



UNIVERSITÀ  
DEGLI STUDI  
FIRENZE

**DINFO**  
DIPARTIMENTO DI  
INGEGNERIA  
DELL'INFORMAZIONE

**DISIT**  
DISTRIBUTED SYSTEMS  
AND INTERNET  
TECHNOLOGIES LAB



# *Safety and Security by Urban planning and design*

Paolo Nesi, [paolo.nesi@unifi.it](mailto:paolo.nesi@unifi.it)

<https://www.snap4city.org>

<https://www.disit.org>

**Crises, Emergencies and Disasters – a  
Continuum of Challenges and  
Opportunities in the 21<sup>st</sup> Century**

**11<sup>th</sup> to 15<sup>th</sup> September 2023**





# SMART SOLUTIONS AND DECISION SUPPORT SYSTEMS

CONTROL ROOMS - DECISION SUPPORT SYSTEMS - WHAT-IF ANALYSIS - BUSINESS INTELLIGENCE - SIMULATIONS - SMART APPLICATIONS



DASHBOARDS - VISUAL ANALYTICS - SYNOPTICS - DIGITAL TWIN - GRAPHICAL WIDGETS - ANALYTICS - GUI CUSTOM STYLES - VISUAL PROGRAMMING



DASHBOARDS, WIDGETS  
TEMPLATES

PREDICTION - ANOMALY DETECTION - CLUSTERING - ROUTING - SENTIMENT NLP - TRAFFIC FLOW  
PEOPLE FLOWS - SDG - 15 MIN CITY INDEX - KPI - HEATMAPS - ORIGIN DESTINATION - ETC...

API - MICROSERVICES - GIS - BPM  
VIDEO - REPORTS - MAPS - 3D ...

ANY: DATA, BROKER, NETWORK AND VERTICAL

EXPERT SYSTEM, KNOWLEDGE BASE  
SEMANTIC REASONING  
SMART DATA MODEL  
IOT DEVICE MODELS, STORAGE

BIG DATA ANALYTICS, ARTIFICIAL INTELLIGENCE  
EXPLAINABLE AI, MACHINE LEARNING  
OPERATIVE RESEARCH, STATISTICS

VISUAL PROGRAMMING, ADAPTERS  
DATA FLOWS, WORKFLOWS  
PARALLEL DISTRIBUTED PROCESSING  
DATA DRIVEN

Native and External  
Applications  
Smart Parking  
Smart Light  
Smart Waste  
Smart Energy  
Social Media Analysis

METHODOLOGIES  
LIVING LABS  
COURSES AND COMMUNITY  
DEVELOPMENT TOOLS



Powered by  
FIWARE

FREE  
TRIAL

PEN Test  
Passed

EU GDPR  
COMPLIANT

SNAP4  
Appliances and Dockers  
Installations

EUROPEAN OPEN  
SCIENCE CLOUD



JS Foundation

E015  
digital ecosystem





<https://www.snap4city.org/577>



*On Line Training Material (free of charge)*

	1st part	2nd part	3rd part	4th part	5th part	6th part	7th part	8th
what	Overview	Dashboards	IOT App, IOT Network	Data Analytics	Data Ingestion processes	System and Deploy Install	Smart City API: Web & Mob. App	Design and Develop Smart Solutions
PDF 2022								
Interactive (2022) with video and animations								

Video1								
Video2								
Video3								
Video4				none		none	none	none

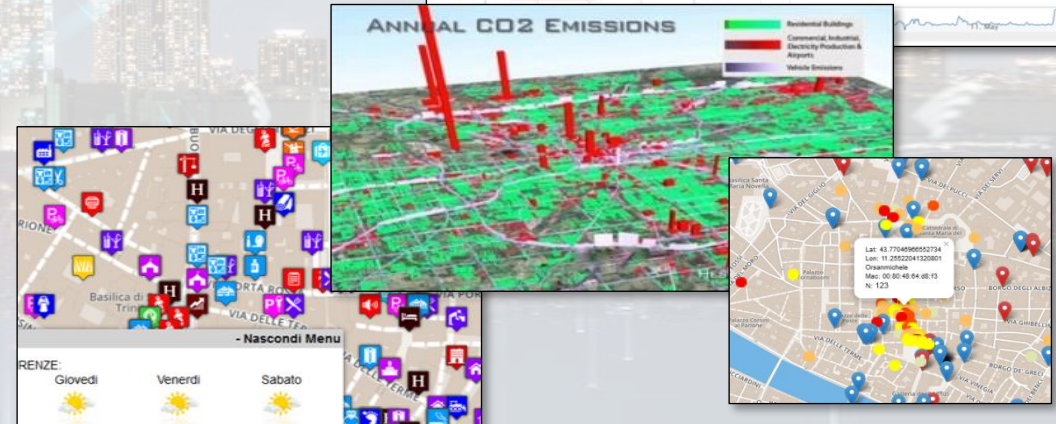
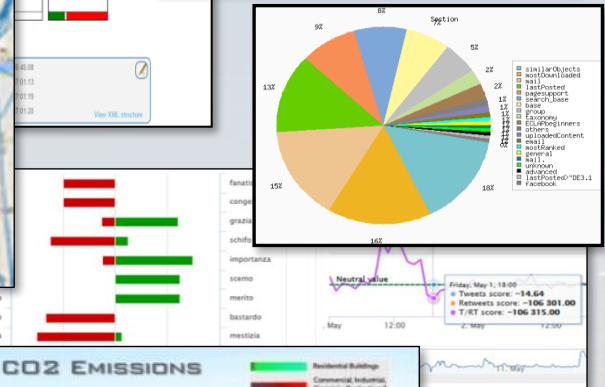
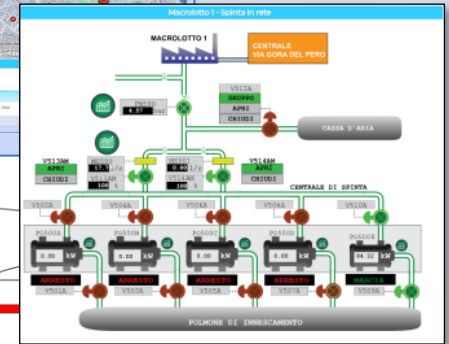
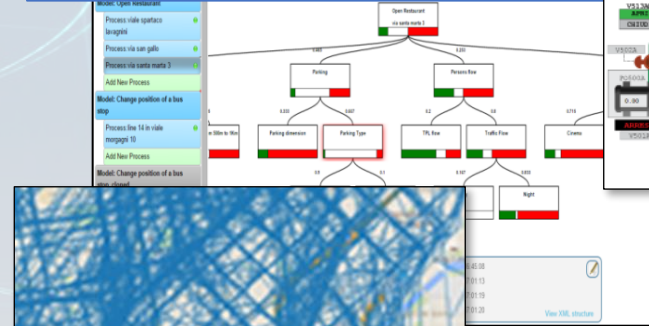
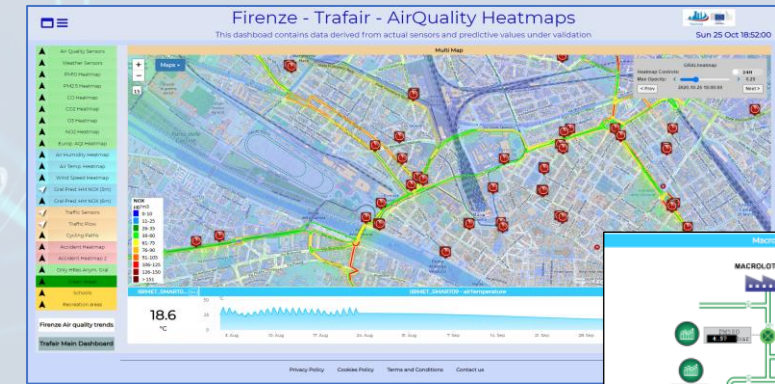






# Data Driven Decision Support

- Decision Support system
- Assessment / Strategies
- Data Rendering,
  - visual analytics, business intel..
- Data Analytics, ML, AI
- Data aggregation, Storage, indexing
- Data Ingestion





# Challenges vs Technologies

- **DSS, Decision Support Systems**, with multiple objectives:
  - **Quality of life** for citizens, improvements of services, cost reduction, innovation, attractiveness for tourists and/or industries and/or commercial activities, etc.
- **provide the decision-making process with simulation tools integrated with short-, long- and very long-term prediction algorithms**  
 → *what-if analysis*
  - Analyse *incipient events* to cope with events;
  - Analyse future situations for structural planning: tactics/strategic.
- **Opportunities and needs**
  - exploit **huge amounts of heterogeneous data (Big Data)** that come from the territory, from the structures and services of the city and from the stakeholders;
  - **flexible, dynamic and interoperable models and analysis tools;**
  - **accessible for:**
    - Operators, decision-makers, stakeholders;
    - In some measure also for citizens: as a tool for illustrating and discussing possible solutions and development plans with them: cowork









# Global Digital Twin

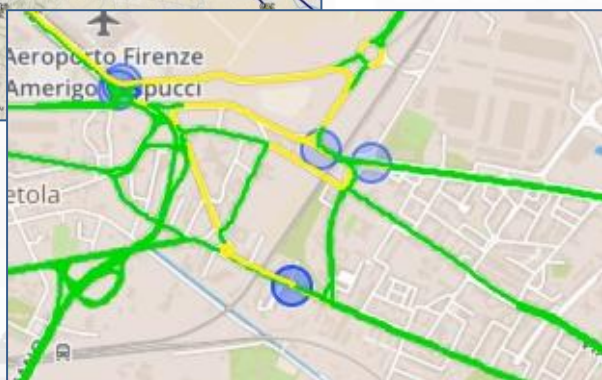
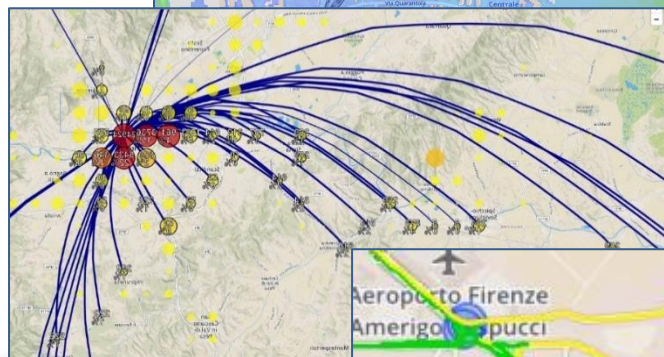
## 3D representation of the city with...

- geomorphological, hydrogeological aspects,
- private and public transport networks,
- waste recovery systems,
- weather conditions, climate and microclimate,
- events, emergencies, ..., parking, sharing, ...
- tourist and city user flows, origin destination matrices,
- commercial activities, urban decorum, public lighting,
- green areas, cleanliness, safety on the road and in pedestrian areas,
- places for entertainment events, cultural activities, attraction and aggregation points of the city,

**Complex and heterogeneous information**, structured and unstructured, historical series and in real time data, public/private and sensitive data for security aspects.

### → Reuse of legacy systems

- GIS (Geographical Information System),
- ITS (Intelligent Transportation System),
- AVM (Automatic vehicle monitoring),
- from IoT (Internet of Thing) systems and networks.





# Main tasks

- **Unexpected unknowns**
- **Controlling Status: management, and operational**
  - Monitoring via KPI
  - Computing predictions data from the field and KPI
  - Anomaly detection
  - Early warning on critical conditions
- **Making plan: tactic and strategic, medium and long range**
  - Prescriptions
  - Risk assessment
  - What-if analysis on scenarios
    - Simulation and predictions
  - Resilience



# Available DA / AI Solutions on Snap4City

- **Mobility and Transport**
- **Environment, Weather, Waste, Water**
- **City Users Behaviour and Social analysis**
- **Energy and Control, Security, .....**
- **High Level Decision Support Solutions**
  - **Management Strategies**
  - **Resilience and Risks Analysis**
- **Low level Techniques**

<https://www.snap4city.org/download/video/course/da/>



[https://www.snap4city.org/download/video/DPL\\_SNAP4SOLU.pdf](https://www.snap4city.org/download/video/DPL_SNAP4SOLU.pdf)



