MOBILAIR

DATA-DRIVEN & USER-CENTRIC MOBILITY FOR AIR IMPROVEMENT IN THE CITY OF THESSALONIKI

MOBILAIR

# Replication Guidelines

*How to replicate a data-driven, user-centric approach to air quality and urban mobility in your city*



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# Introduction

MOBILAIR (Data-Driven and User-Centric Mobility for Air Improvement) was implemented in Thessaloniki between 2024 and 2026 to help citizens choose cleaner, healthier ways to move. The project connected air-quality data with mobility data and brought them to citizens through the MOBILAIR app. The app shows air quality across the city, suggests routes with lower exposure to pollution, compares the time, cost and environmental footprint of each option and rewards sustainable trips. The app was designed together with citizens and tested in a pilot with more than 100 users.

These guidelines are written for cities, public authorities and organisations that want to follow a similar approach. They are organised in six chapters, in the order in which a city can implement them. The six building blocks are connected (Figure 1): the living lab hosts the solution, citizens shape it from the start, data feed the app and the web services, and the experience of users feeds back into the next cycle.

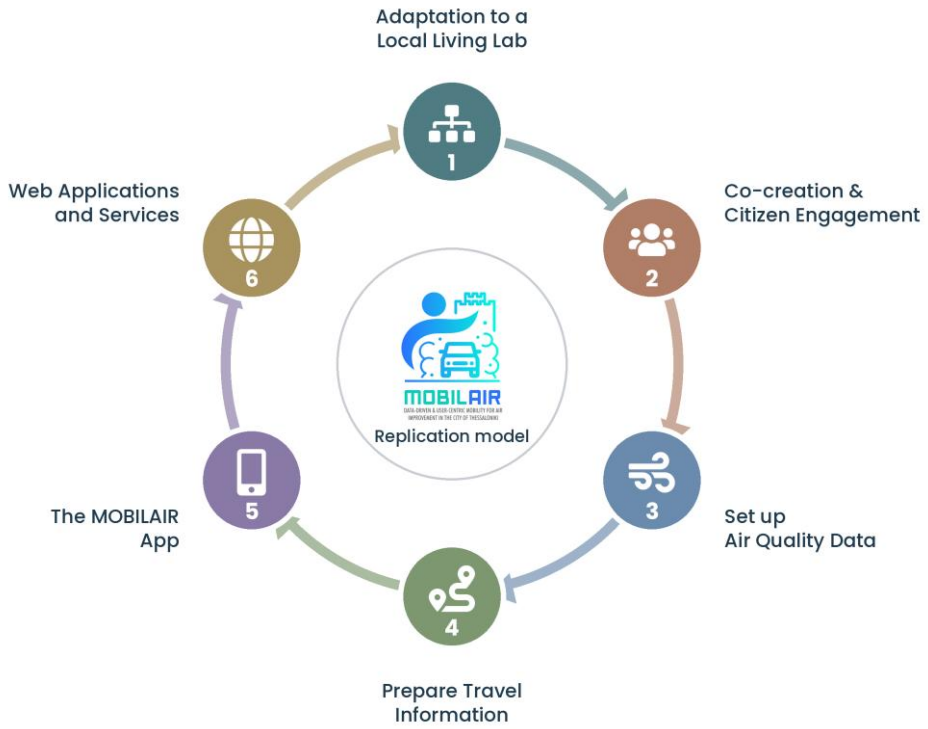



*Figure 1: The six building blocks of the MOBILAIR replication model*

1. **Adaptation to a Local Living Lab:** building the local ecosystem that will host the solution and keep it running after the project.
2. **Co-creation & Citizen Engagement:** involving citizens from the start, so that the solution responds to their real needs.
3. **Set up Air Quality Data:** monitoring, forecasting and estimating the contribution of traffic to air pollution.
4. **Prepare Travel Information:** turning local transport data into comparable travel alternatives.
5. **The MOBILAIR App:** bringing data and recommendations to citizens through a mobile application.
6. **Web Applications and Services:** making MOBILAIR's information available without installation, in public space and to the city's own systems.

