

The GEMINI evaluation framework

19/11/2026

TRANSPORT & MOBILITY LEUVEN

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GEMINI
GREENING EUROPEAN MOBILITY
through cascading innovation INITIATIVES

Co-funded by the European Union

GEMINI D2.3 The GEMINI Framework

GREENING EUROPEAN MOBILITY
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D2.3 Final Version of GEMINI Framework

Contributor(s): Transport & Mobility Leuven, GEMINI MLL partners

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Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the Climate Infrastructure and Energy Executive Agency (CINEA). Neither the European Union nor CINEA can be held responsible for them.

Funded by the European Union



Figure 2. Overview of the mobility solutions implemented in the four GEMINI ML and Munich.

Greater Copenhagen established mobility hubs with shared car municipality of Rudersdal. In the Helsinki MLL, e-bike and dema were tested to improve first- and last-mile connections in Kark tested community-led, non-commercial car sharing through neig Munich piloted a Park & Ride (P&R) shuttle and traffic-managem Allianz Arena to reduce congestion during match days (Figure 2).



Figure 3. Overview of the mobility solutions implemented in th

Paris-Saclay operated a station-based electric car sharing corporate e-bike sharing for A1 employees and a digitally guid guests. Porto combined integrated ticketing, a dedicated eve services around Estádio do Dragão on match days, and Turin in application integrating PT and shared mobility (Figure 3).

Evaluation was integrated throughout the design, implementat GEMINI MLLs. The evaluation aimed not only to assess the effect also to understand how the measures were implemented, whi uptake and effectiveness, and what could be learned for the replication.

At the start of the project, GEMINI deliverable **D2.1** *GEMINI e evaluation plans* established the common impact and proc translated it into specific evaluation plans for each MLL. The fram **process and impact evaluation approach** (Engels et al.,

A first step for cities, regions and Member States is therefore to ensure that future travel surveys distinguish shared from privately used modes, while retaining consistency with the main modal categories.

Especially for NMS, it is important to align the survey focus with the target group to which the new service is offered, potentially supported by targeted communication and other supporting actions. In GEMINI, different targeted approaches were used.

The **Porto MLL** implemented a **targeted before-and-after measurement**. Rather than measuring city-wide travel behaviour, **supporters were surveyed on-site at Estádio do Dragão** during selected matchdays. The baseline campaign covered four home matches with different event profiles in 2024, and the survey was repeated during the operational phase in 2026 (Figure 8). The surveys collected 2,480 valid responses in 2024 and 1,863 in 2026. Supporters were asked about the modes used to travel to the stadium, their origin, parking behaviour and other mobility-related factors. Using the same target group and trip purpose in 2024 and 2026 made it possible to compare the modal split over time.

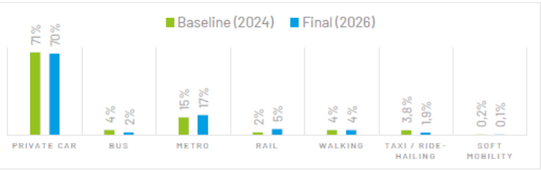


Figure 8. Porto MLL: Modal share of supporters travelling to Estádio da Dragão stadium, 2024 and 2026.

A similar **targeted approach** was used in the **Ljubljana MLL**, where the evaluation focused on A1 **employees' work-related trips**, for which the shared e-bike service was introduced as an alternative to company cars, private cars and taxis.

A digital baseline survey was sent to around 480 A1 employees, contained 29 questions and received 81 responses. For the modal share indicator, employees reported their most frequently used mode for work-related trips. The follow-up digital survey received 44 responses and included both users and non-users of the shared e-bike service, allowing the same modal-share question to be repeated after implementation (Figure 9).

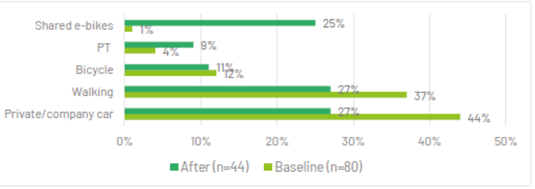


Figure 9. Ljubljana MLL: Modal share of employees for work-related trips, 2024 and 2026.

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Mentimeter - Word cloud

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~~Mentimeter~~ - Word cloud

Just type your answer in the chat

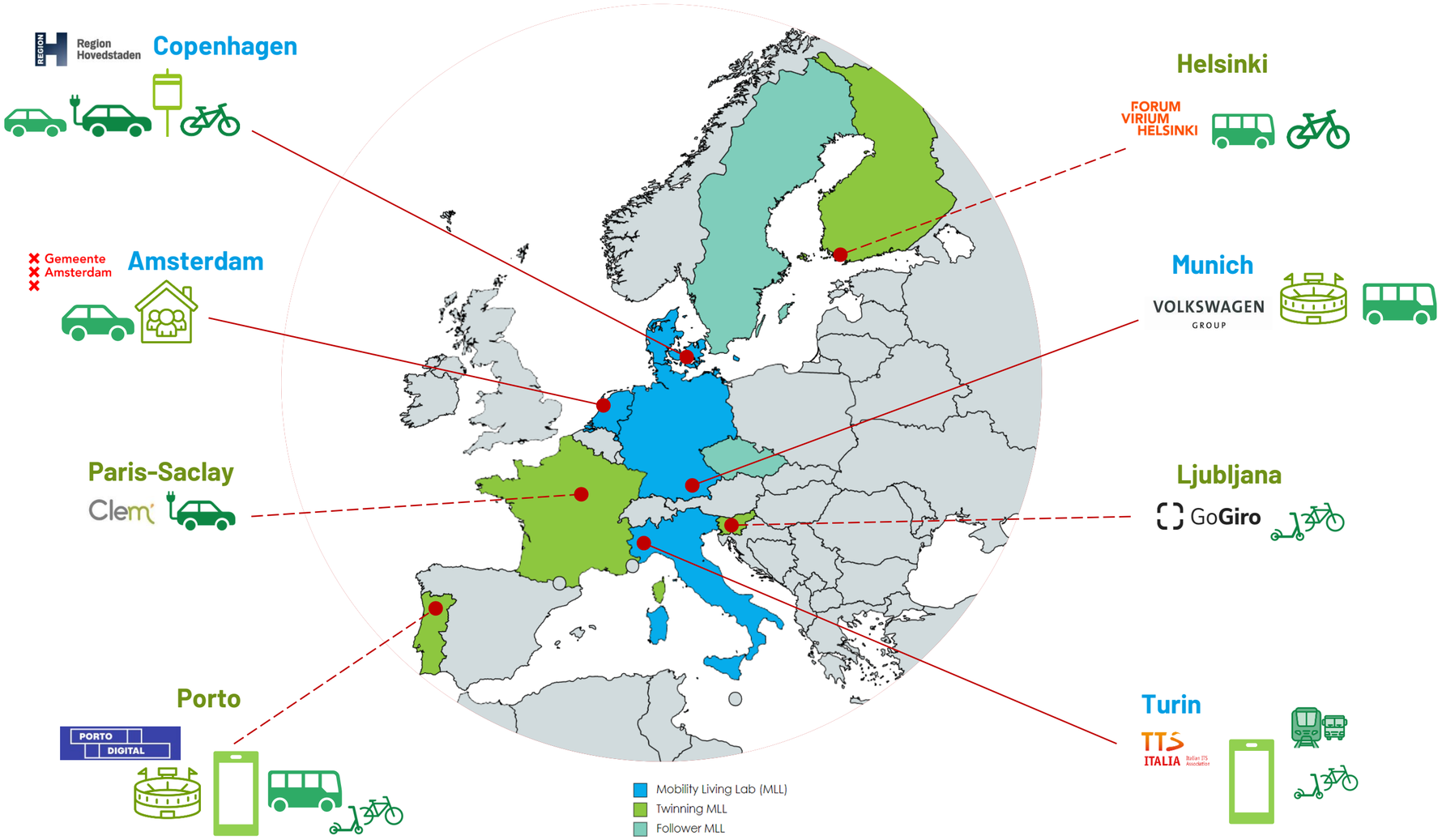


What is the hardest part of evaluating a mobility pilot?