# Public Spaces as Critical Infrastructures

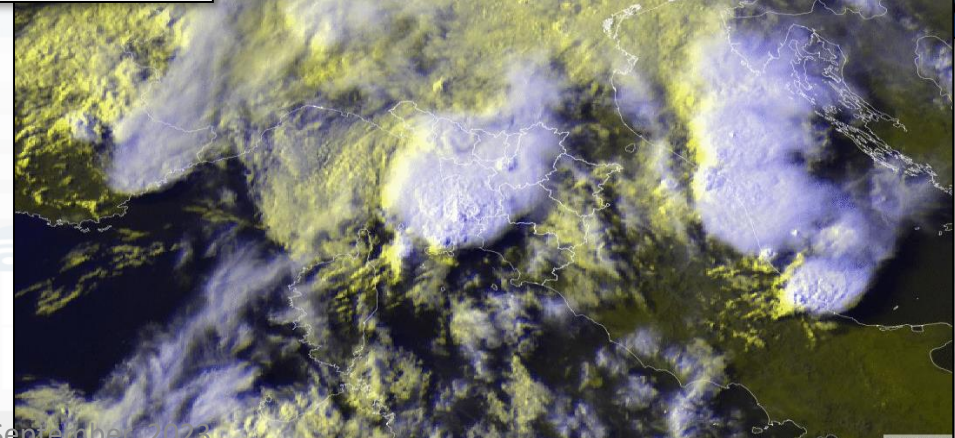
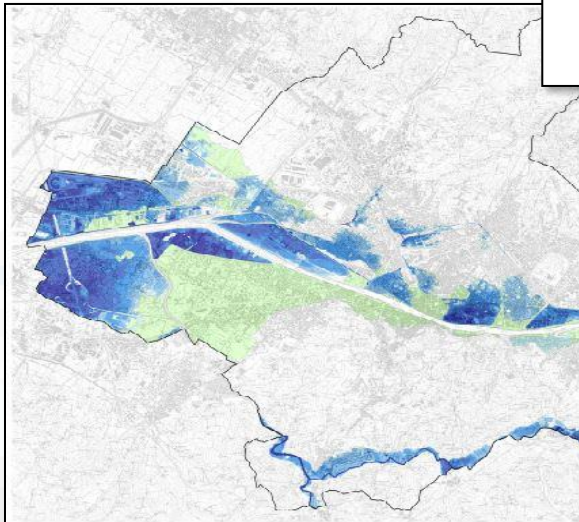
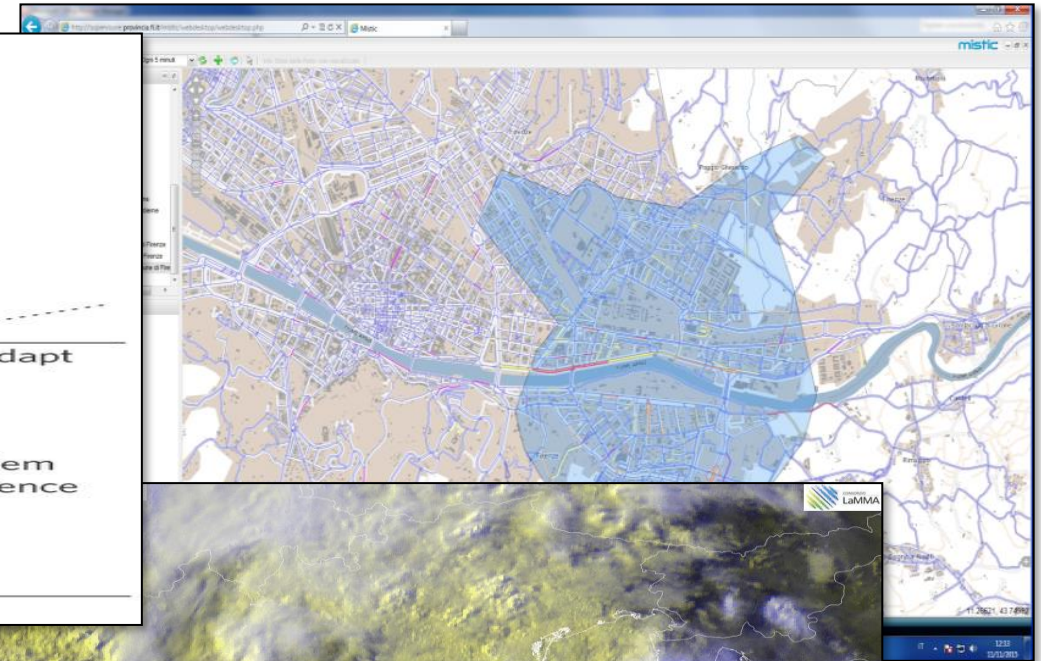
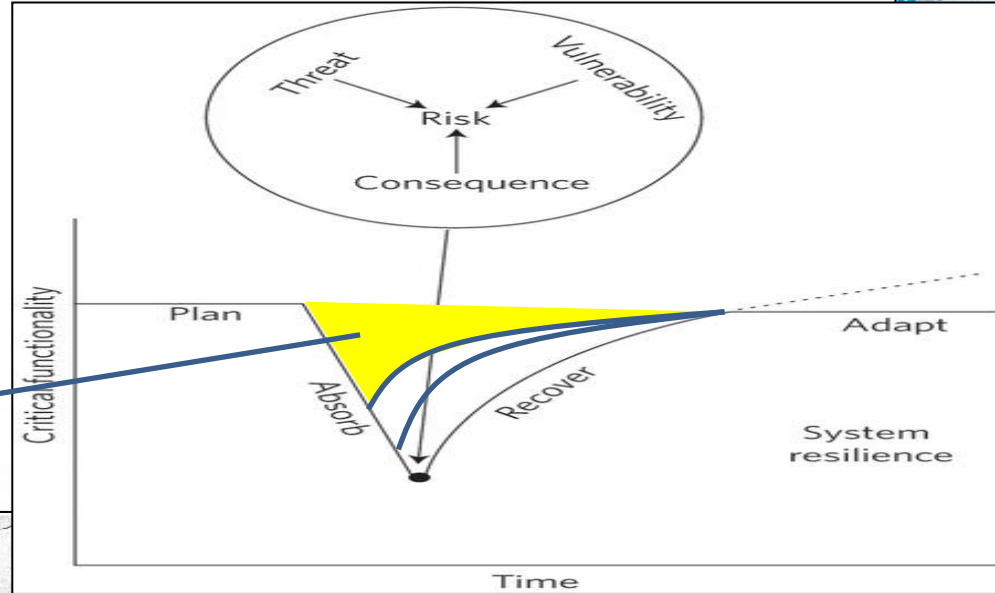
- City is a system of systems
  - Cascading effects
- Transport networks
  - Main means for rescue teams, food, water, etc.
- Energy networks
  - Communication, power supply for health, cyber systems, etc.
- Hospitals networks
- Aggregation areas



## Early Warning, Detection

**P**repare  
**A**bsorb  
**R**ecover  
**A**dapt

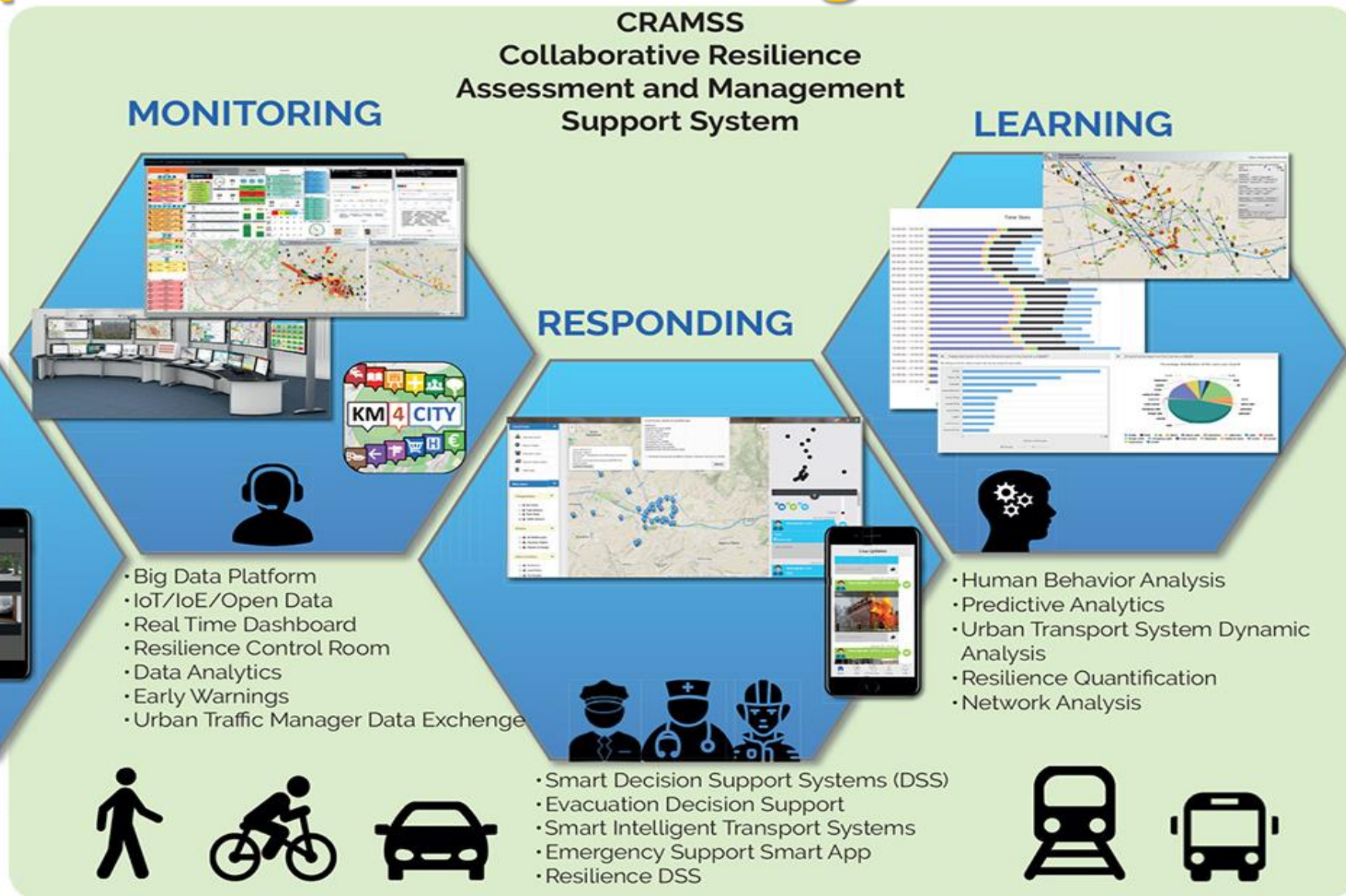
damage





# ERMIG: European Resilience Management Guide

<http://www.resolute-eu.org/>





<http://resilienceds.km4city.org>

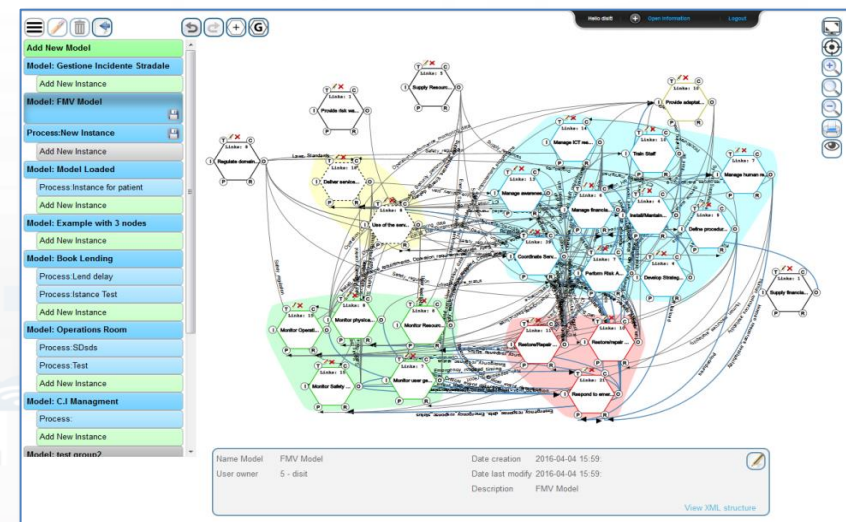
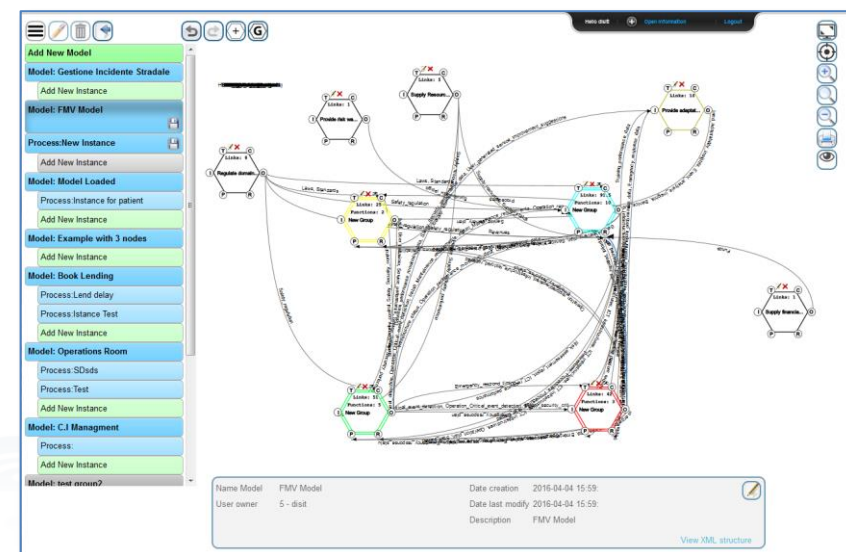
## • FRAM Model

- Macro FRAM processes
- Metrics for Process complexity assessment
- Operational Semantic for executing FRAM model
- Connection with SmartDS
- Connection with BigData open to multiple sources of data and workgroup results, Km4City

## • Collaborative work, web tool

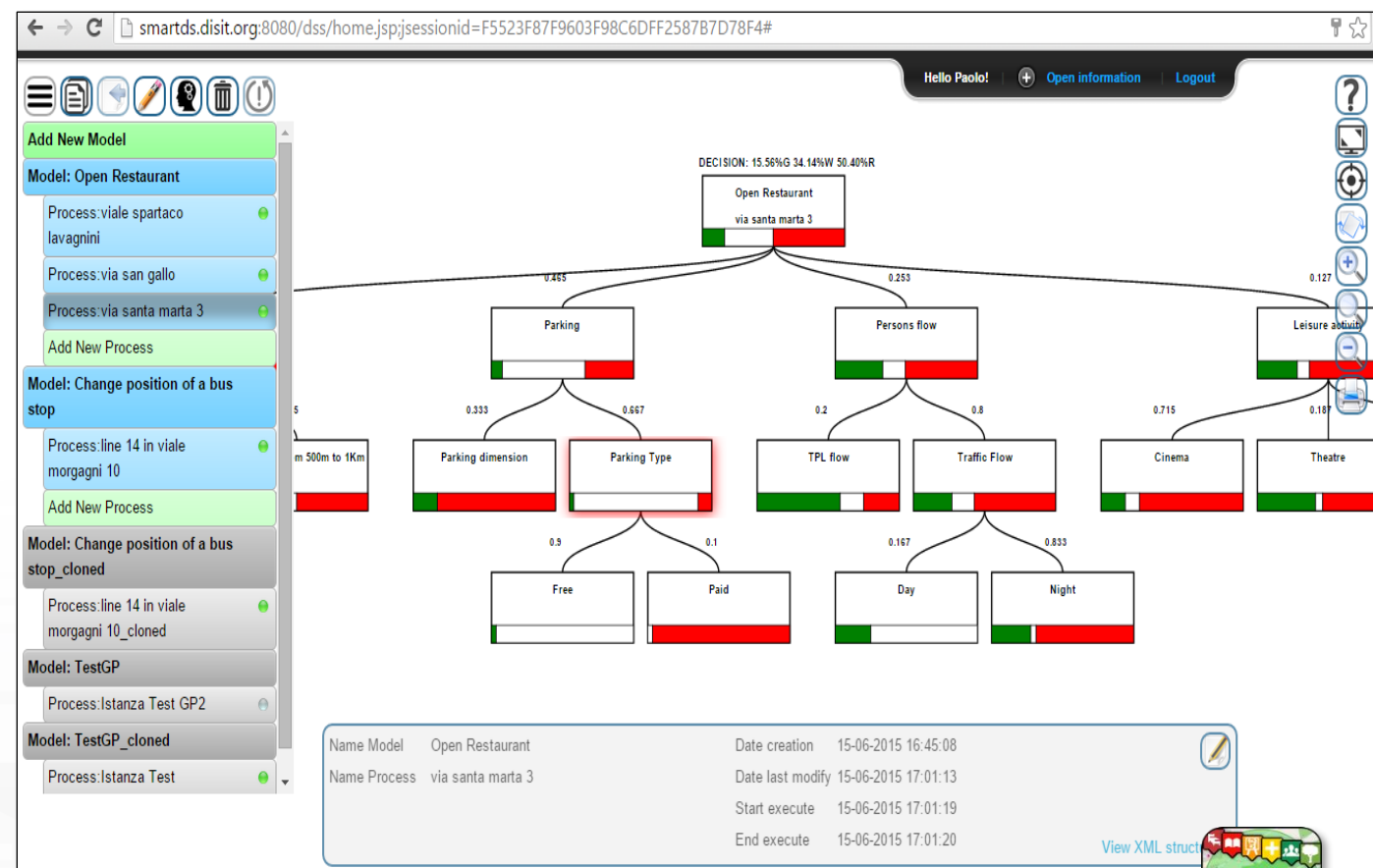
## • Open for all

## • Validated on ERMG: European Guidelines



# Smart Decision Support , system thinking

- **Smart Decision Support System** based on System Thinking plus
- Actions to city reaction, resilience, smartness, ...
- Enforcing Mathematical model for propagation of decision confidence..
- Collaborative work, ...
- Processes connected to city data: DB, RDF Store, Twitter, etc.
- Production of alerts/alarms
- Data analytics process
- Twitter Processes
- reuse, copy past, ...



