

Senator

Advanced Technical Brochure

Smart Operator Platform

NOVEMBER 2024 [SENATORPROJECT.EU](https://senatorproject.eu)

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Chapter 1

Overview

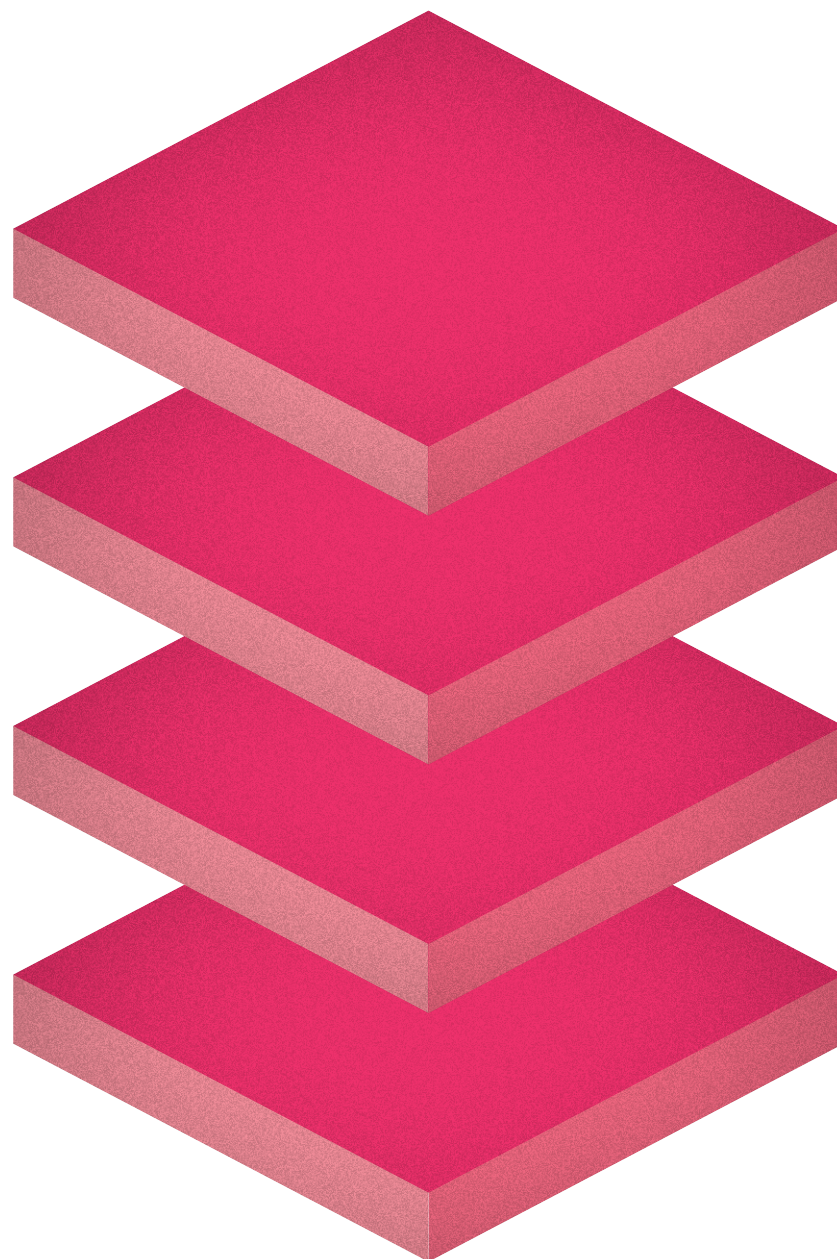
The Senator project, funded by the EU's Horizon 2020 programme, is leading an innovative approach to urban logistics. Focusing on four key urban layers—end-receiver, transport, logistics, and infrastructure—the project has developed a Smart Network Operator Platform, supported by an advanced ICT framework for **shared, integrated and more sustainable urban freight logistics**.

This document presents an overview of the Senator Smart Network Operator Platform, including its target users, data integration processes, tested scenarios, as well as its design and functionality. It also highlights the platform's potential to **enhance decision-making and collaboration** among logistics operators, carriers, and urban planners, contributing to a more sustainable future.



1.1 Senator Governance schemes

The key benefits include enhancing logistics efficiency through digitalization, improving urban space management, and integrating more sustainable transport modes.



01
User Demand Planning



02
Transportation Planning



03
Freight and Logistics Planning



04
Urban Infrastructure



Scan to watch the live demo of the Senator platform!



Chapter 2

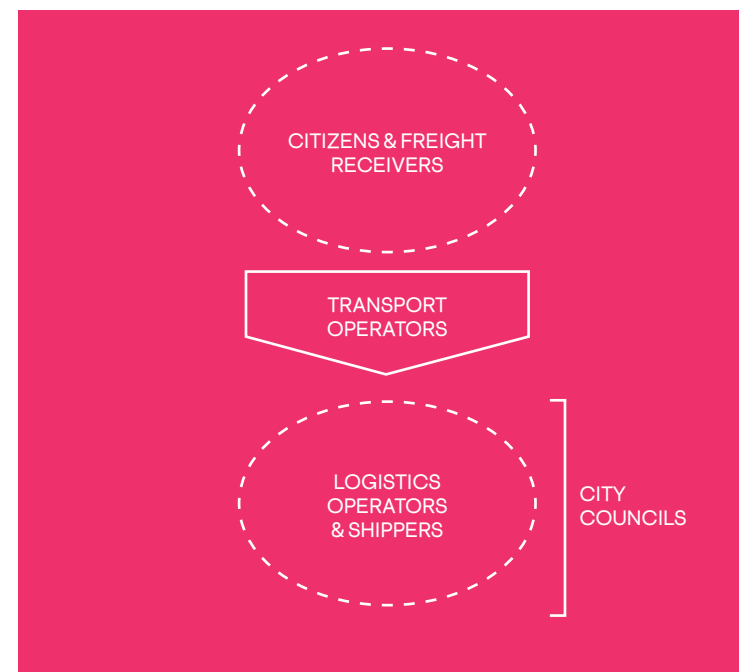
Target user groups



2.1 Stakeholders

The Senator Platform transforms urban logistics by providing essential support to various stakeholders in the sector, driving sustainability and efficiency in freight transport:

- **Transport Operators:** Delivery companies, freight carriers, and transport agents benefit from improved route planning, reduced delivery times, and enhanced fleet management. Real-time tracking of shipments, resources and incidents allows for data-driven decisions and operational optimization to quickly adapt to changing conditions.
- **Logistics Operators & Shippers:** The Senator Platform helps operators efficiently handle inbound and outbound shipments and streamline communication with logistics providers. Access to real-time data on consolidation processes and shipment statuses enhances operational efficiency and minimizes the environmental impact of urban freight transport.



- **Municipalities and City Administrators:** The Senator Platform provides city planners, local government officials, and urban managers with integrated and, when possible, real-time data on logistic movements and urban infrastructure monitoring. This enables the development of informed policies for urban logistics, regulatory compliance, and sustainable development.



2.1 Stakeholders

Senator Platform’s design is tailored to the specific needs of each user group, ensuring that everyone has access to the information

and tools necessary to optimize their operations.