Each chapter explains **why** the component matters, **what you need**, the **steps** to follow and, where relevant, **tips and lessons learned** from the MOBILAIR experience. The guidelines describe what worked in Thessaloniki, but every city should adapt them to its own data, infrastructure and community.

CHAPTER 1

# Adaptation to a Local Living Lab

1

**Contributors:** CERTH/HIT

## Why

To have a lasting impact, the MOBILAIR solution needs to be embedded in a local living lab or city ecosystem, so that it continues after the end of the project. MOBILAIR is by definition a cross-sectoral innovation, which requires city leadership as well as stakeholders' engagement. Living labs provide cities with:

- the knowledge to prepare the right conditions for embracing innovation, and the arguments for involving society and stakeholders;
- the capacity to develop cross-sectoral synergies and the policies that will stimulate and generalise the uptake of the MOBILAIR solution, maximising the impact of deployment;
- the tools for a common understanding of challenges and for exchange between actors from different sectors, supporting sound decision-making;
- the organisation to monitor efficiency and to support the adoption of the MOBILAIR solution and its resilience to unexpected conditions.

## What you need

If an **existing living lab is already in place** in the fields of urban mobility, air quality, pollution and health, or climate neutrality, MOBILAIR can be adopted by the organisation in place for future experimentation in a real-life urban context. MOBILAIR will then be blended with the local innovations and datasets, and cross-fertilisation will emerge:

- the local innovation ecosystem will contribute its local knowledge and understanding of the problems to be solved;
- in parallel, the external MOBILAIR innovators will increase the local ecosystem's capacity.

As a result, MOBILAIR will naturally become part of the living lab through collaboration in new innovation developments, problem solving and policy formulation.

If a **living lab is not in place yet**, MOBILAIR may become the catalyst for the transition from a single project to a living lab. In this case, a few things need to be considered in advance:

- assess the city's innovation readiness;
- build and engage a coalition of stakeholders;
- align the living lab's mission with the city's challenges and missions;
- build capacity, create a value proposition, and attract funds and investments.

## Steps

1. Use assessed results to build arguments for generalisation, transferability and scale-up, and recognise the challenges to be faced.
2. Align with new trends, policies and the ecosystem's needs.
3. Map the local innovation capacity and identify enabling stakeholders and veto players.
4. Capitalise on project outcomes to build stakeholders' value propositions, and engage a first group of living lab stakeholders.
5. Secure living lab infrastructure and tools for real-life experimentation.
6. Showcase, through the living lab, the value for society, citizens and public and private actors, continuously redefining the value proposition, synergies and experiments with innovative solutions.

## Tips and lessons learned

**Involve the municipality from day one.** In Thessaloniki, the Municipality supported MOBILAIR from the proposal stage, which made it easier to align the project with the city's Sustainable Urban Mobility Plan and Climate City Contract.

**Formalise partnerships early.** Letters of Support from the public transport authority, mobility operators and the local development agency helped secure rewards and data.

**Start administrative procedures early.** Interventions in public space, such as digital displays, need approvals from several authorities and take longer than expected.

CHAPTER 2

# Co-creation & Citizen Engagement

2

**Contributors:** AUTh & CERTH/HIT

## Why

Co-creation sessions, and more precisely participatory design, can be used to engage citizens and bring their needs forward in a comprehensive and integrated manner. Citizens who feel that their opinions are valued are more likely to engage in behaviour-changing activities. Providing people with the tools, knowledge and guidance to come up with their own solutions can therefore increase the perceived value of the final product and lead to greater adoption.