<http://smartds.km4city.org>



- **hydraulic**
- **Seismic**

# indicators

- **United Nations Sustainable Development Goals, SDGs** (for which cities can do more to achieve some of the 17 SDGs, <https://sdgs.un.org/goals>);
- **15 minutes cities** (where primary services must be accessible within 15 minutes on foot);
- **objectives of the European Commission** in terms of pollutant emissions for: NO<sub>2</sub>, PM<sub>10</sub>, PM<sub>2.5</sub> ([https://environment.ec.europa.eu/topic/s/air\\_en](https://environment.ec.europa.eu/topic/s/air_en));
- **PUMS: mobility and transport vs wnv**
- **SUMI: mobility and transport vs env**
- **ISO indicators: city smartness, digitization. Tech level**
- ....

Global  
Vs  
Local



## SUSTAINABLE DEVELOPMENT GOALS



				WHO guidelines	
Pollutant	Averaging period	Objective and legal nature and concentration	Comments	Concentration	Comments
PM <sub>2.5</sub>	One day			25 µg/m <sup>3</sup> (*)	99 <sup>th</sup> percentile (3 days/year)
PM <sub>2.5</sub>	Calendar year	Target value, 25 µg/m <sup>3</sup>	The target value has become a limit value since 1 January 2015	10 µg/m <sup>3</sup>	
PM <sub>10</sub>	One day	Limit value, 50 µg/m <sup>3</sup>	Not to be exceeded on more than 35 days per year.	50 µg/m <sup>3</sup> (*)	99 <sup>th</sup> percentile (3 days/year)
PM <sub>10</sub>	Calendar year	Limit value, 40 µg/m <sup>3</sup> (*)		20 µg/m <sup>3</sup>	
O <sub>3</sub>	Maximum daily 8-hour mean	Target value, 120 µg/m <sup>3</sup>	Not to be exceeded on more than 25 days per year, averaged over three years	100 µg/m <sup>3</sup>	
NO <sub>2</sub>	One hour	Limit value, 200 µg/m <sup>3</sup> (*)	Not to be exceeded more than 18 times a calendar year	200 µg/m <sup>3</sup> (*)	
NO <sub>2</sub>	Calendar year	Limit value, 40 µg/m <sup>3</sup>		40 µg/m <sup>3</sup>	



# 15MinCityIndex

***What would support my neighborhood to become a 15-Minute City?***

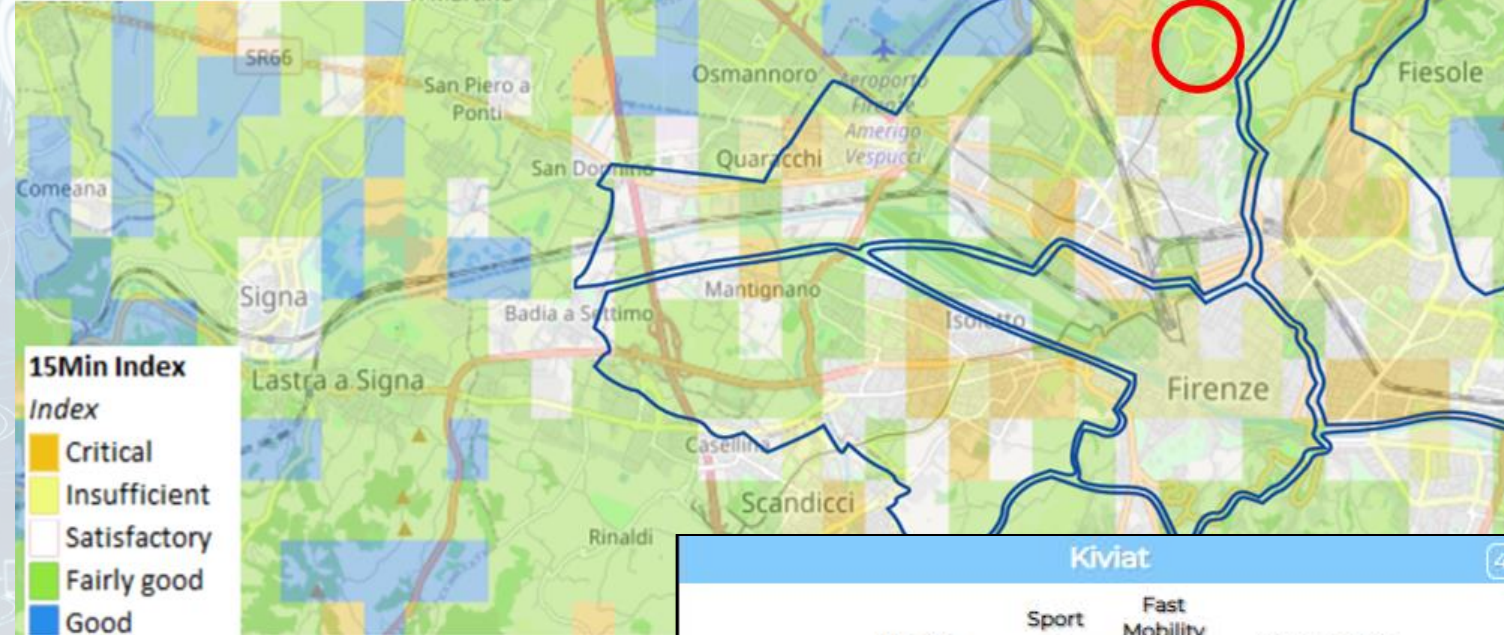
## Using the Open Data:

We developed a data analytic tool based on municipal and national open data to assess services adequacy for people living in each 15 minutes areas of the city.

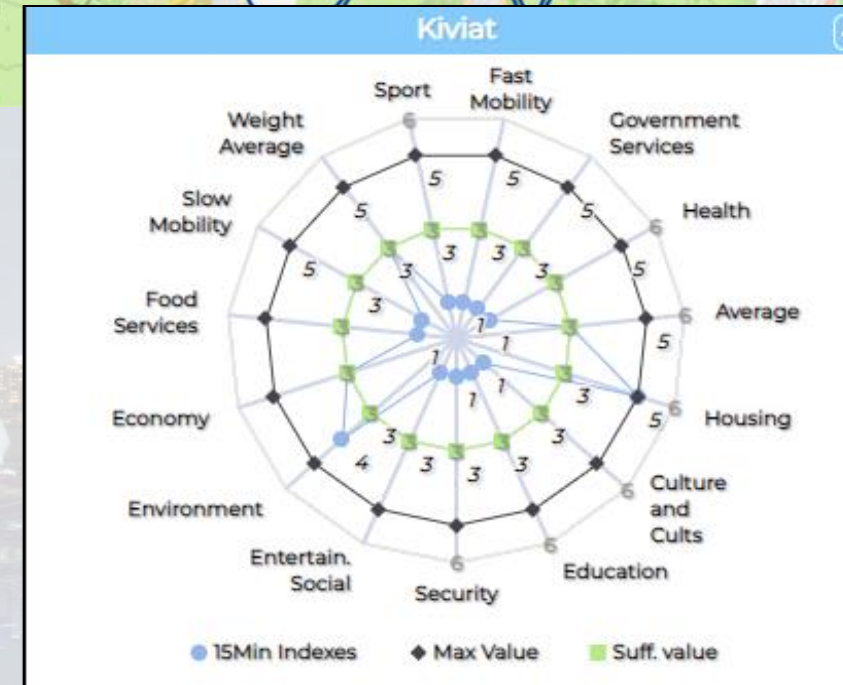
Good public transport services: bus, new tram line, train stations, cycle paths.



Careggi/Rifredi is a relevant district in Florence because of hosting the main Florence/Tuscany hospitals Careggi and Meyer, but also university headquarters and many other workplaces.



The tool supports the becoming of a 15-Minute city evaluating the service level in various domains.



<https://www.snap4city.org/dashboardSmartCity/view/index.php?iddashboard=MjkzOA==>



TOP

# Florence Digital Twin

<https://digitaltwin.snap4city.org>



 **SNAP4**  
Appliances and Dockers  
**Installations**



# Florence





# Smart City Control Room

## Florence Metropolitan City



reference



- **Multiple Domain Data**

- Thousands of Open/Private data, POI, IOT, etc.
- **mobility and transport:** accidents, public transport, parking, traffic flow, Traffic Reconstruction, KPI, ...
- **AND:** environment, civil protection, gov KPI, covid-19, social & social media, people flow, tourism, energy, culture, ...

- **Multiple dash/tool Levels & Decision Makers**

- Real Time monitoring, Alerting, quality assess.
- Predictions, KPI, DSS, what-if analysis

- **Historical and Real Time data**

- Billions of Data

- **Services Exploited on:**

- Multiple Levels, Mobile Apps, API

- **Since 2017**



<https://www.snap4city.org/747>







# Firenze Oggi



Mon 16 May 12:59:27

20991

fissi

COLONNINE

COLONNINE

42 % ACTIVE

3 % IN USO

24 % NON ACTIVE

GENERAL	NETO
MONDO	BASSO
RISCHIO IDRAULICO	
RISCHIO TEMPORALI	
RISCHIO IDROGEOLOGICO	
RISCHIO NEVE	
RISCHIO GHIACCIO	
RISCHIO VENTO	

SITUAZIONE VIABILI

0 INCIDENTI

0 CHIUSURE AL TRAFFICO (TOT)

0 CHIUSURE PER CANTIERI

0 PROGR. 0 NON PROC.

0 LIMITAZIONI AL TRAFFICO (TOT)

0 LIMITAZIONI PER CANTIERI

0 NON PROC. 0 PROGR.

0 TOT. EVENTI SULLA RETE

SMN

42.2

Rischio di 100 anni

BINA

54.5

Rischio di 100 anni

FORT

23.2

Rischio di 100 anni

LEOP

37.3

Rischio di 100 anni

CALZA

48

Rischio di 100 anni

S.AM.

58.6

Rischio di 100 anni

PART

55

Rischio di 100 anni

CARE

13.8

Rischio di 100 anni

BECC

77.6

Rischio di 100 anni

ANALYSIS

Energy

Environment

Mobility

Social

Resilience

FLUSSI INGRESSO CIT.

TOTA

Current

Previous

92207

VEICOLI

FLUSSI INGRESSO ZTL

TOTA

Current

Previous

15964

VEICOLI

Nati Italiani

175

Rischio di 100 anni

Nati s.

48

Rischio di 100 anni

Dece

499

Rischio di 100 anni

Matri

72

Rischio di 100 anni

Unio

2

Rischio di 100 anni

Manutenzioni Strad.

