Antifragile Cities – Decision Support Tools to Support the Implementation of the Climate-neutral and Smart Cities

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antifragicity

Introduction

The articles output was to present an innovative framework that:

- Recognizes when an event may disrupt the existing urban equilibrium;
- Manages the short-term effects of the mobility disruption to maintain safety, innovation, and city operations;
- Examines and simulates potential scenarios for future growth while adhering to the EU sustainability and CO2 reduction targets;
- Proposes an optimal new path forward that optimizes the improvements in the urban mobility landscape, while ensuring public acceptance and rapid adoption.

Uncertainty popularity index 2004-08/2022, Google Trends

Introduction

Black Swan

An unpredictable or unforeseen event, typically one with extreme consequences

Antifragility

The property of systems in which they increase in capability to thrive as a result of stressors, shocks, volatility, noise, mistakes, faults, attacks or failures.

Homeostasis

a self-regulating process by which biological systems maintain stability while adjusting to changing external conditions

Requirements

Simulator for Urban Mobility Antifragility

What The key tool in the decision-making process towards urban mobility antifragility

Why To be able to alter the parameters of the urban environment to test different scenarios.

How By analyzing geospatial data, simulating the flow & the actions and reactions of the users

Recognize a disrupting event	Mobilize cities quickly	Manage the short-term effects of the mobility disruption
Examine and simulate potential scenarios for future growth	Propose an optimal new path for the urban mobility landscape	Ensuring public acceptance and rapid adoption

The Components

Mobility

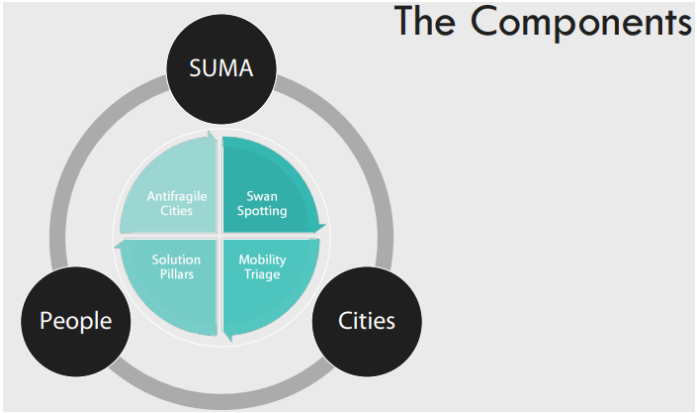
1. Use of Traditional transportation planning tools
2. Optimization algorithms
3. Full scale traffic/mobility simulations that focus on vulnerable groups (pedestrians, disabled, micro mobility etc.)
4. Align with Urban Mobility Goals
5. Align with EU Road Safety Policy Framework 2021-2039