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GEMINI Mobility Living Labs (MLLs)

8 implementation roadmaps and operational plans of NMS

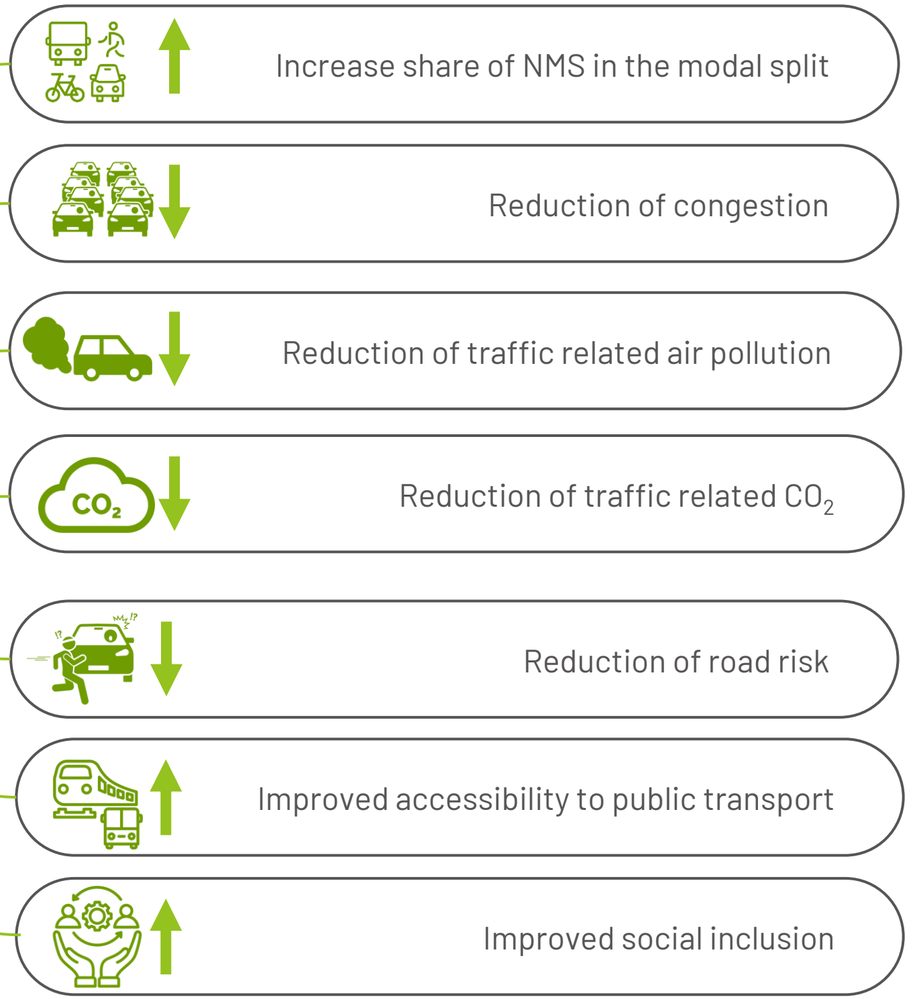


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Expected Impacts

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~~Mentimeter~~ – 2. Poll

Just type your answer in the chat



A shared mobility pilot has attracted 300 active users. Can we conclude that it is successful?

- Yes — 300 active users show good uptake
- Not yet — we need more evidence
- Only if the pilot has reduced private car use

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GEMINI impact & process evaluation

Foundation: CIVITAS 2020 process and impact evaluation framework



Impact evaluation: Evaluation of the effects or impact of the implemented measures using a set of selected **impact indicators**



Process evaluation: Analysis of implementation, identifying **barriers and drivers** of the implementation process, and **supporting activities** to facilitate implementation and strengthen impact.

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MLL evaluation sheets

MLL X – CITY: TITLE

Objectives

List the environmental, societal, safety & security, and economic objectives. If possible quantify the target.

Environmental *(e.g. green areas, reduced emissions and air pollution, sustainability, etc.)*:

Societal *(e.g. neighbourhood cooperation, social inclusion, accessibility, gender considerations, etc.)*:

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Other *(e.g. good functioning sharing system)*:

Measure description

Situation before

Describe the situation in the city or site before the implementation of the measure, including any problems and challenges in relation to the measure. Include key data sources for the information given.

General description

Give a description of the main elements of the measure

Output

List the direct results of the measure (e.g. the acquisition of 5 electric buses, ...)

Supporting activities

Discuss the supporting activities of the measure. Examples of such activities are communication campaigns, stakeholder involvement and citizen engagement activities.

Test area and target groups

Include figure

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Stakeholders

List and describe the role of the main partners and actors involved during the different stages of the measure.
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Level of activity: L: Leading role - P: Principle participant - O: Occasional participant

Actor	Type of organisation	Level of activity	Role

City context indicators

The city context indicators give an overall understanding of the city context in relation to mobility, e.g. it is a more car-oriented city (car-ownership is high), the city has a robust cycling infrastructure etc. These indicators are usually measured at city level, depending on the availability of the data.

No.	Indicator	Definition	Method	Frequency	Area/Target group

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Planned implementation phases

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MLL evaluation sheets

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GEMINI

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HOW? Indicators

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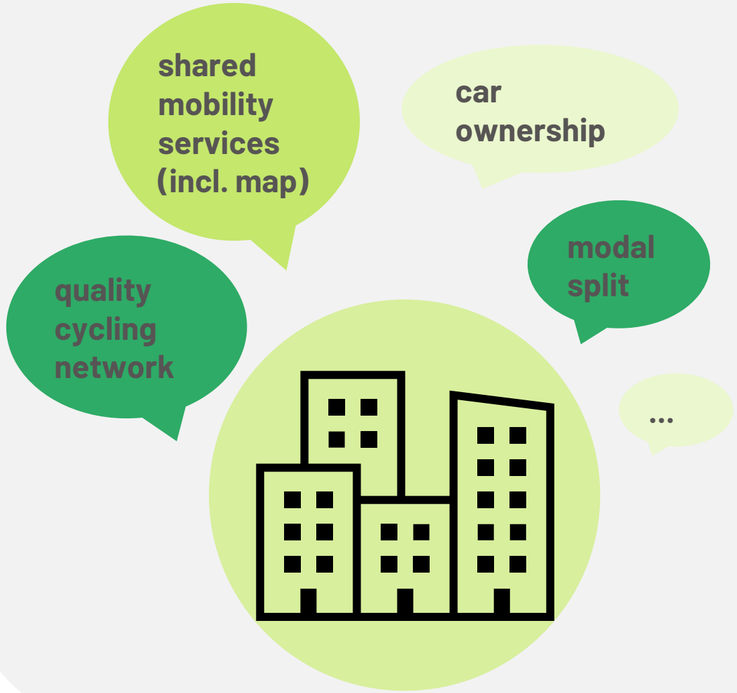
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GEMINI impact evaluation

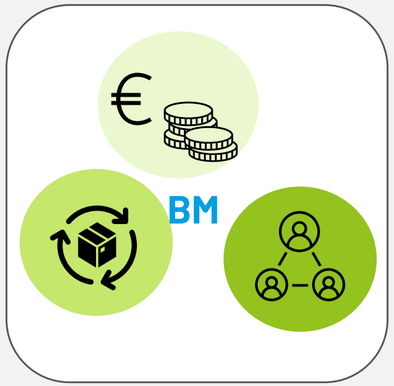
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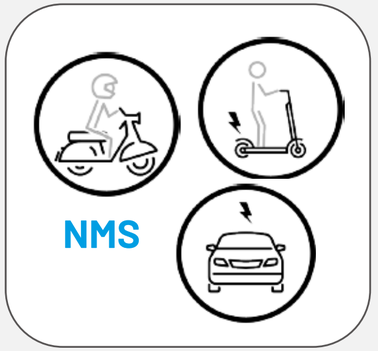