19

Rischio di 100 anni

Verif

18

Rischio di 100 anni

Decoro Urba

3

Rischio di 100 anni

Reint

5

Rischio di 100 anni

Indicatore Rt per la provincia di



0.94

Linea

Linea

Linea

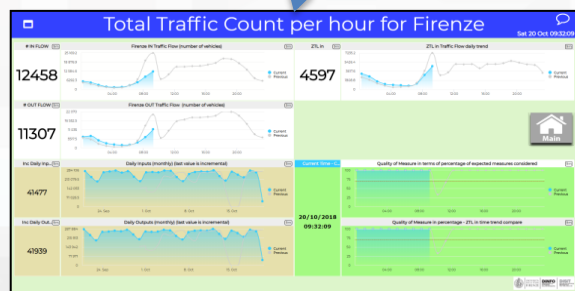
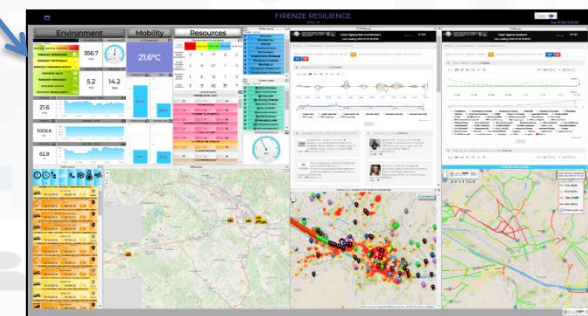
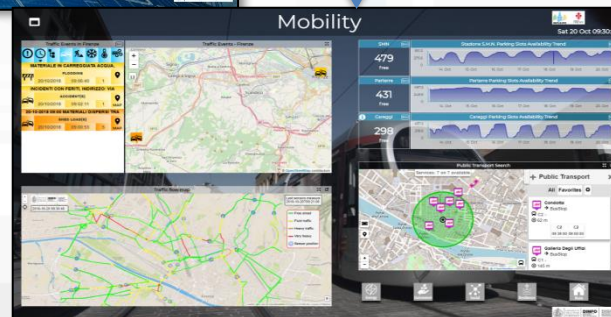
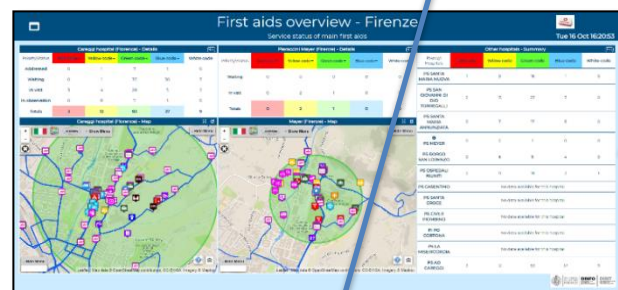
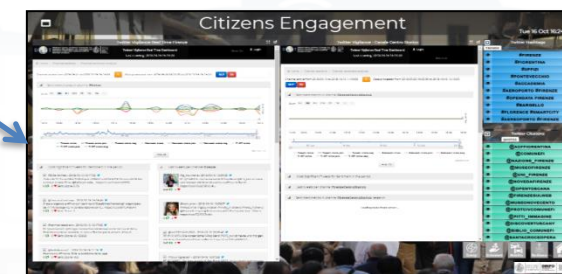
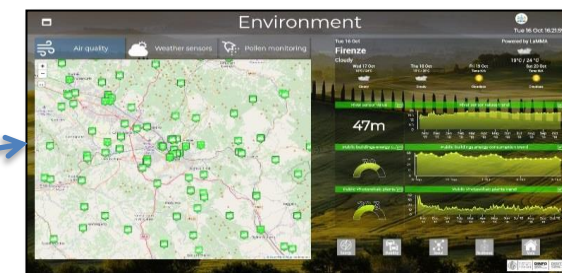
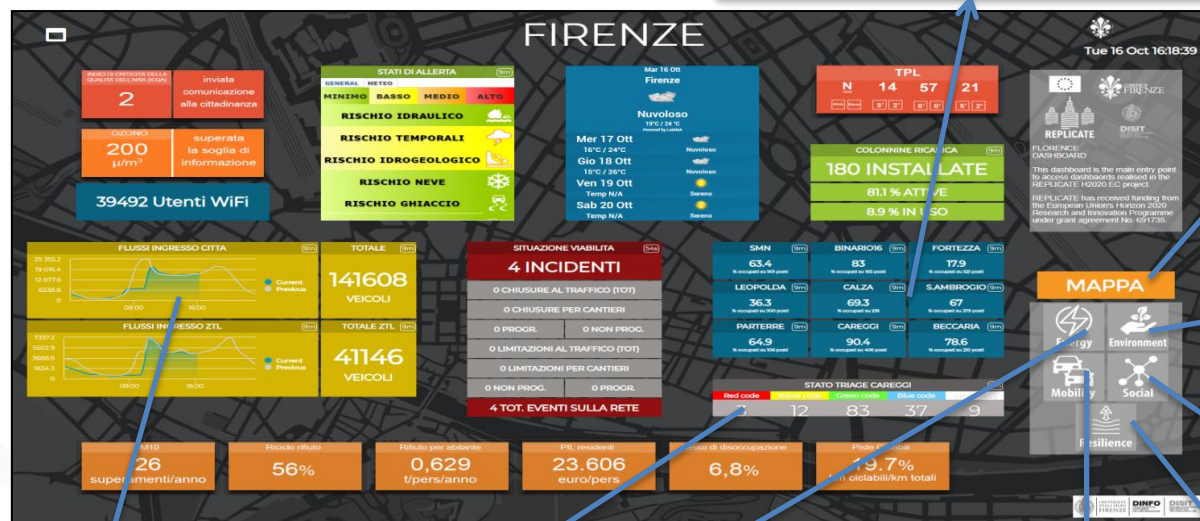
Linea

Linea

Linea

The European House  
AmbrosettiThe European House  
AmbrosettiThe European House  
AmbrosettiThe European House  
Ambrosetti









## 3D Map



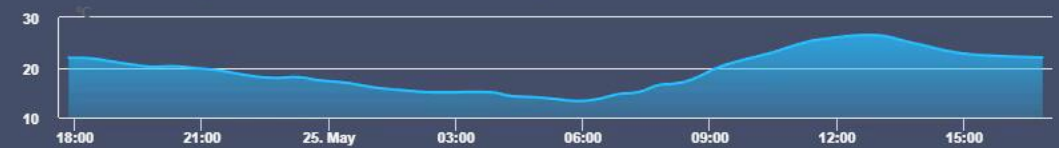
## Air Quality FI-BASSI - NO2

6m



## Weather\_sensor\_Open Weather 3176959 - Air Temperature

6m

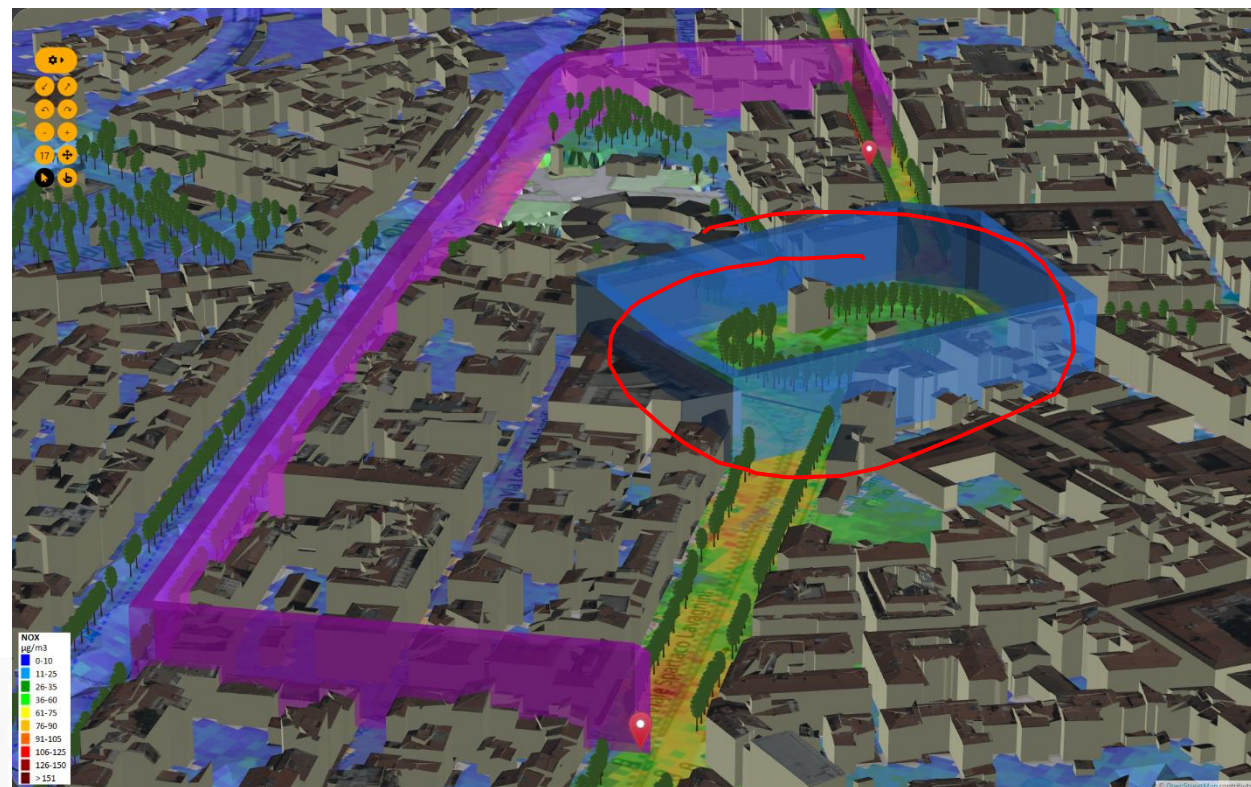
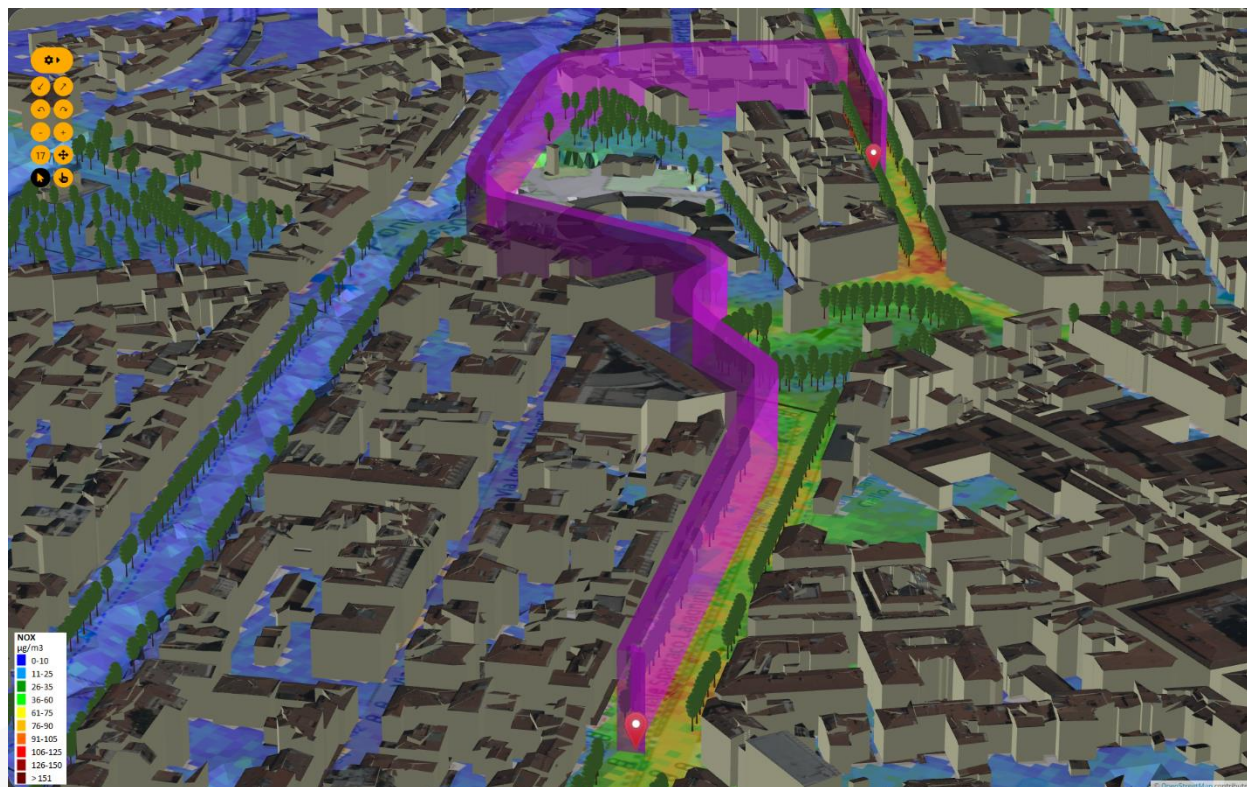


<https://youtu.be/JLzT9k3Xbc0>





# Dyamic Routing in 3D space







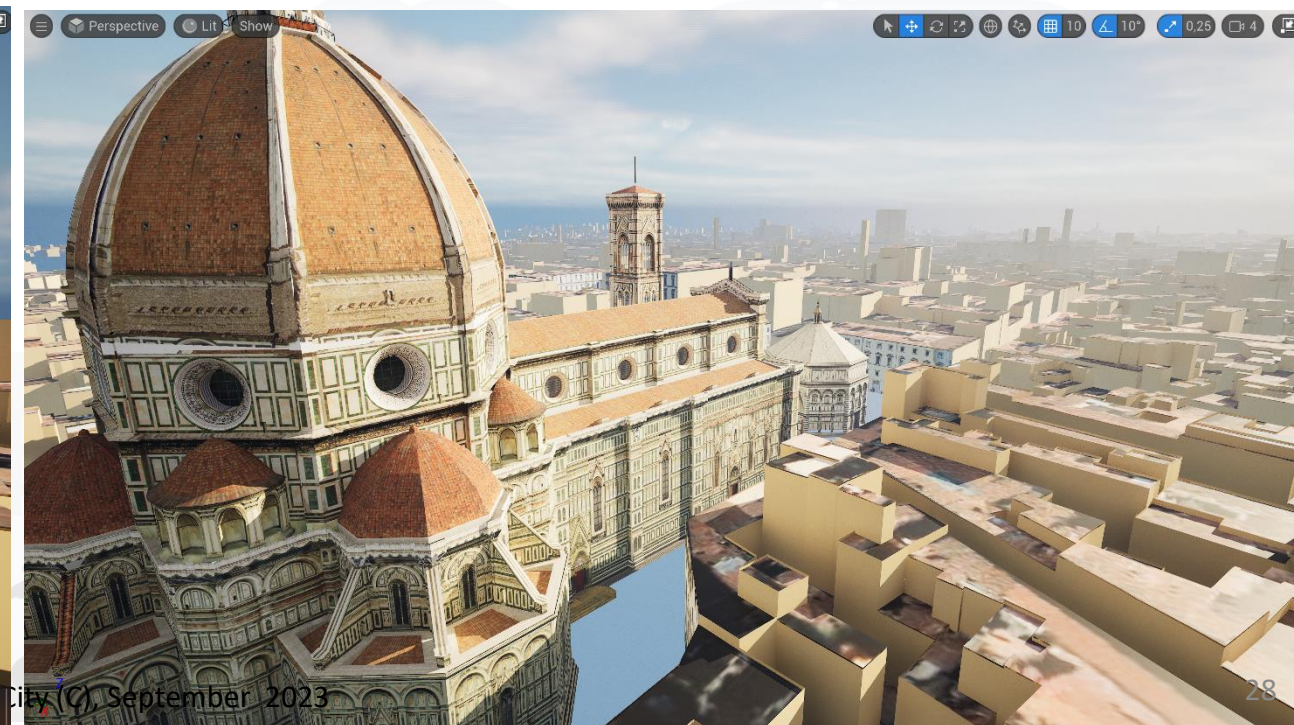
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# OCULUS