Environment

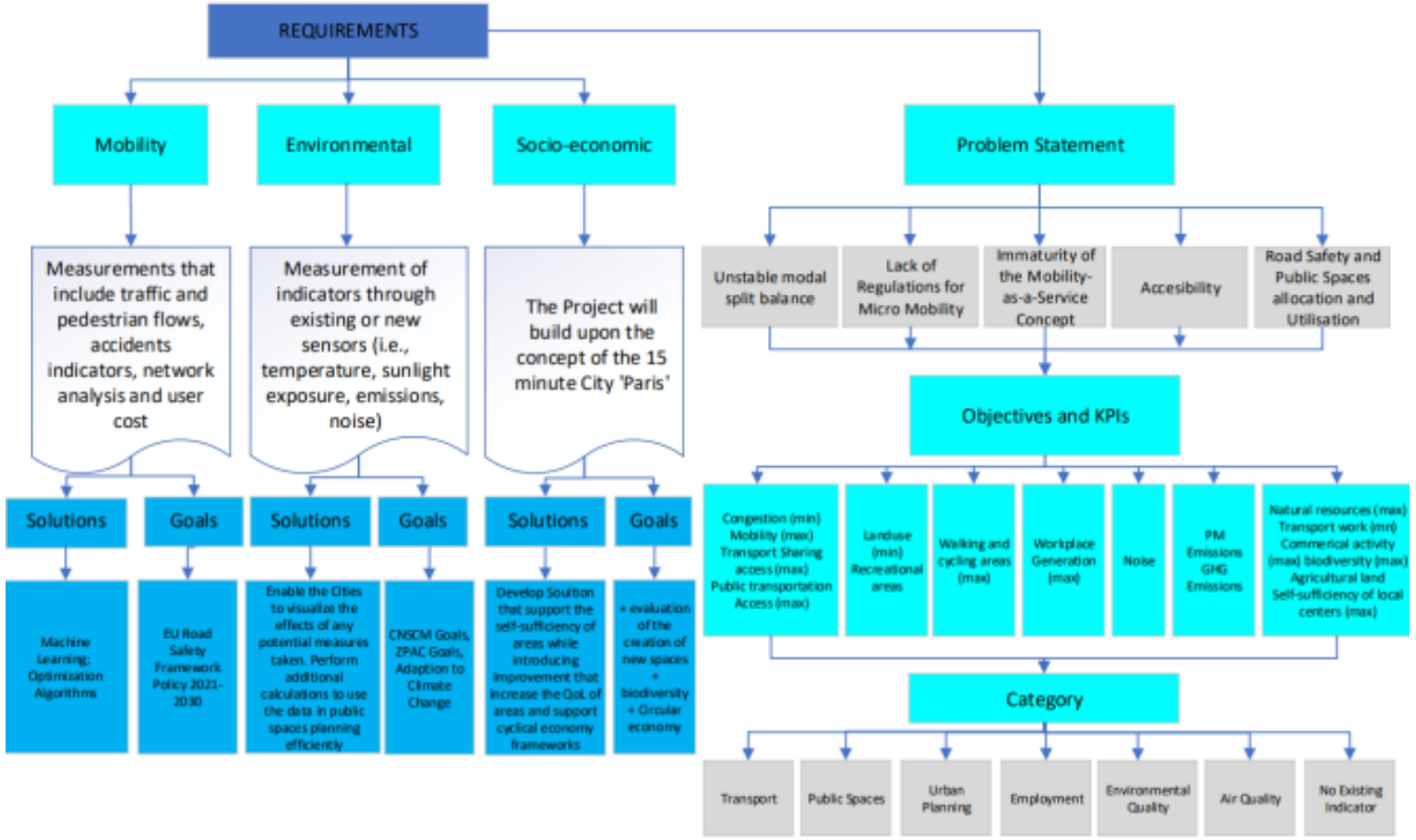
1. *Existing & new sensors*
2. *Simulation and visualization of the environmental parameters*
3. *Adapt to climate change (simulate extreme conditions)*
4. Align with CNSCM goals
5. Align with ZPAC goals

Society-Economy

1. Concept of the 15' min city
2. Evaluation of public space allocation and utilization
3. Support biodiversity
4. Increase in the QoL
5. Support Cyclical Economy frameworks



Resilience is not enough...