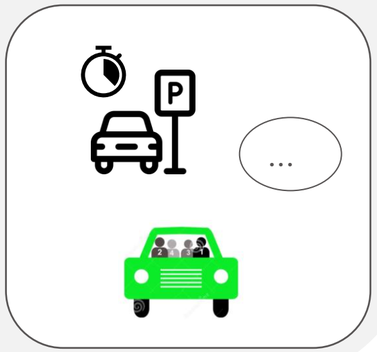
Impact indicators



Additional indicators







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Impact indicators



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Impact indicators



Increase share of NMS in the modal split

Impact indicators



Impact indicators



Increase share of NMS in the modal split

WHAT TO MEASURE

Modal share (% of trips by mode), modes replaced by NMS

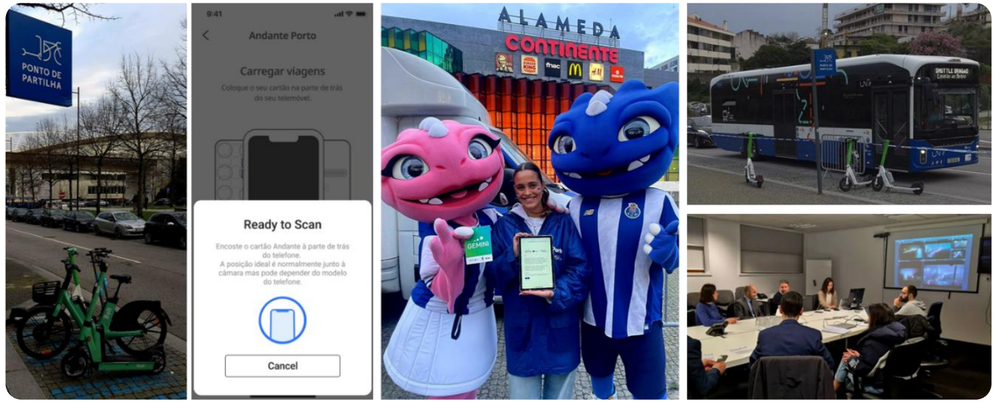
DATA & METHODS

Comparable before-after travel surveys, mode-replacement questions

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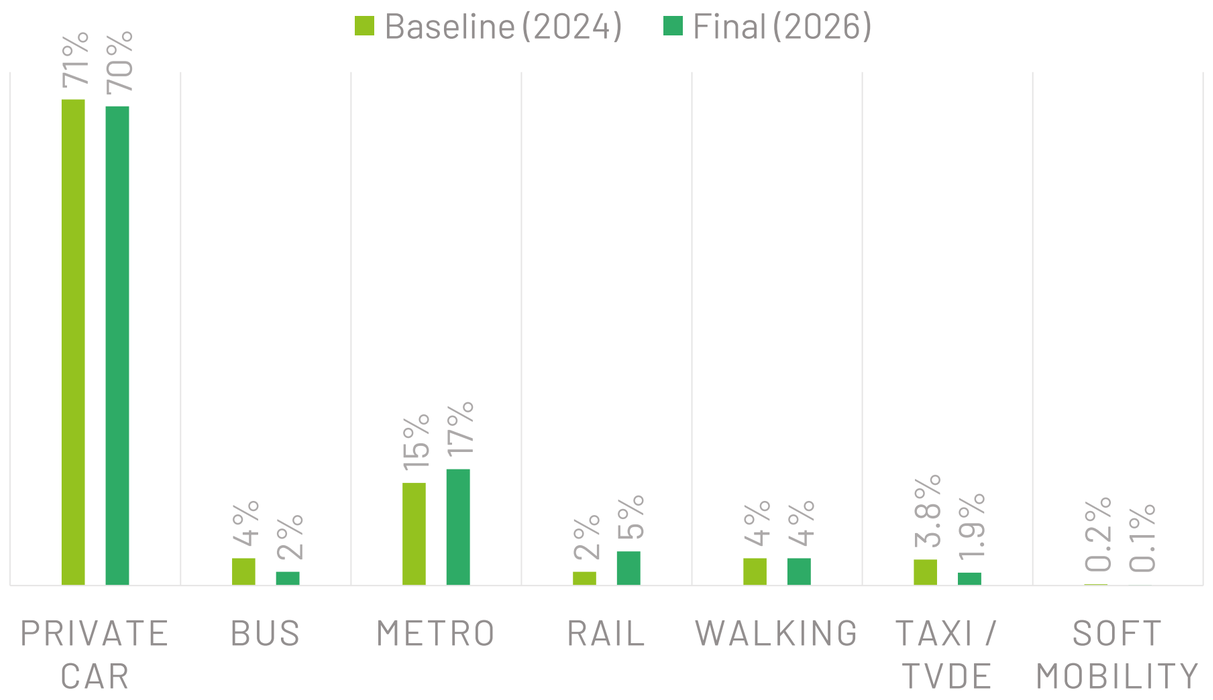
Porto – matchday travel to Estádio do Dragão stadium





FanMove app (match + PT ticket) · shuttle bus · micromobility · traffic management

On-site survey of supporters at the Estádio do Dragão
4 home matches, n = 2,480 (2024) and 1,863 (2026)



Public transport: 21% → 24%

Private car: 71% → 70%

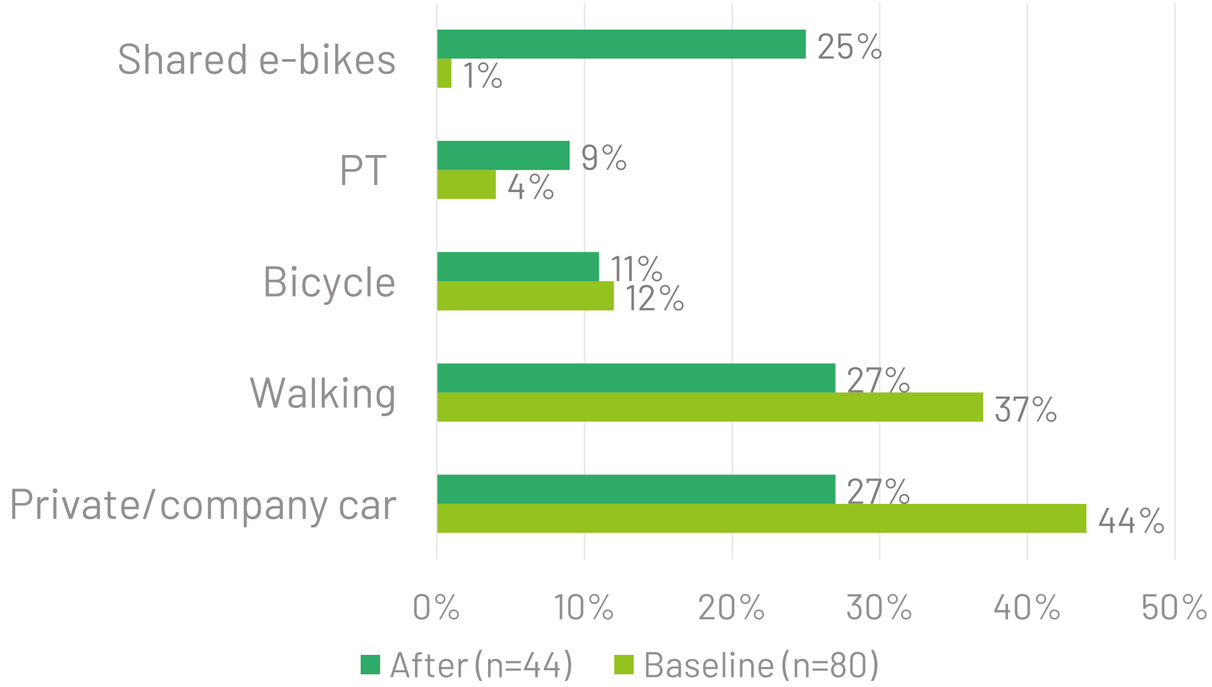
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Ljubljana – shared e-bikes for employees of company A1



Shared e-bikes for work-related trips at company A1

Before–after survey of A1 employees
most frequently used mode for work-related trips,
n = 80 (before) and 44 (after)



Car: 44% → 27%

Shared e-bikes: 1% → 25%

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Copenhagen/Rudersdal – multimodal hubs in the peri-urban area



TIER-Dott
200 shared bikes

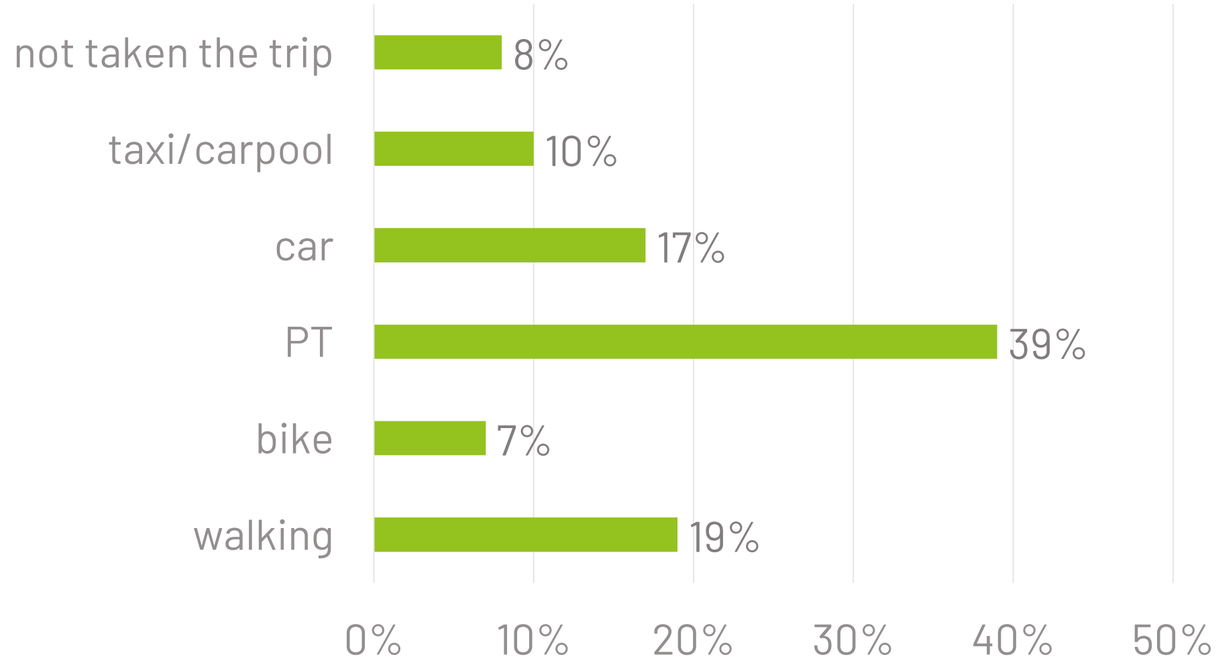


KINTO Share
12 station-based shared cars



GreenMobility
20 free-floating electric shared cars

Survey respondents were asked: "If the shared service had not been available, how would you have made this trip?"



Source: Epinion resident survey, March 2025 (n=1,234 overall).
Mode substitution results based on NMS users only.

