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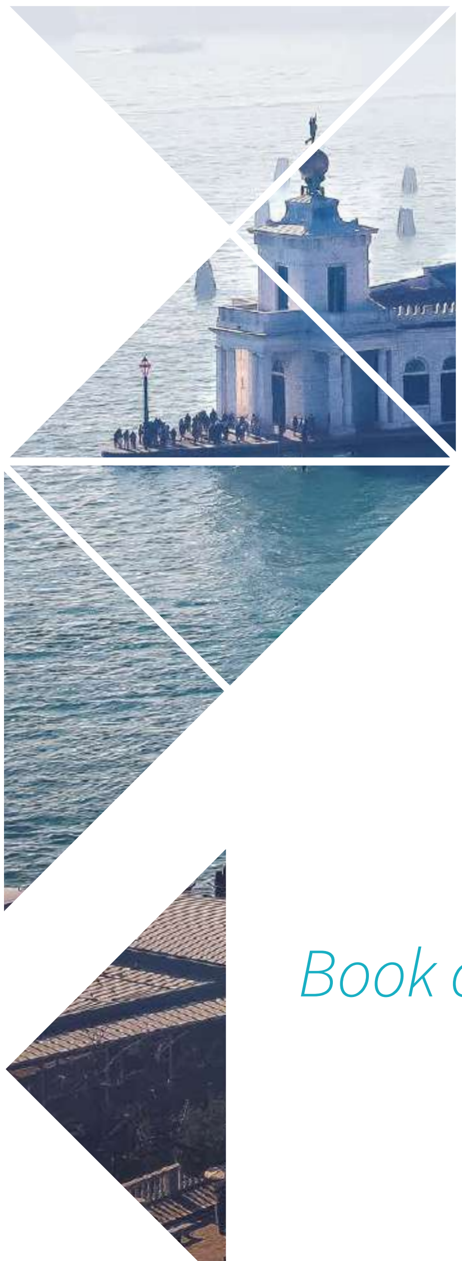

# PLANNING FOR TRANSITION

## *Book of Papers*

I-U-A-V Università Iuav di Venezia

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# SP31

## Learning loops in the public realm. Enabling social learning in communities to tackle the challenges of cities in transition

# Participatory sensing within co-creation: improving the transformation of the urban environment. The Verona case inside the LOOPER project.

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**Abstract:** This paper illustrates methods, technologies and tools used and developed to support a co-creation method for the transformation of the urban environment, developed and tested in the framework of the Verona case from the LOOPER project. The LOOPER project (Learning Loops in the Public Realm), is an European Research Project co-funded under the JPI Urban Europe program. Other two cities are involved: Brussels, working on traffic related issues; Manchester, working on quality of spaces. Co-creation brings together participatory sensing, co-design and other activities to activate a participatory process. The LOOPER co-creation methodology, in the way it is applied at the Verona case study, is therefore based on working with the stakeholders since the first steps of the project, meaning that participatory sensing is grounded on the scoping and monitoring of urban issues done by citizens, enabling them to gain better result thanks to the knowledges obtained in the beginning. To support this process different technologies are used: passive sensors for $NO_2$; noise boxes; PM2.5 portable sensors; user-friendly visualisation dashboard to collect and visualise data. These methods and technologies have been used to improve co-creation to ideate and design urban transformation facing some issues in the city of Verona Sud.

**Keywords**: Co-creation, Co-design, Participatory sensing, Learning Loop

## Introduction

The transformation of the urban environment is a complex process that involves many stakeholders, different topics and many personal or institutional interests. The consequences of this complexity are the slowing down of the transformation process and the rising of conflicts and frictions between citizens and public administration. But another aspect that influence on the scant implementation of urban transformation is the intricate and farraginous cluster of norms and regulatory plans supposed to facilitate and coordinate the management of the city development, but on the contrary, because of their top-down approach, they entrap many potential small and local urban transformation in the name of a unitary and coordinate approach at urban problems.