TOP

# Data Analytic Artificial Intelligence, XAI, Machine and Deep Learning

FROM CITY  
DASHBOARD TO  
APPLICATIONS

DATA GATHERING  
AND CITY DATA  
KNOWLEDGE  
MANAGEMENT

FORGING &  
MANAGING OPEN  
AND FLEXIBLE WEB  
AND MOBILE APPS

IoT APPLICATIONS  
VS IoT EDGE  
DEVICES

IoT/IIoT DEVICES  
AND NETWORKS

IoT APPLICATIONS  
LOGIC AND  
PARTNERS

ADVANCED  
SMART CITY A  
MICRO SERVICE  
SNAP4CITY A

SNAP4CITY  
LIVING LAB FOR  
COLLABORATIVE  
WORK

DATA ANALYTICS  
INTELLIGENCE,  
WHAT-IF AND  
SIMULATION

SNAP4CITY  
ARCHITECTURE AND  
ECOSYSTEM. OPENED  
TO DEVELOPERS  
AND STAKEHOLDERS

TWITTER  
VIGILANCE: SOCIAL  
MEDIA ANALYSIS

HOW TO ADOPT  
SNAP4CITY, AND  
OUR ROADMAP

DECISION SUPPORT  
SYSTEM AND CITY  
RESILIENCE

SNAP4CITY  
AND KM4CITY  
PROJECTS

SNAP4CITY THE  
VIEW OF THE  
ADMINISTRATORS

100%  
OPEN  
SOURCE

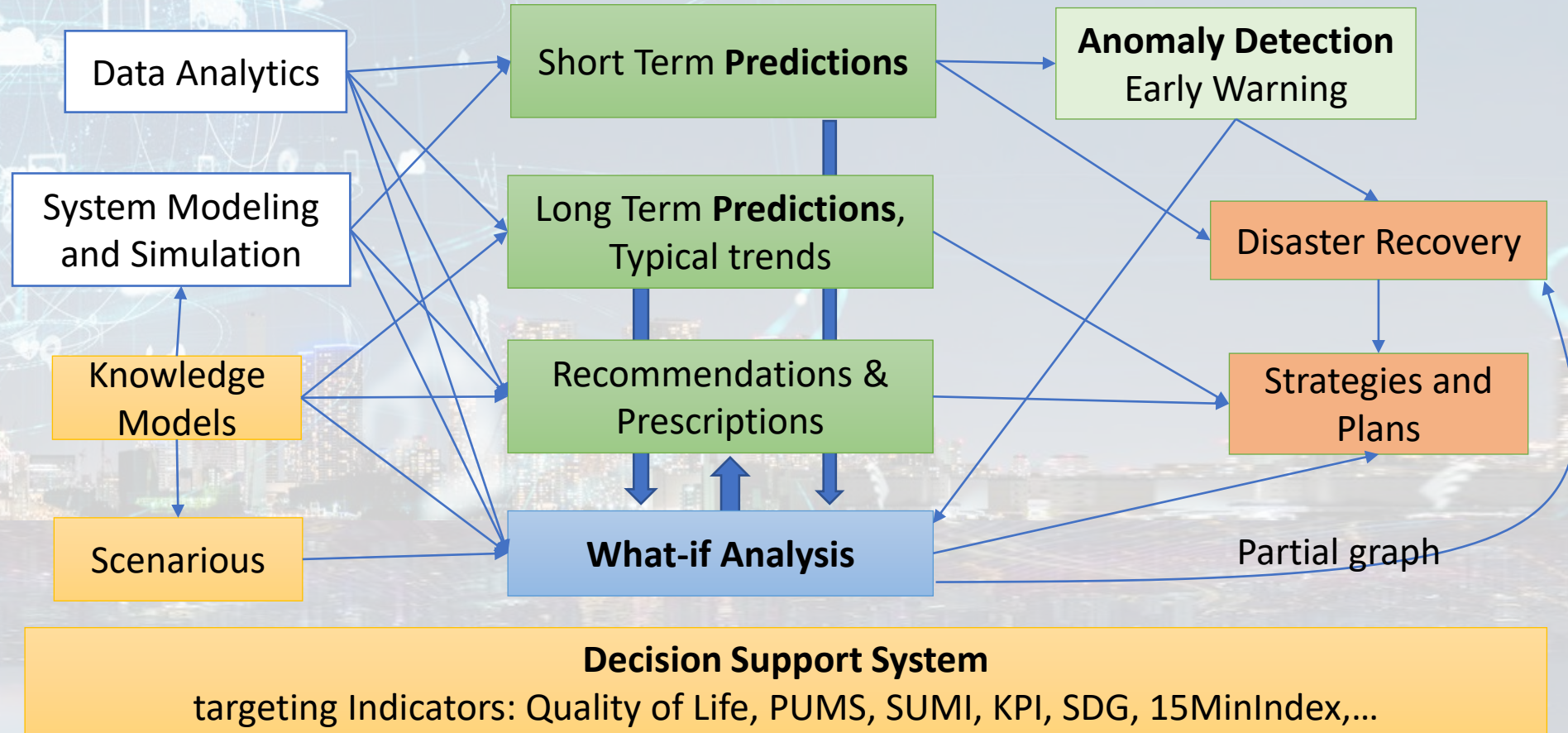
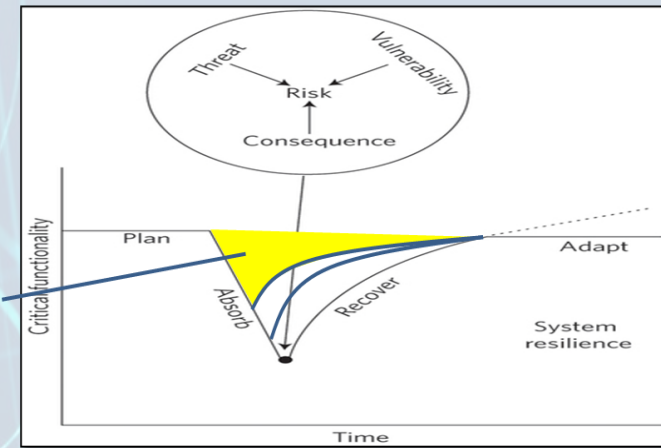
 **SNAP4**  
Appliances and Dockers  
**Installations**



# Snap4City Analytics

- Decision support systems
- Improvement of life quality
- Sustainable Solutions
- Reduction of costs
- Risk Assessment
- Resilience

**P**repare  
**A**bsorb  
**R**ecover  
**A**dapt







## • 15 Minute City Index:

- 13 subindexes: energy, slow mobility, fast mobility, housing, economy education, culture and cults, health, entertainment, gov, food, security...

10/22



- Monitoring and Prediction of energy consumption
- Stimulating: Bike sharing, e-bikes, car charge, etc.
- Community of Energy, planning energy plant



- Industry 4.0 integrated solutions
- Decisions Support Systems
- Process optimization, control
- Predictive maintenance



- Smart City infrastructure: monitoring and resilience, long terms predictions
- Effective and Low cost smart solutions
- What-if analysis, Simulations
- Origin Destination matrices computation



- business intelligence tools for decision makers
- Reduction production costs
- Monitoring resource consumption
- Optimization of Waste Collection



- Monitoring and Predicting: NO<sub>2</sub>, NO<sub>x</sub>, CO<sub>2</sub>, Traffic flow, pollutant, landslide, waste, etc.
- Traffic flow reconstruction
- Demand vs Offer of Mobility analysis



- Shortening justice time
- Anonymization and indexing legal docs.
- Prediction of mediation proneness
- Ethical Explainable Artificial Intelligence

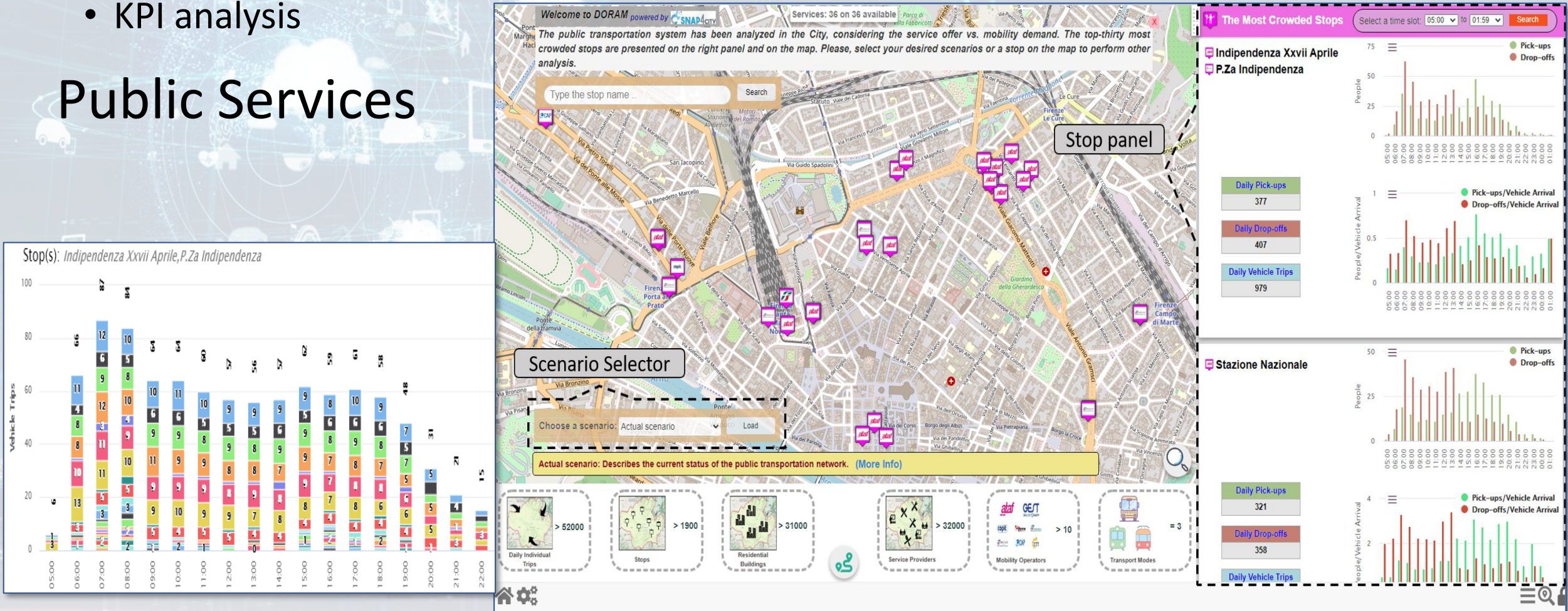


# What-if Analysis on Pub Transport



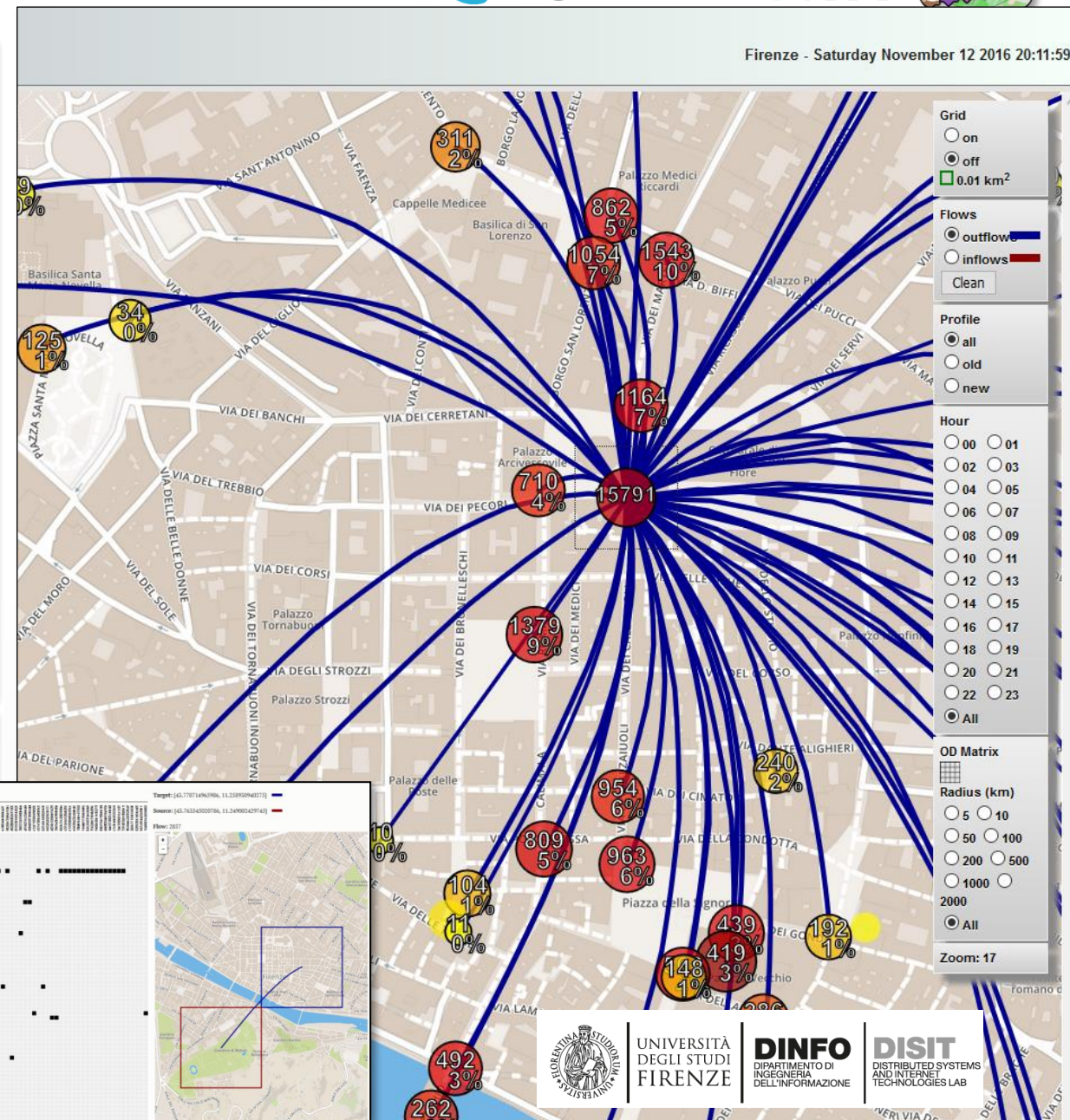
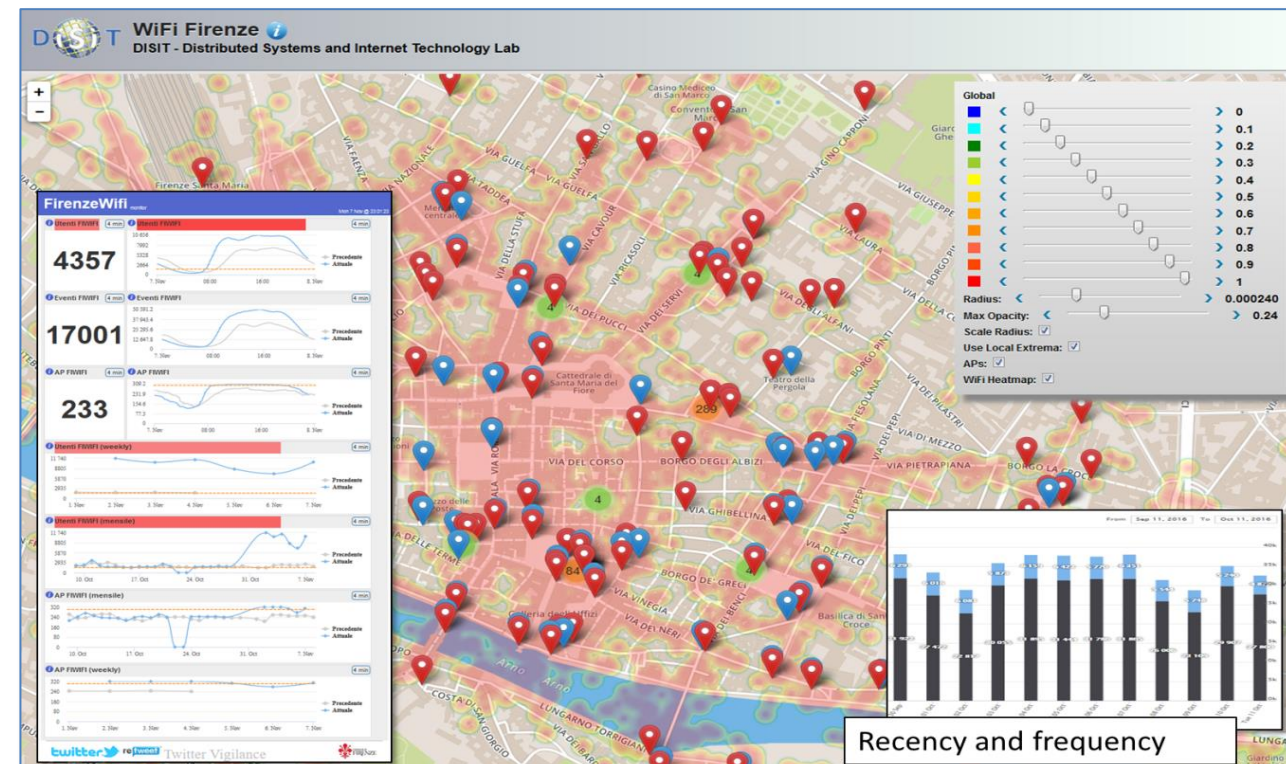
- Definition of scenarios impact on
  - Traffic, Pollutant, parking, public transport, private flows, etc.
  - KPI analysis