TABLE 1 SENATOR PLATFORM TARGET USER GROUPS

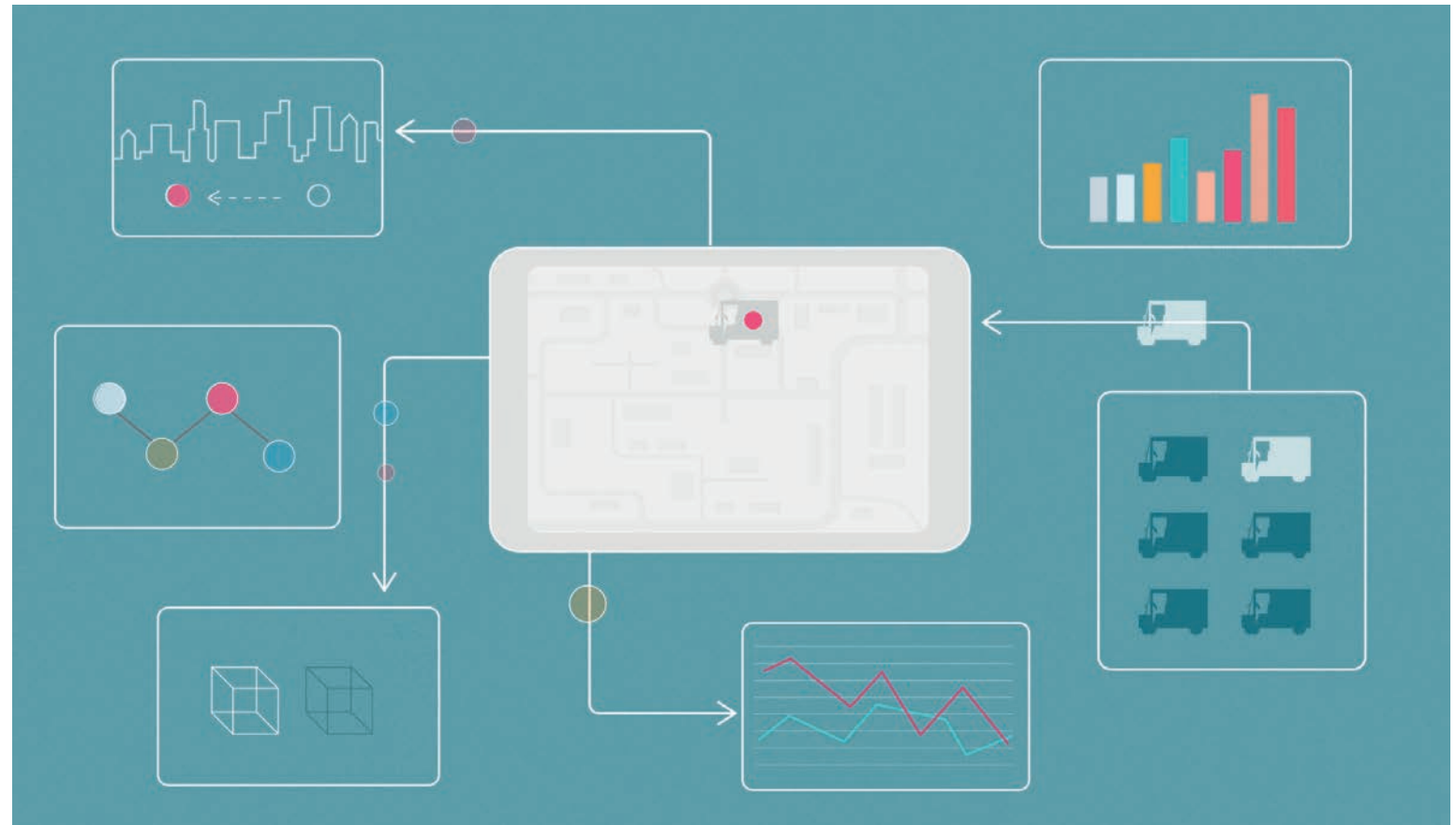
TARGET USER GROUP	ROLE	NEEDS
Urban Managers	Act as the regulatory body overseeing urban logistics and transportation.	<ul style="list-style-type: none"> ● Monitoring of impact of delivery flows. ● Access to high level data for planning and regulation of urban logistics. ● Tools to assess the impact of new local regulations (e.g., zero-emission zones).
Transport Operators	Companies responsible for the movement of goods.	<ul style="list-style-type: none"> ● Efficient management of fleets and routes. ● Real-time tracking of shipments, resources and incidents. ● Tools for managing and optimizing delivery operations.
Urban Consolidation Centre (UCC) Operators	Facilities that consolidate shipments to minimize urban congestion.	<ul style="list-style-type: none"> ● Efficient management of inbound and outbound shipments. ● Tools for real-time communication with logistic providers. ● Access to data on consolidation processes and shipment statuses.

Chapter 3

Data Management and Integration



3.1 Data Management and Integration



Senator is designed as a collaborative network that addresses the needs of different stakeholders, working together to meet both functional and non-functional requirements.

Thus, **defining a modern, stable, and extensible software architecture** is essential for the development and integration of those different services.



3.2 Layered Data Architecture

The Senator platform utilizes an advanced data architecture for seamless data input and access. Key components include:

- Data Collection Layer. A set of mechanisms that extract, transform, and aggregate real-time data from IoT devices, municipal databases, and external APIs related to shipments, traffic, and environmental conditions into the Senator platform.
- Data Access Layer. The access point for structured data across the following three types:
 - Time-Series Databases for delivery events and patterns.
 - Geospatial Databases for smart visualization and logistics routes planning.
 - Relational Databases for structured information on system interactions and users.
- User Interfaces. Accessible via web and a mobile application for real-time data access, with API support for seamless external integration.



The Senator Platform ensures that each user group has **access only to the information relevant to their role**, delivering practical insights.

Data is anonymized to protect sensitive information while offering valuable insights.



3-3 Real-Time Data Integration and Management

By integrating IoT devices, such as sensors, mobile devices and fleet management systems, the Senator platform collects real-time data on the fleet and urban environment. This capability supports rapid decision-making, enabling operations to adapt to current traffic conditions and delivery needs.

The platform gathers real-time data from various sources, including:

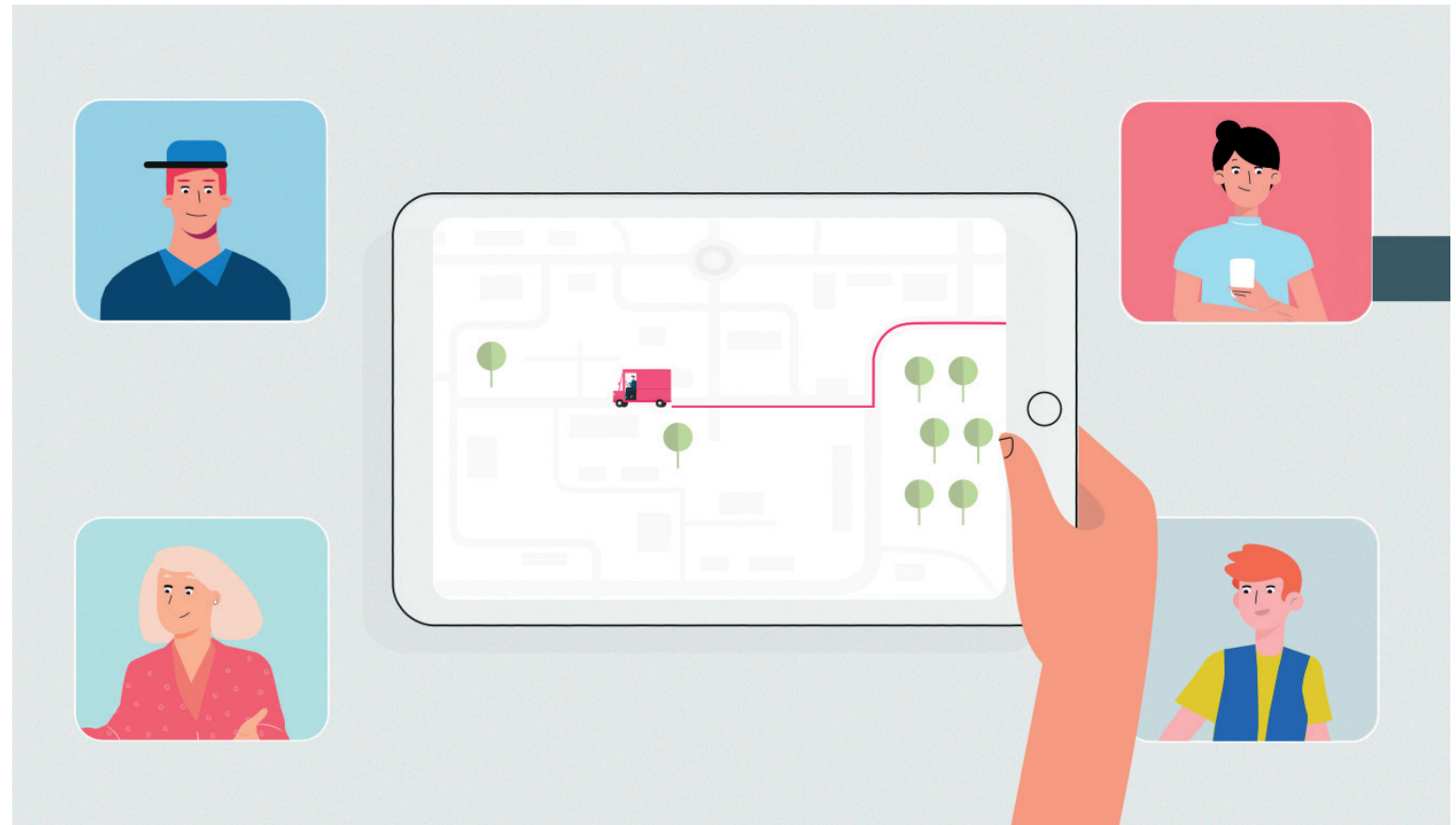
- GPS tracking from postman and vehicles.
- Delivery actions from logistics operation.
- Environmental data to assess logistics impacts.
- Real time traffic information from the city councils.
- Real time parking status information from the city councils.

TABLE 2 SENATOR PLATFORM DATA SOURCES

DATA SOURCES	DATA COLLECTION
Delivery Demands	Data related to shipments, such as dimensions, pick-up and delivery locations, and time windows
Vehicle Fleet Data	Information regarding vehicle types, capacities, and operating constraints (e.g., driving hours, restrictions).
Fleet Tracking	Continuous location and operational data from vehicles or personal devices (PDAs/APPs)
Urban Infrastructure	Road conditions, traffic information, details about urban infrastructures, including loading/unloading zones and restricted areas (like Low Emission Zones).



3.4 Multi-Objective Optimization for Efficient Logistics



Additionally, multi-objective optimization allows the platform to consider various factors—such as travel distances, cost, time, and emissions—ensuring that logistics decisions are more efficient and aligned with sustainable urban logistics goals.

Chapter 4

Appearance and Usability

The Senator Platform provides a user-friendly and efficient environment for urban logistics management. Designed with operators in mind, it delivers a unified, visual overview of all logistics operations and resources. Key features include user management tools, real-time KPI analysis, and a comprehensive view of logistics services for all the stakeholders.

4.1 Global Dashboard

The interface of Senator Platform is built to optimize user interaction, making it easy for operators to access and manage critical information. Once logged in, users access the dashboard, featuring three main tools:

- **Main Map:** Displays all geospatial data synchronized with user interaction in filters, searches and other available tools.
- **KPIs & Charts:** Offers dynamic data visualization, updated with both standard and geospatial filters.
- **Tools:** Includes search by address or coordinates, along with filters (spatial/temporal) and a geographic/data comparator so user can focus on its main interest.

User types

The interaction of entities and individuals with the different components of the Senator Platform will ultimately vary depending on the type of user:

- **Control Tower Manager:** A user with comprehensive control over the platform and complete access to all unit information.
- **Administrator and Manager:** Team leaders who manage access and data for their unit. They can load and save new data sources within the platform, accessible only to their division. Administrators are frequent users, well-versed in datasets, configurations, and user permissions.
- **Standard User:** Designed for continuous interaction, this user configures custom dashboards to generate insights effortlessly. The platform is tailored to help them streamline daily tasks and work with business data efficiently.

User types

USER ROLE	DESCRIPTION	ACCESS & PERMISSIONS	USAGE PATTERN
Control Tower Manager / Administrator	Global administrator of the platform and their users and services	Can load new data sources and save data within the platform.	Timely interaction for setup interventions but with full knowledge of datasets, configurations, and user capabilities.
Manager	A team leader responsible for managing access and data within their work unit.	Can load new data sources and save data within the platform.	Intensive user with daily access for long time periods. With full knowledge of datasets, configurations, and user capabilities.
Standard User	Users who interact continuously with the platform to perform daily tasks	Focused on configuring a custom dashboard and generating outputs or insights easily. The solution is designed to help them manage business data effectively.	Regular interactions with the platform to complete daily tasks.