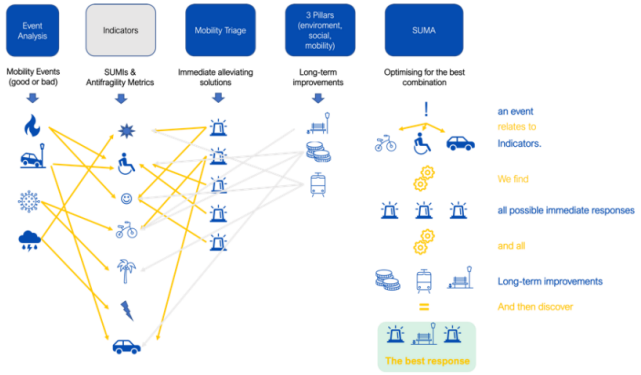


Antifragicity Conceptual Framework

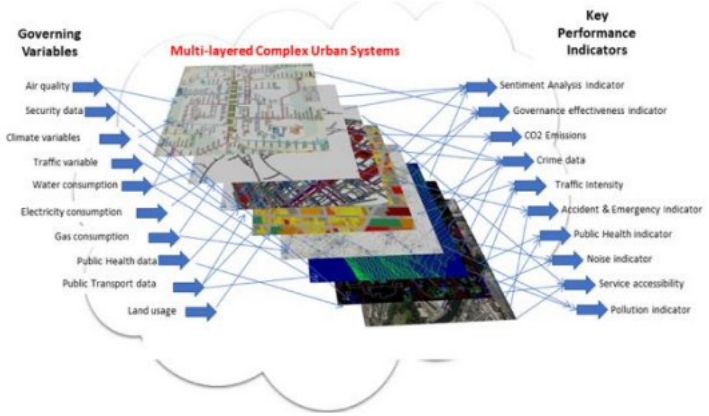
Methods & Measurements

OBJECTIVES	METHODS	MEASUREMENTS
OBJ 1: SUMP	Devise innovative, reliable, and efficient solutions for the movement of people by taking different user profiles and their behavior into account; Deploying the models, methods, and tools, developed as part of SUMA across the demonstration projects.	Develop decision-making mechanism with dynamic risk-based prediction incorporating cutting-edge forecasting models continuously augmented with real data.
OBJ 2: Ontology	Corroborate and make sense of sensory and social media data and information real-time, using a combination of machine learning and natural language processing algorithms; Rely on the AntifragiCity ontology that elaborates on potential risks based on historical information and state-of-the-art literature.	Develop forecasting models that leverage sensory and social media data and information; Develop forecasting risk models that leverage sensory and social media data and information.
OBJ 3: Real-time senses	Improve road infrastructure safety by redesigning the hierarchy of road system based on the need of speed limit. Appropriate measurement of data of traffic volumes and modes that are important.	Re-assess and re-design road infrastructure system. Share of micro-mobility vehicle parking in dedicated parking areas (e.g. micro-mobility-hubs).
OBJ4: Models	The methods used for the environmental assessment are based on the performance approach (versus means approach) to cover the goals of the climate change mitigation and adaptation, the biodiversity preservation, and no net land take. Thus, the environmental performance of implemented solutions (e.g., increase the green area and bike lines, better communication, etc.), will be assessed.	In situ sensors, to “reduce air pollutant emissions” and “decrease noise hindrance”. • Dynamic Life Cycle Assessment (DLCA) method, to “Reduce greenhouse gas emissions”. •Biotope Area Ratio/Factor (BAR/BAF) method to “reduce impacts on global biodiversity & enhance local/in-situ biodiversity” and “Optimise the urban area/land use: contribute to the no net land take goal”.

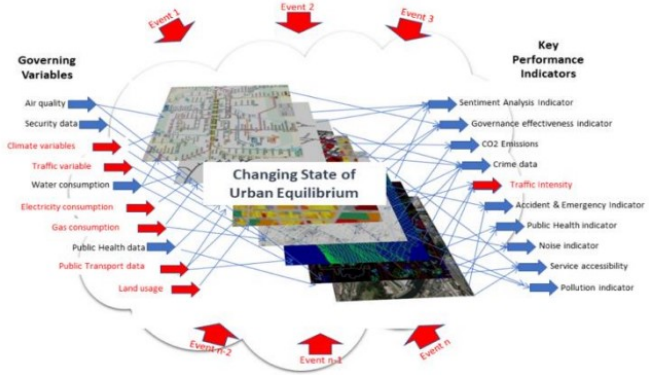
AntifragiCity Conceptual Framework



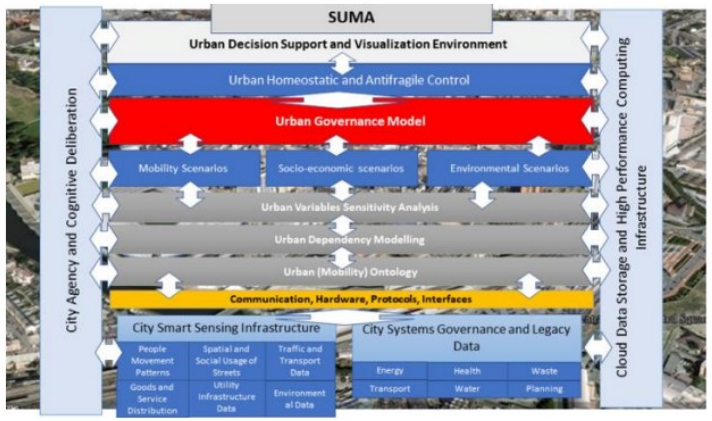
AntifragiCity Framework in a nutshell



City Systems Dependency Modelling



City Systems Management and Actuation



City Integrated Management Infrastructure

Six-stage nature-inspired approach

The first stage involves citizen engagement with a view of preparing the local population to the step changes that will be brought to the city via the planned demonstration project.

