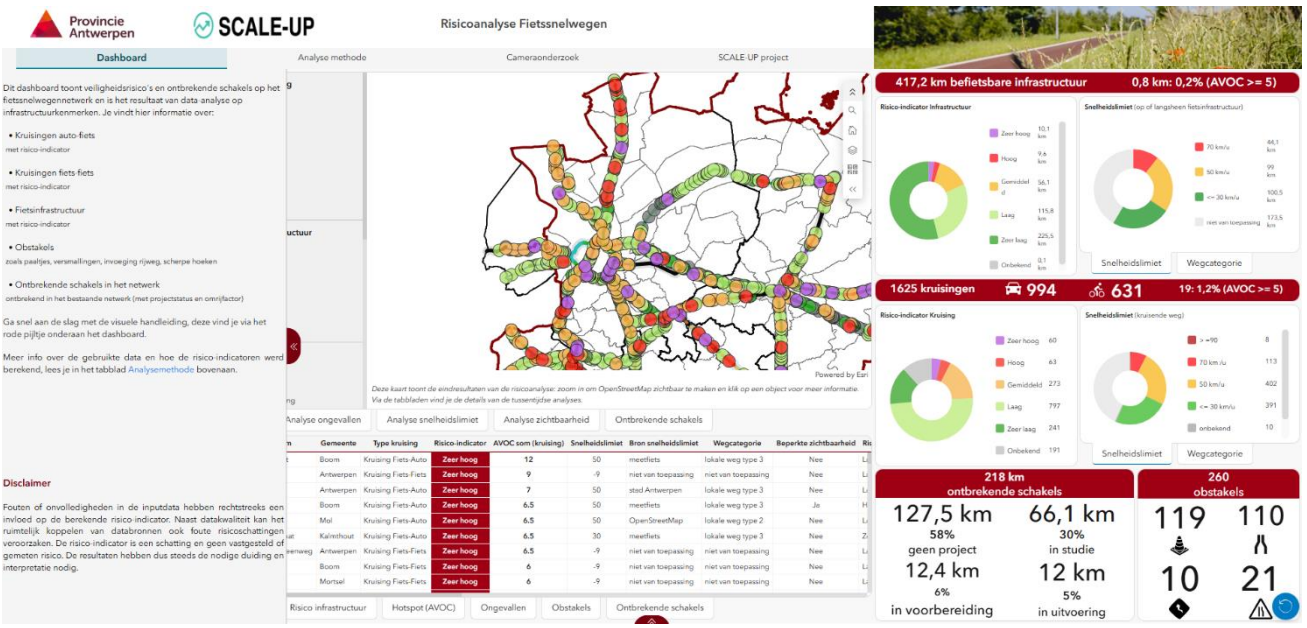

Figure 6 Final Dashboard 'Risk analysis on Cycle Highways

The dashboard shows risks on the cycle highways, both at intersection level and infrastructure. For each intersection or part of the network we show the estimated risk, the actual risk based on accidents (AVOC), and the combination of both which we call the risk-indicator. It ranges from very low (green) to very high (purple).

The dashboard also contains the missing links, their project status if already applicable and the detour factor for the shortest route from A to B.

For both the intersections and infrastructure as the missing links the cycling potential is linked to enable the prioritization of risk points and missing links.

In the last six months a lot of effort was put in improving the data analysis on the cycle highways and troubleshooting for the dashboard with the results. The improvements were a result of feedback received by the Provine of Antwerp in spring 2024, after they brought together a focus group of safety experts to discuss the analysis. Especially the analysis on accident data (AVOC) was adapted for a better focus on traffic safety for active road-users.

To their recommendation information about the amount of heavy vehicles was added as an important parameter and the assessment matrix which is used to assign the estimated risk based on the combination of parameters, was adjusted to their feedback. The final enrichment of the data aimed to prioritize the risk locations, for

this purpose information about the cycling potential of the bicycle highways and information about the road authority was linked. The bicycle potential was calculated in a study done by MOW. The bicycle potential and information about the road manager involved for something point makes the developed tool more suitable for prioritizing and communicating opportunities to improve traffic safety

The dashboard environment was expanded with documentation about the analysis, the methodology to estimate the safety risk, all the used data sources and a description of the current data quality.

In 2024 the province of Antwerp submitted an abstract for the Flemish Road Safety Congress that will take place in spring 2025, and was selected as a speaker. This provides a platform to present and improve the data analysis and methodology in front of a wider group of experts with their feedback and knowledge.
The list of intersections with their estimated safety risk and established risk by accident rates was used to select four intersection for an in-depth camera analysis.
The four intersections selected by the province of Antwerp are the result of an extensive data analysis carried out on the bicycle grid in the transport region of Antwerp and, by extension, the entire province of Antwerp.
Two types of intersections were chosen: two intersections with only bicycle-bicycle interactions and two intersections with bicycle-car (and bicycle–bicycle interactions).

The measurements took place in October 2023. At the intersections, cameras record the movements of all road users. This information is immediately converted into data using artificial intelligence. That information makes it possible to record near-accidents and objectify road user behaviour. When two road users cross with each other during a 1-second time frame, at less than half a meter and at a specific angle, this is registered as a near accident.

Thanks to these camera images, the province of Antwerp gets a good picture of how road users behave and where they clash. This serves as a basis for proposing improvements to the infrastructure that improve road safety. The results of the camera surveys also serve to verify and adjust the data-analysis part by identifying blind spots in the methodology.

During the summer of 2024 the Province of Antwerp received the preliminary results of the camera-analysis. This was later than expected due to other assignments with the supplier that had run out. The reports were thoroughly proofread, several meetings were necessary to correct errors, and to give feedback. Not all findings in the report were clear at first; it took more time than expected to work together with the supplier to deliver understandable and complete reports for the 4 intersections investigated. This caused a delay, but the province of Antwerp was still able to discuss all results with the local governments where the measurements took place. They also provided

recommendations to improve road safety at the intersections. For one of the four intersections, namely the intersection cycle highway F1 with F11 in Antwerp, the local authority immediately acted on the recommendations, and issued a design brief for the widening of the intersection zone. This intersection showed us the most conflicts and actual registered accidents of the two investigated intersections of the type `bicycle-bicycle interactions´.

The province of Antwerp found in the camera analysis that the method used to image bike-bike conflicts is identical to common methods used to image bike-car conflicts. This leads to a mismatch between the two conflict types. After all, bicyclists are more agile than cars, conflicts are often negotiated interactions, and the mass difference is also less than. These findings were reported to the supplier and are also published so that further research is enabled.

To show cast the results to the broader public, also an extensive story map has been developed which describes the camera-analysis and results, accessible via https://storymaps.arcgis.com/stories/e80e2306ed574f1199c0bb22a9b6acc1

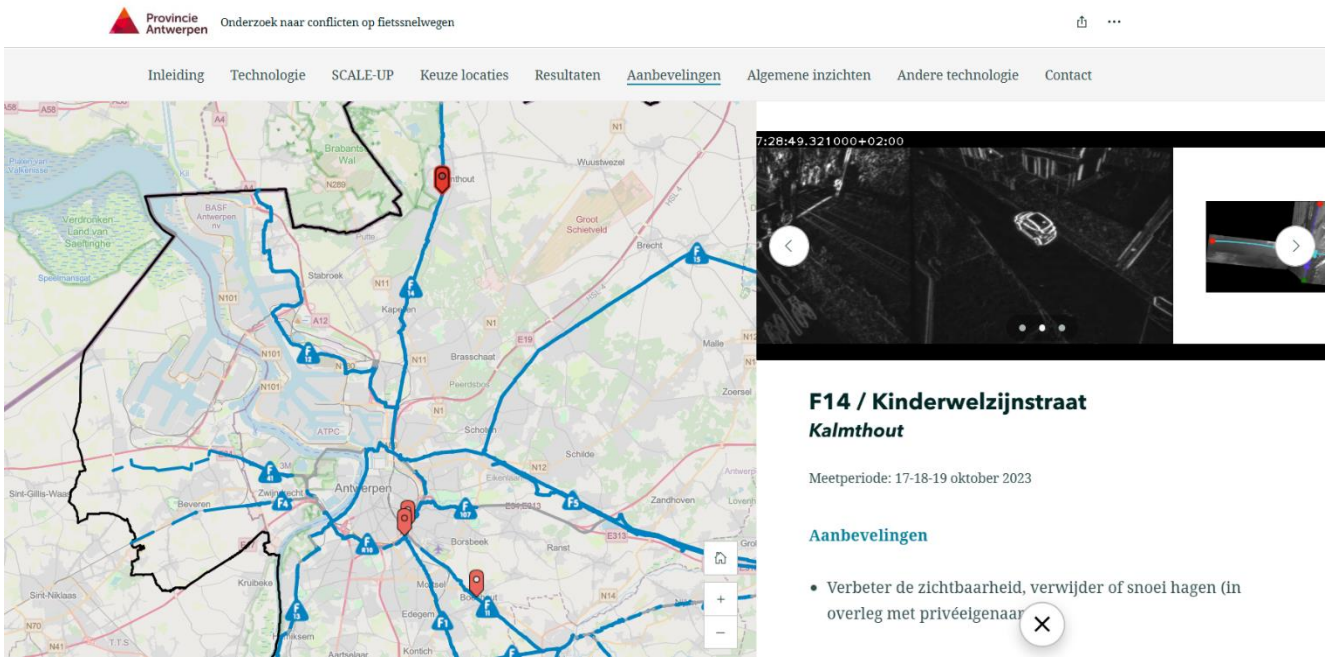

Figure 7 Story map with results of the camera-analysis

A third separate part in the bike data analysis is to examine the connection between the multimodal nodes and the bicycle network. For this the province of Antwerp used a network model based on OpenStreetMap, which was already prepared in an earlier stage. The requirements for the analysis were aligned with ATR at the end of September 2024.

For each multimodal hub, the shortest route was calculated via OpenStreetMap. In

addition, service areas of multiple distance were calculated, these provide quick insight into which parts of the transportation region are connected to the multimodal hub. The results of the analysis, together with background information such as parking spots, the conformity or cycling adequacy of the bicycle network, a direct weblink to Google Streetview and mapillary were brought together in a convenient web map. Also, the enriched dataset of the multimodal hubs were given to ATR so that they can easily be analysed in their own geographical analysis tools.

The results can be seen in an online map, showing how well the multimodal mobility hubs are connected to the cycling network and cycle highways. The result can be used by ATR to detect the location for relevant investments in bicycle connections https://provincieantwerpen.maps.arcgis.com/apps/mapviewer/index.html?webmap=e2420bd391584bde939c300dd7d0fa4c

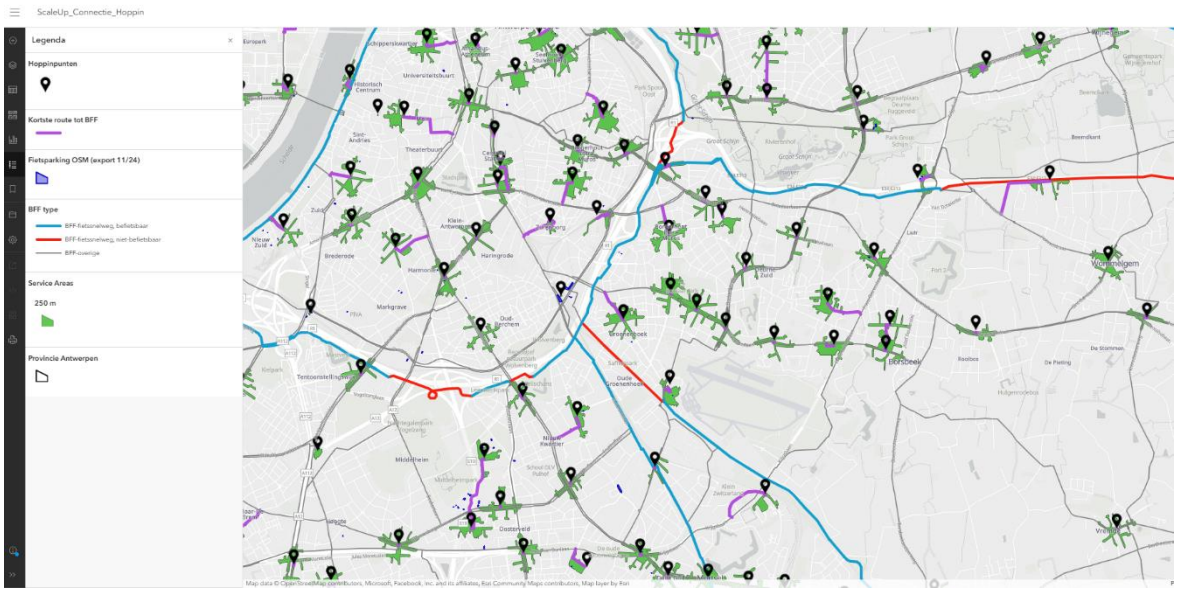

Figure 8 Connection analysis of multimodal hubs and the bicycle network

Furthermore, the province concluded a framework contract for traffic research, a chapter concerning 'Handling GDPR' of the Script for Near Accident Analysis, and an overview for 'risk situations on bicycle highways and influencing factors for the accident risk, with a translation to data needs'.