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Shared mobility is often invisible in travel surveys

Used mode(s)	What the travel survey records
 Shared car	Car
 Shared bike	Bicycle
 Shared bike + train	Train (main mode only)

Recommendation: record shared modes separately – and their combinations with PT

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Impact indicators



Reduction of congestion



Impact indicators



Reduction of congestion

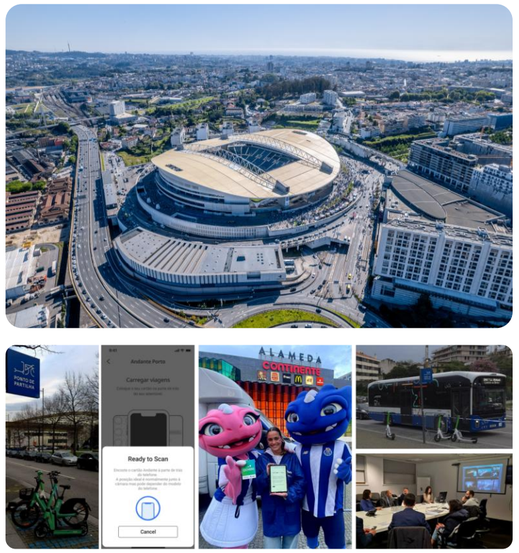
WHAT TO MEASURE

Average vehicle speed, travel time, traffic flow and density

DATA & METHODS

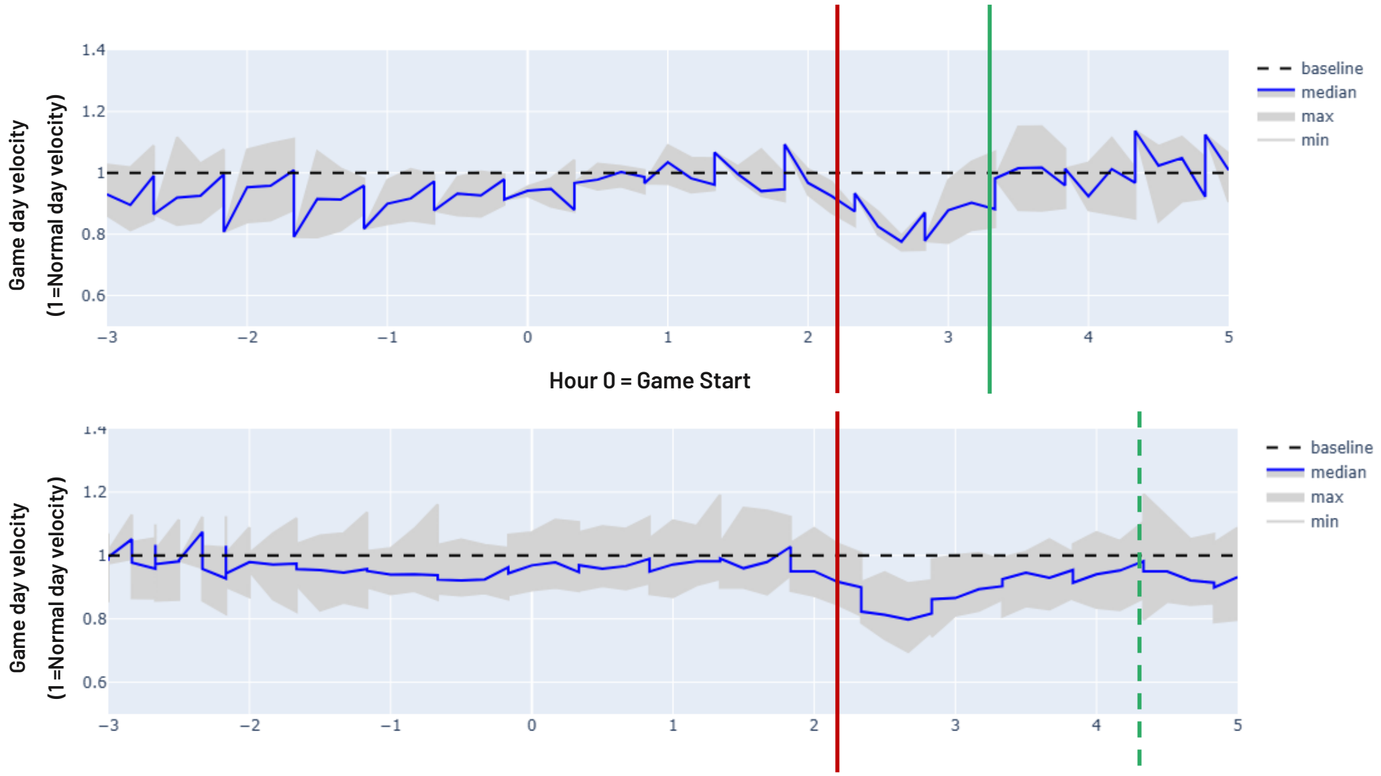
Traffic-controller data, journey-time data, traffic modelling

Porto – Traffic speed recovery around Estádio do Dragão



FanMove app · shuttle bus · micromobility · traffic management

Traffic-controller data (municipality)
matchday speed compared with a normal day (1 = normal)
hour 0 = start of the match , red line = end of the match, green line = speed back to normal



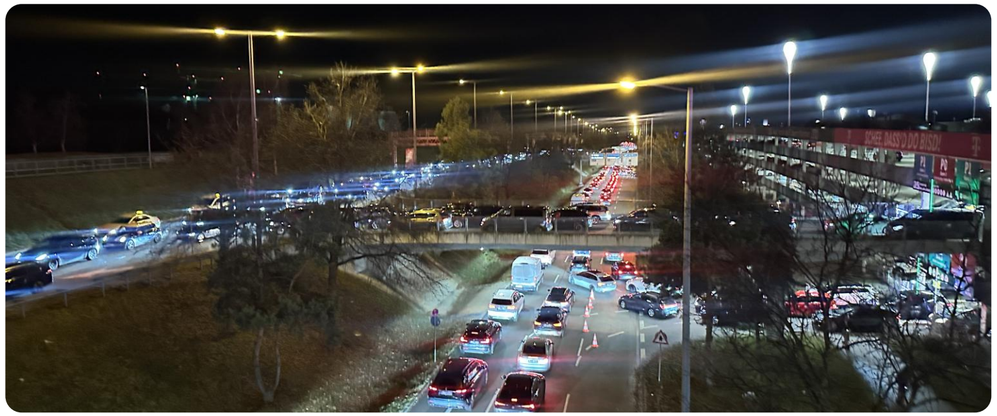
Test games 2026
with traffic measures

Non-test games 2025
before the measures

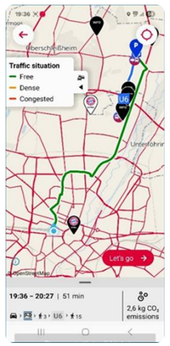
Back to normal speed (5 km) **≈ 1 h in 2026**
vs. almost 2 h in 2025

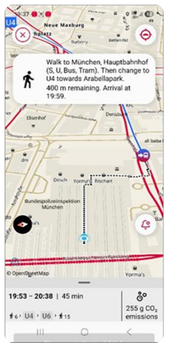
GEMINI

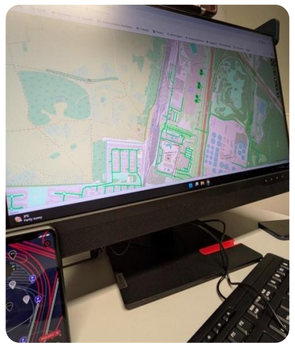
Munich – Allianz Arena stadium







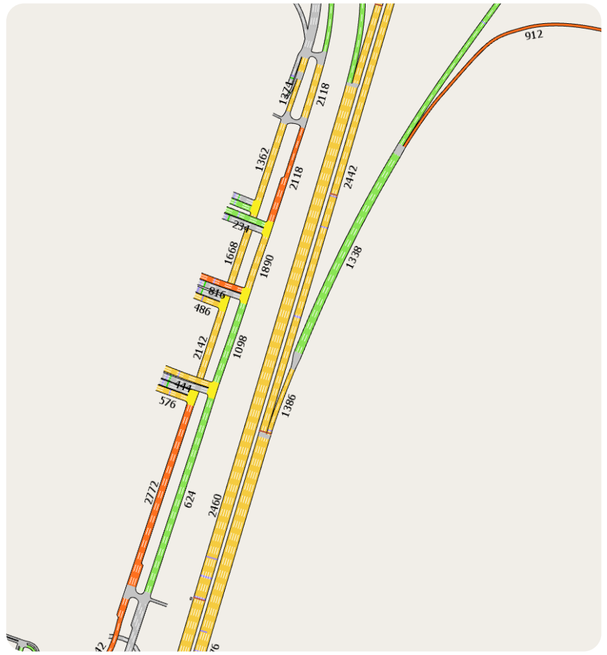




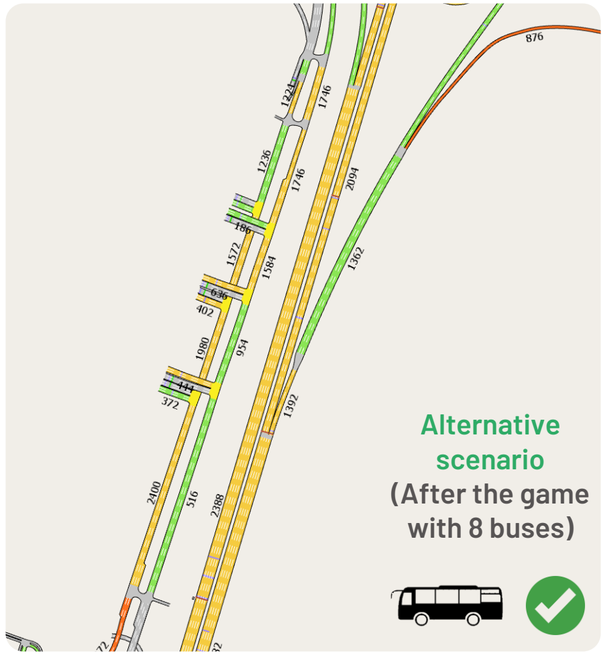
P&R shuttle bus · traffic info app · traffic management

Traffic simulation
Baseline vs. scenario in which car users switch to the P&R shuttle

Baseline



With P&R shuttle



Travel time: –24%

Traffic density: –42%

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Impact indicators



Reduction of traffic related air pollution



Reduction of traffic related CO_2

Impact indicators



Impact indicators



Reduction of traffic related air pollution



Reduction of traffic related CO_2

WHAT TO MEASURE

CO_2 emissions, NOx and PM emissions

DATA & METHODS

Trips, distance, mode replacement and emission factors, XIPE modelling

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Emissions – a simple calculation for small pilots



Karkkila – shared e-bikes for residents





Ljubljana – Shared e-bikes for hotel guests with a digital tour

Estimated avoided car CO_2 emissions =
NMS trips × average trip distance × car-replacement share × car emission factor

Parameter	Karkkila	Ljubljana
Pilot period	10.6 weeks	7 months
Number of NMS trips	~70 e-bike trips	254 rentals
Average trip distance	3 km	3 km
Car-replacement share	30%	27%
Car CO_2 emission factor	60 g/km	120 g/km

Karkkila: ≈ 4 kg CO_2

Ljubljana: ≈ 25 kg CO_2

Indicative gross CO_2 savings from avoided car trips.