There is therefore the necessity of new strategies and approaches at urban problems to stimulate and facilitate the ideation and then the implementation of urban transformations to improve the quality of targeted and local urban places (e.g. a street, a small neighbourhood) through a sort of a bottom-up approach in terms of planning scale: the transformation of single urban places can contribute in the development and transformation of the whole city. On the other hand, to avoid conflicts but moreover to adopt adequate and well-chosen solutions, there is also the necessity of plan these transformations through a co-creation process based itself on a bottom-up approach. It is not a simple task and some conditions are necessaries. "The fundamental precondition for the implementation of a bottom-up approach is the existence of a 'bottom level', which for urban planning corresponds to the existence of a community that has certain needs, problems and expectations, that are different from other communities, and is also willing to participate in planning procedures in order to influence them" (Pissourios, 2014). Another condition is the necessity to involve in the bottom-up process also city institutions with the role of evaluating feasibility of solutions in order to avoid difficulties "in translating a bottom-up procedure of urban intervention into legislation" (Pissourios, 2014).

In this theoretical context, the LOOPER project was ideated with the aim of developing and testing a reliable and adaptive strategy based on the double bottom-up approach, supported by an innovative multi-step co-creation process to improve the transformation of the urban environment. LOOPER (Learning Loops in the Public Realm) is a project co-founded under the JPI Urban Europe program and it works with three pilot cases, to be compared and evaluated, located in Belgium (Brussel), United Kingdom (Manchester) and Italy (Verona). The partners involved are: Vrije Universiteit Brussel, BRAL Citizens association of Brussel; University of Manchester; S4B (Brunswick Regeneration PFI); Click and Links; University Iuav of Venice; Comune di Verona; Legambiente Verona. In this paper the Italian case is used to better explain how the participatory sensing within the co-creation process can improve the transformation of the urban environment.

As abovementioned the Italian application is located in Verona, in North Italy, and more specifically in the area of Verona Sud (Figure 1), that is divided from the historical part of the city by the Adige river and the former freight yard, configuring it as a completely distinguishable and separated area of the city. Its development started at the end of the XIX century, with the completion of the first neighbourhood in the early twentieth century. Up to 1949 the industry grew in the area, occupying the central part of it, and the Z.A.I. (Industrial Agricultural Zone) was established.

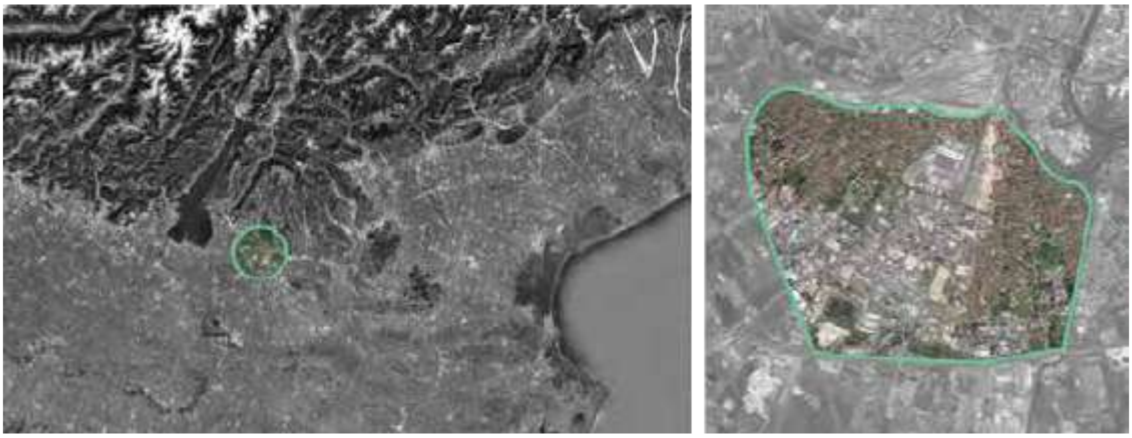

Figure 1 - Verona location in North-East part of Italy and Verona Sud borders

The main issues that influence this area are air quality and noise pollution, mainly caused by heavy traffic, industries, old buildings' heating plants. The presence of this kind of issues lead to the creation of multiple neighbourhood and citizens associations which are interested in solving these problems. The strong willingness of the groups in protesting resulted in a conflictual relationship with policymakers and the public administration of the city (Condotta *et al.*, 2017). In this framework the LOOPER project applies its co-creation methodology to solve the conflicts raised between the parties in order to find new shared mitigation solution to improve the urban environment.