4.2 Functional Capabilities

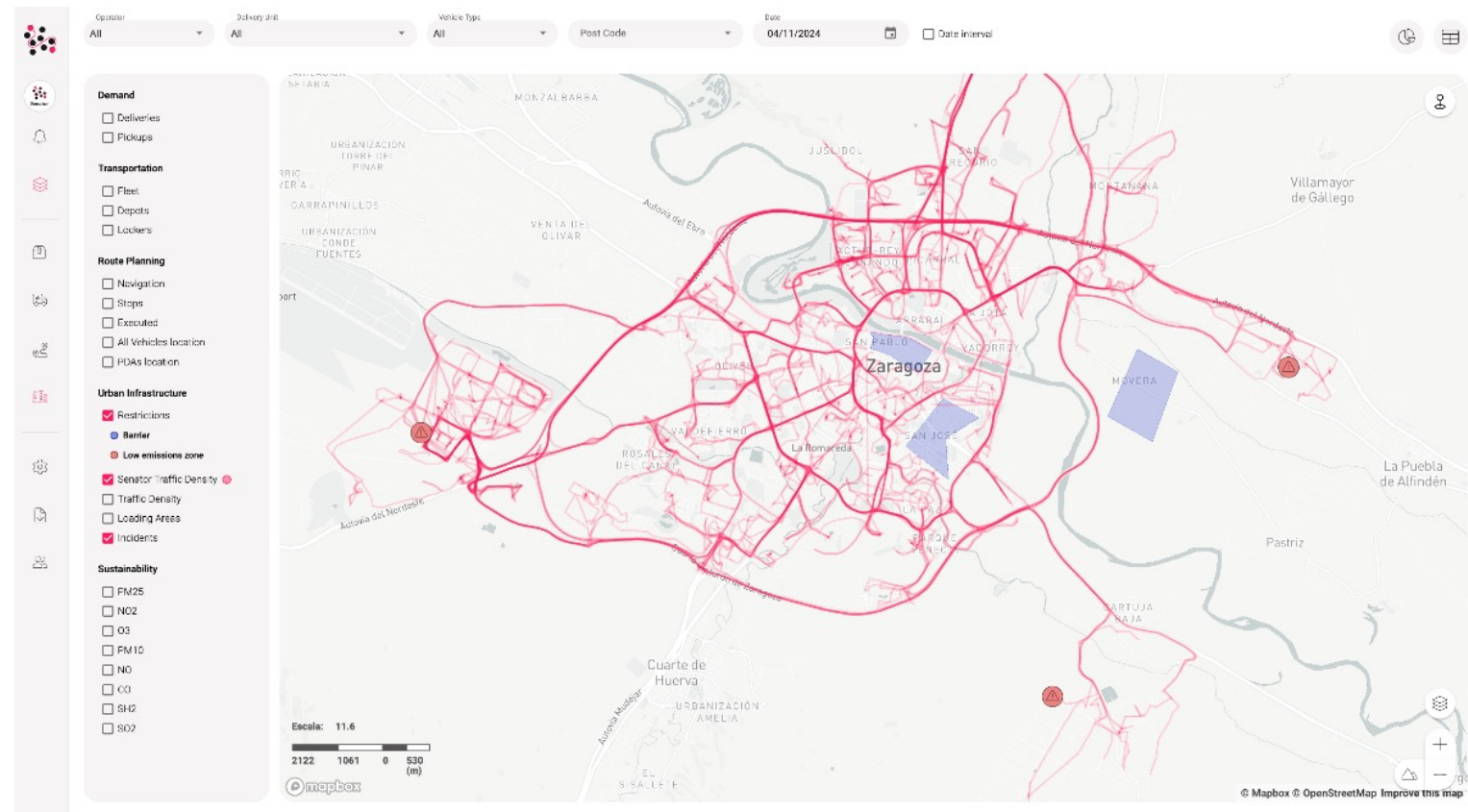
The Senator platform acts as a "control tower" for urban logistics, enabling comprehensive oversight and seamless communication for all stakeholders. Key services include:

- **On-Demand Platform Manager (OPM):** Users can register, manage and check pick-ups, shipments, on-depots, and deliveries' status. This service consolidates demand from various sources, allowing matching with carrier availability to enhance efficiency.
 - **Multimodal Fleet Manager (MFM):** Tracking and managing fleet resources and operational capacity in real time. This tool provides fleet managers with insights into vehicle characteristics, capacities, and availability.
 - **Smart Routes Manager (SRM):** Enables real-time delivery route monitoring and dynamic incident response, optimizing load distribution for greater efficiency. Also, it allows consulting the optimized route planning, that integrates the two
- previous services information with sustainability goals (e.g., low-emission zones) and urban regulations. Operators can track vehicle locations and load status, balancing resources when disruptions occur, while monitoring infrastructure conditions like traffic and loading bays. Real-time monitoring and route configuration improve operational flexibility and support eco-friendly logistics.
- **Urban Infrastructure Diagnosis (DUI):** Provides municipalities and infrastructure managers with insights into the logistics impact on urban areas, including the most trafficked delivery routes, low-emission zones, and regulatory compliance. This service helps manage and optimize urban infrastructure involved in last-mile logistics, enhancing service efficiency and city-wide mobility.

DUI Urban Infrastructure Diagnosis

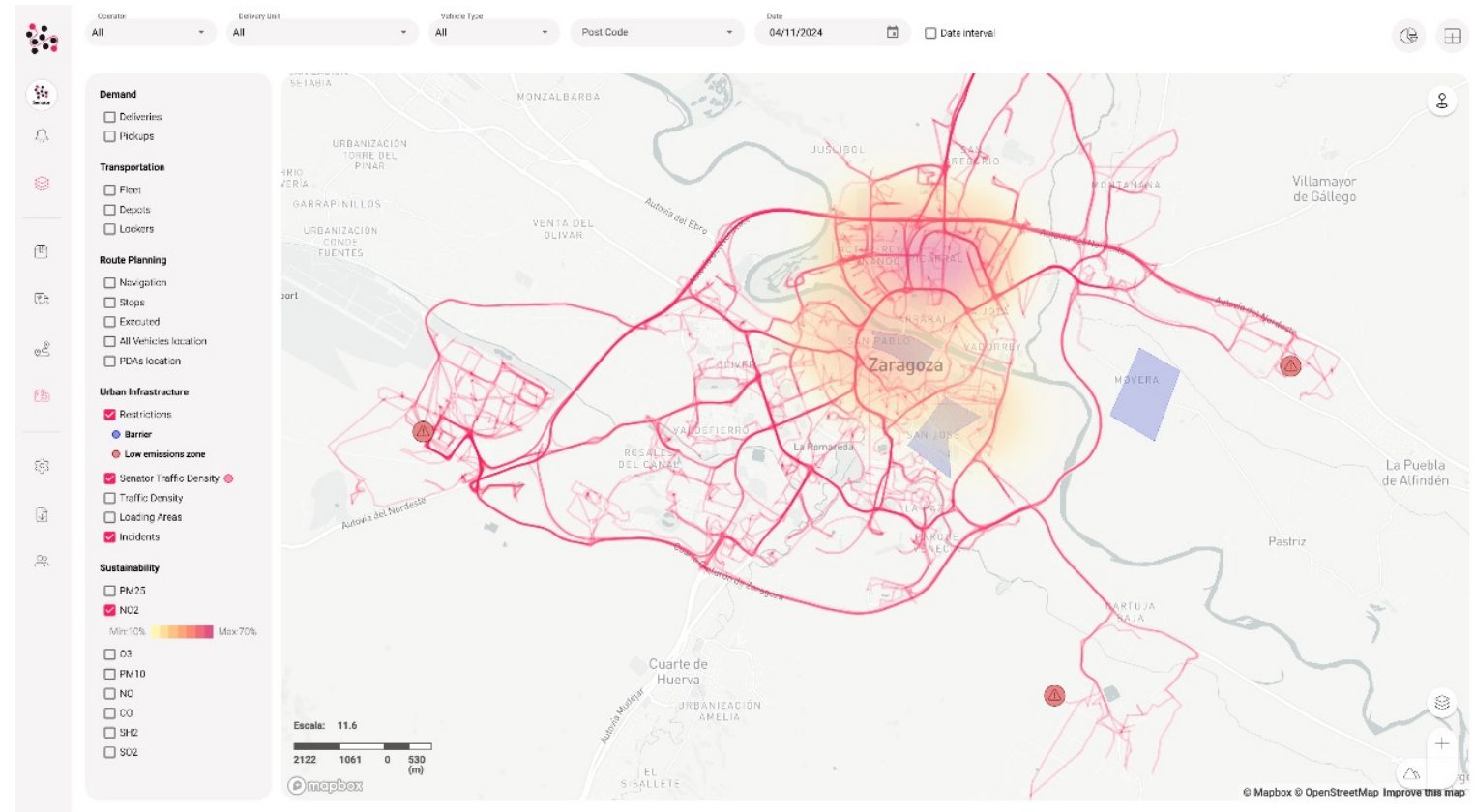
FIGURE 1 URBAN INFRASTRUCTURE DIAGNOSIS

Visualization of areas with restrictions (Low Emission Zones and barriers), traffic density, and recorded incidents.