In 2025 and after the Scale-Up project, the province of Antwerp plans to further improve the data-analysis of the bike network on different levels:

- Adding extra parameters such as floating car data, so that we know the intensity and speed of vehicles.
- Improving data quality through cooperation with the OpenStreetMap community, at provincial level but also at an interprovincial level thanks to the cooperation on bicycle data to which the Flemish provinces are committed

- In addition, the province is also looking at how the analysis now in place for the Transportation Region of Antwerp can be extended to the other transportation regions in the province. And how the results of the data analysis can be anchored in the provincial support offer for local authorities.

During the SCALE-UP project the Antwerp Transport Region saw that the implementation of the multimodal mobility hubs is not always straightforward. One of the main takeaways is that a coordination between stakeholders is key. As it became clear that municipalities often do not have enough capacity (manpower and knowledge), Lantis/ATR took steps in order to support the municipalities. After the project, ATR is planning to continue this support. First of all, ATR will provide information on the implementation and possibilities for subsidies of multimodal hubs. So far, there are no specific plans for financing the infrastructure themself. However, ATR/Lantis will provide tools for the municipalities for making the design and implementation easier. For multimodal mobility hubs with high priority, ATR/Lantis will also finance the design of the hubs.

On the urban level, the city of Antwerp will further implement its strategy and roll out the different multimodal mobility hubs. The first step will be the further rollout of the wayfinding, which can now really move forward. Meanwhile, the city will also continue to work on small and large adjustments in terms of accessibility, compactness, readability, and comfort of the public space, both for larger and smaller hubs. Regarding new products, the city is particularly looking forward to further developing the canopies, specifically for the case of Antwerp-South station.

3.1.5. Conclusion

The Antwerp Transport Region has made significant strides in defining and implementing a network of multimodal mobility hubs. These hubs are being implemented by various stakeholders, including municipalities and the Flemish Agency for Roads and Traffic. The city of Antwerp has been proactive in preparing the implementation of hubs in 13 locations. Efforts have also been made to improve wayfinding at these hubs. The implementation of multimodal mobility hubs has faced challenges due to the involvement of multiple stakeholders and the need for case-by-case analysis. Space limitations at hub locations have also posed difficulties. Despite these challenges, additional efforts were made to support and motivate municipalities for implementation. Future steps include rolling out different multimodal mobility hubs in the city of Antwerp and further stimulating municipalities to implement multimodal mobility hubs through, for example the ATR service centre (see A1).

The development of multimodal mobility hubs in the Antwerp Transport Region

underscores several key lessons. Collaborative planning with municipalities is crucial for effective implementation, ensuring that all stakeholders are engaged. Categorizing hubs by their functions ensures that each serves its intended purpose efficiently. Defining service levels for each hub category guarantees that quality and functionality meet specific standards, enhancing user experience. Emphasizing accessibility and essential equipment, such as parking, bicycle sheds, information carriers, and data exchange infrastructure, ensures the hubs are user-friendly and well-equipped. However, transformations require significant effort, and developing new products such as wayfinding systems, secure bicycle parking, and canopies independently takes much more time than necessary. Therefore, stakeholders should seek assistance whenever possible and utilize existing products where feasible. They should start with accessibility and readability as the foundational layer. Shared mobility and other additions can change over time due to evolving contracts and needs, so they must be used flexibly within the available space. These lessons highlight the importance of strategic, collaborative, and flexible planning in developing effective multimodal mobility hubs.

The work on the digital presence in multimodal mobility hubs involved several key actions and findings. Before the project, a lack of data on user satisfaction and actual hub usage was identified. Also, no methodology existed to remedy this gap. To address this, the city of Antwerp conducted a digital questionnaire across 30 locations, gathering feedback that could be used for further design processes. With this questionnaire as first step, an analysis was made to develop methodologies for measuring user satisfaction and effective use of the hubs, using both online panels and face-to-face fieldwork. Testing the different research methods, revealed the strengths and limitations of each, underscoring the need for targeted recruitment and better question formulation. Additionally, the project highlighted the necessity of a long-term strategy for data collection, including diverse and representative panels, and the importance of validating survey results through face-to-face interviews.

The Flitsmeister app extension for Park & Ride (P&R) in Antwerp was developed to encourage drivers to park at P&R locations and use public transport for the remainder of their journey. The extension, which automatically suggests the most efficient P&R based on the user's destination, was tested from September 2023 to March 2024. The acceptance rate was about 9%, with the most popular P&Rs being new, large, and paid sites. A survey conducted at these P&Rs revealed that many users did not receive the P&R option due to their destination settings. Among those who did, reasons for acceptance included avoiding parking stress and convenience. The integration of digital tools, like the Flitsmeister app extension for P&R use, demonstrated the potential for technology to enhance user experience, though challenges such as data availability and incentivizing use remain.

The Antwerp Transport Region has conducted an initial analysis for a 'bikeability index', identifying areas where bicycle infrastructure is inadequate or risky. The province of Antwerp is building on this analysis. The bike network analysis has identified a large list of risk situations and factors influencing accident risk. A more pragmatic, step-by-step approach has been adopted to focus on basic parameters that are readily available. This results in a comprehensive dashboard and is suitable to monitor the quality of bike paths, missing links, and unsafe intersections on the cycle highways.

A camera analysis at four intersections with the cycle highways was carried out, the results, insights and recommendations for improving road safety were shared with the local governments. For one of the intersections. For one of the intersections on the cycle ringroad in the city of Antwerp, concrete plans are being made to redesign the intersection with a particular focus on widening so that road users can cross safely.

The results of the camera-analysis also indicated that there are still missing parameters in the data analysis, such as gradients of bicycle lanes, traffic intensities. The province of Antwerp will continue with improving the risk assessment through data analysis.

It is a recommendation for the market in traffic studies to improve the analysis method for near accidents between bicycles. It would be interesting if the results of different types in near accident detection could be brought together on a larger, European scale. This could enable the improvement of the analysis method and establishing guidelines or standards that indicate how many conflicts per number of road users is high or low, and thus predict the risk of effective accidents.

Finally, the connection analysis between multimodal mobility hubs and the bicycle network is a successful first step for the ATR as a basis for investments for an improved bike accessibility.

3.2 M2 – Improving multimodal hubs with Park & Ride + public transport at regional level

3.2.1. Context

A total of 15.8 million trips take place daily in the region of Madrid, on all means of transport. In Madrid city centre, public transport, and walking account for up to 75% of the trips. This modal share drops considerably in the metropolitan area (50%) and beyond (41%) where the car remains the main mode of transportation. To ease the transition towards more rational use of the private car and to increase multimodality among commuters, both the region and the city are promoting public transport by combining it with a "Park & Ride" approach.

Moreover, with COVID-19 the trend of mobility changed in Madrid metropolitan area. There was a reduction in journeys for the purpose of commuting and a drastic decrease in the use of public transport.

After the pandemic, the main challenge remains the commuting flow between the city and the neighbouring municipalities located in a 40-50 km radius. In this regard:

- Madrid region already offers 71 parking facilities linked with public transport. 23 of them are located in Madrid city. CRTM is developing a "Park & Ride" plan for the Madrid Region called "Aparca-T". This plan aims to improve intermodality and ease the transition between modes within multimodal hubs where parking facilities are linked with public transport. When people park their car at these multimodal hubs and use public transport, they can profit from cheaper parking fares.
- The city of Madrid is working on its own "Park & Ride Program" which includes 12 facilities between the two ring roads of the city, the M30 and M40 (and beyond the M40). These facilities allow commuters and other people travelling to the city centre to leave their private vehicle next to a rapid transit system that will take them fast, comfortably, and cost-effectively to their destination.

The M2 SCALE-UP measure includes the integration of the park and ride facilities in the Aparca-T regional plan and the development of the Park and Ride Plan in Madrid City.

This measure has been developed in collaboration with the Madrid Regional Consortium of Transportation developers of the Aparca-T plan, Madrid City, which has planned, designed and owns the P&R facilities within the city, and EMT, which manages the P&R facilities as well as the additional services provided in these facilities.

3.2.2. Implementation process

In 2019 the City Council approved three park and ride facilities projects: Aviación Española, Fuente La Mora and Pitis. Up to now, the three of them have been built and they have been in operation since 2021.

With these projects, the City had 6 Park and Ride facilities managed by EMT. The locations of these facilities are strategic, as they improve not only the mobility in the City but are key instruments to enhance the sustainability in the Trans European Transport Network.

Table 1 Park & Ride connections to the TEN-T corridor

Park & Ride Name	Nearest motorway	Type of TEN-T corridor	TEN-T corridor
Fuente La Mora	M11	Railway	Atlantic
Pitis	M40	Railway	Atlantic
Wanda	M40	Motorway	Mediterranean
El Recuerdo	M30	Motorway	Atlantic
Aviación Española	N-V	Motorway	Atlantic
Avda de Portugal	N-V	Motorway	Atlantic

In September 2021 a new Park and Ride facility: Isla Azul P& R started operations (under a public- private agreement). In total more than 5.500 parking spaces are allocated by the City Council to the park and ride use.

In 2021, the Regional Transport Consortium (CRTM) and the Municipal Transport Company (EMT) signed a collaboration agreement for providing free use of park and ride facilities by public transport users and the integration of the three first municipal park and ride facilities into the Aparca-T Plan.

In total 9 P&R facilities at local and regional level managed by CRTM and EMT were integrated in the Aparca-T plan. 7 of them are managed by EMT: Avenida de Portugal, Nuestra Señora del Recuerdo, Wanda Metropolitano Stadium, Fuente de la Mora, Pitis , Aviación Española and Isla Azul (this one under a PPP). CRTM manages the other 2 P&R (Colmenar Viejo and Ciudad Universitaria).

During the first and second periods of the project, the necessary technological requirements for the integration of these P&R facilities in Aparca-T were implemented.

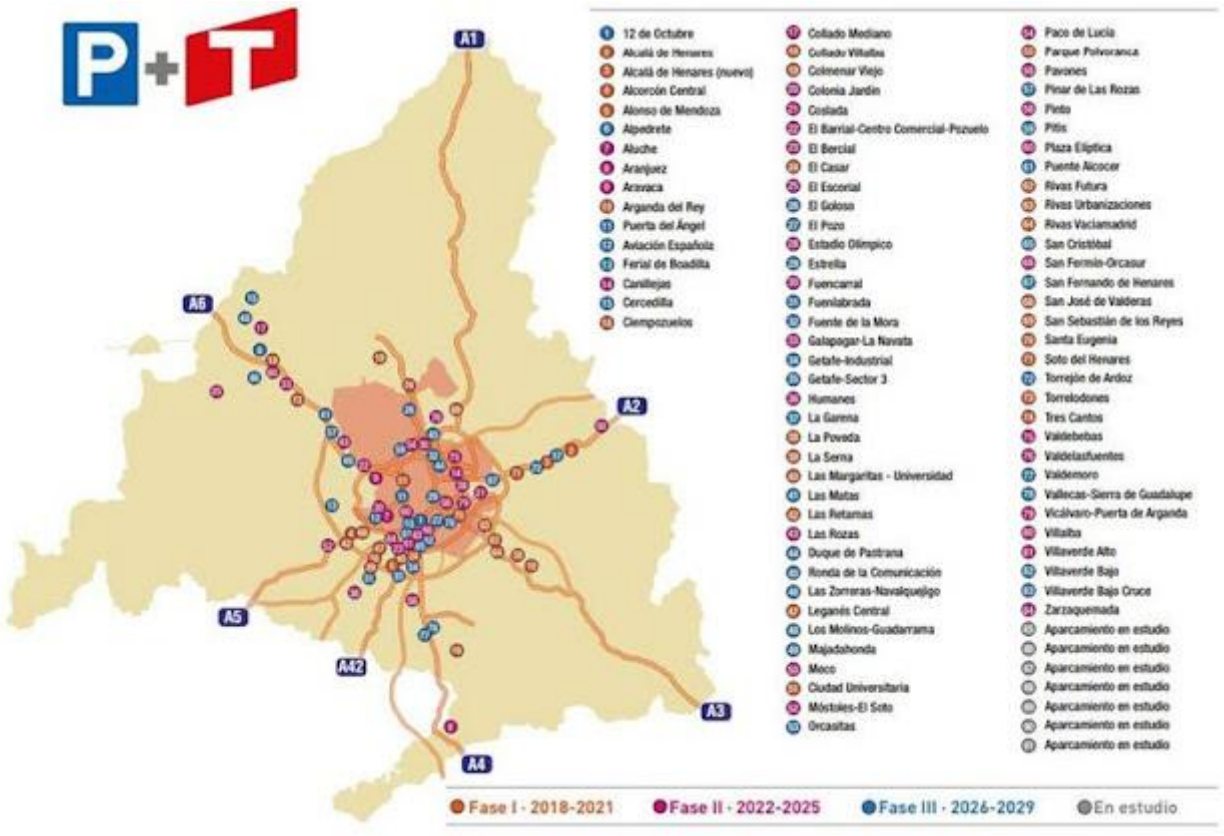

Figure 9 Parking facilities linked to public transport Madrid region

Overview P&R facilities:

- Aviación Española (managed by EMT)
- Fuente la Mora (managed by EMT)
- Pitis (managed by EMT)
- Isla Azul (managed by EMT under a PPP)
- El Recuerdo (managed by EMT)
- Wanda Metropolitano (managed by EMT)
- Portugal Avenue (managed by EMT)
- Ciudad Universitaria (managed by CRTM)
- Colmenar Viejo (managed by CRTM)

During the project the P&R managed by EMT have also integrated the following services:

- Parking:
  - Dissuasive use (see explanation below).
  - Rotation use (short time) with a regular tariff
  - Multiday parking pass
- Electric charging.
- Bicycle parking - BICIPARK.
- Bike sharing system - BICIMAD
- Micrologistics (e-commerce shipment collection services).
- Carsharing.