**LOOPER multi-step co-creation process**

The LOOPER co-creation is a multi-step process based on a bottom-up approach. To create the condition of having a consistent and prepared "bottom level" - and therefore get a successful co-creation process – the strategy is to apply the methodology of the Learning Loop within Urban Living Labs (ULLs).

The Learning Loop (or single/double-loop learning) concept was firstly developed by Argyris and Schön (1995). Single-loop learning is an organisational learning process, meaning that people, organisation or groups modify their behaviour and actions according to how reached outcomes differ from the expected outcomes. The single-loop learning is therefor based on the idea that people change their actions, or behaviours, to avoid mistakes. The implemented version of the single-loop learning is the double-loop learning, which expands the idea of the single-loop by having people to correct not only their actions, but also the underlying causes - i.e. organisational norms, policies - behind the problematic action.

In LOOPER a double-loop learning is used as participants, and stakeholders, are called to consider not only about their actions, but also the framework in which they are working. As this leads to a deeper understanding of the pattern in which they are working, it also allows a better decision-making process within every operation. Double-loop learning also introduces organisational learning in the framework: participants and stakeholders are called to examine the underlying assumptions behind the actions to learn from possible incorrect methods.

Another important concept within the project is that of Urban Living Lab, an evolution of the Living Lab concept that is a user-centered open-innovation ecosystem (Von Hippel, 1986; Chesbrough, 2003; Almirall and Wareham, 2011) which integrates research and innovation processes (Bilgram *et al.*, 2008) within a public-private-people partnership (Pallot, 2010).

The implementation of the learning loop and ULL concepts within the co-creation process takes place by filling three sequential planning stages which are conducted inside ULLs (Figure 2): 1. Identification of problems; 2. Co-design and evaluation of alternative solutions; 3. Implementation and monitoring. After finishing the three-stage process another loop starts by going back at the identification of problems; this triggers a "learning loop" as during the second loop stakeholders already have acquired knowledge and information as a base for it.

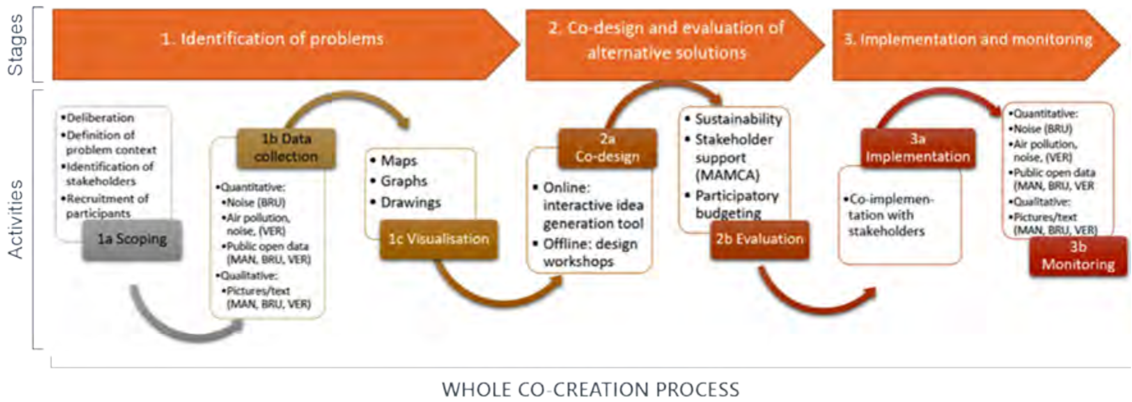


Figure 2 - LOOPER co-creation process

***The learning side of the co-creation process***

In the framework of the multi-step co-creation process, the LOOPER method activates a three "learning stages" process inside ULLs, each of which takes place during every learning loop (Figure 3).