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XIPE: the Cross Impact Performance Emissions tool

Shared Mobility Services

Please fill in the number of shared vehicles per mode and the percentage of them that is electric. e-Scooters will always be electric and are therefore prefilled with 100%. Click the Save Data button to save the data in the table.

Shared Modes	Number of Shared Vehicles	Percentage Electric
Car	32	63
Bike	200	100
Moped	0	0
e-Scooter	0	100 (Always electric)
Other	0	0

Calculate Emissions

Estimated emission change per shared mode in Rudersdal Municipality

Estimated CO2 change

	Car	Bike	Moped	e-Scooter	Other
Tank-to-Wheel (kg/day)	-199.94	-893.21	0.00	0.00	0.00
Well-to-Tank (kg/day)	-25.89	-220.45	0.00	0.00	0.00
Additional life-cycle emissions (kg/day)	52.01	153.08	0.00	0.00	0.00
TOTAL (kg/day)	-173.82	-960.58	0.00	0.00	0.00

Estimated air quality emission change

	Car	Bike	Moped	e-Scooter	Other
NOx (g/day)	-110.93	-460.87	0.00	0.00	0.00
PM (g/day)	-3.81	-21.73	0.00	0.00	0.00

cenex nederland

https://xipe.cenexgroup.nl/dashboard

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XIPE: the Cross Impact Performance Emissions tool

INPUTS: city characteristics, shared mobility fleet, trips and mode replacement

General Variables:

	User Input	Default
Average CO2 emission intensity for electricity generation (gCO2/kWh)		103.00
Well-to-Tank emissions fraction of Well-to-Wheel-emissions ICE cars (%)		20%

Traditional Modes:

	Private Car (per VKT)		Public Transport (per passenger km)				Active modes (per VKT)			
			Road		Rail		Walking		Cycling	
	User Input	Default	User Input	Default	User Input	Default	User Input	Default	User Input	Default
CO2 emission factors for traditional modes Tank-to-Wheel (gr/km)		227.50		63.00				-		-

New Shared Modes:

	ICE				Active		EVs				
	Car		Moped		Bike		E-Car		E-Bike		
	User Input	Default	User Input	Default	User Input	Default	User Input	Default	User Input	Default	User
Average number of trips per day		5.00		5.00		4.00		5.00		4.00	
Average Tank-to-Wheel CO2 emissions (g/km)		133.38		37.00		-					
Average NOx emissions (mg/km)		60.00		60.00							
Average PM emissions (mg/km)		4.50		4.50							
Average efficiency of a shared EV (kWh/km)								0.17		0.01	
Emission factor for life-cycle phases excluding use phase (gCO2/vkm)		55.00		31.00		58.00		81.00		71.00	
Previously used traditional mode – Car		48%		48%		48%		48%		48%	
Public transport	0%	18%	0%	18%	0%	18%	0%	18%	0%	18%	0
Road		10%		10%		10%		10%		10%	
Rail		8%		8%		8%		8%		8%	
Active Modes	0%	34%	0%	34%	0%	34%	0%	34%	0%	34%	0
Walking		33%		33%		33%		33%		33%	
Cycling		1%		1%		1%		1%		1%	
Total	0%	100%	0%	100%	0%	100%	0%	100%	0%	100%	0
Average Trip distance of shared mode – Car		8.00		8.00		2.50		8.00		3.75	
Public transport	-	8.00	-	8.00	-	2.50	-	8.00	-	3.75	
Road		8.00		8.00		2.50		8.00		3.75	
Rail		8.00		8.00		2.50		8.00		3.75	
Active Modes	-	1.75	-	1.75	-	1.75	-	1.75	-	1.75	
Walking		1.00		1.00		1.00		1.00		1.00	
Cycling		2.50		2.50		2.50		2.50		2.50	

OUTPUTS: CO_2 (incl. upstream & life-cycle emissions), NOx, PM

The Cross Impact Performance Emissions (XIPE) model

Estimated Emission Reduction:

	Car	Bike	Moped	E-scooter	Other
Estimated CO2 reduction Tank-to-Wheel (kg/day)	-35.94	-13.48	-35.94	-11.23	0.00
Estimated CO2 reduction Well-to-Tank (kg/day)	2.12	-3.35	-7.41	-2.63	0.00
Estimated additional life-cycle CO2 reduction	10.70	3.56	4.62	6.33	0.00
Estimated CO2 reduction TOTAL (kg/day)	-23.12	-13.27	-38.73	-7.53	0.00
Estimated NOx reduction TOTAL (g/day)	-26.88	-10.08	-26.88	-8.40	0.00
Estimated PM reduction TOTAL (g/day)	-1.12	-0.42	-1.12	-0.35	0.00

	Total	Tank-to-Wheel	Well-to-Tank	Life-cycle
Estimated Total CO2 reduction (kg/day)	-82.65	-96.58	-11.27	25.21
Estimated Total CO2 reduction (ton/year)	-30.19	-35.28	-4.12	9.21
Estimated Total CO2 reduction (ton/year/1000 inhabitants)	-0.04	-0.04	0.00	0.01
Estimated NOx reduction TOTAL (g/day)	-72.24			
Estimated NOx reduction TOTAL (kg/year)	-26.39			
Estimated NOx reduction TOTAL (kg/year/1000 inhabitants)	-0.03			
Estimated PM reduction TOTAL (g/day)	-3.01			
Estimated PM reduction TOTAL (kg/year)	-1.10			
Estimated PM reduction TOTAL (kg/year/1000 inhabitants)	0.00			

Can be used before implementation (scenario analysis) or afterwards (operational data).
Results depend on the quality of the input data, particularly mode replacement.

cenex nederland

https://xipe.cenexgroup.nl/dashboard

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Impact indicators



Reduction of road risk

Impact indicators



Reduction of road risk

WHAT TO MEASURE

Accidents and injuries, near-misses, perceived safety

DATA & METHODS

Operator incident records, user surveys, longer-term accident statistics

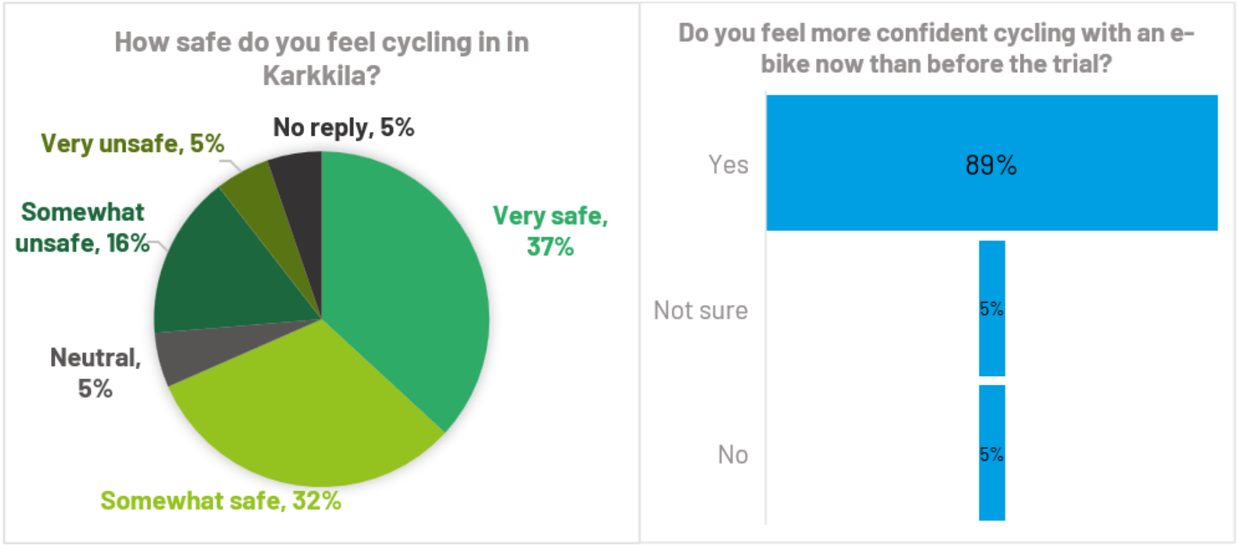
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Road safety – Perceived safety among e-bike users in Karkkila



Karkkila – shared e-bikes for residents

Residents who tested the e-bikes were asked how safe they feel cycling, and whether they feel more confident on an e-bike



69% safe · 21% unsafe

89% more confident

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Impact indicators



Improved accessibility to public transport

Impact indicators



Impact indicators



Improved accessibility to public transport

WHAT TO MEASURE

Trips combined with PT, overall travel time, perceived accessibility

DATA & METHODS

Operator data, end-of-trip surveys, user surveys, before–after measurements

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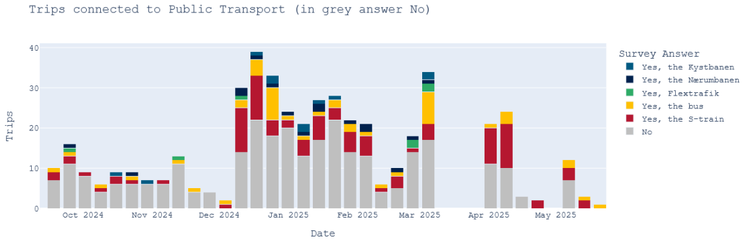
Access to PT – Copenhagen/Rudersdal: trips combined with public transport

through the operators' apps, users were asked: "Did you combine your shared mobility trip with public transport today?"