Figure 10 Fuente de la Mora P&R

Dissuasive use of the car parks allows free parking, any day of the week and at any time, for users who combine the use of these car park facilities with the use of public transport in the city of Madrid (including any means of transport belonging to the Madrid Regional Transport Consortium: Commuter railway, Metro, Light metro and EMT city buses).

To do so, the vehicle must be parked for a minimum of 5 hours and a maximum of 16 hours in connection with the use of public transport to travel within the city. When collecting the vehicle, the user must present the parking ticket, together with

the public transport ticket they used on that same day, either at the Parking Control Office or ticketing machine. The transport tickets enabled for validating this fare are the following: any type of monthly or annual Transport Season Ticket; any ten-trip ticket (Multi Pass); Metro or Light metro single ticket (Multi Card), or EMT, Commuter railway or intercity bus single ticket.

Users must prove that they meet the established requirements in order to benefit from the subsidized dissuasive municipal fare, which means that their stay is free of charge.

EMT has implemented a Smart Park functionality, the Madrid Mobility 360 app. Since November 2021 this functionality offers EMT car park users a digital experience in accessing and paying for this service. They can check the available parking spaces in real time, access and pay through the application. After signing up and registering their payment method and number plate, users can easily access the car park by reading their number plate or QR code. At the end of their stay they can either pay automatically from the app without having to go to the cashier or if they have previously registered the plate number in the platform, the payment is done automatically without any physical interaction upon leaving the parking with the car (through the plate number reader). In addition, in the case of intermodal car parks EMT users can register the Public Transport Card and the application will compare its use to validate and apply, according to the conditions of use, the free stay.

Since 2021, the city council has been monitoring the dissuasive use of these facilities and their impact in the mobility of the city as well as studying other locations in the periphery of the city with the required criteria of proximity to public transport and mobility demand to scale up this measure.

At the moment 11 new locations have been studied, as summarized below:

- **Approved projects**
  - Intermodal car park Villaverde Bajo with 567 parking spaces
  - Tres Olivos Intermodal Car Park with 464 spaces
- **In process of drafting**
  - Aravaca Intermodal Car Park 951 spaces
  - Canillejas Intermodal Car Park 441 parking spaces
  - Barajas Intermodal Car Park: 547 spaces
  - Paco de Lucía Intermodal Car Park 439 spaces
- **Pending supervision and approval**
  - Mar de Cristal Intermodal Car Park.

- Puerta de Arganda Intermodal Car Park

- **Other projects planned:**
  - Valdebebas Intermodal Car Park.
  - Valdebebas Intermodal Car Park.
  - San Fermín-Orcasur Intermodal Car Park.

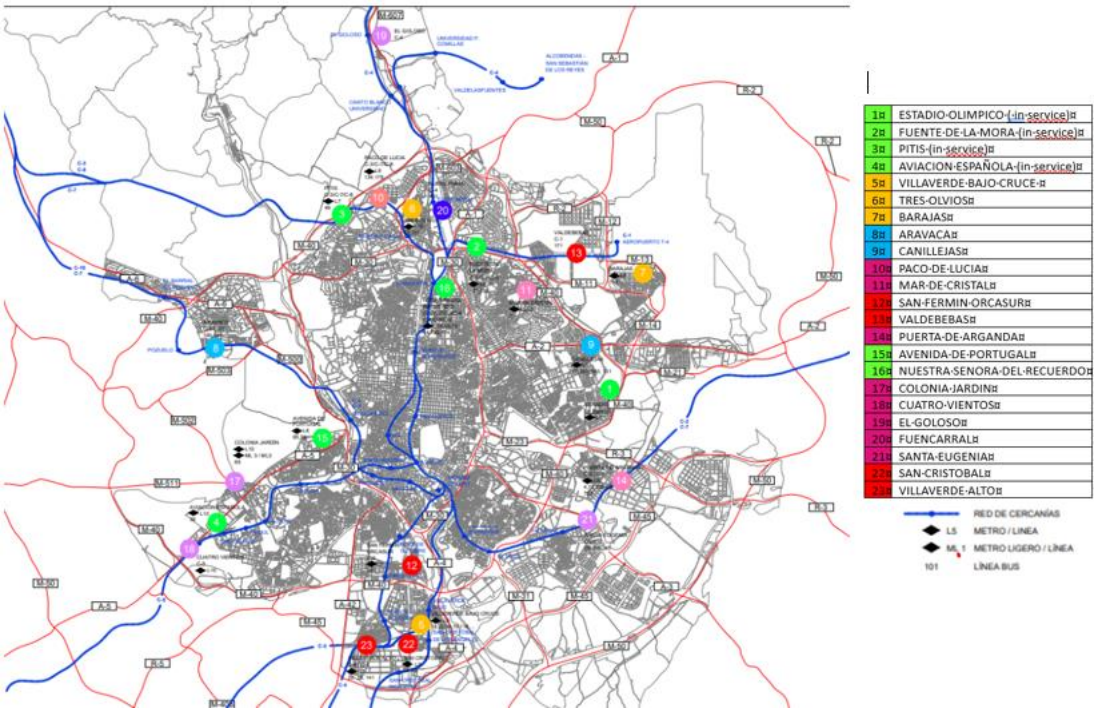

Figure 11 P&R Plan Madrid City

Table 2 Use of P&R Madrid

EMT Park & Ride	Parking lots	Starting date	2020		2021		2022			2023			2024		
			Rotation uses	P&R uses	Rotation uses	P&R uses	Rotation uses	P&R uses	21-22 %	Rotation uses	P&R uses	22-23 %	Rotation uses	P&R uses	23-24 %
Recuerdo	832	15/06/2009	20.699	5.120	35.408	9.624	50.635	21.000	118%	74.043	38.412	83%	92.430	58.190	51%
Av. Portugal	428	28/05/2010	30.524	6.203	53.315	7.520	70.607	18.531	146%	114.635	49.403	167%	100.124	55.229	12%
Islazul	224	01/01/2021			1.125	1.125	2.531	2.531	125%	2.636	2.636	4%	2.263	2.263	-14%
F. Mora	423	14/05/2021			6.037	48	14.051	11.795	24473%	26.676	23.078	96%	24.641	20.543	-11%
Pitis	458	22/06/2021			923	0	4.358	0	-	18.222	0	-	44.148	0	-
Av. Española	379	29/07/2021			17.518	15.855	67.616	61.205	286%	77.900	70.510	15%	80.076	73.882	5%
Metropolitano	3.069	25/10/2021			3.629	2.013	14.847	8.071	301%	10.636	5.928	-27%	8.478	4.351	-27%
	5.813		**51.223**	**11.323**	**117.955**	**36.185**	**224.645**	**123.133**	**240%**	**324.748**	**189.967**	**54%**	**352.160**	**214.458**	**13%**

The occupancy data of the facilities in operation by EMT are shown in table 2. They show that the use has increased notably since 2021.

In the case of Ciudad Universitaria Car Park, the last figure available (October 2024) shows that it was used more than 55,000 times per month.

The dissuasive use of the parkings was moderate in 2021 due to the lasting effects of COVID 19 pandemic. However, we have seen that their use has increased notably since 2022 except for Pitis car park that has registered no dissuasive use. In 2024 there has been an overall increase in use of 13%.

In addition, EMT and the city Council are planning to transform these Park and Ride facilities in sustainable mobility hubs

3.2.3. Risks found and corrective actions performed

The main barrier identified for the success of the measure was the ingrained habit of using private cars for commuting.

The city council, EMT and CRTM have the commitment of contributing to change people's minds by means of communication (media, press releases...), promotional campaigns with free use of parking facilities and the provision of additional services: electric charging, micro-mobility.

During the 2024 Mobility Week celebrated last September, CRTM, Madrid City Council and EMT launched a promotion campaign with handing out of merchandising and direct communication with users. This measure described in D6 included the promotion of Park and Ride Facilities as a multimodal sustainable option to move in the city.

Another difficulty that the City Council is finding for the planning and construction of new park and ride facilities is the ownership of the land. Usually, the potential locations are outside of the municipality. Some of the locations considered and studied had to be dismissed because the city could not reach an agreement with the owners of the land.

Regarding the integration of the city parking facilities in the Aparca-T plan. It was necessary to adapt and implement some technological changes in the city facilities. Apart from the coordination between the administrations it was necessary to invest in these technological integrations.

Last, there are some difficulties and challenges regarding governance. An agreement was signed by the involved administrations, and some extra efforts were needed to coordinate the management and operation.

3.2.4. Results

9 "Park & Ride" (P&R) facilities (at local and regional level) have been deployed (Spaces adapted and services integrated) and integrated in Aparca-T plan (7 managed by EMT and 2 managed by CRTM). The location of the P&R in the city of Madrid can be seen in Figure 9.

EMT, who is managing the City facilities, carried out the IT works for the integration of its P&R facilities within "Aparca-T" app, and has implemented different multimodal services in its P&R facilities.

As shown before, the dissuasive use of the P&R facilities was moderate in 2021 due to the lasting effects of COVID. Nonetheless, the use of park and ride facilities has increased notably in the last three years. This translates into a reduction of more than 72,400 trips to the city in 2021, 246.300 in 2022, 654.200 in 2023 and 410.200 in 2024.

In the framework of the SCALE-UP project, UPM conducted a survey in 2023 to evaluate the satisfaction of users of the aforementioned car parks, as well as knowing the characteristics of their journey and their use of the service.

The case studies selected for the evaluation were Avenida de Portugal car park, Nuestra Señora del Recuerdo car park, Metropolitan Stadium car park and Ciudad Universitaria car park.

The results show:

- More than 90% of the parking users use public transport.
- 80% of the trips are "obliged mobility" (working and studies purposes).
- 61% of the users would use their private car if the park and ride was no option. However, only 26% of the users asked would agree with paying for the car park service.
- The majority of users asked knew about the dissuasive service by word of mouth while 22% knew the service through radio, tv and social media advertisements.
- Regarding the satisfaction of the users, the general level of satisfaction has been quantified with values from 1 to 5 being 1dissatisfied with the service and 5 very satisfied with the service. The results are shown below:

Aparcamiento	Satisfacción general (1-5)
Av. de Portugal	**3.69**
Nuestra Señora del Recuerdo	**3.64**
Wanda Metropolitano	**3.45**
C2 Ciudad Universitaria	**4.15**
Average P&R	**3.82**

Four years after the pandemic, mobility has reached similar numbers to the pre-pandemic situation with 14 million journeys per day registered in last April and with public transport demand that is even higher than the pre-pandemic demand.

The City Council, EMT, Madrid Regional Government and Regional Consortium of Transports continue monitoring the use of the park and ride facilities and assessing the impact on the mobility of the metropolitan area. The next steps that both administrations plan are:

- To continue working to integrate more P&R premises into CRTM Plan, even though the digital platform where all facilities at a regional level should be integrated is still not in place.
- To integrate new EMT "Park & Ride" facilities in the "Aparca-T" tool to foster their usage by giving users some facilities like booking a slot in advance.
- To continue the deployment of other P&R within the Madrid metropolitan area and consider possible new locations.
- To evaluate the P&R with lower use rates to determine the reasons and to implement the pertinent actions to reach to more users.

EMT Madrid is additionally working on the design of two integrated, energy-autonomous mobility hubs in Madrid at the existing park and ride facilities in Pitis and Fuente de la Mora. The idea is to target the decarbonization of urban transportation, supporting Madrid's goal of climate neutrality by 2030, while addressing energy independence and sustainable mobility needs. These upgraded hubs will serve as scalable models for European cities by combining clean energy production, innovative energy storage, and sustainable mobility solutions.

3.2.5. Conclusion

The modal distribution of Madrid shows a balanced reality, in terms of car use, very similar to that of other European cities of similar size. However, if we go down to an analysis by areas, there is evidence of an unequal modal distribution showing a much higher use of the car, both in transversal mobility within the periphery (30%), from the periphery to the city centre (31%) and in penetration from its Metropolitan Area (61%) compared to the reduced use of private car in the city centre (13%).

In 2019 both Madrid region, with the Aparca-T plan, and the City Council aimed to achieve a park and ride network in the proximity of commuting railway stations and public transport interchange stations to promote the use of public transport and

reduce car dependency.

Currently Madrid region offers 71 parking facilities linked with the public transport. 23 of them are located in Madrid city and seven are managed by EMT. The Citiy Council has built three new park and ride facilities that started operating in 2021, and were integrated into the Aparca-T plan. In addition, 11 more locations have been studied and planned.

The use of the park and ride facilities managed by EMT has experienced a significant increase except for one of the facilities, Pitis, and the general satisfaction of users with the service is quite good.

The increasing use of Park and Ride facilities translates into the reduction of trips made by car in the city. According to the last mobility data the number of trips by car from the periphery to the city centre and from the Metropolitan Area to the city have decreased by 14% since 2021.

