

An ICT framework to support Nature Base Solutions implementations in Smart Cities

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Abstract— UNaLab (Urban Nature Labs) [1] is a project funded by the European Union under the Horizon 2020 research and innovation programme. The UNaLab consortium is comprised of 28 partners from 10 cities across Europe and beyond, including municipalities, research, business and industry. The UNaLab partner cities commit to addressing the challenges that cities around the world are facing today, by focusing on climate and water related issues, within an innovative and citizen-driven paradigm. With three demonstration cities, seven replication cities and several observers, the UNaLab project aims to develop smarter, more inclusive, more resilient and increasingly sustainable societies through innovative nature-based solutions (NBS). With this paper, we introduce in further details the UNaLab project, with a special focus on the ICT framework to be used by the front-runner cities.

Keywords—Smart Cities, IoT, Internet of Everything, data interoperability, data visualization, Nature Based Solution, Co-creation

I. INTRODUCTION

The UNaLab project [1] is contributing to the development of smarter, more inclusive, more resilient and more sustainable urban communities through the implementation of Nature-Based Solutions (NBS) co-created with and for local stakeholders and citizens. Each of the UNaLab project's three Front-Runner Cities – Eindhoven (NL), Genova (IT) and Tampere (FI) – has a strong commitment to smart, citizen-driven solutions for sustainable urban development. The establishment of Urban Living Lab (ULL) innovation spaces in Eindhoven, Genova and Tampere supports on-going co-creation, demonstration, experimentation and evaluation of a range of different NBS targeting climate change mitigation and adaptation along with the sustainable management of water resources. The Front-Runner Cities actively promote knowledge and capacity building in the use of NBS to enhance urban climate and water resilience within a network of committed partner cities, including as well as several Follower Cities. Collaborative knowledge production among this wide network of cities enables UNaLab project results to reflect diverse urban socio-economic realities, along with differences in the size and density of urban populations, local ecosystem characteristics and climate conditions. Evidence of NBS effectiveness to cope with the negative impacts of climate change and urbanization will be captured through a comprehensive monitoring and impact assessment framework. Further replication and up-scaling of NBS is supported by development of an ULL model and associated tools tailored to the co-creation of NBS to address climate- and water-related challenges, a range of applicable business and financing models, as well as governance-related structures and processes to support NBS uptake. The results of the project will be a robust evidence base and go-to-market environment for innovative, replicable, and locally

attuned NBS. The three front-runner cities main nature base solutions are:

- Eindhoven: Air quality improvement in the Vestdijk area by implementing more green spaces. Flooding risk reduction by daylighting the Gender river.
- Genova: Flooding risk reduction and air quality improvement by transforming the Gavoglio area into an urban park.
- Tampere: Water treatment with nature-based water management systems such as green roofs, rain gardens and rainwater harvesting.

II. IOT ISSUES AND PROPOSED SOLUTION

Pushed by the Digital Transformation trend, the cities publicly released city-related data on the web and adopt digital infrastructures (such as for urban remote sensing). However, this data is currently underutilized on account of the high heterogeneity in data formats, the lack of a single access point to the data, the fragmented ownership and stewardship (“data silos”).

UNaLab ICT framework gives value to non-processable urban data by providing tools to discover already available dataset on the web, to plug-in new IoT devices and sensors, to find correlations among data, to harmonize the dataset with respect to a standard format and to guide in creating personalized dashboards in order to calculate and analyze Key Performance Indicators based on the data.

III. UNALAB ICT FRAMEWORK

The UNaLab ICT framework used by front-runner cities is mainly derived by the adaptation and tailoring of the Digital Enabler [2], the Internet of Everything Platform provided by Engineering. In fact, Digital Enabler enables new kind of stakeholder involvement (e.g. time and place independence) and fact-based decision making allowing the participation to the co-definition and impact assessment of nature-based solutions (NBS) in the urban environment. In addition, the tool suite permits to give value to the urban data, providing features to automate and facilitate data discovery, harmonization, analysis and visualization. In addition, according to the no lock-in principle, Digital Enabler ensures the interoperability and the independence from any vendor and technology releasing the code under open source license and adopting standard protocols and data models. Target group for the tool suite are professionals like urban planners, living lab managers, cities’ decision makers, city employees, as well as any citizen interested about their environment and joining co-creation activities. In fact, graphical features ensure no coding approach facilitating the management of the data sources (including IoT devices), KPI engine, as well as the possibility to design interactive charts and maps to ease the data understanding.