DUI Urban Infrastructure Diagnosis

FIGURE 2 URBAN INFRASTRUCTURE DIAGNOSIS
Sustainability Indicator; NO2 Pollution Levels.



MFM Multimodal Fleet Manager

FIGURE 3 MULTIMODAL FLEET MANAGER VIEW
Featuring a selection of depots, lockers, and available fleet.

Operator: All | **Delivery Unit:** All | **Vehicle Type:** All | **Post Code:** | **Date:** 10/10/2024 | Date interval

Map Legend:

- Deliveries
- Pickups
- Transportation**
 - Fleet
 - Depots
 - Lockers
- Route Planning**
 - Navigation
 - Stops
 - Executed
 - All Vehicles location
 - PDAs location
- Urban Infrastructure**
 - Restrictions
 - Senator Traffic Density
 - Traffic Density
 - Loading Areas
 - Incidents
- Sustainability**
 - PM25
 - NO2
 - O3
 - PM10
 - NO
 - CO
 - SH2
 - SO2

Map Info: Escala: 11.7 | 2067 1034 0 517 (m) | Mapbox © OpenStreetMap

DATA TABLE | COMPARE

Choose a layer: **Depots**

Name	Address
Mercado de San VICENTE de PAUL	C. de San VICENTE de PAUL, 22. 50004 Zaragoza
Correos USC 1	Joaquín Anselmo Clavé, S/N
Correos USC 2	Gabriel García Márquez, 5
Correos Unidad Reparto 1	Vía Hispanidad, 100
Correos Unidad Reparto 2	Joaquín Anselmo Clavé, S/N
Correos Unidad Reparto 3	Plaza de España, 13, 514

Rows per page: 100 | 1-13 of 13

DEMAND | SERVICE | SUSTAINABILITY

Demand

- Sum of capacities of all vehicles Vs Sum of weight of all parcels: **111,056Kg - 0Kg**
- Sum of capacities of all vehicle Vs Sum of volumes of all parcels: **564.56m³ - 0m³**
- Number of vehicle by driving force: **194** (Total)