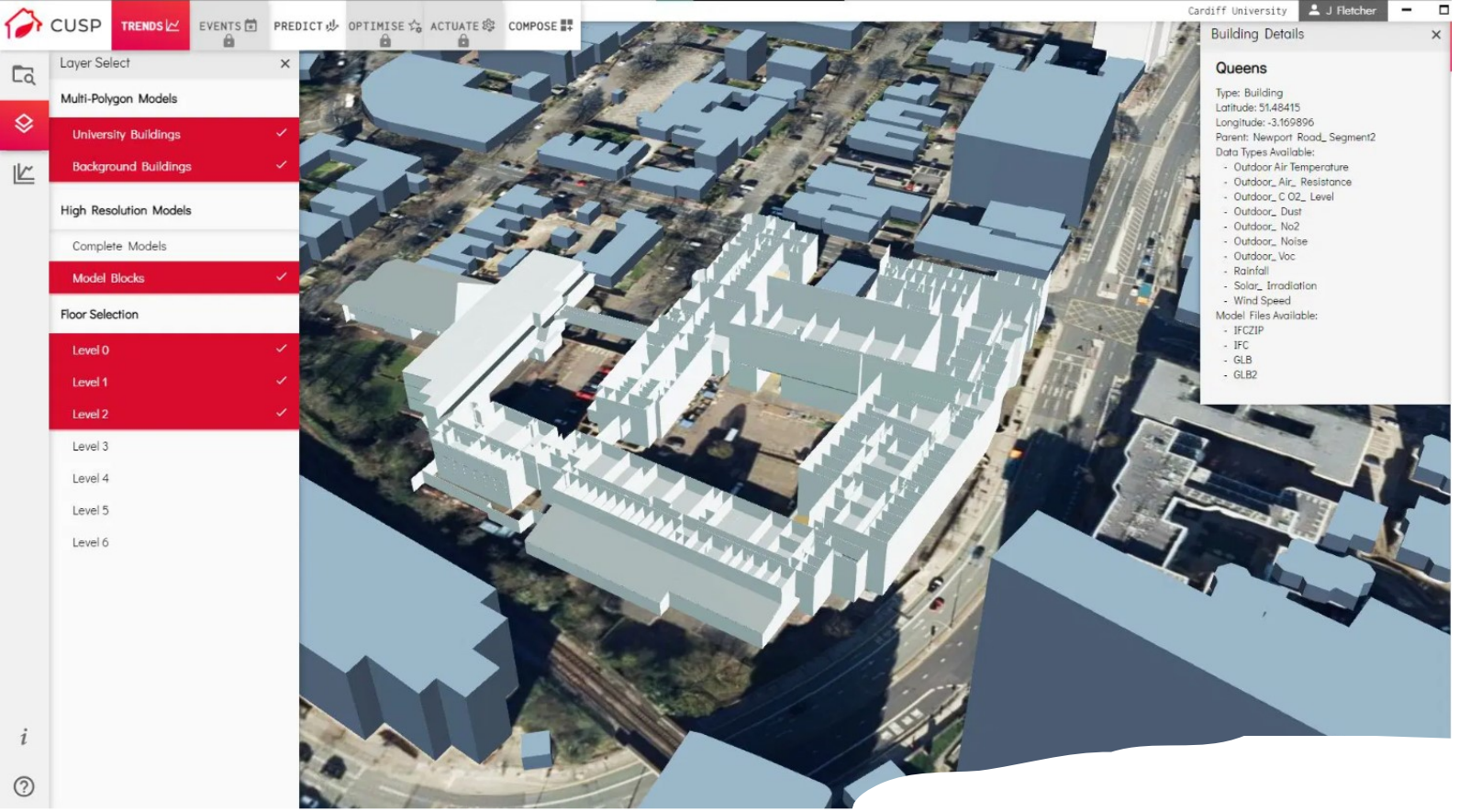
The second stage concentrates on developing an urban systems integration approach, which involves semantic conceptualization of urban systems.