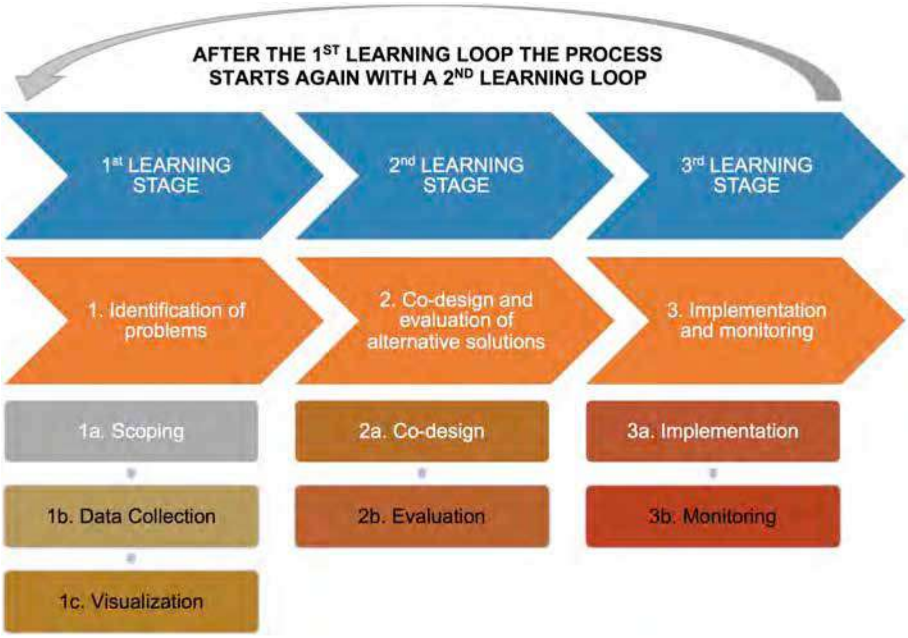


Figure 3 - Learning stages inside the framework of the LOOPER co-creation process

Each learning stage can be matched to one of the co-creation process' stages, which will be better explained later on. The first learning stage is meant to create awareness about urban issues and bout the status of the problems through some consciousness activities. This first type of learning starts by focusing on the scoping of issues, done during the ULL meetings which are organized together with all stakeholders. During these meetings participants start to learn what others perceive as issues, which matters are real or perceived, and which of the issues are most relevant. The learning later moves toward applying what was learnt previously to organize the data collection activity which uses a crowd-sourcing approach. As soon as the data collection is completed, the visualization adds other skills and knowledge to the learning as participants are called to analyse the data they collected by using the online interactive geo-platform that shows every collected data with a user-friendly approach.

The second learning stage covers the activities of co-design of possible urban mitigation solutions and the evaluation of which are worth to be implemented. During the co-design activity participants are asked to propose possible solutions to solve urban issues. This co-design activity is done by having within the participants both citizens and policymakers, this allows to have an open dialogue on which proposed solutions are feasible, effective and sustainable. Moving forward to the evaluation, each of the solutions considered to be feasible, effective and sustainable by participants are assessed by using the MAMCA (Multi-Actor Multi-Criteria Analysis).

The third learning stage seeks to implement the selected solutions into the urban environment, with a second data collection to monitor if there are any effects after the implementation. During this stage participants - both citizens and policymakers - assess the results of their activities and, in this way, they increase their knowledge and awareness on possible transformation and mitigation measure to approach urban issues. At the end of this stage another loop begins, allowing to have even more learning as it starts from a more advanced knowledge base.

Furthermore, the co-creation process based on the ULLs and the learning loop methodology, which is applied in the framework of the LOOPER project, does not only aim at giving knowledge to participants, it also has the intent, or pedagogical ambition, of transforming the most common negative feelings of anger and protest, which usually citizens have towards policymakers, into positive energies of proposition and participation. This is a very important point of the process as usually these negative feeling stem from a low knowledge which citizens have when talking about urban issues, leading to a form of inertia when improvement measures are applied by public administrations.