 - Electric
 - Combustion
 - Human

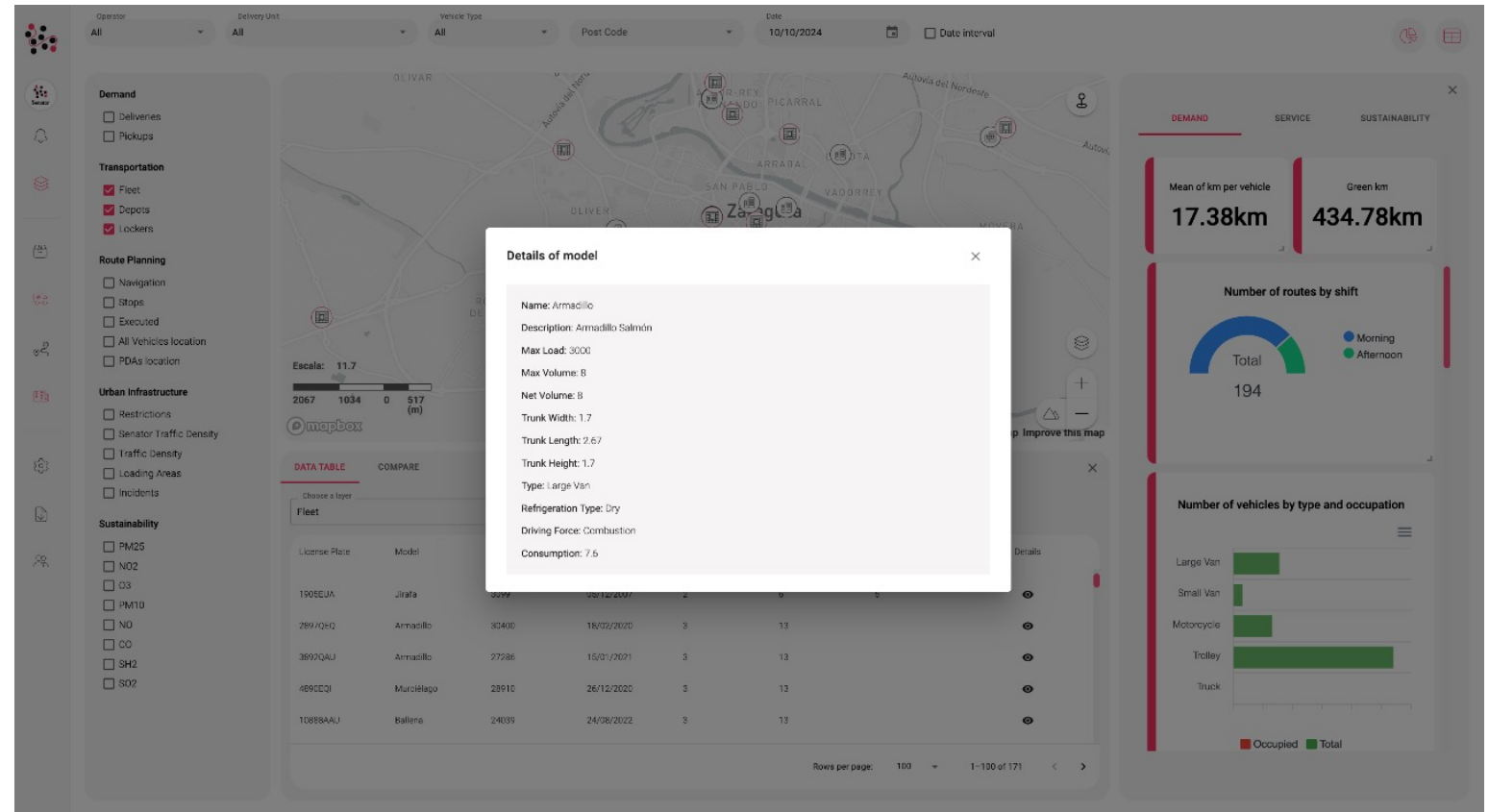
Percentage of vehicles by type

- Motorcycle
- Large Van
- Trolley
- Small Van
- Truck

MFM Multimodal Fleet Manager

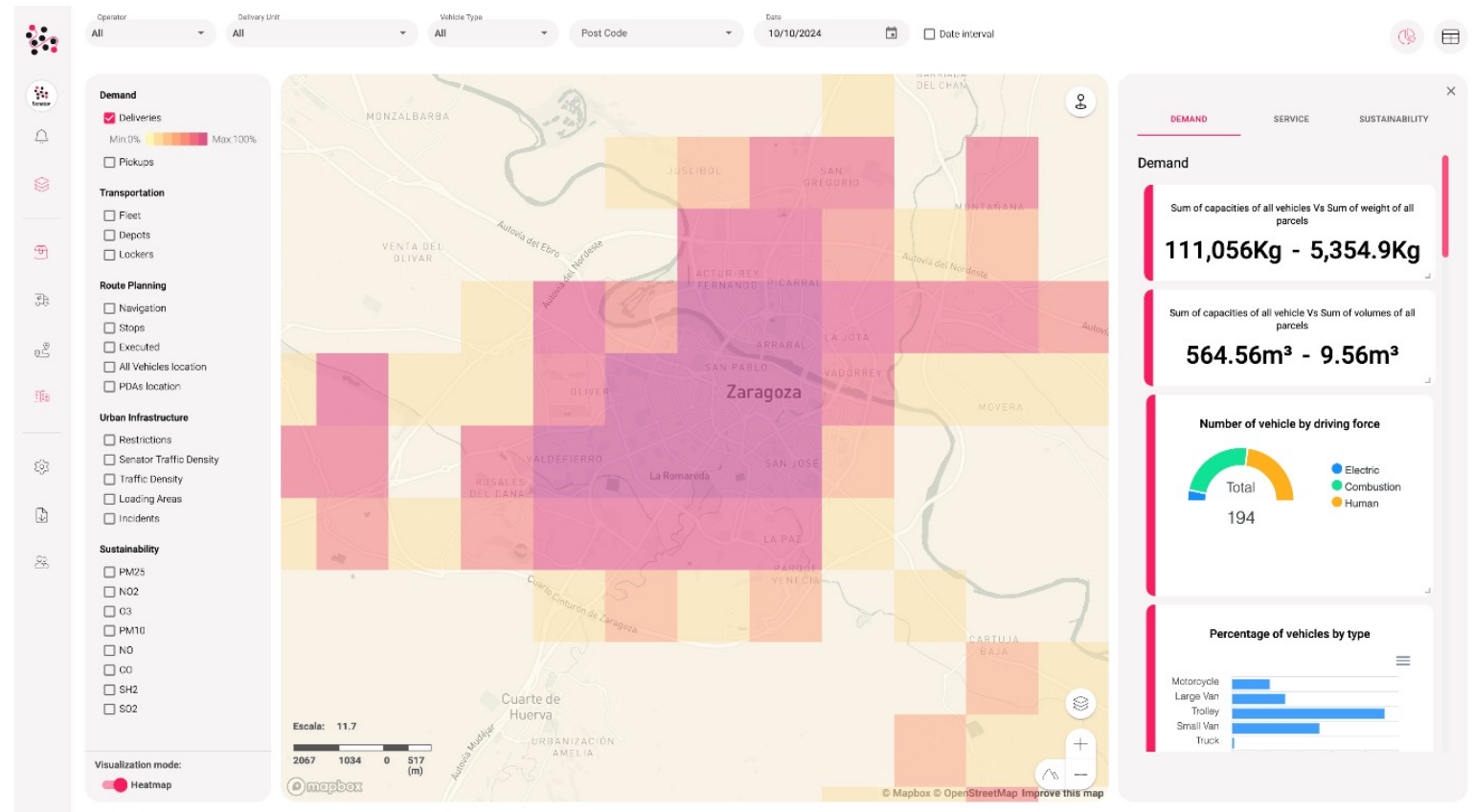
FIGURE 4 MULTIMODAL FLEET MANAGER VIEW

Showing a detailed overview of the transport vehicle and its capacity.



OPM On-Demand Platform Manager

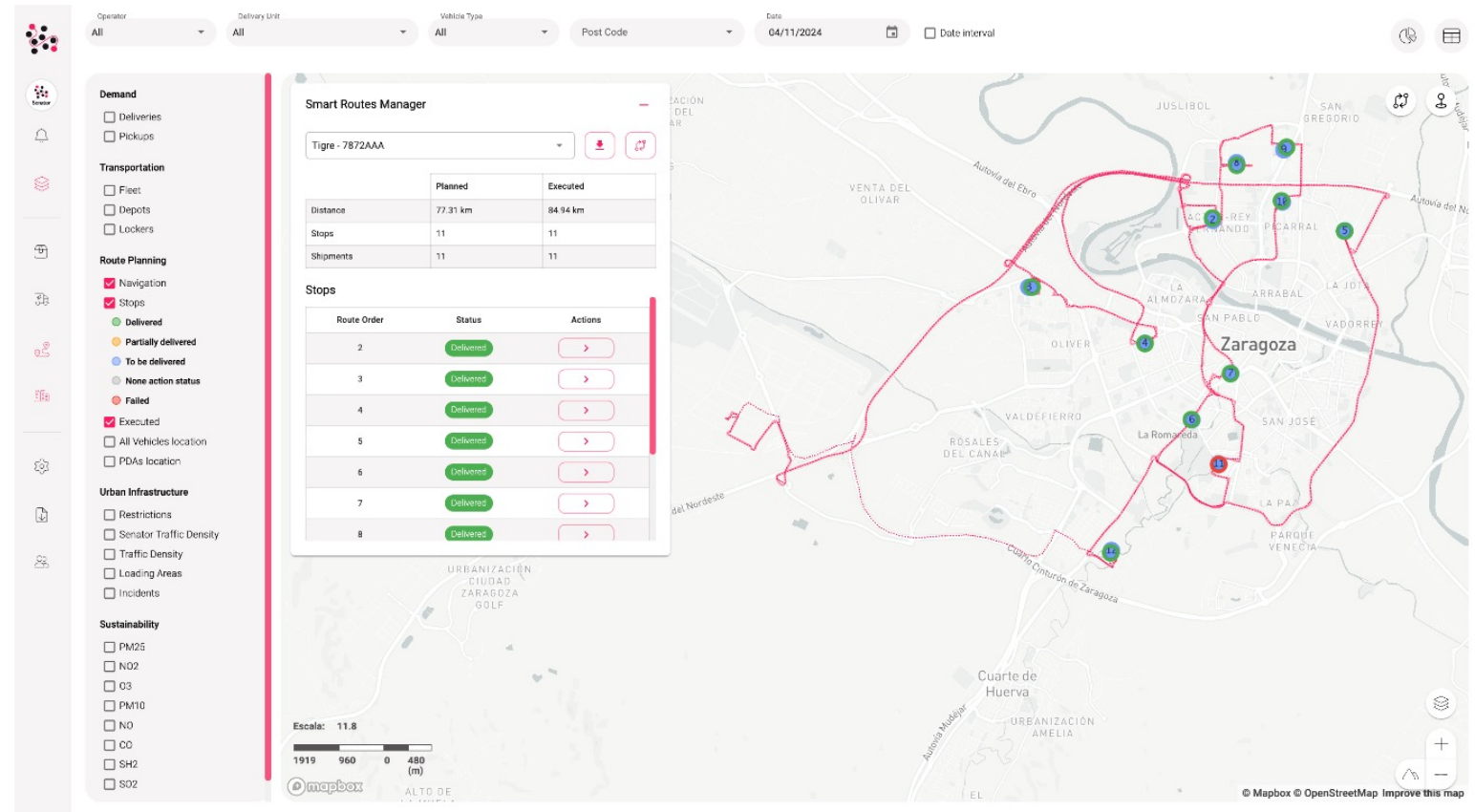
FIGURE 5 HEATMAP VIEW OF DEMAND ON THE ON-DEMAND PLATFORM SERVICE.
Heatmap view.



SMR Smart Route Manager

FIGURE 6 SMART ROUTES MANAGER

Overview of the route itinerary, shipments' delivery actions, and distance travelled.



SMR Smart Route Manager

FIGURE 7 VIEW OF A SHIPMENT'S STATUS ON THE ROUTE.