3.3 M3 – Fostering sustainable first and last mile logistics by mobility hubs.

3.3.1. Context

Madrid City considers mobility hubs as one of the initiatives for improving air quality in Madrid through the transformation of mobility. Mobility hubs and microhubs are key strategic cornerstones in the Madrid 360 strategy and the new city Sustainable Urban Mobility Plan.

A 'mobility hub' is a recognizable space where various services coexist that promote the transformation of mobility in cities, facilitating shared active mobility, the electrification of the vehicle fleet and optimizing logistics activity. All of them are under the umbrella of digitalization.

Additionally, EMT manages 28 parking facilities in the city that could potentially play a key role in urban logistics, acting as consolidation centres or cross-docking stations, and providing additional services such as charging infrastructure for electric vehicles. In this regard, the EMT Strategic Plan 2021-2025 also includes mobility hubs as a fundamental service to promote during these years.

It is within this general context that, under the framework of SCALE-UP, a new and avantgarde "Sustainable Mobility Hub of services" has been planned and fostered in the city centre.

The so-called "Canalejas 360" hub is located under Sevilla Street and Canalejas Square, very close to Puerta del Sol, in an emblematic area in Madrid city centre.

LOCATION

Figure 12 Location of the mobility hub "Canalejas 360"

The access and exit ramp for vehicles is located at number 20 Calle Alcalá, opposite the Alcázar Theatre. This access is also shared with the public car park under Calle Sevilla and the private car park belonging to the Canalejas Complex.

This measure has been developed in collaboration by Madrid City Council, owner and promoter of the initiative and EMT that currently manages the operation and services in the mobility hub.

Figure 13 Access to the mobility hub "Canalejas 360"

3.3.2. Implementation process

The "Canalejas 360" mobility hub was launched in August 30th, 2022, with the presence of Madrid Mayor, Mr. José Luis Martínez Almeida, and Madrid Councilor on Mobility and Environment, Mr. Borja Carabante.

Therefore, the measure entered the demonstration and monitoring phase with two months delay (initially scheduled by June 2022).

Figure 14 Madrid Mayor and Mobility and Environment councillor the day of the launching

The development of this hub of Canalejas has converted the -1 floor of an existing underground infrastructure into a reference living lab for sustainable mobility in general and electric mobility in particular, occupying an area of 5,500 m2. The ownership of this entire floor is entirely in the hands of the Madrid City Council, and its management is done by EMT Madrid.

This hub, which involves the integration of all mobility and last-mile distribution services in the capital, integrates many different uses oriented to improve sustainable mobility in the city:

- The largest charging station for EV in Spain
- A zero-emission shared mobility area
- Bike parking and storage
- Logistics: Last mile distribution point, lockers, and a pick-up hub

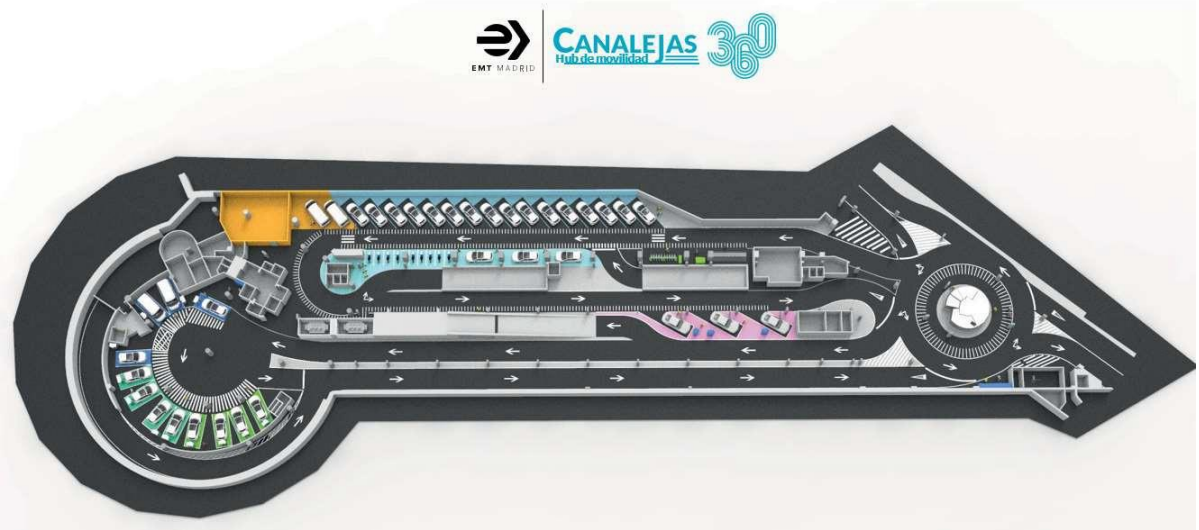

Figure 15 Floor plan of the mobility hub "Canalejas 360"

There is no record of similar initiatives at the national level, not even at the European level, that contemplate the level of integration of services proposed by these solutions and with this size.

Description of the spaces and associated uses:

Charging station

It includes the largest charging station in Spain, with a total of 12 charging points and a maximum power supply of 2.4 MW. 4 out of these 12 points, are last generation ultra-fast chargers with a maximum power of 400 KW, 4 additional ones are ultra-fast charging points with 150 KW power, and another 4 points with 50 KW. If technology allows it, an EV will be charged in a time close to 5 minutes. As a traditional gas station, it also has washing and vacuuming services, refuelling and tire inflation.

Figure 16 EV chargers at the hub "Canalejas 360"

Another point to be taken into account is that this charging station presents a gauge that allows the access to semi-industrial vans and it is equipped with a loading and unloading dock with direct exit to Canalejas Square. This allows battery charging times to be made compatible with activities of urban distribution of goods.

Urban freight/logistics

The hub includes different specific areas to facilitate last mile distribution of goods through environmentally sustainable vehicles that allow reducing the impact of the urban traffic correspondent to this activity (crossdocking/consolidation centre), as well as lockers for the citizens' collection of small and medium e-commerce shipments, including a pick-up point for bigger items. The logistic operator was awarded after a public tendering process (SEUR company).

Figure 17 Logistic area managed by SEUR company.

Zero emissions shared mobility area

Clean shared mobility also has a place in this sustainable mobility hub, with dedicated parking lots for shared mobility services, including charging infrastructure, open to carsharing and moto sharing companies that operate in the city of Madrid. In total, these are the carsharing operators with allocated parking lots: Free2Move (4 lots), Sharenow (5), Zity (5) Wible (5) and recently Voltio (4); for the motosharing companies Acciona (2 lots) and Silence (1). Since the last report the company Iberdrola operated by Cooltra has finished operations. In addition in September 2022 a battery station was installed allowing users of electric motorcycles to swap out a low-charge battery for another already at 100% almost instantaneously.

Figure 18 carsharing area at the mobility hub "Canalejas 360"

Bicycle parking

Cycling also plays an important role in the hub; it includes cycling parking lots for residents for temporary and permanent use with the possibility of charging the bike in case it is electrically assisted. The EMT BiciPark bicycle parking system (safe parking for private bicycle users) allows the storage of up to 14 bikes. In addition, there is a secure parking and charging station for e-scooters (also for private users) with capacity to house and recharge 8 e-scooters (charging service provided by Iberdrola).

Figure 19 BiciPARK service at the mobility hub "Canalejas 360"

Customer Support

Finally, the hub also includes a customer centre open to public for any matter that may apply regarding the uses included in this infrastructure.

3.3.3. Risks found and corrective actions performed.

The main risk during the planning and deployment phase has been obtaining all permits and the administrative paperwork, as well as the grid supply arrangements due to the high power requested; these have been the reasons for the delay in starting operations.

Once in operation, the main risk perceived at first was the potential lack of users (specially for the charging services for electric vehicles).Therefore, the main corrective action was to set the fees for charging quite low. However, the hub turned out to be quite well used. (See next section)

3.3.4. Results

According to the latest figures, Canalejas360 is working well, especially regarding the charging stations, stations and logistic services, as indicated in the next figures. In the case of the charging infrastructure, the observed increase in December 2023 and January 2024 was due to a very high demand from the carsharing companies which has stabilized with time. For the logistic services, a steady growth is observed with the logical reduction of activity during summer months.

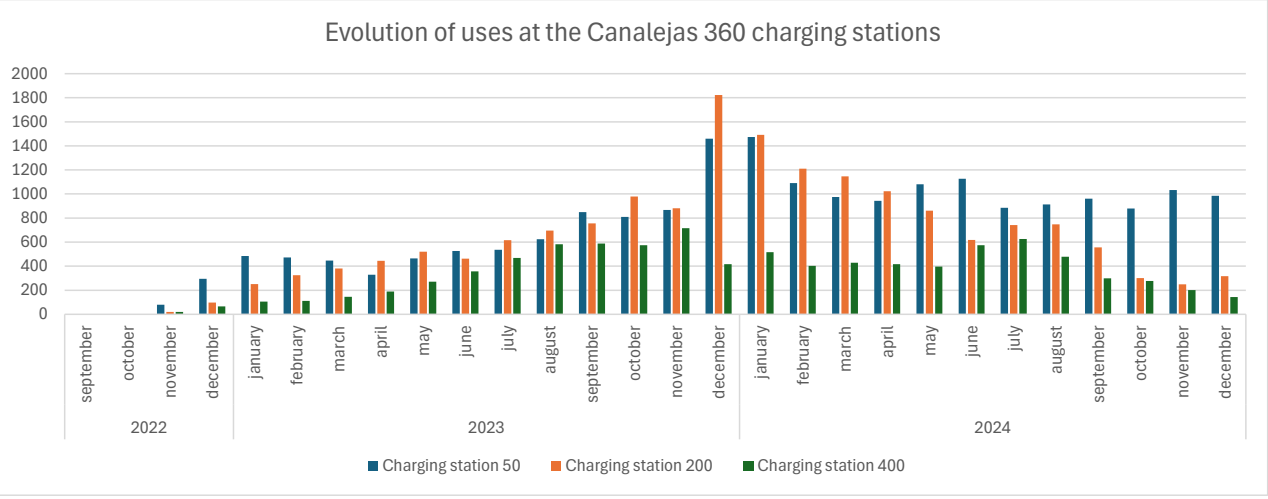

Figure 20 Evolution of charging uses at "Canalejas 360" hub since November 2022

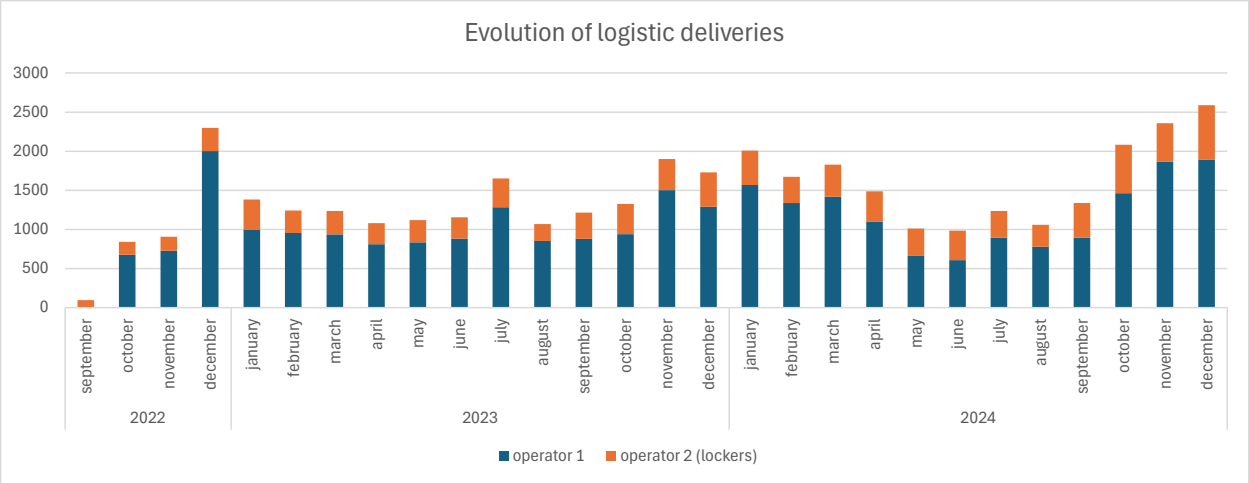

Figure 21 Evolution of logistic deliveries by the two main operators at "Canalejas 360" hub since August 2022

Moreover, the development of Canalejas mobility hub has also been a model of successful public- private collaboration of different agents of the new mobility ecosystem and has improved the collaboration, coordination and dialogue between the City Council, EMT and the private operators.

Though the measure has been already accomplished, both Madrid City Council and EMT are working on possible new locations to deploy additional mobility hubs in the city. The Canalejas 360 hub is a benchmark for public-private partnerships, paving the way to further deployments in other areas of the city. As a matter of fact, in June 24th 2024 the second mobility hub of the city was launched, called Recoletos 360. Its Floor -1 is destined for the mobility hub, with 72 spaces for shared electric vehicles, electric car sharing, as well as DUM (urban distribution of goods), recharging and BiciPARK spaces. The joint plans of the City Council and EMT Madrid include the expansion of high-powered recharging points in the near future. Floor -2 consists of spaces for residents and floors -3 and -4 are spaces for short stay parking spaces.