## What you need

A clear scope of what you want to achieve in these sessions is the number one priority, as it will help you decide how to approach the subject. Research and map the organisations relevant to, or affected by, the problem you are trying to tackle, and decide which approach suits which group. MOBILAIR followed two approaches: a one-time session and a participatory design cycle with multiple sessions.

Communicate the purpose of the project in clear, simple language, focusing on how it works and its end goal. Useful tools include questionnaires, either extended or concise, and interactive polling tools such as Mentimeter, which MOBILAIR used to understand how participants perceived the problems addressed by the project. For online sessions, a collaborative whiteboard such as Miro can also be useful.

For the design thinking sessions, you will need post-its in two sizes, voting stickers, markers, A2/A3 paper or a whiteboard to keep notes and, of course, a room to host the session.

## Steps

1. **Figure out your audience**

   Map and contact your stakeholders, and decide which of them will form your focus group for each session type.

2. **Get to know them and introduce the initiative**

   Present the initiative, its purpose and its goals clearly. Learn about their view of the issue through targeted questions.

3. **Facilitate a design thinking session (optional)**

   Divide the group into teams of 4–5 people and follow at least four of the five phases of the design thinking method:

   - **Empathise:** understand the needs, feelings and pain points of the focus group, and create a persona.
   - **Define:** hypothesise and define the problem according to the persona(s).

- **Ideate:** produce as many ideas as possible that could solve the problem, using "How might we…" statements.
- **Prototype:** create a mock-up of what you want to make, explore it and learn from it, and decide whether to revisit any of the previous phases.
- **Test:** usually after a first version of the product is available, a separate session where a focus group gives feedback on it.

4. **Guide them in creating their own solution (optional)**

   After the mock-up, participants can develop a more precise version of their solution. Provide them with specific thematic units that help them work together, expand their research and come up with a solid proposal.

5. **Invite them to present their vision (optional)**

   Ideally, the final session is a presentation of their proposals. In MOBILAIR, participants created two proposals (one per cycle) for a green mobility and air-quality app, with 41 features, 17 of which have already been incorporated.

6. **Keep citizens engaged during the pilot**

   Inform citizens through digital campaigns and public events, and organise forums with pilot users. In MOBILAIR, these activities gave direct feedback for the next version of the app.



## Tips and lessons learned

**Keep questionnaires short.** In the first cycle, the online questionnaire had more than 40 questions and proved laborious for participants. We switched to fewer, more precise questions, answered online and during the sessions through Mentimeter, which also showed participants instantly how their views compared with others'.

**Combine online and in-person.** Online questionnaires reach more people, but physical interactions may produce more reliable data.

**Allow enough time and use examples.** A design thinking session should last at least one hour. Examples help participants understand how design thinking works and what the result may look like. A simple example used in MOBILAIR was the invention of the waffle cone by Italo Marchioni in 19th-century New York.

CHAPTER 3

# Set up Air Quality Data

3

**Contributors:** AUTh

## Why

To provide regularly updated information on urban air quality and to distinguish the contribution of road traffic from other pollution sources. MOBILAIR combined atmospheric modelling, monitoring data and AI-based forecast correction to produce air-quality information for mobility services and municipal decision-making.

## What you need

- Historical and ongoing air-quality measurements, particularly for $PM_{10}$, $PM_{2.5}$ and $NO_2$, the most common pollutants of interest in urban areas.
- Meteorological data and an emissions inventory that distinguishes road traffic from other sources (the more detailed, the better).
- An atmospheric modelling system to estimate pollutant concentrations at the spatial and temporal scale of interest, computing and storage resources, and expertise in air-quality modelling and machine learning.
- Agreed arrangements for accessing measurements, exchanging outputs and maintaining the monitoring infrastructure.

## Steps

1. **Assess and strengthen the monitoring network**

   Review existing stations and identify gaps in traffic-influenced and background locations. In Thessaloniki, MOBILAIR complemented the municipal network with three additional monitoring stations. Establish reliable data collection and check measurements for missing or faulty records.