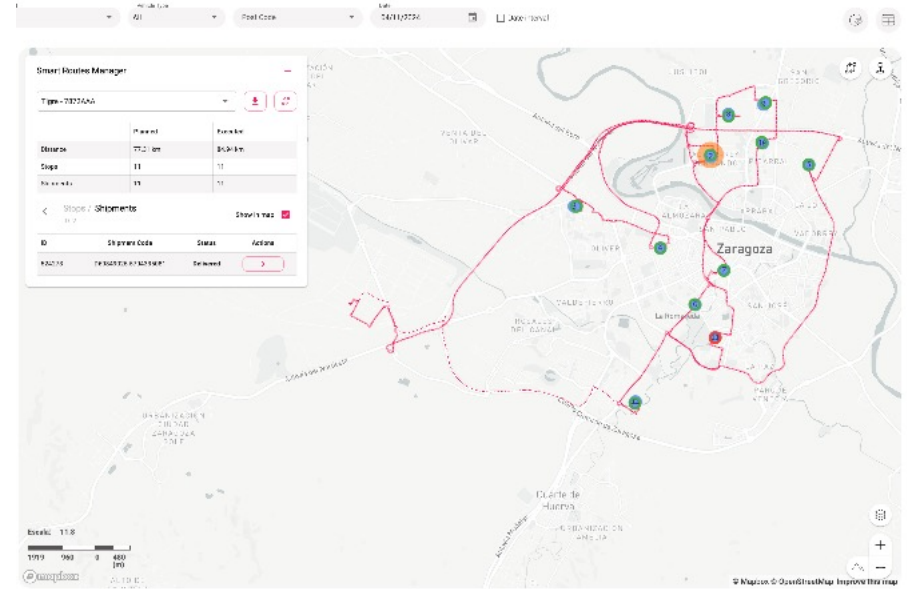
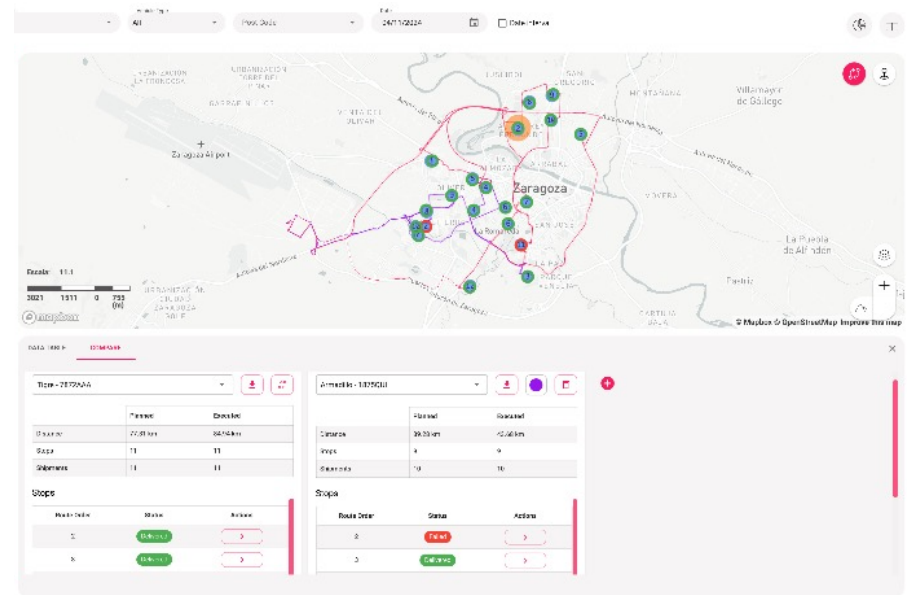


FIGURE 8 SIDE-BY-SIDE VIEW OF TWO ROUTE ITINERARIES.



SMR Smart Route Manager

FIGURE 9 SMART ROUTES MANAGER

Detailed route view, including stop logs, ordered sequence, vehicle load capacity, completed deliveries, and travelled and estimated distance.

The screenshot displays the Smart Routes Manager interface. At the top, there are filters for Operator (All), Delivery Unit (All), Vehicle Type (All), Post Code, and Date (04/11/2024). The main area is divided into several sections:

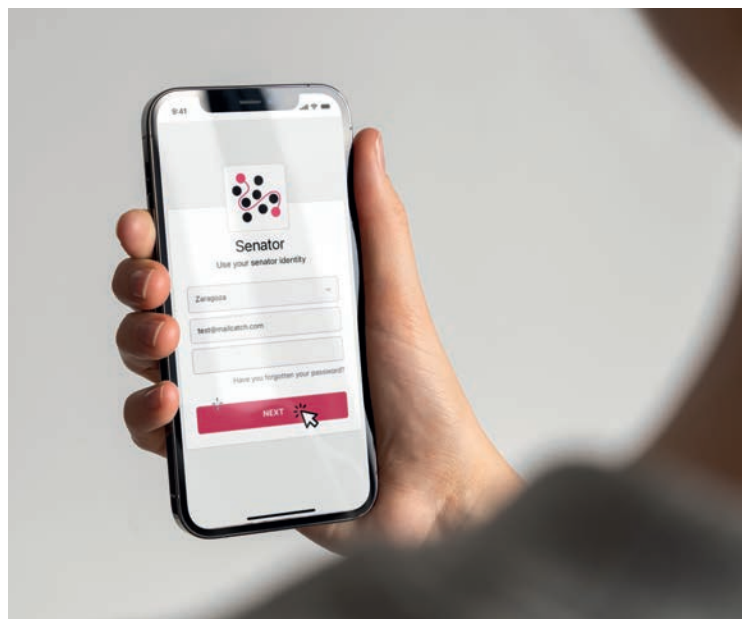
- Left Sidebar:** Contains various filters and settings under categories like Demand, Transportation, Route Planning, Urban Infrastructure, and Sustainability.
- Smart Routes Manager Panel:**
 - Search: Tigre - 7872AAA
 - Summary Table:

	Planned	Executed
Distance	77.31 km	84.94 km
Stops	11	11
Shipments	11	11
 - Stops Table:

Route Order	Status	Actions
2	Delivered	>
3	Delivered	>
4	Delivered	>
 - Map: Shows a route in Zaragoza with numbered stops (1-11) and a red line indicating the path.
 - DATA TABLE:

Route ID	Route Order	Route Order	Arrival Time	Arrival Capacity	Departure Time	Departure Capacity
24150	planned	2	04/11/2024 16:19	4.07	04/11/2024 16:39	4.06
24150	planned	3	04/11/2024 16:47	4.06	04/11/2024 17:03	4.05
24150	planned	4	04/11/2024 17:08	4.05	04/11/2024 17:26	4.04
24150	planned	5	04/11/2024 17:38	4.04	04/11/2024 17:47	4.03
24150	planned	6	04/11/2024 18:00	4.03	04/11/2024 18:21	4.02
- Right Panel (DEMAND):**
 - Planned Km vs Executed Km: Bar chart showing Planned (blue) at ~77.31 km and Executed (green) at ~84.94 km.
 - Planned time vs Executed time: Bar chart showing Planned (blue) and Executed (green) time intervals.
 - Sum of capacities of all vehicles Vs Sum of weight of all parcels: **853kg - 0kg**
 - Sum of capacities of all vehicles Vs Sum of volumes of all parcels: **4.2m³ - 0m³**

4-3 Senator Mobile App



The Senator mobile app is designed specifically for logistics operators and affiliated agents involved in the project, enhancing urban delivery efficiency and sustainability. It leverages Senator's advanced technologies for last-mile logistics management. Initially a tool for testing key Senator features, the app has the potential to become a regular tool for carriers and delivery managers, ensuring GDPR compliance and the use of anonymized data.