## Public Services

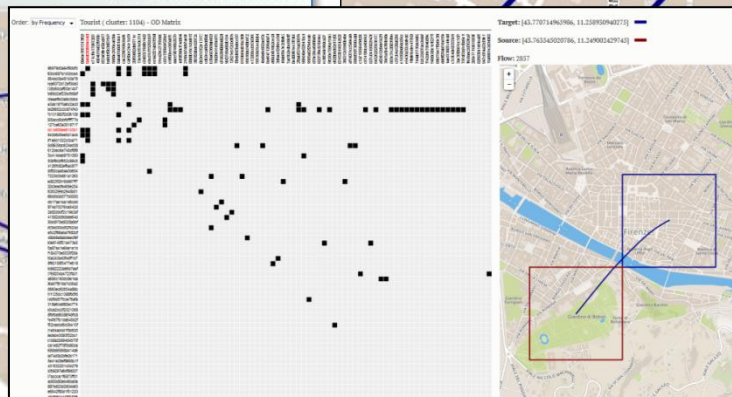




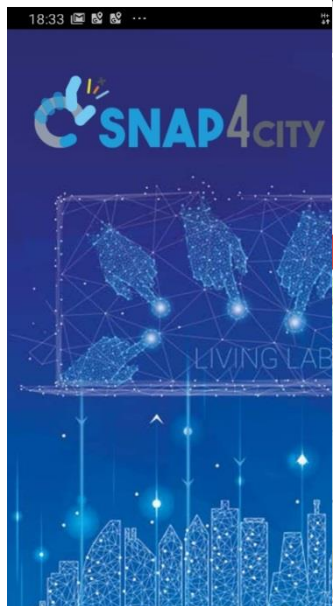
# Origin Destination Matrix Estimation

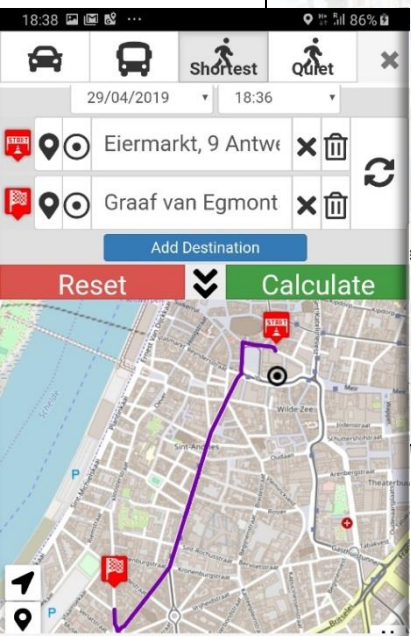


Wi-Fi based







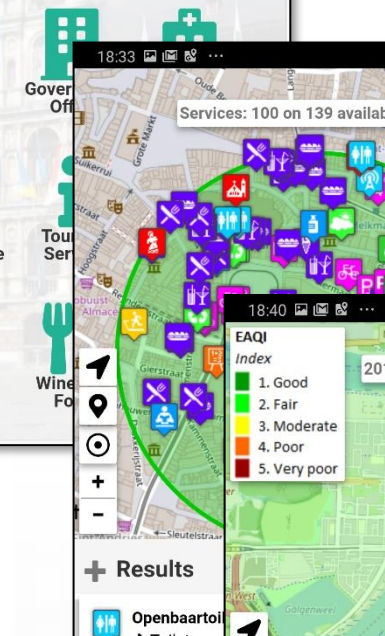


29/04/2019 18:36

Shortest Quiet

Add Destination

Reset Calculate



Services: 100 on 139 available

EAQI Index

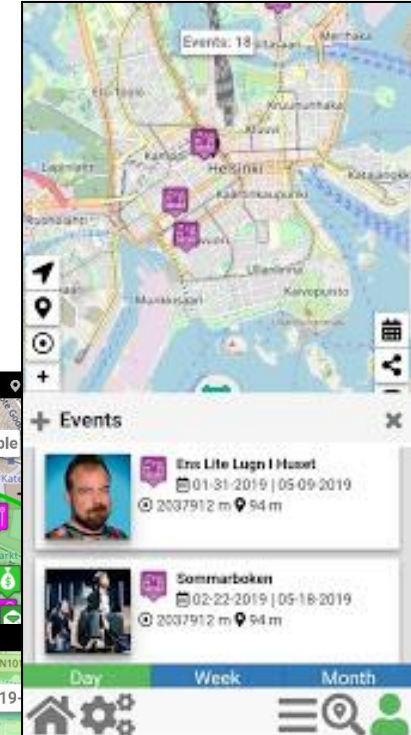
- 1. Good
- 2. Fair
- 3. Moderate
- 4. Poor
- 5. Very poor

Results

Openbaartoi → Toilet

Reset → Gym fitness

Hard Rock C

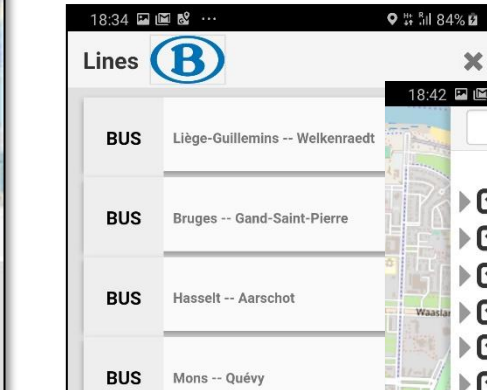


Events: 18

Events

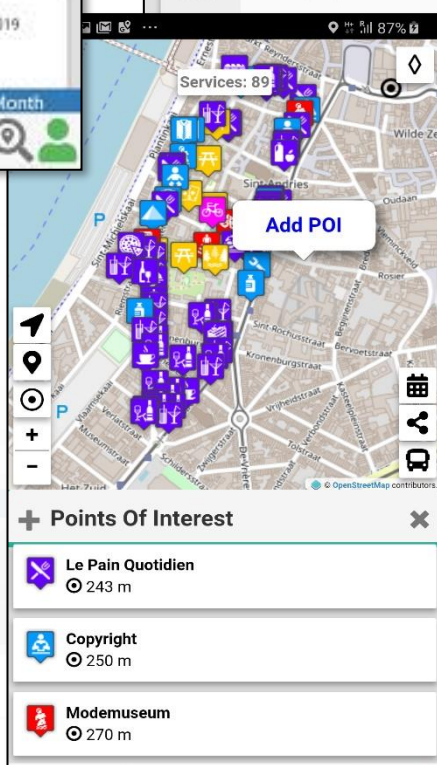
- Erns Life Lugin I Huset 01-31-2019 | 05-09-2019 2007912 m 94 m
- Sommarboken 02-22-2019 | 05-18-2019 2007912 m 94 m

Day Week Month



Lines B

- BUS Liège-Guillemins -- Welkenraedt
- BUS Bruges -- Gand-Saint-Pierre
- BUS Hasselt -- Aarschot
- BUS Mons -- Quévy

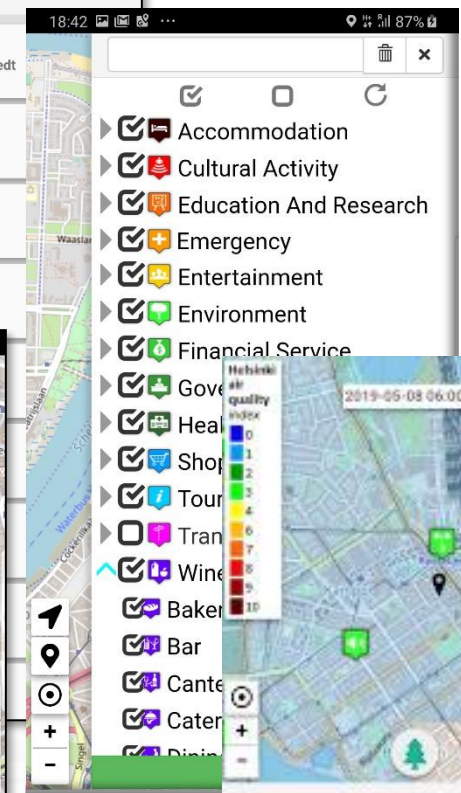


Services: 89

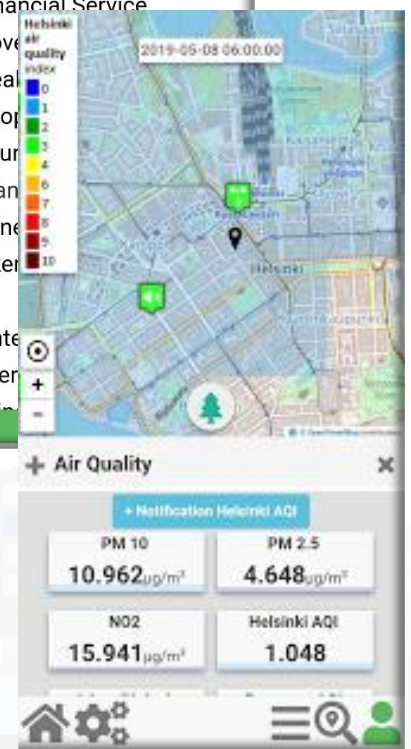
Add POI

Points Of Interest

- Le Pain Quotidien 243 m
- Copyright 250 m
- Modemuseum 270 m



- Accommodation
- Cultural Activity
- Education And Research
- Emergency
- Entertainment
- Environment
- Financial Service
- Gover
- Heal
- Shop
- Tour
- Trans
- Wine
- Baker
- Bar
- Cante
- Cater
- Disin



2019-05-08 06:00:00

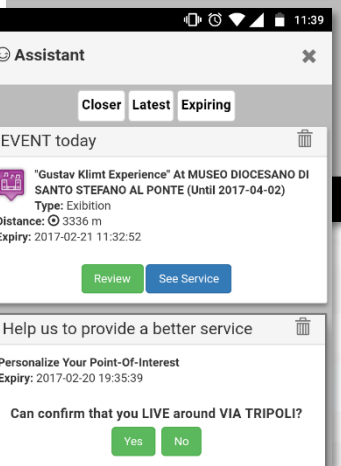
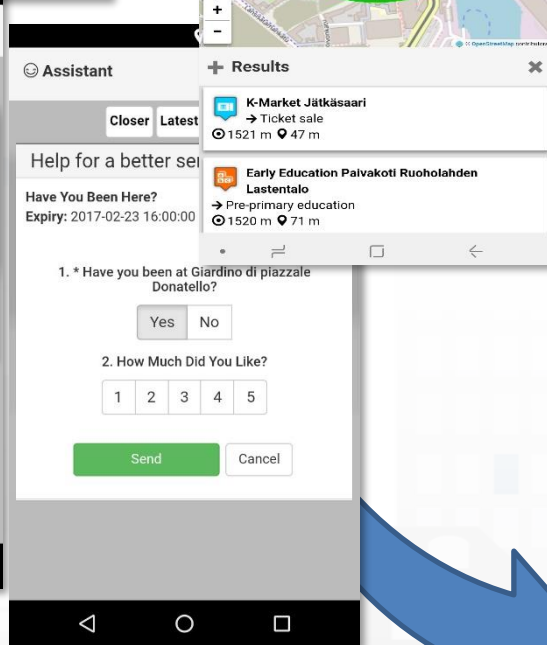
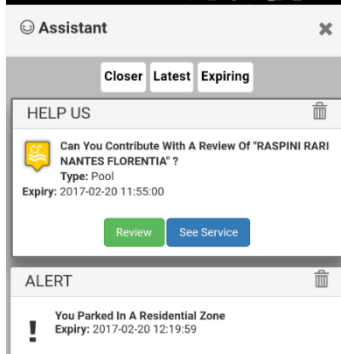
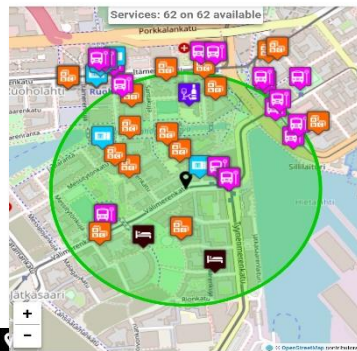
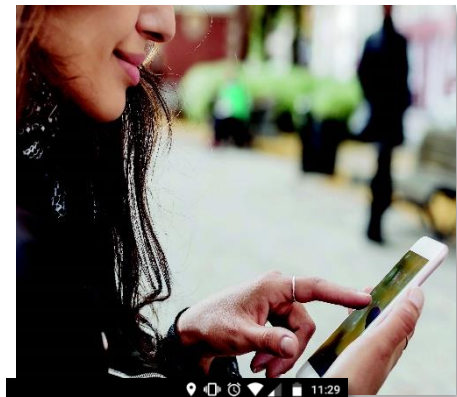
Air Quality