2. **Set up the atmospheric forecasting chain**

   Adapt the modelling domain, emissions inventory and meteorological inputs to the city. MOBILAIR used the WRF–NEMO–CAMx modelling chain, available through the LIFE-SIRIUS EMS infrastructure, to generate daily forecasts with hourly pollutant concentrations.

3. **Correct forecasts using local observations and AI**

   Match historical model outputs with monitoring observations and meteorological data. Train an AI model to identify and correct forecast errors, and evaluate its performance against observations not used for training. MOBILAIR used a hybrid LSTM–CNN model to improve $PM_{10}$, $PM_{2.5}$ and $NO_2$ forecasts.

4. **Estimate the contribution of road traffic**

Combine the corrected concentrations with emissions separated by source and modelled wind fields. Apply a dispersion and mass-balance approach to account for pollutant transport between neighbouring areas and estimate the traffic-related component of total concentrations. This separates traffic contributions from background pollution, rather than treating all urban pollution as traffic-generated.

5. **Prepare and deliver operational outputs**

   Produce hourly maps of total pollution, traffic-related contributions and the corresponding European Air Quality Index. Agree spatial formats and delivery schedules with the receiving technical team. In MOBILAIR, environmental outputs were supplied to CERTH/HIT for integration into mobility services, and the monitoring-station data flow was transferred to the Municipality for internal use.

## Tips and lessons learned

**Build on existing infrastructure.** Reusing monitoring networks and forecasting services reduces duplication, while additional stations should address specific coverage gaps.

**Adapt and validate locally.** Another city needs its own emissions, meteorology and observations; the AI correction should not be transferred without local evaluation.

**Plan continuity from the start.** Assign responsibilities for station maintenance, model operation and data access. In MOBILAIR, AUTh remains responsible for station maintenance, while the Municipality receives the station data for internal use.

CHAPTER 4

# Prepare Travel Information

4

**Contributors:** CERTH/HIT

## Why

Mobility data allow a city to translate its transport services into practical travel alternatives. In MOBILAIR, the multimodal planner combined street-network information, public transport timetables and shared-mobility locations to produce door-to-door journeys in Thessaloniki. Each alternative was described by its travel time, distance, cost and estimated environmental externalities. These attributes provided the basis for comparing options and generating personalised recommendations in the app.

## What you need

MOBILAIR used an OpenStreetMap street network and public transport data in General Transit Feed Specification (GTFS) format, together with the locations of shared-mobility stations and Park & Ride facilities. Existing mobility information was available through Thessaloniki's Smart Mobility Living Lab (ThessM@LL). Local fares, vehicle operating costs and environmental cost parameters supported the comparison of journeys.

The technical set-up consisted of OpenTripPlanner and a routing API developed by CERTH/HIT. User profiles supplied information on usual travel habits, available transport modes and walking constraints for the recommendation workflow. Replication therefore requires both the local transport datasets and the parameters that determine how journeys are assembled and compared.

## Steps

1. **Identify the transport options to include**

   MOBILAIR considered walking, public transport, private cars and bicycles, shared e-bikes and scooters, and combinations involving Park & Ride. Start by identifying which of these options exist locally and where transfers between them are possible.

2. **Prepare the network and service information**

   Configure OpenTripPlanner with the OpenStreetMap network and the GTFS feeds of the city. Add the locations needed to connect services, including shared-mobility stations and Park & Ride facilities. In Thessaloniki, the planner considered Park & Ride connections at the New Railway Station and Nea Elvetia.

3. **Assemble complete journeys**

   Use the routing service to connect individual legs between the requested origin and destination. MOBILAIR included walking to and from shared-vehicle stations and coordinated successive legs using arrival times and a configurable transfer buffer, combining the legs into a common journey format.