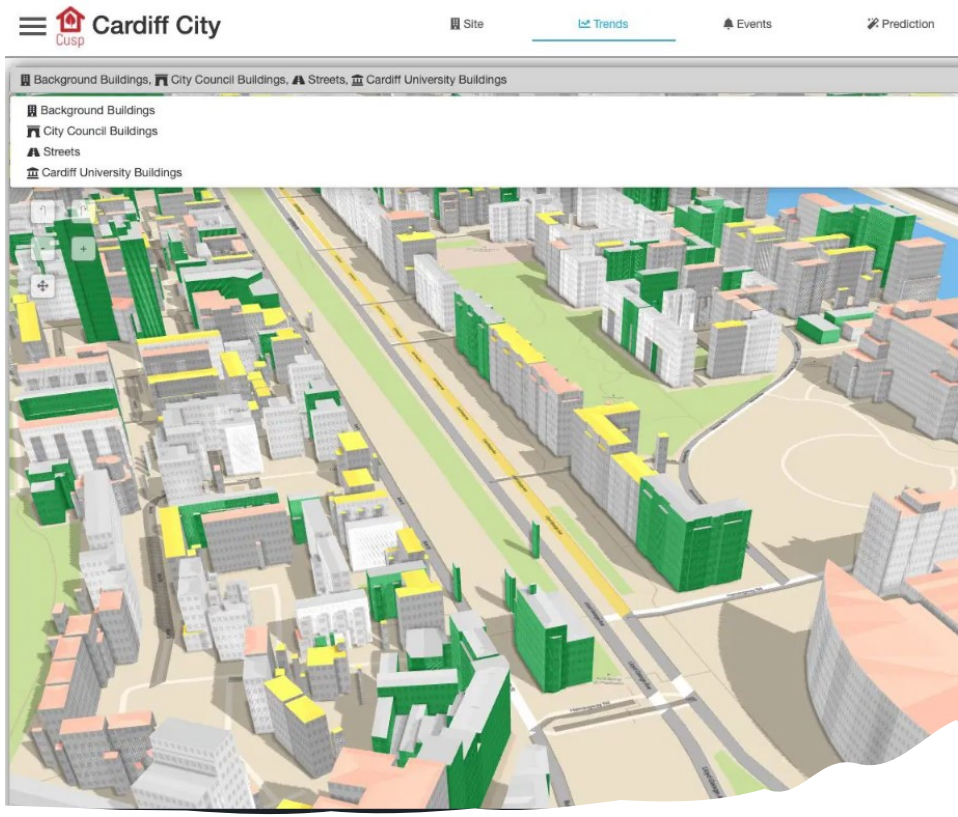
The third Stage involves the understanding and mapping of Technical, Commercial, Geospatial and Regulatory Interdependencies within each participating city.

The fourth stage will involve building a holistic and dynamic urban analytical modelling environment that incorporates the above understanding of inter-systems variable interdependencies and uses indicators to assist city holistic informed decision making.

The fifth stage will involve exploiting the semantic, dependency, and predictive models developed in the previous stages to deliver managed city systems with a decision-making capability that factors in decision criticality, implications, stakeholder, and citizen views, as well as security, confidentiality, and data sensitivity issues.

The sixth stage will be to explore the potential of different business models to promote efficient integrated UM and wider infrastructure systems, and develop tools for monitoring and evaluation by understanding the mechanisms

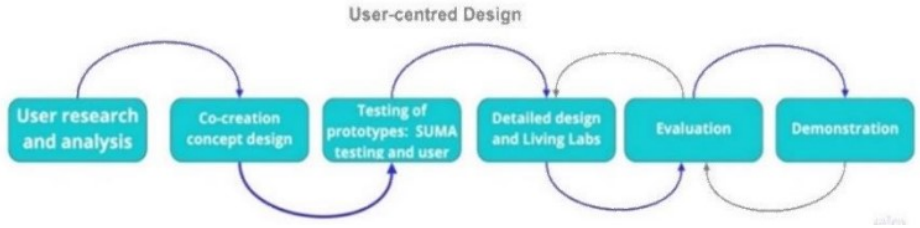




The Computational Urban Sustainability Platform (CUSP) is designed to optimise energy consumption, with the ultimate goal of steering you towards reaching Net Zero.