Notification Helsinki AQI

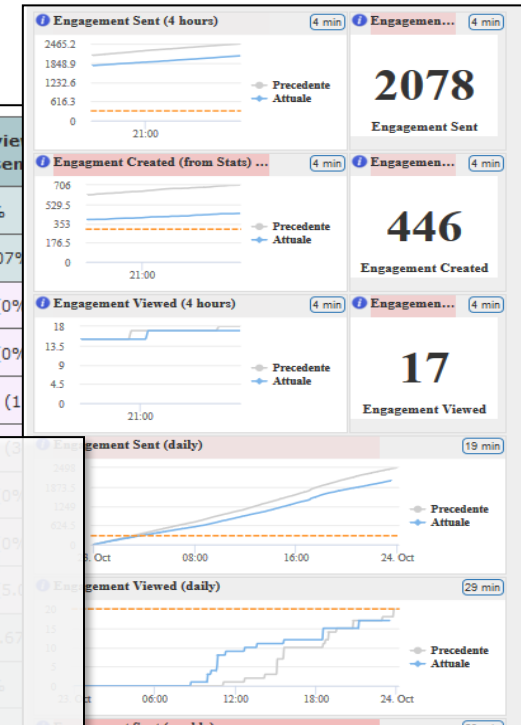
PM10	PM2.5
10.962 $\mu\text{g}/\text{m}^3$	4.648 $\mu\text{g}/\text{m}^3$
N02	Helsinki AQI
15.941 $\mu\text{g}/\text{m}^3$	1.048



# Users' Engagement



Rule name	Type	#sent	#viewed	#viewed / #sent
daily_event_de	ENGAGEMENT	1 (0%)	0 (0%)	0%
daily_event_en	ENGAGEMENT	1720 (2.12%)	70 (7.1%)	4.07%
- commuter		5 (0.29%)	0 (0%)	0 (0%)
- student		14 (0.81%)	0 (0%)	0 (0%)
- tourist		1462 (85%)	25 (35.71%)	25 (17.16%)



## Inform

Air Quality forecast is not very nice  
You have parked out of your residential parking zone  
The Road cleaning is this night  
The waste in S.Andreas Road is full

## Engage

Provide a comment, a score, etc.

## Stimulate / recommend

Events in the city, services you may be interested, etc..

## Provide Bonus, rewards if needed

you get a bonus since you parked here  
We suggest: leave the car out of the city, this bonus can be used to buy a bus ticket

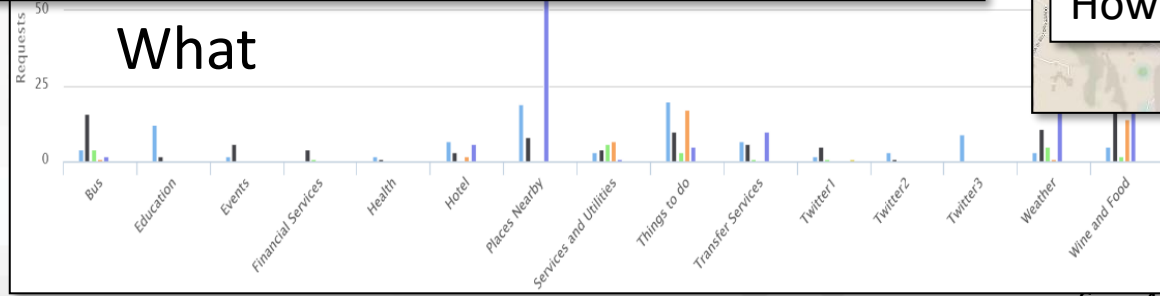
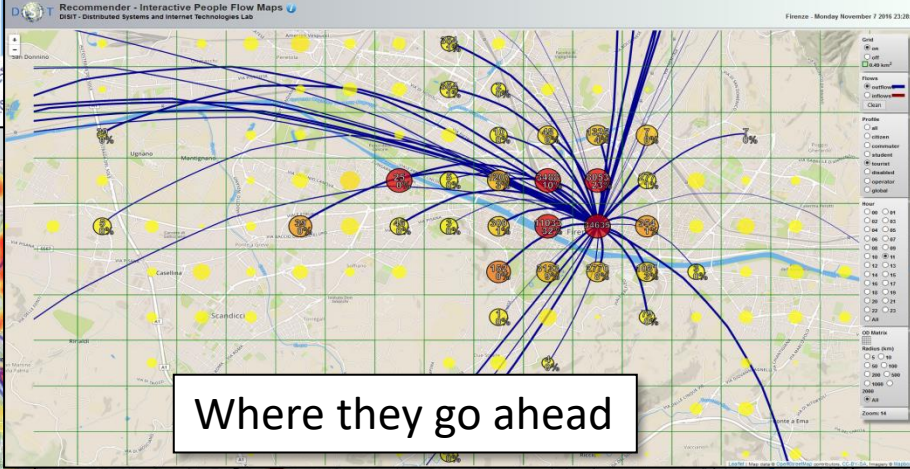
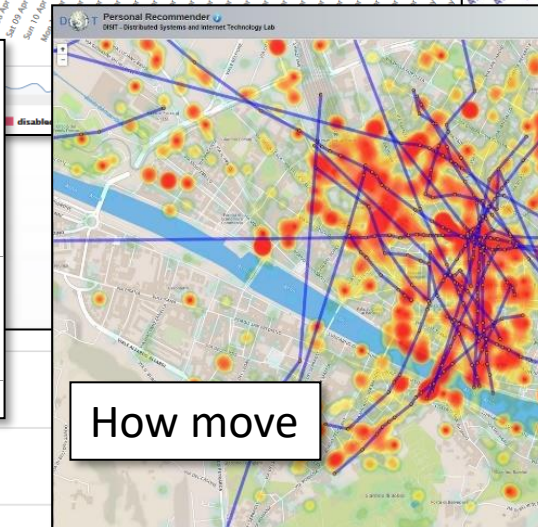
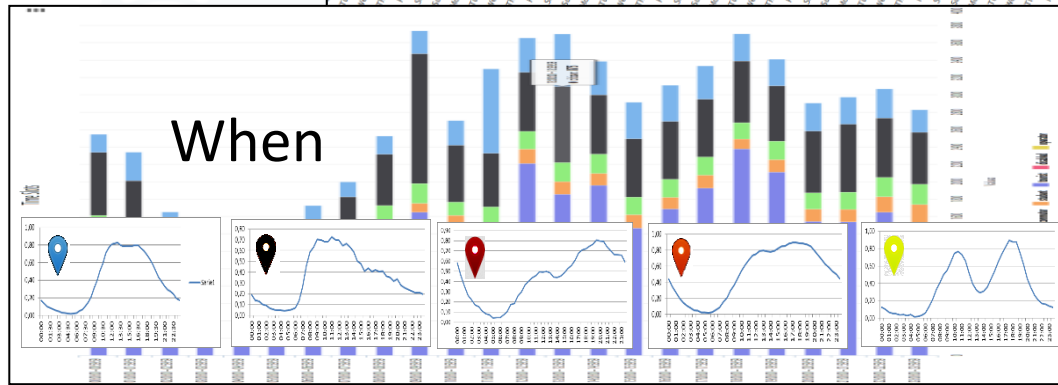
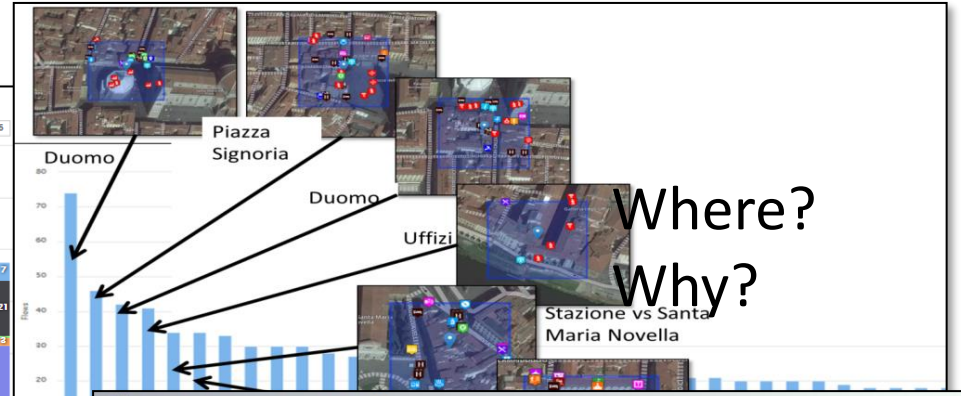
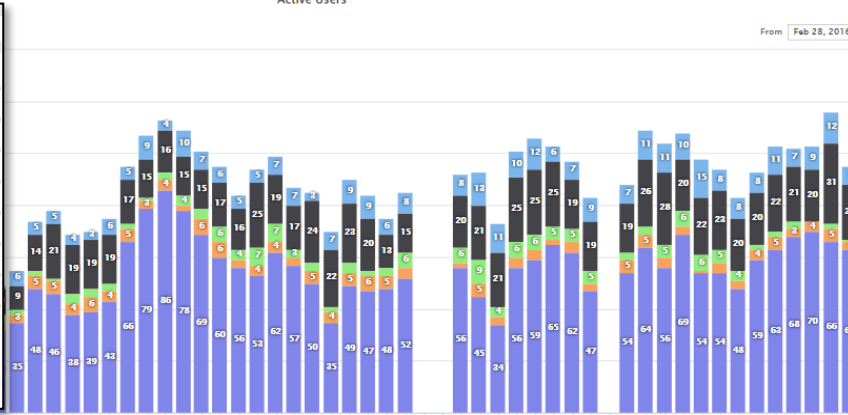
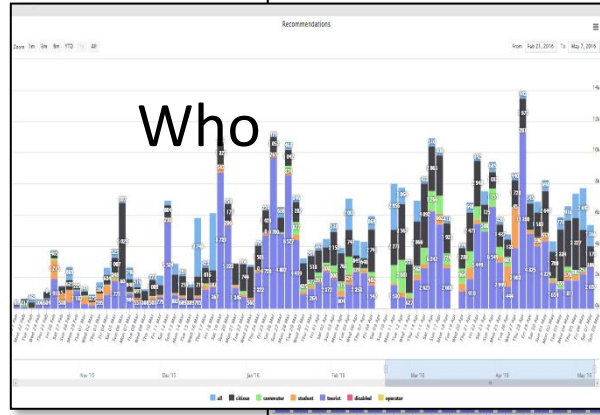
Rules