Figure 22 Recoletos 360 Mobility

Also, on Friday 27th December 2024, the third mobility hub on Paseo de los Artilleros (Vicálvaro) was launched. This mobility hub is managed by EMT Madrid, and it is located above the Vicálvaro Metro station, in the historic centre of this district. It consists of two floors below ground level, with a total capacity of 149 spaces, with 76 for short stay and 73 for residents, 16 charging points, BiciPARK and parcel collection points, including two car par slots for urban distribution of goods.

In addition, the City Council and EMT have the plan to develop 11 more mobility hubs: one in Plaza de España, which is expected to be operational in 2025, another three in the areas of Orense street, Colón square and Pitis railway station that will open their doors in 2026, two more in the areas of Plaza de Jacinto Benavente and Plaza Mayor, which will be launched in 2027.

3.3.5. Conclusion

Despite the initial delay, the measure has run smoothly, and it is fully accomplished.

The Canalejas 360 hub is a benchmark for public-private partnerships and multimodality providing sustainable solutions for the mobility and urban distribution of goods in the city.

The results and the evolution of the logistics services, charging station as well as other services such as carsharing, moto sharing, and battery swaps are beyond what was expected.

Given the success of Canalejas mobility hub, the City Council and EMT have already replicated this initiative in 2 other locations and plan to scale up the deployment of mobility hubs with 11 more hubs until 2027.

3.4 T2 – Implementing Mobility hubs in the Turku region

3.4.1. Context

Currently the city of Turku and the Region of Southwest Finland do not have any small- or large-scale mobility hubs. There is a decision to develop a larger Travel and Service centre that can serve as the main mobility hub in the city of Turku and in the Region of Southwest Finland. This new travel centre is to combine the services of the current train and bus stations, at the same time enabling a wide array of different mobility services. The original estimated time of construction of the Travel Centre was 2024-2029, but still there is no plan decided.

In this measure, the focus is on creating new mobility services to the region together with companies and developing the preconditions for successful services in the multimodality mobility hub. The services are first piloted at the regional level in the station areas of the municipalities Loimaa and Uusikaupunki and in the city of Turku at the current long-distance bus station, which is situated in the proximity of the future Travel and Service centre location. The services to be tested at these station areas include at least the following: shared mobility, last mile logistic delivery, repair services, parking services and information services.

The mobility service operations are evaluated and scaled up accordingly. In Turku, the lessons learnt from the measure are incorporated into the planning and procurement documents of the Travel and Service centre. In the region of Southwest Finland, the outcomes are incorporated into the future regional development plans.

The measure is realized in synergy with measure T1, T3, T4 and visible on the T5 regional mobility data platform. The mobility services tested in the measure will contribute to the promotion of the regional train (T1) at the regional train hubs, as well as the MaaS services and adaptive parking solutions developed in T3.

The broader context of developing mobility hubs has remained stable in the city of Turku and the Region of Southwest Finland. In city Turku, three locations, namely, the Travel Centre, Ferry Terminal and Kupittaa Science Park hold strong potential for developing into multimodal mobility hubs of regional, national and international relevance. Additionally, planned development of regional train service will, if implemented, change the regional landscape of multimodal mobility remarkably. These developments provide the framework for future mobility services to synergise and scale up with.

3.4.2. Implementation process

The City of Turku with cooperation of Regional Council of Southwest Finland has carried out baseline analyses of the mobility hubs and identified terminology challenges in connection with the mobility hubs. The city of Turku rented a bus station lobby since September 2021 for open use and started a pilot with battery charging for e-bikes in the lobby. A regional bike brand was designed and launched in Spring 2022 to support the visibility of actions. A student work on the travel chains has been carried out to provide ideas for the pilots. Travel chains are trips made up of several mobility modes. Often, public transport is the backbone of a travel chain and walking and cycling are strongly present, but there may be exceptions. The aim of the developed travel chains is to replace or reduce the need for private car use. One project workshop on the travel chains was carried out in June 2022.

The Regional Council of Southwest Finland carried out a survey in June 2022 on the desired service level of regional train services. The questionnaire also collected ideas from residents for the pilots to be executed in the municipalities of Loimaa, Uusikaupunki and Turku. The SCALE-UP evaluation baseline City level mobility survey, carried out by TUAS during summer 2022, together with the earlier surveys also have accumulated wishes for the pilots. All the materials have been accumulated as a baseline material for the next steps.

In May 2023 the City of Turku and SWF published a joint call for tenders for mobility pilots. Tendering was intended for service experiments to address sustainable mobility challenges, particularly at the hubs within the travel chain. The aim was also to support the development of new business models and to create conditions for new market-based mobility services.

The tender was divided into four sub-projects, the so-called challenges. For Turku, the call was for sustainable mobility service experiments, which respond to the challenges identified in and around Turku bus station. For the SWF, the procurement is focused on service experiments that promote sustainable and accessible travel chains in Uusikaupunki and active mobility in Loimaa.

Through this call the city of Turku received one proposal which was accepted. Other pilots are acquired through direct procurement process from service providers. The City of Turku carries out pilots to improve the mobility services on its bus station. Unfortunately, the tendering process in May 2023 did not deliver the wanted results for Loimaa and Uusikaupunki so other measures had to be planned so that pilots in Loimaa and Uusikaupunki could take place.

Turku bus station pilots

Luggage storage lockers

From the joint call for tenders, a service of luggage storage was selected to be installed in the Turku bus station. In the design of the storage solution, a strong emphasis was placed on accessibility. The city, together with the service provider, consulted with the advisory group of disabled to take into account their specific needs. This encompassed the selection of the colour scheme, superscript numbers and floor access to the lockers. The visual design was also coordinated to be in line with the general signage protocol of the city. The use of the lockers requires no pressing of buttons or touchpads, since these are an obstacle and inconvenience not only to disabled users, but general users as well. The payment scheme is set up in anticipation of the storage solution being economically viable for the operator even after the trial period is over.

The luggage storage lockers were installed on the 29th of August 2024 at the Turku main bus station. In the design of the storage solution, a strong emphasis was placed on accessibility.

To survey acceptance and satisfaction of the lockers, a sign with QR-code link to the survey was placed on the locker door.

Signage

Signage and guidance elements at the bus station were developed through several pilots. A new signpost has been designed and ordered for installation on the arrivals platform. The main focus on this new signage is to make it easy to find the continuation points of the travel chain. New signage clearly shows the locations of stops of local transit, city-bikes and routes to train stations. In accordance with this signage, also the information screens inside of the station have visual guides to access local transit and city-bikes. Since lack of light is a major issue during the winter months, the signage of the platform numbers with lights was planned but eventually could not be implemented due to high costs.

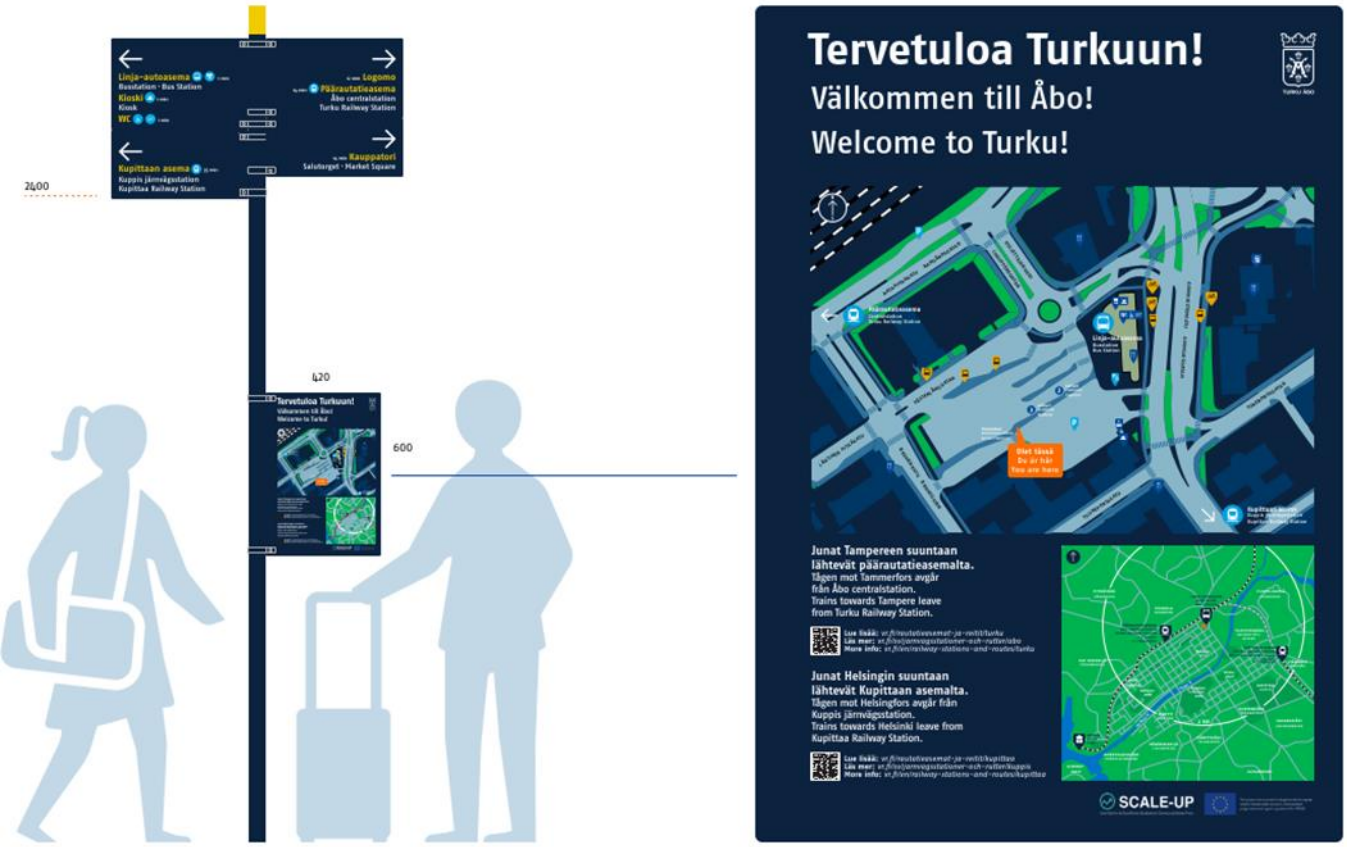

Figure 23 New signage at bus station for enhanced connections to local mobility

Desing of the new physical signage elements at the arrival platform was done to adhere to the fresh signage concept of the city. New signposts were designed and ordered for installation on the long-distance arrivals' platform. The main focus of this new signage was to make it easy to find the continuation points of the travel chain. The new signage elements clearly show the locations of stops of local transit, city-bikes and routes to train stations.

Walk-in bike maintenance pilot

A walk-in bike maintenance and small repairs pilot was implemented by local service provider Fillaritalli. The aim of the timely pilot was to encourage citizens to get back on their bikes after a possible winter interruption. The service was available on 4 Fridays in April and May 2024 between 11:00-17:00. One occasion had to be cancelled due to bad weather. This timely pilot aimed to encourage citizens to get back on their bikes after a possible winter interruption. The pilot showcased high demand for such a service with overwhelmingly positive customer feedback and some 240 customers getting their bicycles maintained over the four days. The service was free of charge for the citizens. A targeted survey was conducted to the bike maintenance users on-site.

Figure 24 Pop-up bike repair service at the Turku bus station. Photo: Eetu Sonck

Online guidance map

In addition to physical guidance, an online area map of the bus stations was created with strong focus on people with visibility restrictions. The map encompasses the indoor spaces of the station, immediate surroundings, and paths towards most central points of interest such as the market square and the railway station. The online guidance map allows familiarizing oneself with the bus station area in advance and supports routing between services displayed on the map. The map supports audible routing, which drastically improves the service level for the visually impaired.

Figure 25 A screen shot of the Citynomadi digital guidance of the Turku bus station

Cycling equipment vending machine

Through a tendering process, a service provider was found to create a new service of cycling equipment vending machine at the Turku bus station. The cycling equipment vending machine hosts a selection of equipment for both the bike and the cyclist, such as brake pads, pedals, lamps and locks.

The vending machine was delayed and was operational 1.11.2024 in the lobby area of the bus station. By the 3rd December, the machine has been used five times according to service provider data.

Other services

To further enhance the service level of mobility solutions, a cargo-bike station (measure T6) has been located in the bus station for convenient access. Also the measure took part also in establishing a delivery locker Agora on the bus station area.

The development of the Travel and Service Centre has been delayed from the original timetable. The project has impacted on the documents developed for the Travel centre regarding hub services and also taken part in developing the new main railway station especially in regard to bicycle stands.

Loimaa and Uusikaupunki

Try out themes for Loimaa and Uusikaupunki were:

1. In Loimaa **active** travel chain from train station onwards
2. In Uusikaupunki travel chain from bus station onwards , suitable also for disabled

people

For Loimaa, a 20-wheel city bike trial was negotiated, starting in early July and ending at the end of October. Bikes were Donkey Republic bikes operated by KaaKau. Feedback on the trial was collected during the trial through the city's own feedback channels and through the KaaKau application. After the trial period an open feedback survey was carried out, which also collected feedback from citizens who did not use the bikes. However, only 16 responses were received.