Key features include:

- **Package Reception & Logging**
Delivery unit managers can quickly confirm package arrivals by scanning barcodes, with automatic checks against the Senator database for immediate logging.
- **Optimized Route Visualization**
The app displays customized delivery routes, allowing managers to select the most efficient options based on parameters like distance, time, and transportation mode.
- **Real-Time Tracking & Alerts**
Real-time tracking of deliveries, confirming successful deliveries and notifying of any issues. Users can also input alerts for unforeseen events such as road closures or delivery delays, enhancing operational flexibility.

Through these functionalities, the Senator app empowers logistics professionals to optimize urban delivery operations, promoting sustainability and responsiveness.

Chapter 5

Scenarios tested

5.1 Testing scenarios

The Senator platform has been validated through practical implementation in two Urban Living Labs (ULLs) located in Zaragoza (Spain) and Dublin (Ireland).

Last-Mile Delivery Management

Evaluation of delivery efficiency in urban settings, focusing on reducing congestion and improving service quality.

Dynamic Route Optimization

Implementation of algorithms that adjust routes in real-time based on traffic disruptions and operational conditions. Assessment of improvements in delivery times and cost reductions.

Integration of Urban Infrastructure Data

Assessing the impact of real-time information (traffic-data, environmental-data, new restrictions to mobility) on delivery performance and urban logistics operation.

Urban Consolidation Centres

Testing the usage of UCCs or micro-hubs that enable more reliable, efficient and environmentally friendly last mile deliveries, as a result of not having heavy vehicles driving through congested city streets.

5.2 Urban Living Labs

Testing is conducted in two main urban environments:

Zaragoza, Spain: Focused on integrating the platform with local delivery services.

Dublin, Ireland: Evaluating platform effectiveness in simulated urban logistics scenarios.

5.3 Scenarios tested

Scenarios have been tested in urban environments, such as Dublin and Zaragoza, focusing on both real-time logistics management and simulated theoretical trials.

- **Route Optimization:** Testing the platform's effectiveness in calculating and suggesting optimal delivery routes in response to daily demand.
- **Dynamic Planning:** Various scenarios have been developed to optimize delivery schedules based on real-time data and incident management. Scenarios involve adapting to real-time changes in order demands and travel conditions, including vehicle breakdowns and new customer requests.
- **Multimodal Transport:** Evaluating efficiency in urban delivery using multiple transport modes, such as electric vehicles and cargo bikes.
- **Fleet Composition:** Analyzing scenarios under different fleet electrification rates (e.g., current, 50% electric, 100% electric) to measure operational and environmental impacts.
- **Urban Consolidation Centre (UCC):** Exploring the deployment of UCCs to enhance delivery efficiency in specific urban areas.
- **Impact of extensive pedestrianisation, LEZ and using Micro Hubs on the city centre.**
 - Low Emission Zones: Assessing the impact of LEZ regulations on route planning, delivery capacity, and environmental benefits.
 - Micro-Depots: Assessing the use of micro-depots for last-mile delivery to improve access to urban demand points.

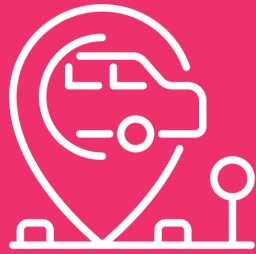
Chapter 6

Benefits of use of the Senator platform

6.1 Enhanced Operational Efficiency

The Senator Platform streamlines logistics operations, resulting in reduced delivery times and improved resource utilization.

Key benefits include:



Optimized Planning

The platform's advanced algorithms significantly reduce delivery routes and times, enhancing vehicle utilization and service reliability.



Real-Time Updates

By providing real-time information sharing, the platform minimizes delays, ensuring timely deliveries and improving overall service quality.

6.2 Environmental Impact

The Senator Platform contributes to a greener urban environment by optimizing delivery routes and encouraging the use of cleaner transportation options:

Reduced Carbon Footprint

The platform minimizes the negative impacts of freight transport on city environments through optimized route planning, especially in zero-emission zones where only some vehicles are allowed to operate.

Lower Emissions

Significant reductions in GHGs (CO₂ and other emissions) have been observed, particularly with higher levels of fleet electrification. The platform demonstrates the potential for substantial decreases in pollutant concentrations when using a fully electric fleet.

Sustainable Practices

By integrating environmental information monitoring, the platform promotes sustainable urban logistics practices, facilitating the transition to greener transport options.

6.3 Increased Delivery Efficiency

The platform's ability to enable real-time re-planning enhances the success rate of deliveries, ensuring that logistics operations run smoothly and efficiently.

Real-Time Visibility

Logistics operators and local authorities gain real-time visibility into delivery statuses, improving incident response capabilities and overall operational transparency.

Cost Reduction

Through optimized routes and vehicle usage, logistics operators can achieve significant reductions in operational costs, enhancing their bottom line.

6.4 Data-Driven Insights

The Senator Platform leverages advanced analytics and AI-driven insights for better urban planning and logistics management. Key features include:

Enhanced Transparency

Integrated blockchain technology ensures accountability and traceability in tracking shipments and managing transactions.

Informed Decision-Making

The provision of key performance indicators (KPIs) and analytics empowers logistics operators to make informed decisions that enhance service delivery.

6.5 Improved Collaboration

The Senator Platform fosters better coordination among stakeholders, including logistics providers and local authorities:

Strengthened Partnerships

The platform encourages collaboration among municipalities, logistics providers, retailers and shippers, creating a more cohesive urban logistics ecosystem.

Enhanced Communication

Improved communication channels facilitate real-time updates and coordination among all stakeholders involved.

6.6 Economic Impact

The platform is projected to reduce operational costs for logistics companies while improving customer service performance, resulting in a positive economic impact on the urban freight logistics sector.

6.7 Social Benefits

Improvements in urban logistics contribute to the overall quality of life in cities by:

Reducing Traffic and Pollution

Streamlined logistics operations lead to decreased traffic congestion and lower pollution levels.

Improving the Usage of Urban Infrastructure

A reduction in delivery traffic volume within the city has a clear impact on decreasing the use of urban infrastructure, such as public roads and parking spaces, thereby contributing to overall urban improvement.

Efficient Access to Services

Enhanced logistics facilitate more efficient access to products and services for urban residents.

Chapter 7

Conclusion

The Senator Platform stands at the forefront of transforming urban freight logistics, offering innovative solutions that enhance efficiency, sustainability, and collaboration among stakeholders. By leveraging advanced technologies and data-driven insights, Senator not only streamlines logistics operations but also contributes significantly to reducing environmental impacts and improving the quality of urban life.

As cities continue to evolve and face increasing challenges related to congestion and pollution, the Senator Platform provides the tools necessary for effective urban logistics management. Embracing this platform means investing in a smarter, more sustainable future for urban transportation, ultimately benefiting municipalities, logistics operators, and the communities they serve.



Senator