TIER-Dott

200 shared bikes

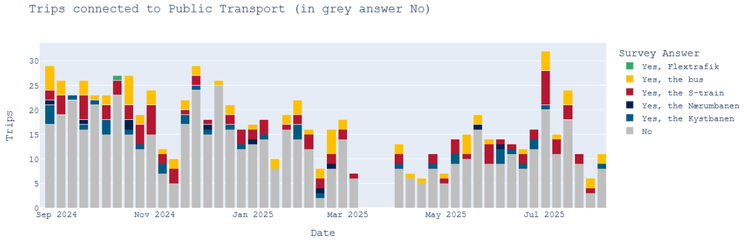


38%
connected to PT



GreenMobility

20 free-floating cars

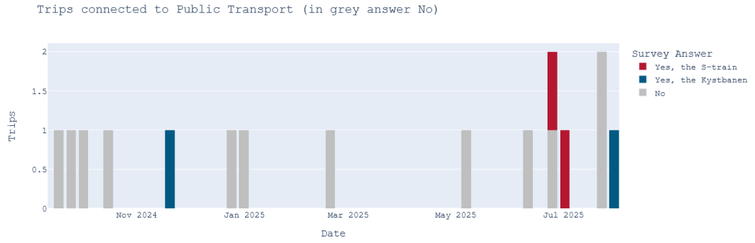


28%
connected to PT



KINTO Share

12 station-based cars



25% (n=16)
connected to PT

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Impact indicators



Improved social inclusion

Impact indicators



Improved social inclusion

WHAT TO MEASURE

Access to activities, affordability, who benefits

DATA & METHODS

User surveys, user characteristics, service costs

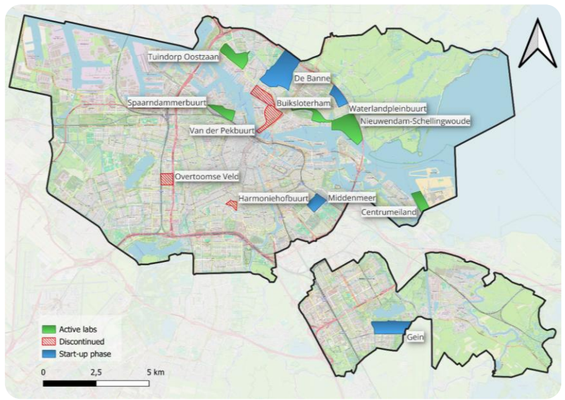
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Social inclusion – Amsterdam: Mobility as a Commons (MaaC)

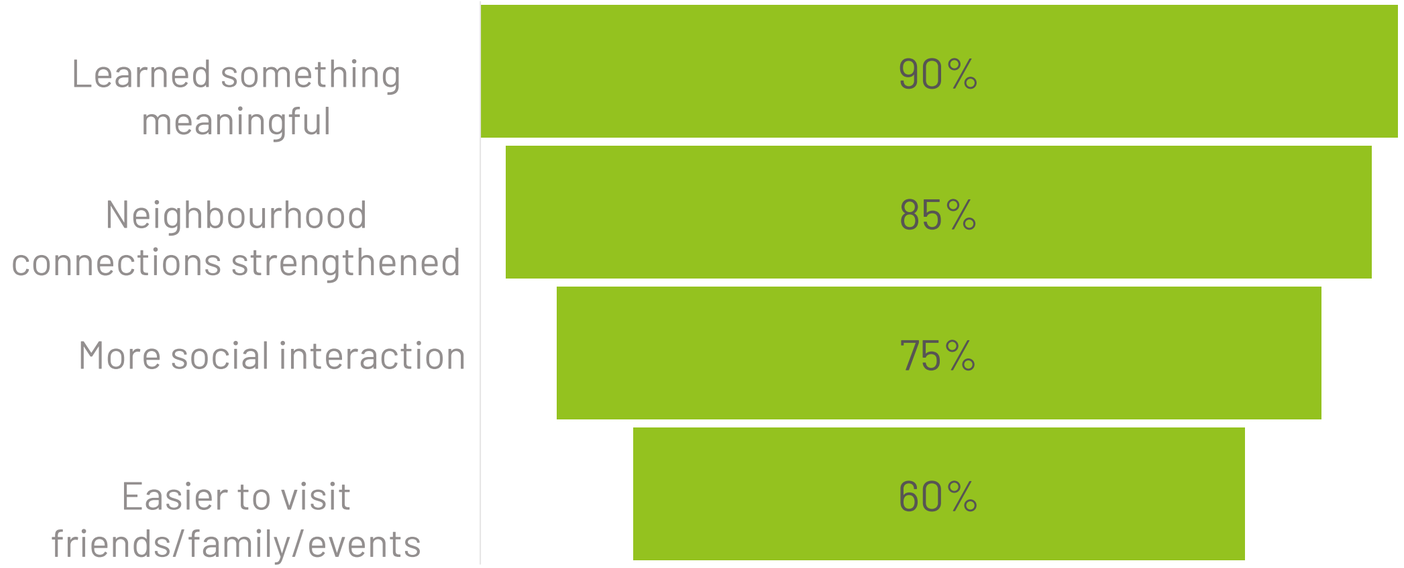


Amsterdam neighbourhood car sharing cooperatives:

active, **discontinued**, **start-up phase**

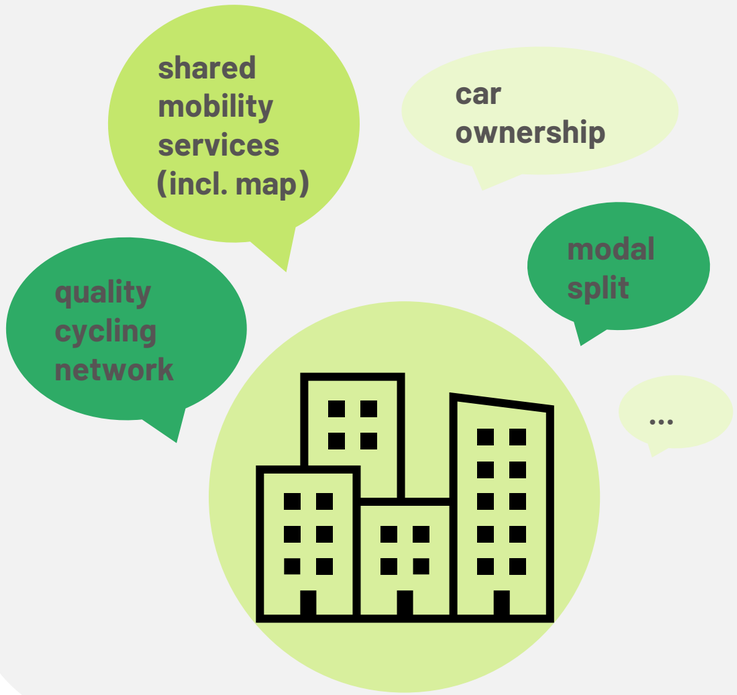


Survey of MaaC members



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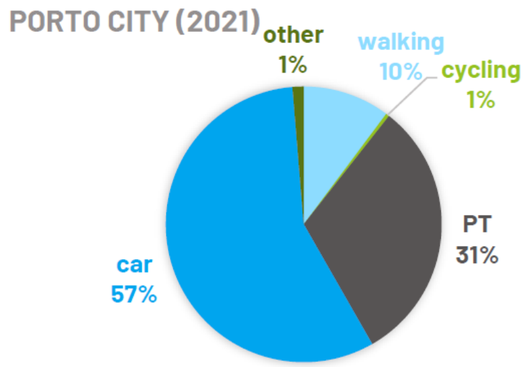
City context indicators



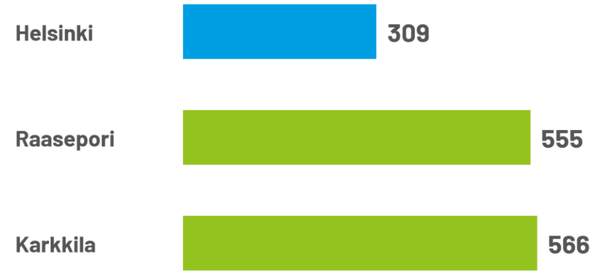
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City context – what we collected in the MLLs