Figure 26 City-bikes in Loimaa. Image: Heidi Caven

The Loimaa city bike trial lasted for four months. During this time, the bikes were used 147 times by 56 individual users. 10 of these users took 43% of the trips made with the bikes.

Negotiations with Loimaa on a possible continuation of city bikes took place after the trial. Unfortunately, the municipality was not willing to pay all the cost of the service by itself and tried to get big companies to participate as well. Companies did not see the value of the service so, at the moment, there are no city bikes in Loimaa. The municipality is in favour of the city bike service, though, hence the situation might change in the next couple of years.

SWF organised a webinar for the municipalities about the benefits of the city bike system also in small or middle-sized municipalities. The webinar took place in May 2024. After that, some discussions among smaller municipalities took place but just on an idea level and for example city of Salo is very interested of testing the citybikes.

The pilot scheme in the municipality Uusikaupunki had to be slightly redesigned. In early autumn, the city of Uusikaupunki put public transport operators out to tender and included the on-demand bus service on procurement.

In Uusikaupunki, an online ordering service for the on-demand bus service, Vukikyyti, was implemented, which was launched in December 2023. Before this pilot, ordering on-demand transport buses was only possible by calling or texting the driver directly. The aim was to develop an easy, customer-friendly online ordering service for Uusikaupunki. The service was developed by the operator LS-Linjaliikenne Oy, which is also the operator of the on-demand transport service.

A general survey was conducted in November 2024 in Uusikaupunki inquiring about the use of Vukikyyti and it got 51 respondents.

The online ordering service pilot for Uusikaupunki on-demand bus service lasted for 10 months and pilot ended in October 2024 but the service will continue and it is developed further based on customer feedback.

3.4.3. Risks found and corrective actions performed

Table 3 Risks and corrective actions for T2 measure

Risks found	Corrective actions performed
The concept of mobility hub is not understood.	Discussion on the terminology has been initiated on the regional and national level.
Lack of economic sustainability of short-term pilots after the pilots are over.	Identification of different tendering options and possible continuation options for the pilots.
Some permits for the infrastructure work is probably needed for the pilots.	Preparations to showcase the win-wins for all the stakeholders.
Lack of potential service providers of mobility services in the region.	Procurement process is adjusted more towards direct acquisition.
Lack of knowledge of potential mobility service providers within the city organisation.	Knowledge and connections to mobility service providers is being distributed whenever possible to developers of relevant projects around the city.
Compromised interlinking and commitment of mobility hub goals	Personal participation of personnel of mobility solutions is being requested

to the planning of current major developments.	on major development projects where relevant.

3.4.4. Results

Participation of the inhabitants for the developing of the future sustainable mobility solutions is essential for gaining the acceptance of the new services. It is also vital to get the feedback from the end users and hear what services are most important to them.

A survey was carried out in June 2022 on the desired service level of regional train services. It collected ideas of residents for the pilots to be executed in Loimaa and Uusikaupunki. 6062 responses and 1,259 suggestions were received. The most popular of the options given were city bikes, but open responses highlighted in particular the need for connection options from the stations and secure storage facilities for e-bikes and scooters. The attitude towards local train traffic seems very positive based on the results and developing a sustainable travel chains in Southwest Finland interests people.

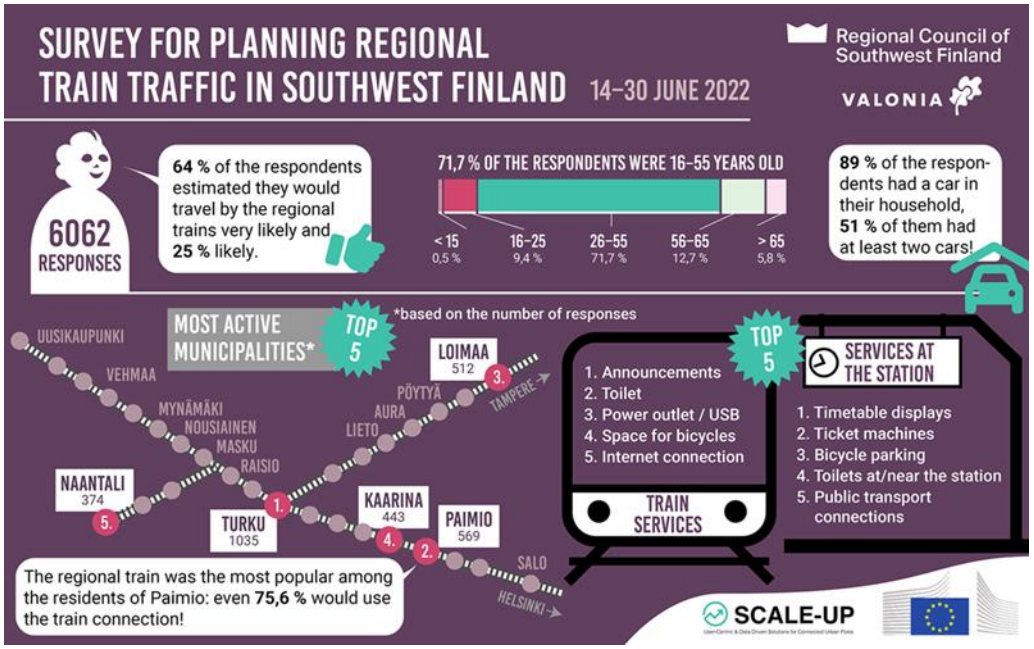

Figure 27 Survey for planning regional train traffic in southwest Finland

The regional council has written blog texts, news articles etc. about the goals of getting regional trains back to Southwest Finland. All together 34 news items about the Scale-Up – project and regional train issues have been published in 27 different medias, social media included based on Regional Councils media releases and newsletters. Most of these media hits are due to the survey about the service level of the regional train stations.

Turku bus station pilots

The city of Turku has identified several needs for developing functional mobility hubs. Identification of these needs is a crucial requirement in going forward with development of mobility hubs that satisfy the needs of their users.

Luggage storage

Feedback on the luggage storage solution was collected via specific online feedback form and on general feedback of the bus station. Out of the pilots in the bus station, the luggage storage was most noticed, with 80% of the respondents reporting having noticed it. 75% of the respondents were very satisfied or satisfied with the luggage storage solution. 100% of the respondents considered luggage storage to have positive or very positive impact on their urban mobility. Additionally, 100% of the respondents considered it very important that the luggage storage will be available also after the pilot has ended. To sum up, luggage storage was, as anticipated, much appreciated improvement to the services in the bus station. The luggage storage will stay in operation under the bus station operator.

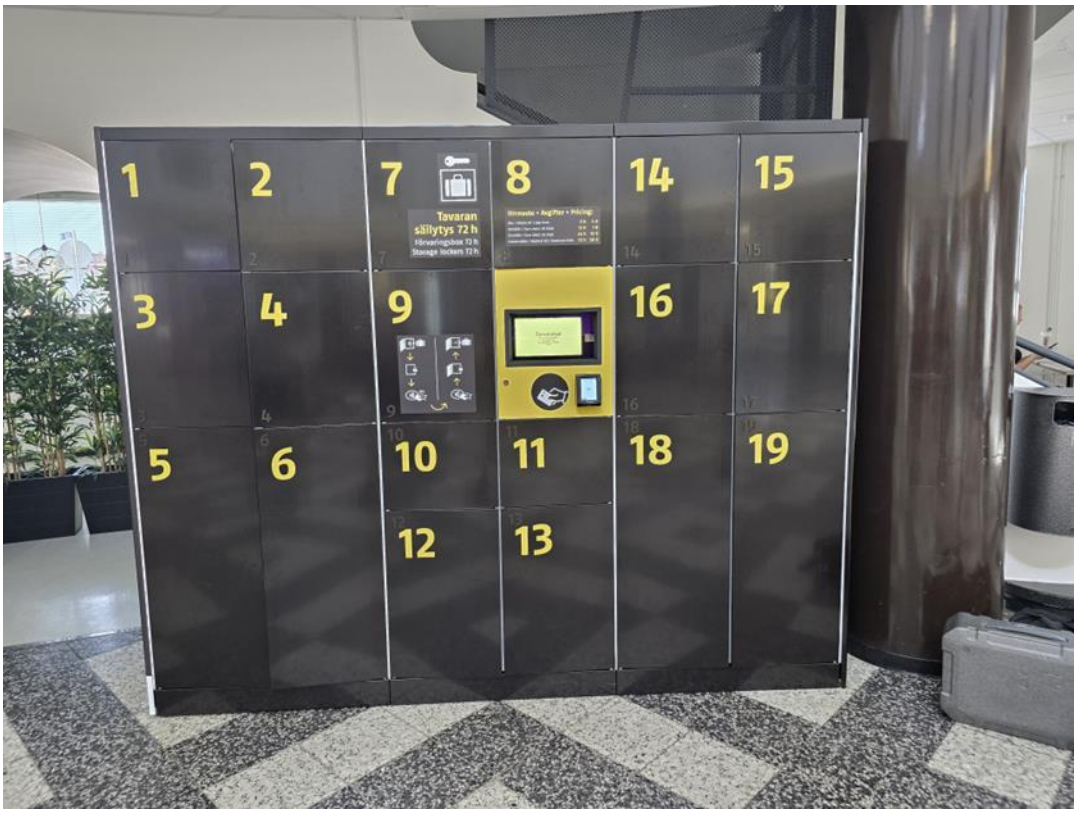

Figure 28 Luggage storage in operation at Turku bus station. Photo Patrik Wirman

Walk-in bike maintenance pilot

Feedback regarding walk-in bike maintenance pilot was gathered through feedback forms which customers filled out while waiting for their maintenance. Of special interest is the impact such trials have on the willingness to cycle instead of using inactive modes of mobility. The pilot showcased high demand for such a service with overwhelmingly positive customer feedback and some 240 customers getting their bicycles maintained over the four days. Collaboration with Fillaritalli was smooth and has lowered the threshold for further collaborations.

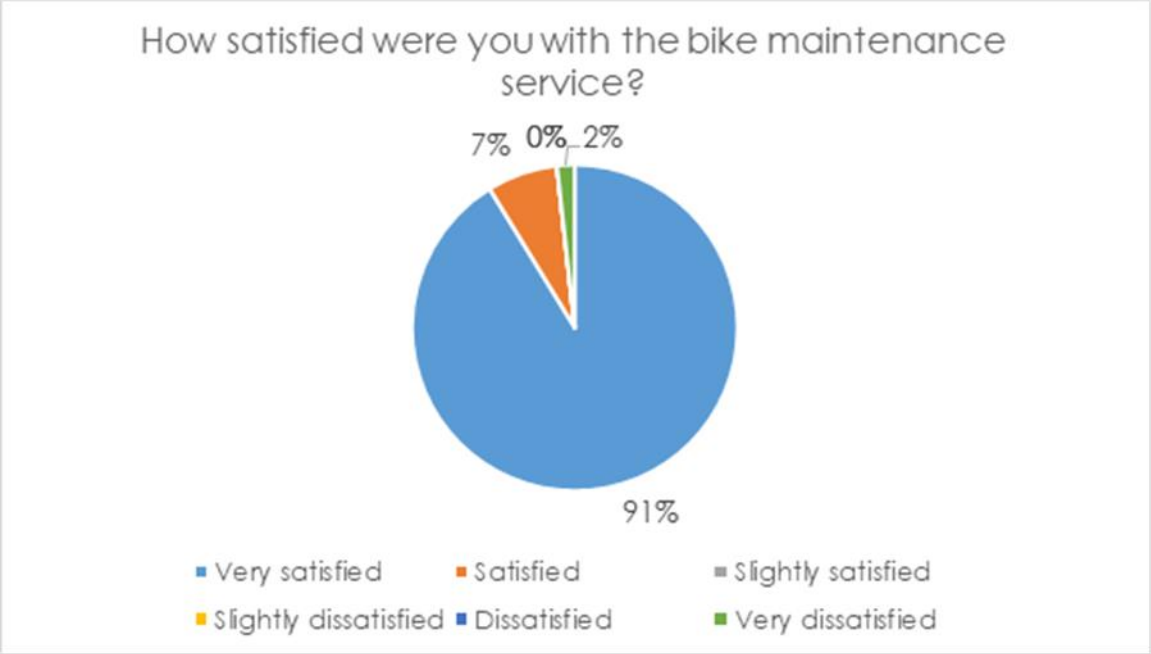

Figure 29 Feedback on the cycle maintenance trial at Turku bus station.

Signage and guidance

Signage and guidance elements at the bus station were developed through several pilots. A new signpost was designed and installed in early September 2024 on the arrivals platform. New signage clearly shows the locations of stops of local transit, city-bikes and routes to the train stations and adheres to the fresh signage concept of the city. 100% of the respondents on the general survey of the bus station reported being satisfied or very satisfied with the new signage element at the arrivals platform and 100% consider it important or very important that the signage element stays in place after the pilot is over.

Figure 30 New physical signage at the arrival platform of the Turku bus station. Photo: Stella Aaltonen.

In addition to physical guidance, an online guidance map of the bus stations was created with strong focus on people with visibility restrictions. The map was published and operational on 1st of November 2024. Only two respondents on the general survey of the bus station evaluated the digital guidance map, but both of them reported themselves as satisfied with the service. The routing function has been used 277 times online to draw routes on the map for users.