**The "participatory sensing"**

The learning side of the co-creation process, that we have described in the previous paragraph, play therefore a relevant role in creating the necessary conditions for implementing an effective bottom-up approach. Another strategy to enhance the bottom-up approach is to embrace a "participatory sensing" approach within the first stage of the learning loop; this is what we have done while applying the LOOPER method at the Verona experience.

The participatory sensing concept can therefore be found in the whole first stage of the co-creation process as it is a collective way of gathering knowledge while perceiving and interpreting the urban space that surrounds the community itself. The process gets called "participatory sensing" (Figure 4) and aims to *collectively involve* (participatory) the community in *observing*, *measuring* and *interpreting* (sensing) the urban criticalities and the data collected to reach the design of possible ideas to transform the urban environment. From the scheme in Figure 4 it is possible to see how – under the umbrella of participatory sensing – the sum of the activities of the first stage of the project actually built the "bottom level" which is necessary to have a well-functioning bottom-up approach. Indeed, it is possible to reach good, and useful, results with a bottom-up approach only if citizens are given the tools to empower themselves.

To give a more complete explanation we can say that each of the activities done during the first stage give some knowledge which allows to develop participatory sensing within a community, that later on improves the co-creation process. During the scoping of issues activity citizens are able to collectively interpret and create a framework in which to work, and this collective choosing allows a feeling of involvement without which it would not be possible to trigger a bottom-up approach. During the monitoring activity the participatory sensing gets empowered as citizens are called to collectively monitor what they previously decided to scope, and this is the first active on the ground work that they are called to make. During this activity the participatory sensing reaches its peak. Moving towards the visualisation, citizens are called to interpret the data they collected about the issue they chose.

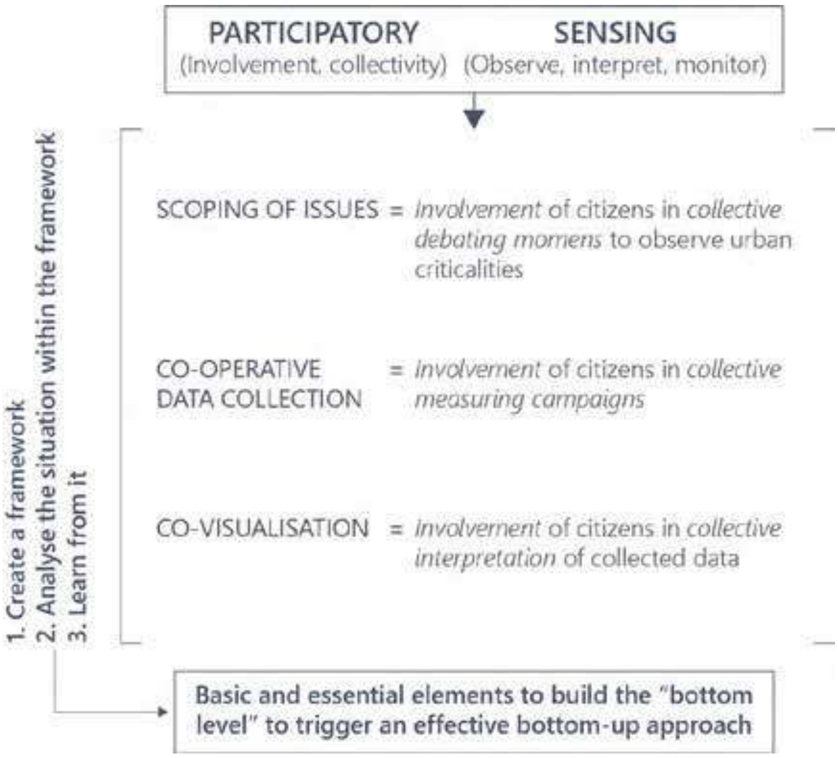


Figure 4 - Participatory Sensing concept applied at the first stage of the LOOPER process

***First Stage of the LOOPER co-creation process: identification of problems.***

As we here will focus on the participatory sensing and how it can improve the transformation of the urban environment, it is necessary to deeper explain the first learning loop experience of the LOOPER project and how it has hence been applied and customized at the Verona case. The loop started in November 2017 and will end in September 2019, going throughout the stages of 1. Identification of problems, 2. Co-design and evaluation of alternative solutions and 3. Implementing and monitoring. The general aim of the first stage was to identify, in practical detail, the problems of a local community through a three-step process. But within these activities the word "problem" started to include the idea of "opportunities", and possible pathways to go forward.