[Smart City AI & Semantics Energy Efficiency Solution (cuspplatform.com)]

The AntifragiCity Urban demonstration activities

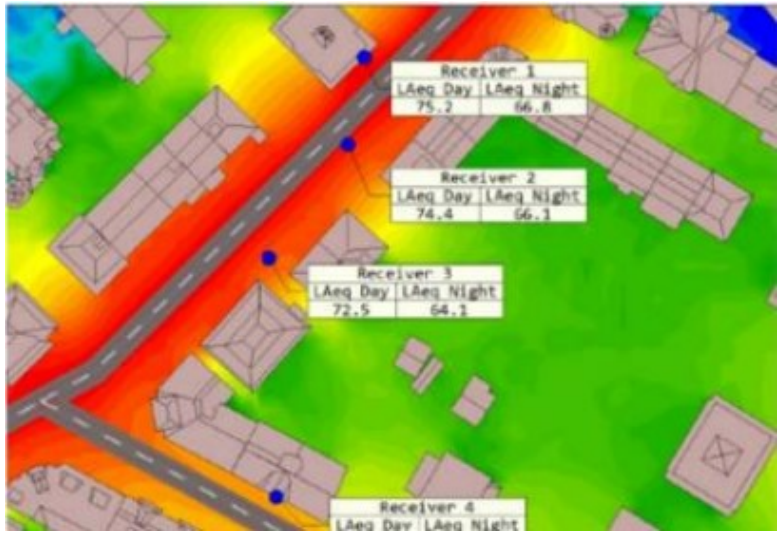


CSTB

- MithraSIG is a sound mapping software which calculates the sound level exposure of inhabitants outside buildings, i.e., what is the sound pressure level to which building facades and pedestrians are exposed to.
- The software is used to produce the “strategic noise maps” as required by EU, to assess the number of inhabitants exposed to given sound pressure level intervals for all big city (>100 000).
- Two functions:

First - a more detailed traffic model allows the simulation of the motion of each individual vehicle. Thus, the noise exposure is calculated and gives additional noise exposure indices related to the dynamics of traffic flow.

Second - MithraSOUND can “auralize” the simulated soundscape thereby allowing the user to evaluate perceptually the sound environment over a given period.



Black Swan special demonstration, Re-design road and public space quality responding to needs of all users – Odessa, Ukraine

Innovation: Mobility triage implementation, address the reduction of safety risks to all and diverse groups of users providing safe, environmentally and resilience mobility areas.

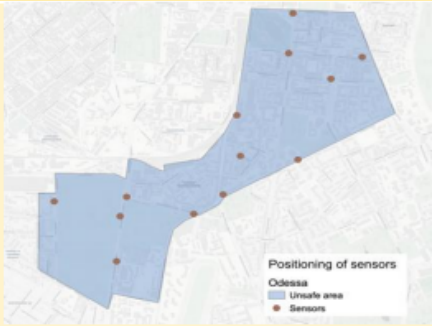
Background

Odesa is the 3rd most populous city and municipality in Ukraine and a major seaport and transport hub located on the northwestern shore of the Black Sea. The population is about 1 million, with a density of 6300 residents/km^2.

City challenges to tackle with the demonstration

The transition from the difficult situation of the war to the normal situation of citizens' liveability and mobility, different challenges will be needed to be faced by stakeholders and policymakers. Re-assessment and re-design of road and public space quality responding to needs of all groups and especially to diverse groups in order to reduce the potential risks parameters for accidents and to increase the safety and the accessibility of citizens is crucial. Shared road infrastructure, construction of bike-lanes and e-scooter lanes are some of the proposed measures.

Demonstration idea



The Odessa demonstration is a special demonstration case given the ongoing circumstances and, as such, the city does not fall squarely into neither the lead nor the follower city categories. Nevertheless, it was selected as a unique opportunity to demonstrate the immediate and long-term benefits of the AntifragiCity project under an ongoing black swan phenomenon[25]. The unsafe area provided by the municipality is the city centre.

The demonstration consists of two phases:

1. Providing immediate solutions to the ongoing problem of movement through a war-struck city through the mobility triage WP. This is going to be in the form of a report and coincide with sensor placement.
2. Providing long-term getting-out-of-crises-stronger solutions that aim to redesign urban space in order to provide safe, affordable, resilient and environmental-friendly space for all and vulnerable groups (children, the elderly and other vulnerable groups such as disabled people). This is going to happen after analyzing data from different sensors (traffic and environmental), implemented in the targeted location and implementing simulations and scenarios from the SUMA PaaS. The AntifragiCity project includes budget for widening soft mobility accessibility through areas of the city.