Cycling equipment vending machine

Vending machine for cycling equipment was implemented 8th of November 2024 at the lobby of the bus station. Between its launch and 4th of December, the machine had been used 5 times. One respondent evaluated the vending machine and reported being satisfied with it. Respondent also considers the vending machine as a good way to support cycling in the city.

Figure 31 Cycling equipment vending machine at the Turku bus station. Photo: Stella Aaltonen

Apart from local pilots, the development of mobility hubs has been on-going within major development projects and strategic decisions taken by the city. New services and learnings piloted at mobility hub are already feeding into the concurrent planning work in the Kupittaa Science Park, Ferry Terminal and Travel centre.

Loimaa and Uusikaupunki pilots

From the citybike trial in Loimaa, results were as follows: The bikes had 56 unique users, of which 10 were monthly users, 46 occasional users. There were 147 bike rents. This is not much but it was a good start. According to GPS data, more than half of the trips were up to 3 km. The data also shows the frequency of certain trips. The most popular rental was from Loimaa station to Loimaa station, meaning the bike was picked up from and returned to the train station. It is reasonable to assume that some of the monthly renters have used the bike for commuting - taking the bike from the train station on arrival and continuing to the workplace. Summer visitors probably also use the citybikes as mentioned. In Loimaa, city bikes could be a solution to the 'last mile' challenge in commuting. In the negotiations about the continuity of citybikes, larger

companies in Loimaa were also involved. So far the companies have not warmed to the idea of contributing to the costs of the city bike system.

Loimaa citizens gave some feedback through the city's feedback service. The feedback was mostly positive. Most of the feedback was related to communication and station locations. Communication was not considered sufficient, much more information would have been appreciated before the bikes arrived. In the future communication issues must be taken more seriously into consideration. Communication issues are the plausible flaw also in the lack of answers to the feedback questionnaire. Even though flyers with the QR-code were made to boost the online campaign, people just were not interested enough in answering the questions.

Pilot period in Uusikaupunki's on-demand bus service lasted until end of October 2024. Originally was planned that feedback from customers is collected two times during pilot. This was proven unnecessary because needed data was revised from ordering service itself and people sent some feedback through city feedback channels. Only one survey was made in the end of the pilot period, and it got 51 respondents. From 38 respondents 23 had used the service and 10 of them had used the online ordering. They had been very pleased with the service and 7 out of then admitted that online service has made the ordering easier. During the pilot period altogether 710 orders were made, 14 of them were now-shows and 696 were completed rides. 225 orders were made via online service. Even though online service makes it possible to order the service beforehand and during evenings and weekends, so it is much more flexible to use, phone service was more popular during the pilot period. Presumably phone service is more familiar specially among elderly people who are the most common users of Vuki-kyyti.

3.4.5. Conclusion

Smaller towns (Loimaa and Uusikaupunki) did not have any shared vehicle system before the Scale-Up pilots. Public transport in the city was also rather limited. After the city bike experiment in Loimaa, market based electric scooters appeared in the streets. It is assumed that the city bike experiment has created a suitable platform for this kind of service. The saying "money makes money happens" could be translated as mobility services makes mobility services happen.

Issue regarding citizen engagement is twofold: on one hand some people are interested in enhanced mobility services at mobility hubs and are able to communicate their needs, and on the other hand some struggle to understand what new services for multimodal mobility could be and what the possibilities of these improvements could mean to their daily mobility. Visible pilots and well executed communication of them will eventually improve the general awareness of the citizens

about the potential changes the improved services at mobility hubs could allow for them in their everyday lives.

Communication plays significant role in offering new mobility services as in many cases it is not enough that services are offered but inhabitants must know that they are there and most of all they must know how to use new services. Sometimes "fear" of using something wrong way might lead to not using the service at all.

Another conclusion concerns the organisation, interconnectedness and information within the city organisation. As with the citizens in general, there is a lack of understanding the potential of multimodal mobility hubs and the variety of mobility services they could provide with the city officials. This is visible in some lack of commitment to providing the suitable space and infrastructure for new mobility services in hubs currently in planning. This is in great part because of current planning guidelines which, as things stand, do not include mandatory allocations for new mobility services. For this reason, for new developments to seriously consider mobility services of the future, it is required that some outspoken and insightful people are present at the planning process at the right times. For many occasions, this is not the case as things stand.

Major steering document has been created in collaboration with the spearhead project of the Turku Science Park to create the service levels for the up-and-coming major mobility hubs in Kupittaa, Travel centre and Ferry terminal. This work on the service levels of the future major mobility nodes has been a collaboration of many branches of the city and multiple stakeholders and has deepened the mutual understanding of needs regarding travel chains and multimodal mobility hubs. The document focuses heavily on the user experience on the multimodal travel chain and will works as a blueprint for creation of user-friendly major mobility hubs in the future.

The creation and development of mobility hubs and travel chains are also successfully solidified in the fresh Sustainable Mobility Plan of Turku. The focus and momentum in developing mobility hubs has translated well into the important SUMP-document which will steer the planning of all aspects of sustainable mobility in Turku.

Development of the regional public traffic trunk routes provides an opportunity to scale up the delivered services and learnings. Also, the digital guidance map framework is easily repeatable on major mobility locations as well as during events. Pilots such as the digital area guidance and routing system can be readily scaled up to other cities, and Turku could act as a forerunner on this regard. Ever-intensifying regional collaboration also opens up avenues for Turku pilots to find their use cases in other municipalities in the FUA. The luggage storage lockers have already been of interest to the planners of future Travel centre and the Kupittaa Science Park area. A bicycle equipment vending machine can also be scaled up in connection with bike

repair stations around the city and in development of future mobility hubs and bicycle parking locations.

In the pursuit of regional rail services, other mobility services play an important role. When smaller communities, such as Loimaa and Uusikaupunki, understand the importance of various mobility services as a part of a functional travel chain, they start to develop the services. Mobility services such as shared bikes or different types of public transport services will not be seen only as a matter for big cities. This will lead to more services and, of course, more users.

Collaboration with major development projects has been more systematic thanks to the focus on developing mobility hubs. This is a promising precedent for mobility hub and travel chain development in the city in the future.

3.5 T3 – Introducing MaaS ticket combos and adaptive parking in Turku region

3.5.1. Context

Mobility as a Service (MaaS) has been identified as one of the key areas to develop in the field of mobility and transport of the city of Turku. This is indicated in the Climate Plan 2029[11], in the Finnish state agreement concerning land use, housing and transport (MAL), and in the city's spearhead projects. So far, the Turku Regional Public transport has developed a MaaS platform that is technically able to integrate different operations together. This does not include a sales platform. Ticket integrations have also been tailor made for each individual case and are not generic. In addition, all negotiations have been carried out separately with each operator.

During 2020, the city of Turku has digitalized its parking management and thereby created an opportunity to combine data sets for introducing new innovative parking services with MaaS operations.

This measure had several components inside it and therefore it was divided into two sub-measures with each two parts. In T3.1.a Ticket integrations to public transport, an open interface for event ticket combination with the public ticket system was created, tested, and marketed towards different event actors. An important part of the part T3.1.b MaaS, was to create a systematic MaaS ecosystem with stakeholder engagement.

In T3.2a Parking hub the city of Turku developed a parking hub platform by integrating new data sets and creating base for par and ride pilots and in T3.2.b Park and ride pilots 3 adaptive parking solutions in different locations, including park and ride tests in

connection with events were piloted.

This measure relates to T2, T5, T8 and T9. MaaS services can be piloted at the hubs (T2), and they were integrated to the mobility data platform (T5). In T8, mobility services were incentivized. In T9, mobility guidance in connection with events and exceptional circumstances is developed, thereby also facilitating the usage of mobility services in the city.

Over the past two years, the mobility sector has suffered from a failure of several service providers and the number of actual successful integrations has been low. Also, the Corona times impacted seriously on the reduction on the number of service providers and their interest towards ticket integrations. This has resulted in a difficulty in finding operators and business cases that could be piloted within the project.

Digitalization of services has been in focus for many national and EU process, this has impacted on the implementation of the actual measures, due to the fact that it is not yet clear what the data standardization requirements and data pools will require from local implementations. It is important to avoid additional work in planning of the technical specifications and the long process in regard to the common grounds has hindered some of the measure planning.

3.5.2. Implementation process

This large measure has been divided workwise into two areas with subdivision:
T3.1.a Ticket integrations to PT and T3.1.b MaaS.
T3.2.a Parking hub development, T3.2.b Park and ride pilots.

Below is described what has been done in each of the areas.

T3.1. a Ticket integrations to PT:

A new open interface for event tickets combinations to the public ticket system has been procured, designed, tested and is ready for use. This feature has been marketed to small event organizers and integration of 2 new event organizers has been already implemented and is in use, several others are under preparations.

For the city's Public Transport (PT) several ticket combination solutions have been considered and plans for further development have been done. There was a need for the PT mobile application integration to provide the users with park and ride possibility for commute, events, and other needs without the need to drive a car to the city centre where congestions, air quality and lack of space are major issues.

A process in which a park and ride feature has been designed and developed into the PT app has been carried out together with service provider PayIQ. As a result of that, the users can use the park and ride free of change when paying their PT trip

through the app. This feature has been piloted as part of park and ride pilots T3.2b. The data from the feature is stored in T3.2a parking hub. It became evident that also paid parking combination with PT single ticket would be needed and this feature has been coded for future use.

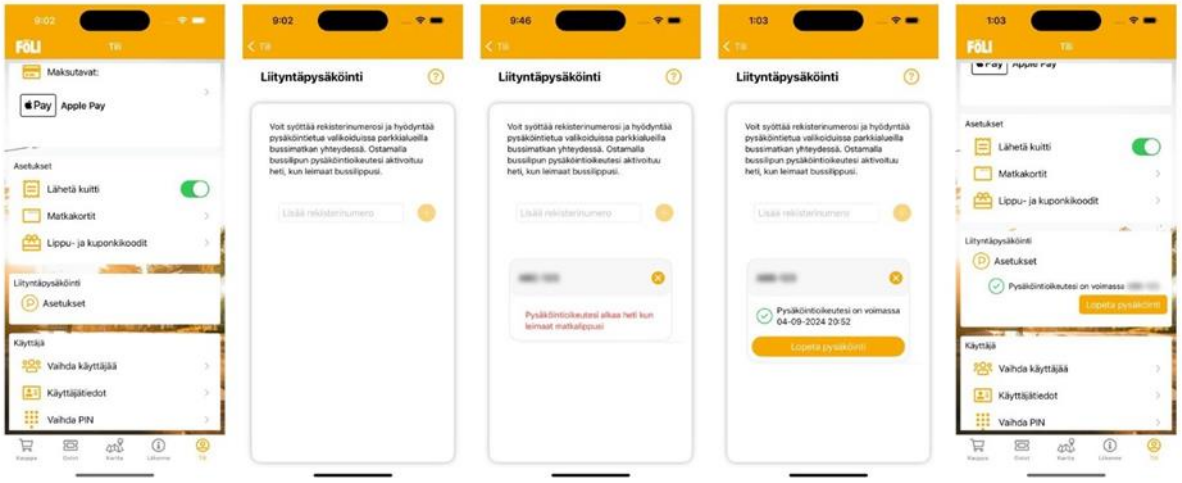

Figure 32 Föli mobile app

T3.1.b MaaS

The existing MaaS environment has been analysed to provide a better understanding of it as well as to create basis for different kind of park and ride combinations. Different MaaS business cases and stakeholders have been identified and evaluated. Further development for the potential implementation has taken place with following packages:

- hotel accommodation and PT ticket combination and
- supermarket food delivery and park and ride with PT.

In both of the cases, it became clear that it is very hard to get relevant stakeholders onboard for piloting of these business cases.

It took a year to get one hotel onboard to pilot the business case. The pilot was carried out in August 2024 with Hotel Kakola and the regional public transportation operator Föli. During the time 60 travel cards were sold and 169 trips in total were taken with them. Hotel Kakola found the experiment successful and would be interested in continuing the co-operation with Föli. In an ideal case the nudge should be done so that the Föli travel card is included in the price of the hotel room and no additional fee is charged.

The experiment was widely communicated through various channels and carried out jointly with the project, Föli and the hotel. During the experiment, it was found that a similar overnight package would also be feasible on a larger scale and with hotel chains, for example.

A business model for the food delivery brought to your car combined with park and ride with PT was not as successful, as the supermarkets did not want to carry it out at this stage. Luckily, they were willing to test the park and ride with PT on their premises (T3.2b).

Co-operation with Cities 4.0 project that organized mobility competitions has taken place and through that discussions with new mobility service providers have taken place. A pilot with E-Mobility Solutions was carried out regarding urban logistics. The pilot included two electric mini-vans and a charging station for the vans' batteries. The pilot started 30th July 2024 2024at a summer terrace area next to the Turku Cathedral. Mini-vans provided the many businesses at the summer terrace a new low emission option for their logistics in and around the city centre. After the summer terrace closed mid-August, the vans and the charging cabinet were relocated to a new location. From 27th August 2024 onwards the vans and charging cabinet were operational at the House of the Arts in the historic old town district. House of the Arts is another multi-actor environment, with several organisations, businesses and freelancers as users.