The scoping activity - which means the setting of the framework of issues for the pilot case - took place between November 2017 and February 2018. Throughout this activity period, it was possible to determine which where the urban issues to be considered. During the scoping activity (Figure 5), following the broad priorities of the whole Lab setup, the focus was onto particular interventions which could solve problems - or gather opportunities - of specific interest to the community. Particular attention was given to the possible causes and effects. The problems found were later framed in order to allow the collection of data to quantify/qualify the issues chosen to be addressed: air quality and noise pollution.

Figure 5 - ULL scoping activity

Going through the problem scoping activity, a co-operative data collection planning started as it was based on the idea of a participatory sensing activity. As the problems and opportunities were selected, the data to be used as indicator of the selected urban issues were identified with the help of participants. Participants – but above all, citizens – were trained on the various aspects related to the measuring of data related to a specific issue and decided the locations on where to position the sensors available within the framework of the project (Figure 6). It was, in fact, chosen with participants where to position the sensors and when to undertake the monitoring campaign for the data collection. The sensors available for the data collection were both official ones - i.e. mobile stations – provided by the Environmental Prevention and Protection Agency of the Veneto Region (ARPAV) which is the official body in charge of the measurements, to gather more accurate data to be used as control group, and low-cost ones - i.e. noise boxes, AirBeam for PM2.5, Air Monitor for $NO_2$, geotagging tool for qualitative data – for the crowdsourcing activity (Figure 7).

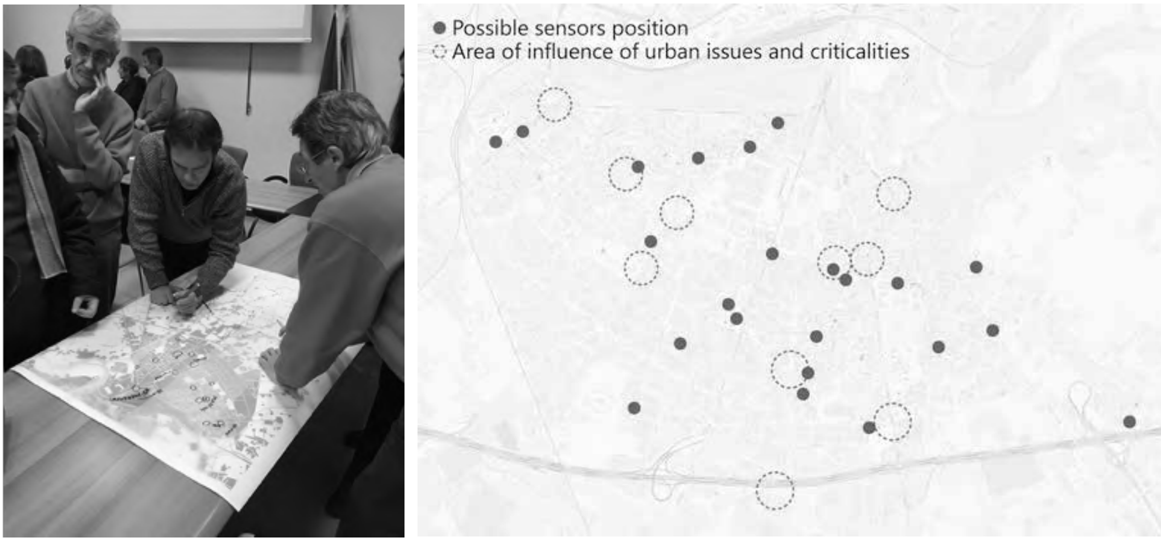


Figure 6 - ULL scoping activity and sensor position

Figure 7 - Noise box, Air Monitor and AirBeam

Considering the crucial importance of where and when the monitoring campaign would take place, the Verona ULL dedicated three meeting in this decisional process and this was done by also thinking at the second monitoring campaign and not only to the first one, and both citizens and policymakers participated and collaborated with the aim of finding a solution which could suit the needs and wills of every stakeholder participating in the project. In Figure 6 it is possible to see the locations chosen by participants where to position some sensors, from places chosen within participant houses or public buildings, and where these possible positions overlapped with the criticalities found before.