4. **Apply local cost parameters**

   Calculate comparable attributes for each journey, including duration, distance and estimated costs. MOBILAIR distinguished the user's financial and indirect costs from environmental externalities. Adapt fares, vehicle costs and other parameters to the city rather than transferring the Thessaloniki values unchanged.

5. **Pass alternatives to the recommendation service**

   MOBILAIR shortlisted four alternatives according to generalised user cost and then assessed their environmental externalities. A locally hosted language model uses these structured alternatives, relevant user-profile information and the selected nudging strategy to generate personalised recommendation messages, while route calculations and numerical comparisons are produced by the routing services.

6. **Retain the information needed to interpret user responses**

   Store the alternatives offered with each recommendation alongside the user's response. In the MOBILAIR pilot, placeholder alternative-route fields limited retrospective comparisons; keeping the route attributes and the basis of comparison makes later analysis more informative.



## Tips and lessons learned

**Use open standards.** Open street-network data and GTFS timetables make the approach transferable to any city that publishes them.

**Adapt cost parameters locally.** Fares, vehicle costs and environmental cost values differ between cities and should not be copied from Thessaloniki.

**Record what users were offered.** Storing the alternatives shown with each recommendation makes it possible to understand why users accepted or rejected them.

CHAPTER 5

# The MOBILAIR App

5

**Contributors:** CERTH/HIT

## Why

The mobile application is the main interface through which citizens access and interact with the services of the MOBILAIR ecosystem.

## Technology

The MOBILAIR app was developed with the React Native framework, enabling cross-platform development for Android and iOS from a shared codebase. This approach makes development and maintenance more efficient, reduces code duplication, supports consistency across platforms and simplifies future updates and fixes. A cross-platform framework, such as React Native or an equivalent technology, is therefore recommended.

## Main features

The app provides its services through a clear, intuitive interface, with a standard navigation drawer giving easy access to all services:

1. **Home screen:** the project logo, a brief description of the app and a daily challenge checklist; by completing the challenges, users earn the eco-coins available for that day.
2. **Air quality:** the Air Quality Index (AQI) in numerical and qualitative form with a colour-coded indicator, and the share of air pollution attributable to traffic.
3. **Eco-routing:** the app's main service, providing multimodal route recommendations that prioritise environmentally friendly options and use nudging strategies; the suggested alternative is highlighted in green.
    a. **Place picker:** origin and destination can be set by entering an address, selecting a point on the map or using the current location, supported by geocoding and reverse geocoding services.
    b. **Map view:** displays the available routes and the selected route, making it easy to compare alternatives.
4. **Level and points:** the user's progress in the reward system: current level and title, accumulated eco-coins and points needed for the next level.
5. **Quizzes and surveys:** presented in separate tabs; quizzes highlight the correct answer in green for immediate feedback, while surveys show one question at a time and allow users to go back and review their answers.

6. **User account and authentication:** access is limited to registered users, with account creation, email verification, password recovery through a one-time password (OTP), secure login and logout, token management and account deletion in line with the GDPR right to erasure.

## Steps

1. **Define the services**

   Decide which services the app will offer (air-quality information, eco-routing, challenges, surveys) based on the needs identified through co-creation (Chapter 2).

2. **Connect the data**

   Link the app to the air-quality outputs (Chapter 3) and to the routing and recommendation services (Chapter 4) through APIs.

3. **Design the nudges**

   Present each option with a clear personal comparison of time, cost, $CO_2$ and physical activity, and highlight the most sustainable choice.

4. **Set up gamification and rewards**

   Combine challenges, points and levels with tangible rewards from local partners, such as free public transport rides or discounted bike-sharing.

5. **Test with a pilot group**

   Recruit pilot users through events, local channels and partners, and collect their feedback through in-app surveys and user forums.

6. **Publish and support**

   Make the app available on the main app stores, and ensure data protection, account management and regular updates.