Local residents will be engaged as much as possible in order to obtain their subjective responses regarding road safety, environmental indicators, mobility choices, and overall Quality of Life (QoL). This will be achieved by administering surveys before and after the redesign of the street(s).

Expected outcome

- Improve pedestrian feeling of safety based on questionnaire responses by **30%** (phase 1)
- To widen areas accessible without a car by **20%** (phase 2).
- Improve air quality by a reduction in air pollution by **10%** (phase 2)

Potential Barriers & Obstacles

Barriers / Obstacles	Proposed Mitigation Measures
Dispersed regulatory framework and the need for crossmodally and cross sectoral interoperability and commonly accepted standards	The requirement is to analyze these implications to adopt an approach that utilizes collective methods and tools that ensures the participation of all related stakeholders from an early stage to highlight and adequately discuss the respective implications from the design phase.
Implementation dependent of political decisions	The participation of city authorities in the consortium, which have the political mindset to implement the proposed actions, that will ensure the successful implementation of the Decision support tool actions at pilot level.
Conservative mindset and lack of confidence in innovative solutions from the demand / consumer side	The decision support tool user-centric approach is designed to gather and analyze user intelligence, together with its co-creation approach that directly involves users as key stakeholders
Capital intensiveness of innovation, reinforced by problems of financing	The innovative business models and services that will be co-created and proposed by the decision support tool will take into account capital investment needs vs. potential funding sources. Those will be further accompanied by a preliminary estimation of service implementation costs vs. potential inflows for the value chain as a whole.

Beyond State-of-the-Art

The AntifragiCity Framework will progress current state-of-the-art in the following areas:

a) resilient urban areas,

b) land use and urban planning

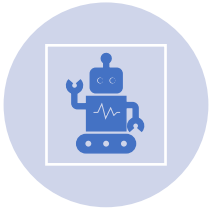
c) urban semantic models for mobility management

d) reference architectures for mobility management, and

e) smart city platforms for UM

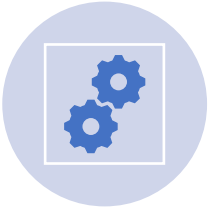
AntifragiCity decision support tool will progress urban resilience by exploiting the nature inspired concept of biomimicry, as exemplified by the natural phenomenon of homeostasis, representing the natural tendency towards maintaining a relatively stable equilibrium between the constituents of a complex system, as maintained by physiological processes, while acquiring an increased resilience.

AntifragiCity will progress current state-of-the-art in UM modelling by developing an UM Ontology that factors in all aspects that underpin the Urban metabolism, thus providing a holistic approach for managing mobility.



The decision support tool will comply with OASC (Open & Agile Smart Cities), and promote interoperability between various urban artefacts, including mobility, through dedicated APIs to access data, and context information. It will also provide the capability to develop a semantic contextualization of data feeds originating from connected objects found in cities, in the form of model constructs aligned with the proposed UM semantic reference model.

AntifragiCity will develop holistic approach to model the urban dynamics from a social (human driven) perspective factoring in a wide range of variables. This model will assist local authorities in their planning process as well as their quest to transition towards inclusive, sustainable, and resilient (including from a gentrification perspective) urban areas.



The decision support tool will extend the IoT stack architecture to include a semantic referential, in the form of an UM reference model, that extends City information models, such as City Geography Markup Language (CityGML), while factoring in security (including data governance) considerations. The decision support tool reference architecture will factor in social constructs to promote a participative approach considering the complete value chain, with a focus on UM.

Conclusion

- The proposed conceptual framework ‘AntifragiCity’ is based on the theory of antifragile whereby the city will resist shortterm effects of mobility disruption, maintain safety, innovation and optimize improvements.
- Four specific objectives (SUMP, Ontology, Real-time Senses, and Models) have been identified with recommended techniques and measurements.
- The framework’s adaptive process of maintaining resilience relating to Homeostasis theory through subjective well-being has been integrated into the methodology.

Questions & Thank you!