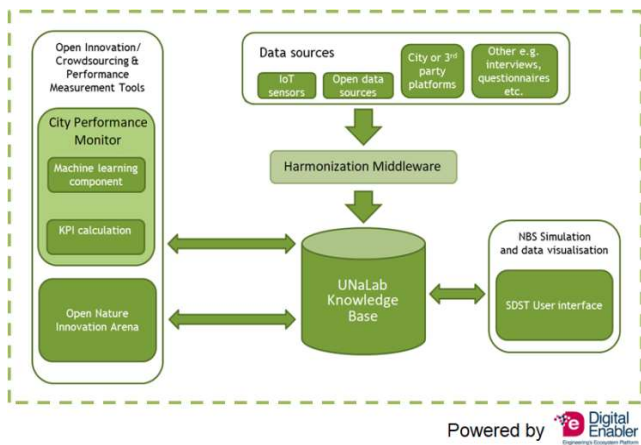


Figure 1 UNaLab ICT framework architecture

The platform provides cities and appointed users with functionalities to support the three main co-creation phases:

- Identification and initial evaluation of the social/territorial issue: Open Nature Innovation Arena (ONIA) [4] enables bottom-up and top down innovation allowing the citizens to notify the urban needs and collaborate to solve them submitting possible solutions in form of ideas. The decision-making process is supported by the City Performance Monitor (CPM) [3], that permits to monitor the current situation providing objective measurements in form of environmental and socio-economic KPIs.
- Assessment and selection of the possible NBS: Following the initial evaluation of the current condition in urban areas, ULL Manager facilitate the understanding of the problem designing an interactive dashboard based on the available data (such as KPIs, open data and historical measurements). ULL stakeholders continue the discussion comparing the possible benefits derived by the implementation of NBSs and tentatively converge to one or more commonly accepted strategy finalizing the idea.
- Continuous evaluation and monitoring: During the Co-implementation phase, data collected from heterogeneous data sources (i.e. IoT sensor devices, Open Data Management System, legacy services) scattered in the city and in the area to be improved are harmonised to be stored and analysed. The CPM relies on this data to make the stakeholders able to monitor the indicators in order to observe the solution effectiveness on the citizen quality life.

In the following sections, the main UNaLab ICT framework's components are detailed.

A. City Performance Monitor (CPM)

The City Performance Monitor (CPM) [3] is the ICT component that allows the UNaLab stakeholders to have an in-depth knowledge about the performances of the urban services and the effectiveness of already implemented NBSs. It aims to facilitate the participatory planning process along the NBS co-creation process, synthesising and presenting environmental and social indicators in a manner that can be used readily by a wide range of individuals, including common citizens and not expert users.

B. Open Nature Innovation Arena (ONIA)

The Open Nature Innovation Arena (ONIA) [4] is the collaborative environment enabling the bottom-up and top-down innovation according to the NBS co-creation process. Indeed, the ONIA will allow all the stakeholders (including Living Lab users and experts) to highlight real, social and territorial difficulty creating new 'Problem', and to collaborate on defining iteratively a possible.

C. IoT Harmonization Middleware

As every city will have at least one existing IoT platform with data from sensors, the UNaLab IoT Harmonisation Middleware (HM) facilitates the plug-in of existing IoT platforms and legacy digital services already in use in the cities. To ensure this goal, in line with OASC principles, the HM exposes standard API and adopts standard protocols and data models to ensure the interoperability. In particular, it is compliant with FIWARE Generic Enabler specification and adopts the FIWARE data models for data harmonization. The back end is composed of a set of APIs acting as secure public interface, a back-end device manager supporting the most common IoT transportation protocols and data format, and a context broker to ensure an effective data exchange among data sources and data consumers. In addition, the HM provides also an effective map based graphical user interface that facilitates the IoT device management without coding.

D. Knowledge Base

The UNaLab Knowledge Base is the umbrella that act as single point of access to the real time and legacy data owned by the city and service providers. It implements an effective mechanism that permits to discover and federate standard data management systems already in use in the cities avoiding the data replication.

E. NBS Simulation Visualisation Tool

The NBS Simulation Visualisation Tool [5] provides a maps-based application that permits to compare the current situation with the future scenario of the possible changes that will occur in the city implementing an NBS against the no action.

IV. CONCLUSIONS

The presented ICT framework propose a novel collaborative approach for the creation of a toolbox of handbooks, models and instruments to guide cities in developing and implementing their own co-creative nature-based solutions. These tools help in processes of ideation, design, simulation and monitoring of NBS while gathering new contributions to improve the toolbox.

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