## Tips and lessons learned

**Practical benefits motivate most.** MOBILAIR users were motivated mainly by saving time (65.9%) and money (63.5%), far more than by rewards or social comparison. A clear personal comparison of each route was the most persuasive nudge.

**Tangible rewards matter.** Rewards with partners, such as public transport and bike-sharing operators, were the most appreciated incentive. Agreements with local shops take longer, so start them early.

**Plan for retention, not only downloads.** Engagement was concentrated in a core group of regular users. Daily challenges, events and quick feedback help keep users active.

**Keep recommendations fast.** Moving the recommendation service to a dedicated system reduced response time from about 15 to 2 seconds, which makes a real difference to the user experience.

CHAPTER 6

# Web Applications and Services

6

**Contributors:** CERTH/HIT

## Why

Not every citizen will download an app, and city authorities need tools for planning rather than for daily travel. Web applications make MOBILAIR's information available to a wider audience, without installation, and connect the project's data to the city's own systems. In MOBILAIR, the web services complement the app: they inform citizens in public space, support municipal decision-making and make the project's results openly available.

## What you need

- The air-quality outputs (Chapter 3) and the routing services (Chapter 4), exposed through APIs that web applications can use.
- A web map component to display routes and pollution layers, and hosting for the web services.
- A project website where the services, results and guidelines are published.
- Agreements with the municipality and other operators on which of their systems will receive data, in which format and how often.

## Steps

1. **Define the users of each service**

   Decide which services are for citizens (e.g. information in public space), which are for the municipality (e.g. planning tools) and which are for the wider public (e.g. results and statistics).

2. **Build a public dashboard**

   In MOBILAIR, the web dashboard (mobilair.gr/services) combines a multimodal route map with the traffic-related pollution heatmap, so that mobility options and their air-quality impacts can be explored side by side.

3. **Bring information into public space**

   Link QR codes in public space to a light web page that needs no installation. In MOBILAIR, scanning a QR code shows public transport information to key destinations, the Air Quality Index at that location and a link to download the app, and is part of the "QR Explorer" treasure hunt game.

4. **Connect to the city's systems**

   Provide APIs so that the project's data can feed existing municipal platforms. In Thessaloniki, the integration of the traffic-related pollution heatmap into the City's ENIGMA platform is under way.

5. **Share results openly**

   Publish metrics, statistics and deliverables on the project website. MOBILAIR's Metrics section presents app usage and project results, with the deliverables available for download.

## Tips and lessons learned

**Web reaches people the app does not.** A QR code on a digital display or a link on the website is often the first contact with the project, and a way to invite people to download the app.

**Design for the city's existing tools.** Municipal staff are more likely to use MOBILAIR's outputs if they appear in platforms they already use, rather than in a new standalone tool.

**Keep one source of data.** The app, the web services and the city's platforms should draw on the same APIs, so that citizens and decision-makers see the same information.

# Key lessons at a glance

*Six lessons from MOBILAIR for cities that want to follow a similar approach.*



### Adaptation to a Local Living Lab

Embed the solution in a local living lab and involve the municipality from day one, so that it continues after the project.



### Co-creation & Citizen Engagement

Design with citizens, not for them: their ideas shape features they will actually use.



### Set up Air Quality Data

Build on existing monitoring and forecasting, and validate AI corrections with local data.



### Prepare Travel Information

Use open data standards and adapt cost parameters to your own city.



### The MOBILAIR App

Make it personal and practical: clear time and cost comparisons and tangible rewards motivate most.



### Web Applications and Services

Web services reach people the app does not, and connect MOBILAIR to the city's own tools.

# About MOBILAIR

MOBILAIR – Data-Driven and User-Centric Mobility for Air Improvement in the city of Thessaloniki – was coordinated by the Hellenic Institute of Transport of the Centre for Research and Technology Hellas (CERTH/HIT), in partnership with the Aristotle University of Thessaloniki (AUTh) and with the support of the Municipality of Thessaloniki.

**mobilair.gr**

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