User context

City context



# User Behavior Analyser for Collective Profiling





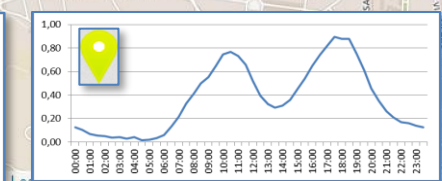
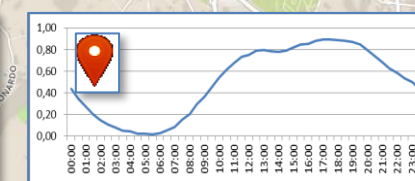
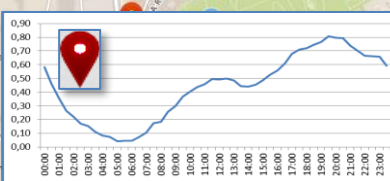
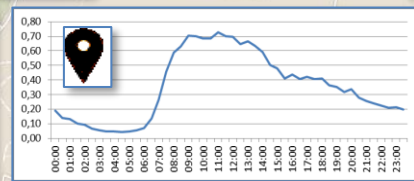
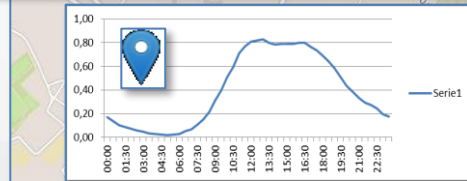
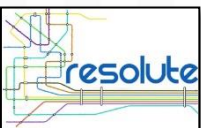
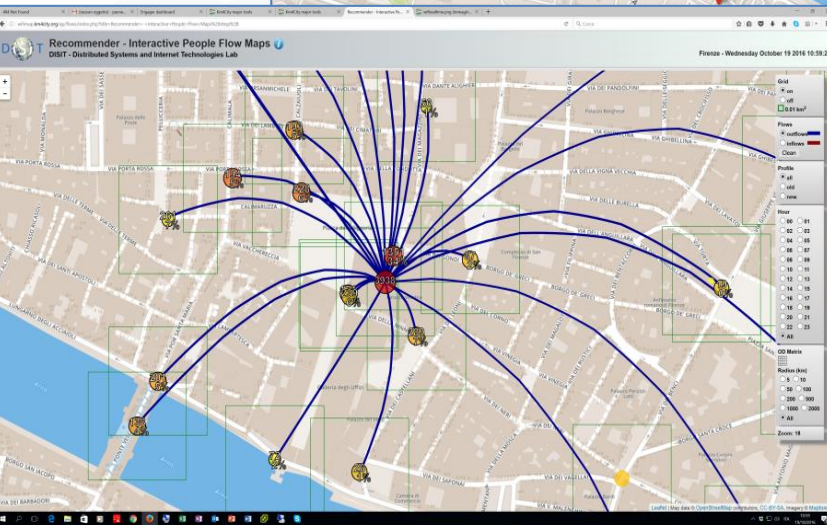
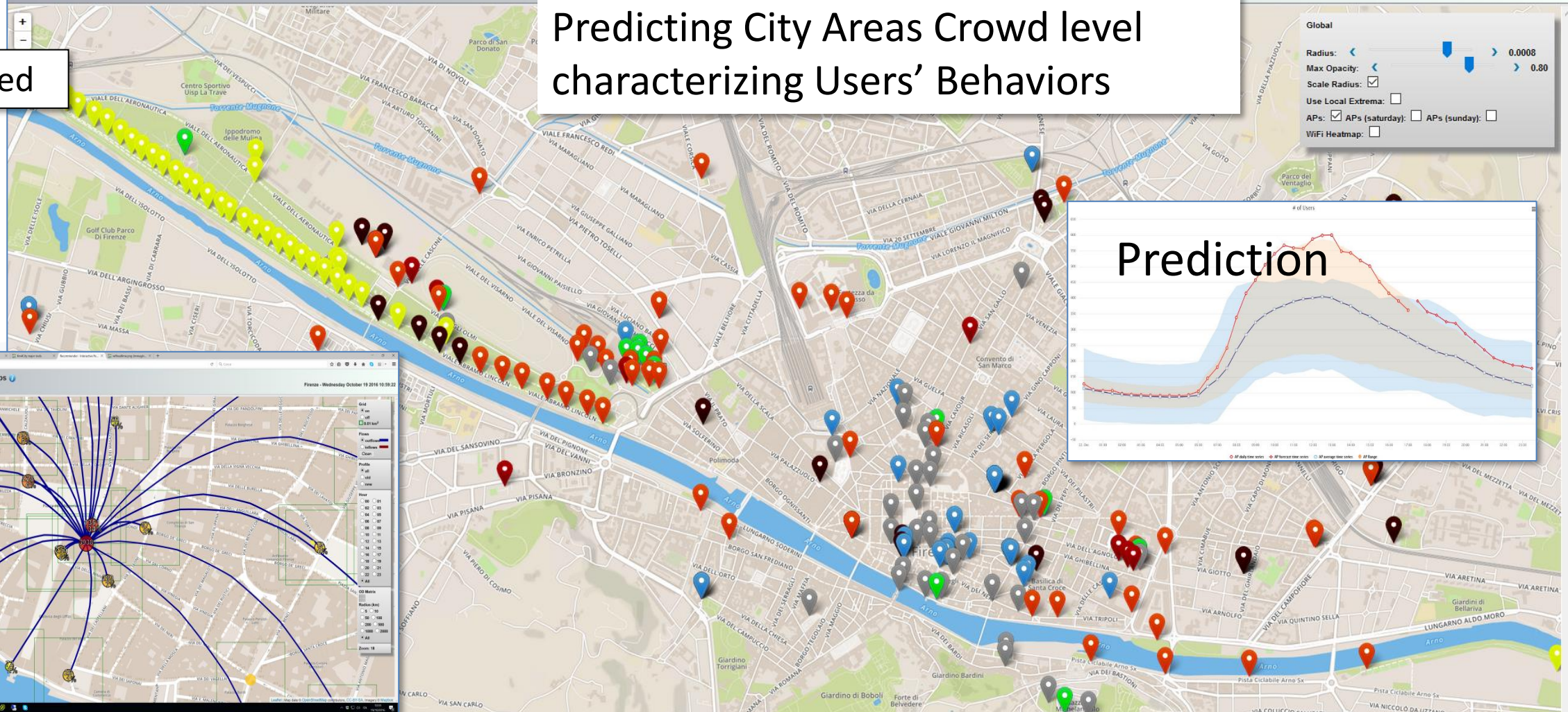
# Characterizing City Areas

DisIT Firenze Wi-Fi: Access Points Clusters Coverage Map  
DisIT - Distributed Systems and Internet Technologies Lab

Firenze - Saturday November 12 2016 19:16:33

Wi-Fi based

Predicting City Areas Crowd level  
characterizing Users' Behaviors

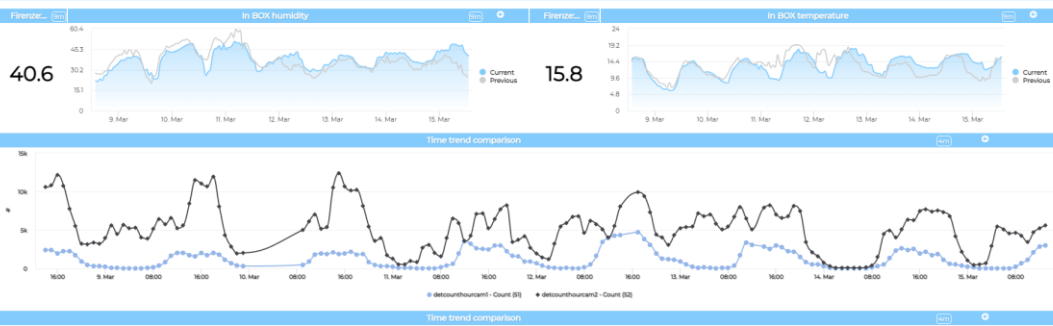




# A view and data from the Thermal Camera



## Detection BOX Snap4Thermal PV Firenze Tue 15 Mar 13:30:41

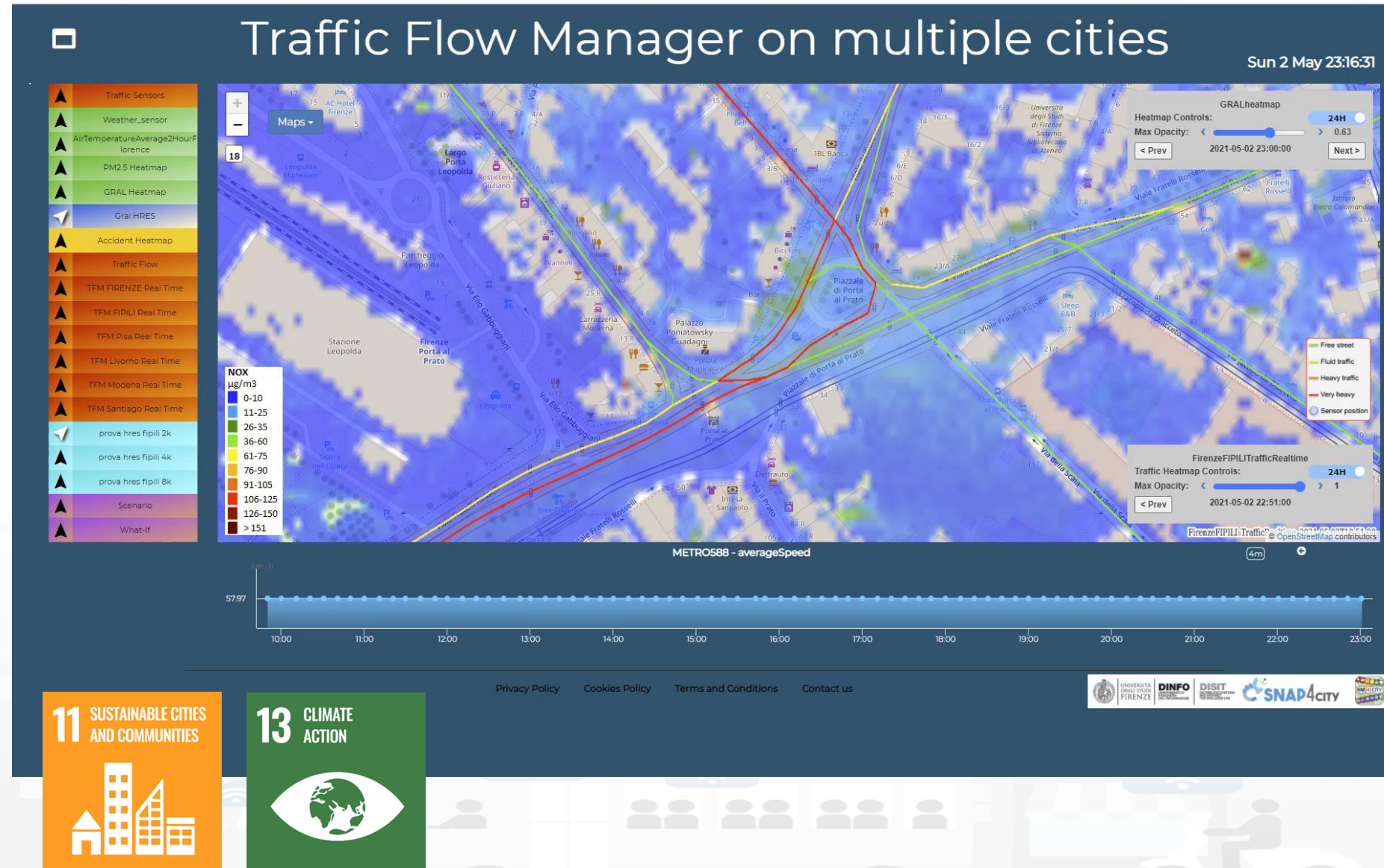


**11** SUSTAINABLE CITIES  
AND COMMUNITIES



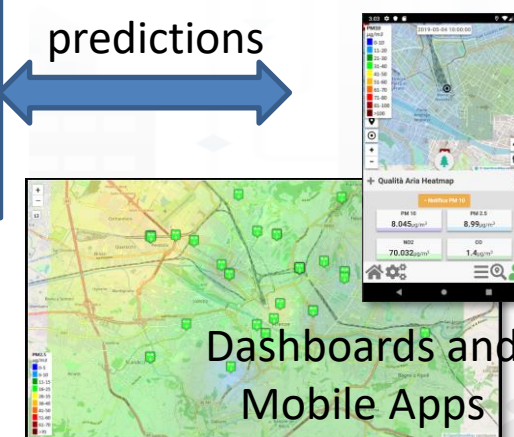
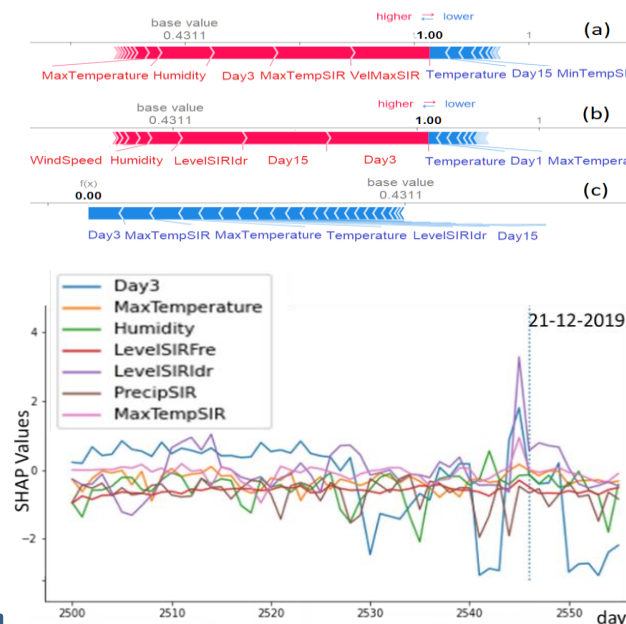
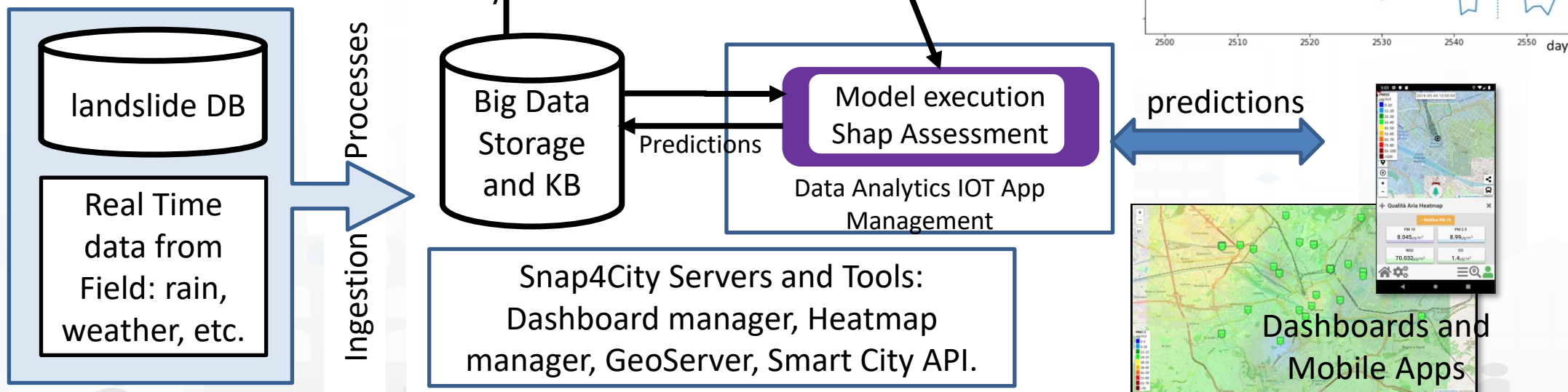
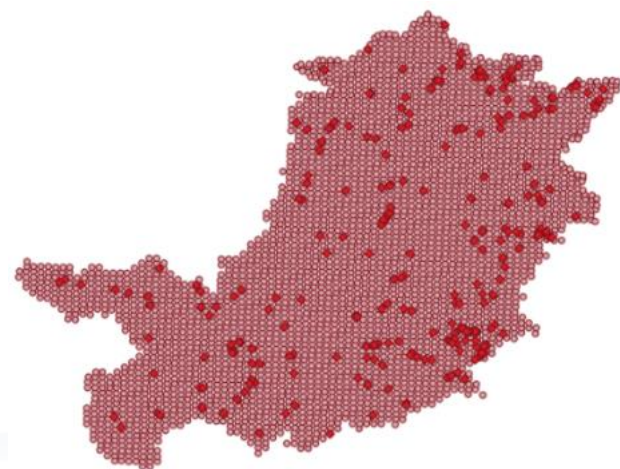


- **Prediction**
  - **NOX Pollutant** diffusion on the basis of Traffic Flow (prediction), weather and 3D structure
  - **NO2 progressive average** (Long term)
- **Project:**
  - **Trafair CEF EC**
  - Mixed solutions of Fluidinamics modeling and AI





# Predicting Land slides





TOP



*Be smart in a SNAP!*



**SMARTCITY**  
EXPO WORLD CONGRESS

7-9 November 2023, Barcelona, Spain

Visit Snap4City in Hall 1

## CONTACT

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[www.snap4city.org](http://www.snap4city.org)



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**Installations**

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