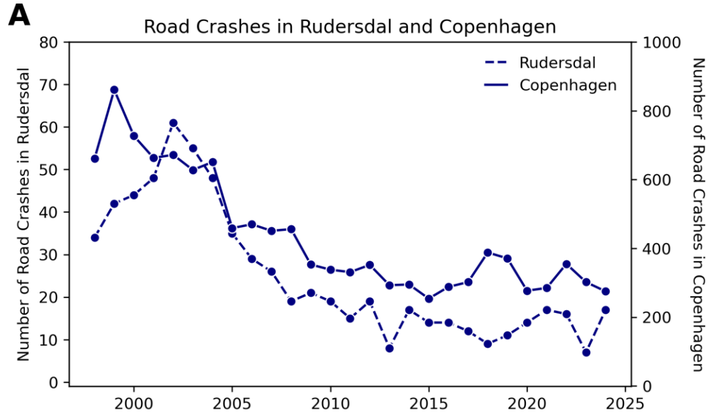
Modal share in Porto



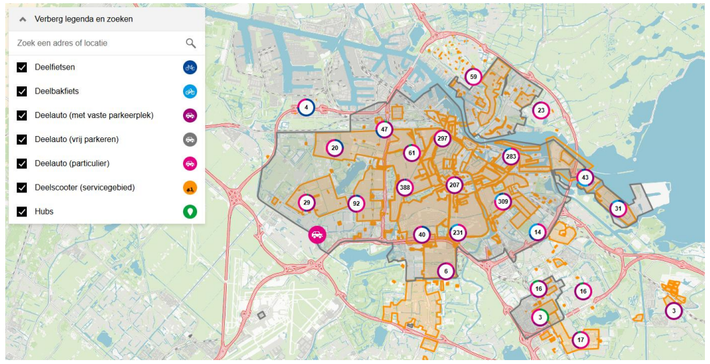
Car ownership · Helsinki/Raasepori/Karkkila



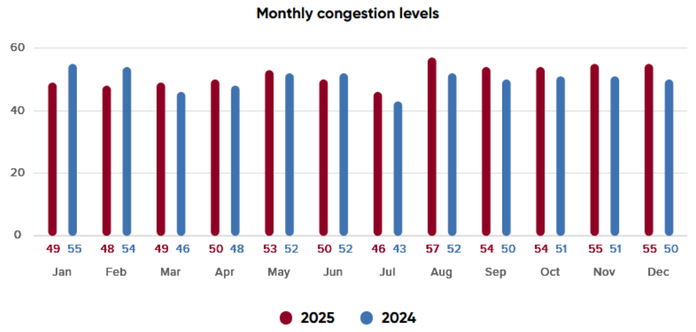
Road safety in Copenhagen/Rudersdal



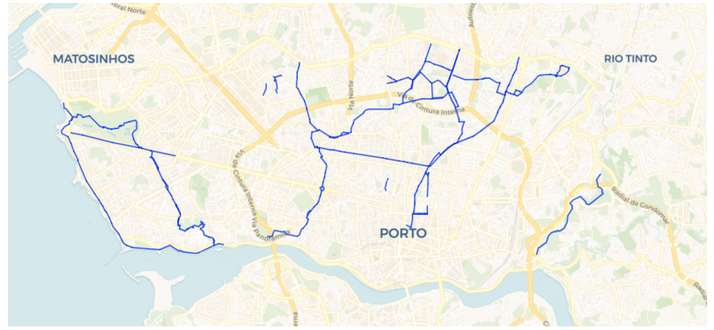
Shared mobility offer in Amsterdam



Congestion in Helsinki

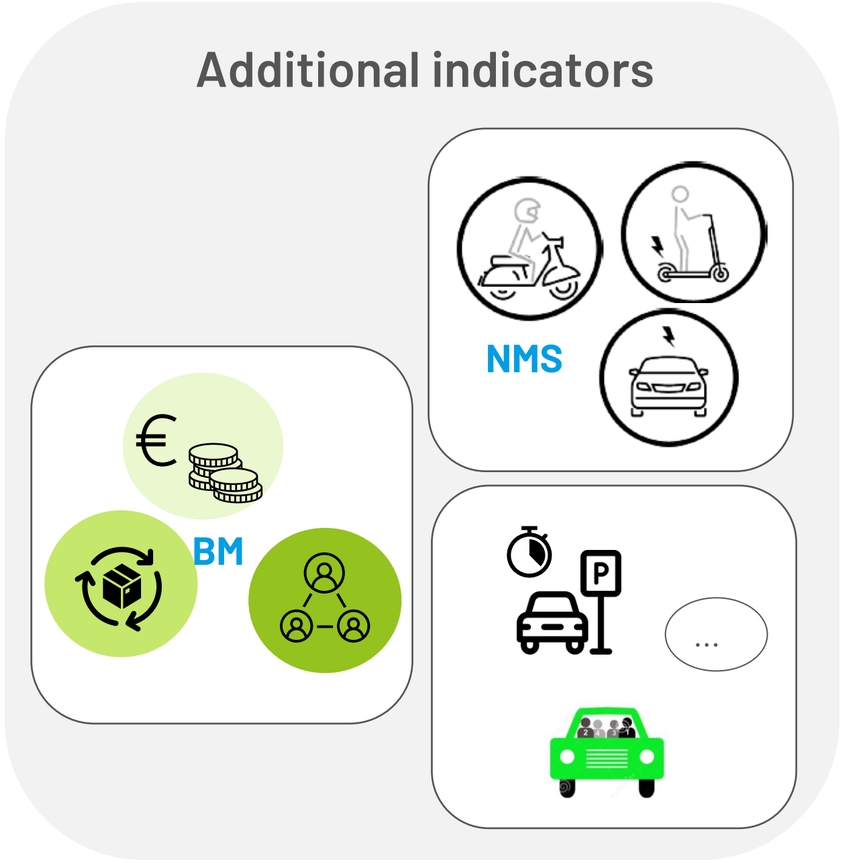


Cycling network in Porto



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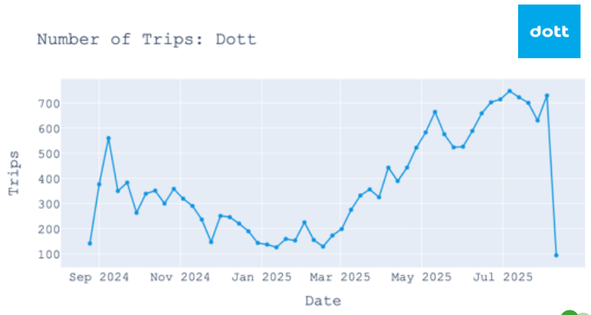
NMS performance and business model indicators



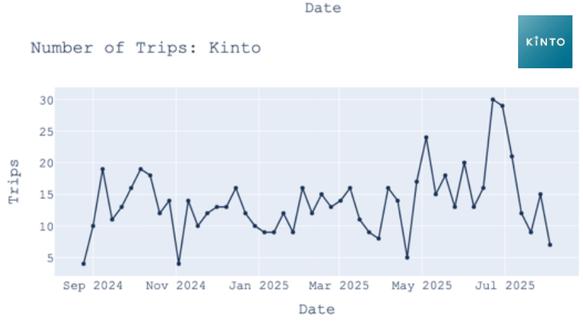
Additional indicators – NMS performance indicators
Copenhagen multimodal hubs