Figure 33 Users of mini-vans were able to independently replace the vehicle's batteries with new ones using a mobile app. Photo: Iiris Yli-Junnila

The feedback questionnaire for the mini-vans shows high satisfaction with the vans, with all respondents being satisfied or quite satisfied with the pilot. All respondents reported that the mini-van replaced trips that would have been otherwise carried out with a car. From a business model perspective, most respondents would be prepared to pay for the service based on hour-based charging (67%) or service based on charges based on daily usage (67%). Most preferred costs of the service the users would be willing to pay are on hourly basis 3-5€, on a daily basis 20-40€, on a per battery swap basis 5-10€ and on a monthly basis 200-400€. The respondents stated that the most important aspects of their future usage of the service would be the convenience of starting and ending the use of the vehicle and the flexible options for usage of the service.

Three MaaS stakeholder forums were organized, the final one through a webinar in April 2024 with the intention to inspire them to develop MaaS integrations. The stakeholders contributed to a questionnaire, based on which it became evident that there is a need to develop the co-operation further in future. Despite this, none of the existing operators were willing to carry out pilots during the project time.

T3.2. a Parking hub development

The parking hub platform collects all the digital parking data in the city of Turku. The parking hub platform with open-source code was redesigned, updated and tested before launch to the production environment. The open API for real-time parking availability has been connected to the city's service map (T5) to provide the needed MaaS information.

A new layer for park and ride was planned, coded and implemented for park and ride pilots. The parking hub has been running full paid parking information and integrated the park and ride data through the park and ride pilots in T3.2b. Parking analysis tools have been further developed and improved by also integrating an enforcement layer to it. This means that all the different parking permissions are now seen by the parking employees.

A design for parking hub data analysis has been carried out and a study on how to integrated AI into it has been made. Due to the change in technical service provider for the open source code services and the change into cloud servers, the AI integration has been delayed until the start of year 2025.

The parking hub has been showcased in the following events: Polis small and medium sized cities meeting in June 2023 and Polis conference November 2023.

T3.2.b Park and ride pilots

The first park and ride pilot was carried out in December 2023 in connection with Path of Light event. In the pilot the park and ride process (contracts, physical space, user points, evaluation, responsibilities etc) was planned, tested and evaluated. This pilot included three different versions: private parking + parking service provider + rented busses, park and ride and PT and private parking + parking service provider + light train connection. The first pilot verified that a parking hub platform with park and ride digital layer is truly needed for the future and the pilot influenced the technical specifications of the parking hub layer in T3.2.a.

This first pilot received only few users mainly because of late and lacking communication. Also, the three different versions of P&R implementation made the pilot appear confusing and splintered. However, the three versions all worked principally fine, even though lacking users and streamlined user experience.

As a second pilot, a park and ride pilot in connection with the Tall Ships Races in July 2024 was designed and carried out. This included the testing of the park and ride layer developed in T3.2. and then marketing it to external parking platform providers. EasyPark modified their system so that they were able to take part in the pilot by feeding the data into the parking hub in T3.2a. In addition, another service provider, Parkman, took part in the development and now has their system connected into the park and ride layer for future use.

The pilot was carried out between the 17th and 21st of July 2024 by renting a parking area outside the city centre in Artukainen for the duration of the event and procuring busses to transport the users to the Tall Ships Races event area. Also security control was procured for the pilot to guide and check the paid parking. Marketing actions were carried out together with the event organizers and at the rented parking area. The cost of a parking was 15 euro + service fee per car and this was paid through the EasyPark app. A total of 401 paid parkings was carried out during the pilot.

A feedback survey on the TSR event in Turku was conducted by the event organizer. The survey collected 961 responses from visitors, and it looked at the park-and-ride parking as part of the event. 92% of respondents arrived at the event as planned. 45% of respondents were aware of the possibility of park-and-ride parking, and 2% of respondents said they had taken advantage of the service.

Figure 34 Signs at Turku Fair Center parking area (Photo: Eetu Sonck)

Figure 35 Banners outside the parking area (Photo: Eetu Sonck)

As a third pilot, a park and ride pilot combining free parking at five supermarket locations with public transportation ticket was tested. Planning of this started in 2022 by identifying suitable park and ride spots in the city (private, unofficial spots and possible future locations). Based on those the most prominent parking areas turned out to be owned by private supermarkets and in 2023 contacting of the landowners and the business owners in connection with private supermarket chain locations took place. This process took a long time and only in the Spring 2024 agreements were signed with five different supermarkets regarding allocating four parking spots for the park and ride pilot. Park and ride signs were designed with usage instructions, guidance materials and marketing materials. In this pilot the park and ride feature designed in T3.21 was piloted. Addition resourcing for this pilot was received from National funding regarding the marketing of the measure (Leppis).

The pilot started on the 11th of September 2024 and during the pilot period until November 26th, eight people have tested the ticket integration. There has been 41 parkings activated altogether, meaning that several users have found the product useful and have returned to utilize the service. The feedback collected has been rather positive, and the residents have hoped that park-and-ride parking will be expanded in the Turku area. 41 people have answered the internet survey, five of which have tried the park-and-ride personally.

Figure 36 Park-and-ride locations in Turku

Figure 37 Example on marketing material used on social mediaFigure

The marketing was carried out in close cooperation with an advertising agency and local public transport Föli. Park-and-ride has been actively advertised on social media both organically and on a paid basis, and two videos, for example, have been prepared and published during the autumn of 2024. In addition, park-and-ride has been announced on the City of Turku website and by contacting the surrounding municipalities and local newspapers.

3.5.3. Risks found and corrective actions performed

With the measure the Finnish social and health care renewal caused resource reallocations in the city's IT department which have causes problems with server building, updates and testing. Also the change of technical and cloud service provider caused delays. These were minimized as much as possible by using internal coders to develop the necessary features.

The PT mobile application development took a long time and needed pushing from the project side and selling the idea and value of park and ride in general.

There have been attempts to previously get agreements with supermarket chains about park and ride type of solutions with quite negative feedback. To minimize this extra effort was put on marketing the park and ride idea, possibilities and easiness to supermarket owners. As a plan b some city owned areas were kept as an option but luckily this risk did not actualize.

Change of staff members in June 2023 caused delays in the measure especially in regards to parking hub development and park and ride pilots. Turku measure has also suffered from the lack of clear leadership within the digital services and on slow general technical support for IT-architecture development from service providers. As mitigation action, the project leader has taken an active role in the digital development of the city, in preparations for technical justification documents for its integrations and taking part in tendering of the future service providers.

An identified risk with MaaS business cases is the lack of interest and resources from the stakeholders and the lower overall interest in MaaS. This risk has been mitigated by investigating several pilots at the same time.

3.5.4. Results

T3.1.a Ticket integrations to PT

The new event ticket interface has proven to be well appreciated and the interest towards it is rising. A specific marketing section of the regional public transportation has been established and a systematic marketing towards different actors is now taking place.

The regional public transportation has started to see the value of park and ride and what it could be in the future. This opens up the possibilities to enlarge the park and ride ticket combinations to the functional urban area.

T3.1.b MaaS

As the reputation and context of Mobility as Service has changed during the last years, it is harder to convince actors to develop these kind of services, let along share data about them.

There have been three MaaS-ecosystem discussions with interested stakeholders. Especially companies have been very interested and happy with these.

For the future ticket interfaces, there needs to be a clear business case for all of the actors involved.

T3.2.a Parking hub development

The data from the parking hub platform is visible in T5 mobility map showcasing the current online status of parking spaces in the city centre. This has enabled showcasing

what it means to develop the parking hub for the end-users.

The parking hub API is working well and the new version with park and ride layer is in production server enabling even more parking permit types can be implemented for various MaaS combinations. The parking hub is available as open-source code in Github [2]. So far 3 service providers regarding park and ride are integrated to the platform.

Parking hub has risen some interest among other Finnish cities looking for data-oriented parking solutions, and further development plans has been discussed with both Helsinki and Stockholm that are currently using the same base code for their parking hubs.

The parking data collected by the hub has been proven useful and will be further analysed to provide more information for the whole mobility environment.

T3.2.b Park and ride pilots

It took a long time to work with several subcontractors in regards to code updates and ticket interfaces. This caused delays in the timings of the pilots.

Private companies are interested in park and ride, but it takes a lot of work to get the pilots going. The originally estimated timetable has changed due to change of personnel. Service providers need very clear instructions as in many cases the negotiations are done by marketing personnel in the company, not by the technical personnel.

At the moment, the interface of the parking hub platform allows the city to monitor activated park-and-ride and event-time parking in real time in private landowners' areas, such as the store parking lots. In the future, the information on the platform should be refined to make it easier to use in practise and private operators should be encouraged to share information more widely.

The park and ride pilot showcased that vital parts of the process are the following: early and systematic marketing of the park and ride, checking the existing signs on the parking place and how the ticket payment is verified in the connecting transportation. In particular, the feedback survey responders asked for the opportunity to continue the journey on the city bike, which should be encouraged.

Retailers have been interested in the experiment, and some have already agreed to extend the agreement at the end of the experiment. In addition, the city has approached the owners of the desired parking areas that have come up in the feedback survey, with the aim of expanding the network of park-and-ride parking spaces in the direction desired by the residents.

3.5.5. Conclusion

The city of Turku has made significant advances in developing Mobility as a Service (MaaS), with a focus on integrating various operations, and parking management. Despite facing challenges, progress has been made in creating an open interface for event ticket combinations, identifying and evaluating MaaS business cases, developing a parking hub platform and carrying out park and ride pilots.

Timing of this measure was optimal, as park and ride has become a hot topic among the politicians. This topic is now visible also in the SUMP agreed by the Turku city board in December 2024. Without the project, this issue would not have been addressed otherwise.

This measure has several large measures inside of it and for the work it would have been wiser to differentiate them into measures of their own.

The measure has showed that the knowhow of digital solutions and how to develop them is relatively low in the city. This has hindered the development of the measure and also caused several misperceptions especially regarding open data and use of AI. In the future, there needs to be more hands-on use cases to sell the value of new digital solutions.

In order to lure new mobility services into a smaller city like Turku, persistent and ongoing co-operation is needed with service providers. Assistance is needed to create conditions for piloting and testing of different use and business cases.

Plenty of time must be allocated to negotiations and agreement-creation in pilots such as these, which involve a lot of external actors. Legal proofreading on both sides will take some effort in novel collaborations such as our P&R pilot.

Some of the most potential location for future P&R areas are starting to be identified more clearly, and going forward there are efforts to implement P&R as more permanent solutions on city-owned premises. The longevity of the service is of vital importance in getting people to trust and learn to use it. For this reason, it will be greatly beneficial for the city to have control over the P&R location to develop in in city's own terms in the long term.

[1] https://www.turku.fi/sites/default/files/atoms/files/turku_climate_plan_2029.pdf
[2] https://github.com/City-of-Turku/parkkihubi

4. Conclusions

This final report describes the implementation process, first results and next steps of the 5 SCALE-UP measures on the design of multimodal hubs and network optimization framed in the multimodality WP3: A3, M2, M3, T2 and T3.

Regarding the multimodal hubs, Antwerp and Madrid are pushing the use of these facilities in the city and metropolitan area to reduce the car dependency, shift the mobility towards more sustainable modes and optimize the transport networks.

The transport region of Antwerp has defined a network of multimodal mobility hubs with different service levels and the city has developed 12 mobility hubs. Both Madrid region and the city have developed plans to promote the use of Park and Ride facilities in the metropolitan area and at the outskirts of the city. Madrid City counts with 9 park and ride facilities that have been integrated into the regional Plan Aparca.T and has projected and studied 11 more parking facilities connected to public transport.

After the implementation, Madrid and Antwerp have monitored the use as well as users' satisfaction through surveys and workshops. When results were not as expected, the reasons were evaluated to take the pertinent actions using the surveys and workshops as input.

Both Madrid and Antwerp are promoting the use of different modes of transportation including different services of micro mobility in their mobility hubs and park and ride facilities.

In the case of Antwerp, ATR has carried out an analysis of the bikebility index evaluating risk situations, conflicts and the connection between multimodal nodes and the bike network.

The City of Madrid has developed a mobility hub through a public and private partnership integrating sustainable mobility services and last mile solutions that will replicate over the city.

The region of SW Finland is planning to develop a larger Travel and Service centre that would serve as the main mobility hub in the city of Turku and in the Region of Southwest Finland. For this purpose, mobility services have been tested in three municipalities to identify the needs and potentialities to improve travel chains and multimodal mobility hubs.

The city of Turku has also tested park and ride pilots in different events and at a supermarket and have worked very hard on the multimodality by integrating different services, business cases, stakeholders, and ticketing into a MaaS.

The cities have shared their experiences focusing on the progress and also the challenges, risks and measures implemented. Knowledge exchange webinars have been very useful and productive. As the implementation of the measures has progressed, these exchanges have focused more and more on results and lessons learned with relevant outcomes for WP3 and for the project.

Overall, all the measures have been implemented as expected. The evolution has been adequate and according to the Grant Agreement schedule. The monitoring of the results (i.e P&R in Madrid and mobility hubs in Madrid and Antwerp and mobility services pilots in Turku) show positive results and impacts in the regions and cities mobilities and great potentiality to scale up the measures in the future.