DTU Technical University of Denmark

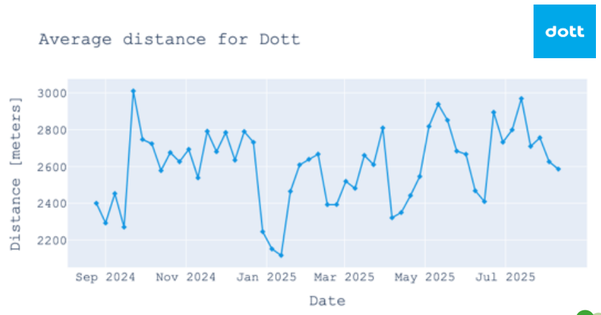
Number of trips

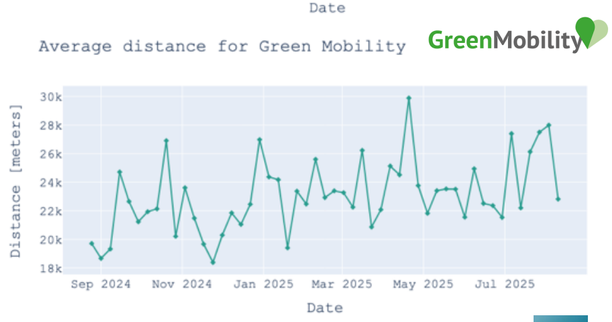


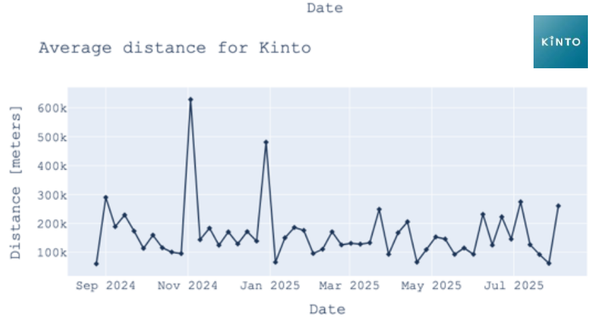




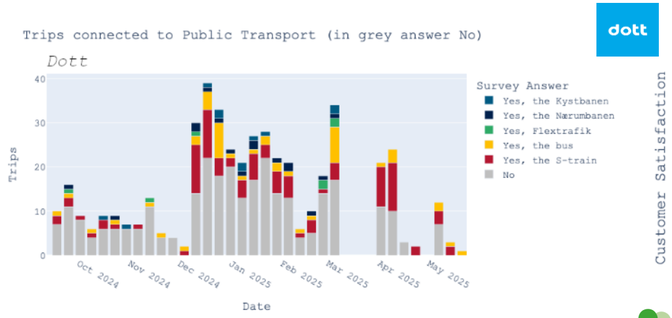
Average distance

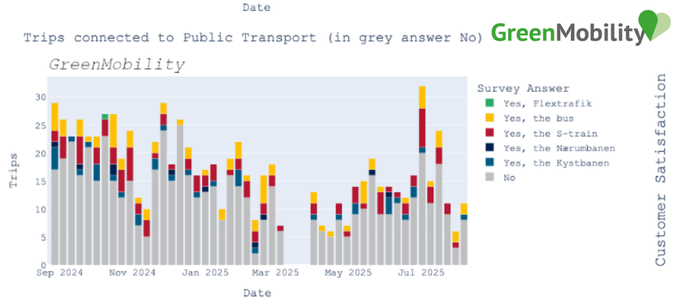


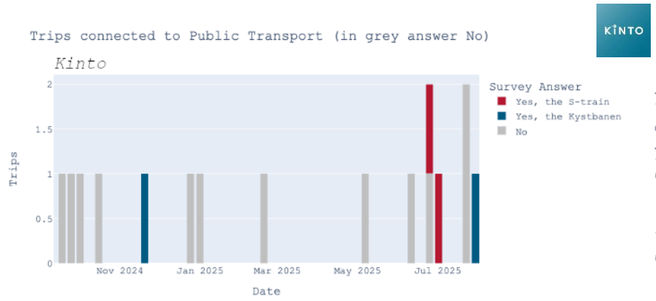




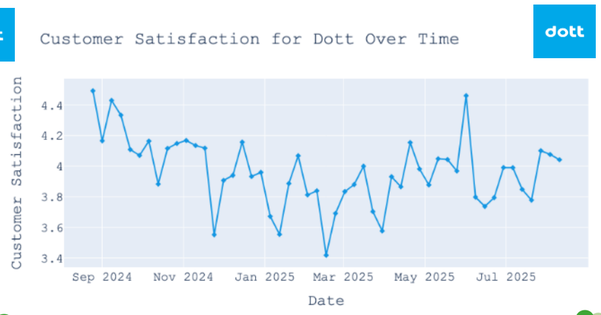
Trips connected to PT

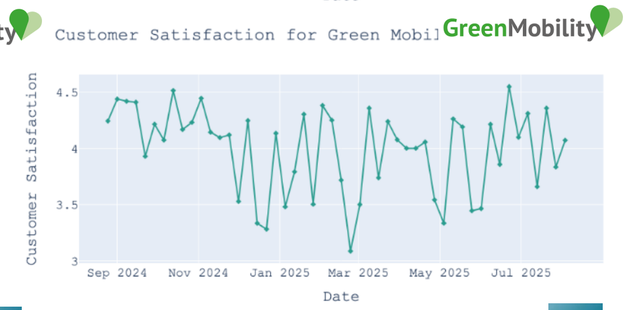






User satisfaction







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Additional indicators – Business modal indicators Amsterdam Mobility as a Commons (MaaC)



No.	Indicator	Spaarndammer-buurt	Tuindorp Oostzaan	Centrumeiland	Nieuwendam-Schellingwoude
	Pilot duration	**36 months**	**35 months**	**39 months**	**24 months**
1	**Investment costs**	€18,438	€20,158	€20,158	€23,596
2	**Operational costs**	€68,040	€99,225	€110,565	€113,400
3	**Subsidisation**	€7,260	€18,390	€18,390	€20,650
4	**Revenues**	€69,218	€100,993	€112,333	€116,346
5	**No. jobs generated**	1.5 FTE at Townmaking Institute			

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Process evaluation

Process evaluation: Analysis of how a measure was implemented, identifying **barriers, drivers and supporting activities** that influenced implementation.

DURING PLANNING

Who, when and how

Stakeholders and their roles, implementation phases and planned supporting activities

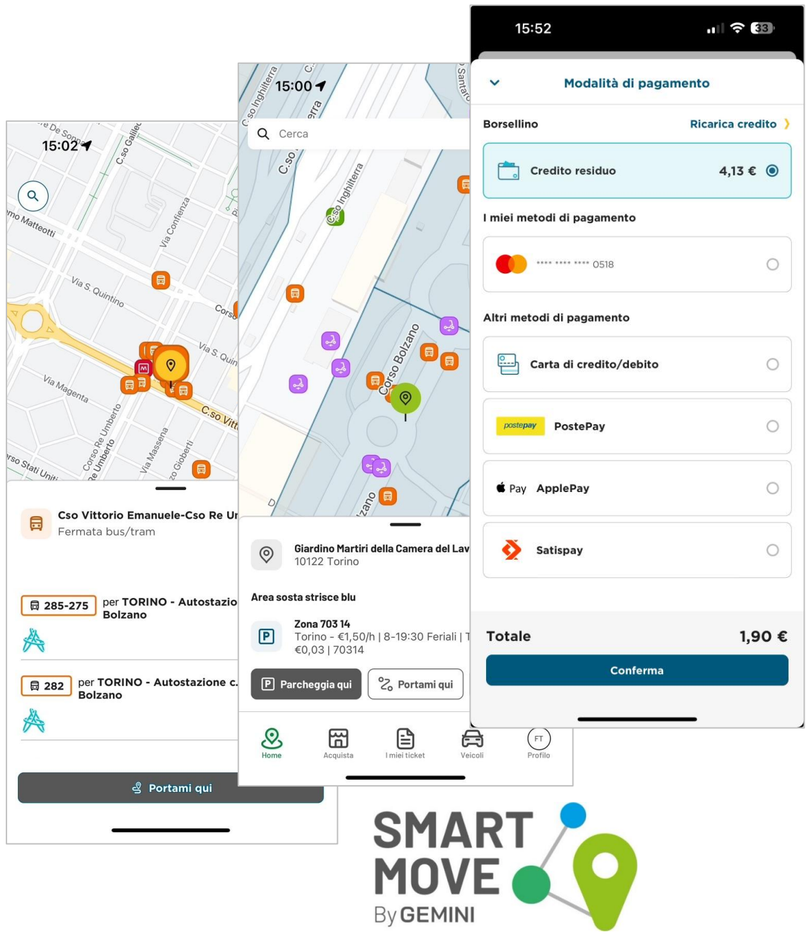
AT THE END

Structured interviews

One common questionnaire for all MLLs: cooperation, resources, barriers, drivers and lessons learned

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Turin – What makes MaaS work?



SMART MOVE By GEMINI

MORE THAN TECHNOLOGY

Commercial & governance arrangementS

A technically functioning platform alone is not enough.

EARLY PROVIDER AGREEMENTS

Secure key mobility providers early

Commercial agreements and technical integration need to progress in parallel.

STRONG LOCAL COORDINATION

A strong local coordinator is essential

Local knowledge keeps implementation moving.

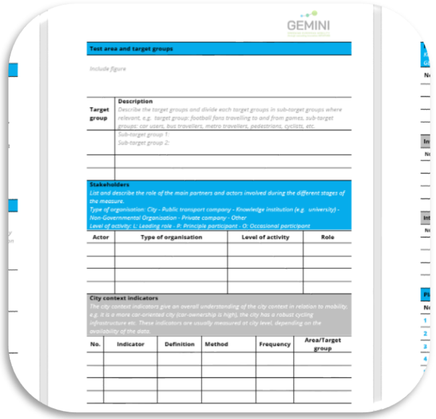
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From results to lessons

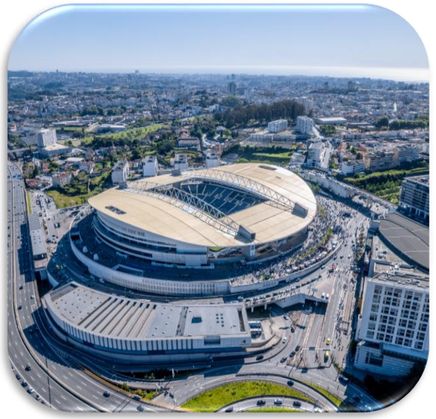
SUMMARISE	EXPLAIN	UPSCALE	TRANSFER
Against the objectives	**What worked – and why**	**Same city or region**	**Other cities**
Indicators, observed changes and limits of the evidence	Combine with the process evaluation: barriers, drivers and supporting activities	Munich: busy matchdays, extra P&R capacity	Transfer the approach, adapt the design to local conditions

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Key takeaways for evaluating NMS









01

Start evaluation planning early

Define objectives, indicators, data sources and responsibilities

02

Adapt the evaluation to the measure

Consider its scale, target group, local context and available data

03

Combine impact and process evaluation

Understand not only what changed, but also why

04

Turn evidence into practical lessons

Recognise limitations and identify conditions for continuation and upscaling

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