After the process of scoping of urban matters, and of questioning on where to position sensors, it was evaluated which places where suitable to position the mobile stations given by ARPAV, and which locations could be used to position the low-cost passive sensors for air pollution. During this activity participants were helped by giving them the tools which were necessary to choose wisely, i.e. knowledge about the issues found during the scoping, competences on sensors and on laws that regulate air and noise monitoring, expertise of council-employees on the feasible space to position mobile stations. The first monitoring campaign took place between February 2018 and April 2018.

Subsequently, the visualisation of the data collected - which was between June 2018 and September 2018 - was made possible by using web-GIS tools, together with other media supports such as audio, image or video. The results of the first cooperative data collection campaign can be found at *verona.looperproject.eu/visualizzazione/*.

The results of the visualisation activity are publicly shared information which were discussed within the ULL by local stakeholders and that were analysed in terms of thresholds, targets, priorities, opportunities. To better clarify, air quality data were matched to official risk categories. Social data such as greenspaces were to be prioritised for action. An assessment/evaluation process decided e.g. which problems to work on, by who, with what resources, in which timescale, in which location.

***Tools to support the participatory sensing***

As the whole co-operative data collection activity is one of the most important activities to reach a complete participatory sensing process here the tools used are explained in detail.

The tools used between February 2018 and April 2018 were:

- Mobile stations from ARPAV (official body in charge of controlling the environmental situation in Italy) which could collect data of: NO; $NO_2$; $NO_X$; PM10.
- Passive sensors from ARPAV which could collect $NO_2$ data from a wider range of places as these are low-cost sensors which need no electricity.
- Noise boxes made up from a low-cost Android smartphone, the OpeNoise app from ARPA Piemonte, a waterproof box and a microphone to be assembled.
- $NO_2$ low cost sensors made with an Arduino board to which a set of other components, including the actual $NO_2$ sensor, need to be embedded.
- PM2.5 low cost sensors which work with a light shattering method with a continuous data collection to find out people exposition to the pollutant.
- A geotagging web app to collect qualitative data about traffic, urban green spaces and any other issue and/or good practice to be found in the area.

The final result was that of a complementary set of tools which gave a more complete understanding of the situation of the project area. This more complete view also helped in realigning the perception that participants had with the actual situation of the spaces they live in. The two main tools which helped in overtaking this discrepancy were the AirBeam - which monitored the PM2.5 - and the noise boxes - which monitored sound levels in dB(A) - as these are the most untrusted data among those collected by the official body.

The AirBeam is a tool which can be used to get instantaneous data of the exposure of a person to PM2.5, it has been developed by HabitatMap which is a non-profit environmental health justice organization whose goal is to raise awareness about the impact the environment has on human health. The big difference between an AirBeam device and an official device relays in how data are collected, indeed the AirBeam measure PM2.5 using a light scattering method; air is sucked in a sensing chamber wherein a LED bulb scatters off particles in the airstream, is registered by a detector and converted into a measurement that estimates the number of the particles in the air (Figure 8).

This device is a crowdsensing one as it works via Bluetooth and sends data to the AirCasting Android app, developed by HabitatMap, every second. The app then maps and graphs the data in real time on the smartphone. At the end of each measuring session all of the collected data are sent to the AirCasting server and there gets crowdsourced with data collected from all the other devices to create a map showing where PM2.5 concentrations are highest and lowest. The device can be considered as a low-cost one as the price is of $ 249,00 for a single device, this though excludes the cost of an android smartphone with internet connection which is a mandatory requirement for it to function. If the smartphone needs to be bought, it is still possible to keep the total price of the sensor under € 350,00.

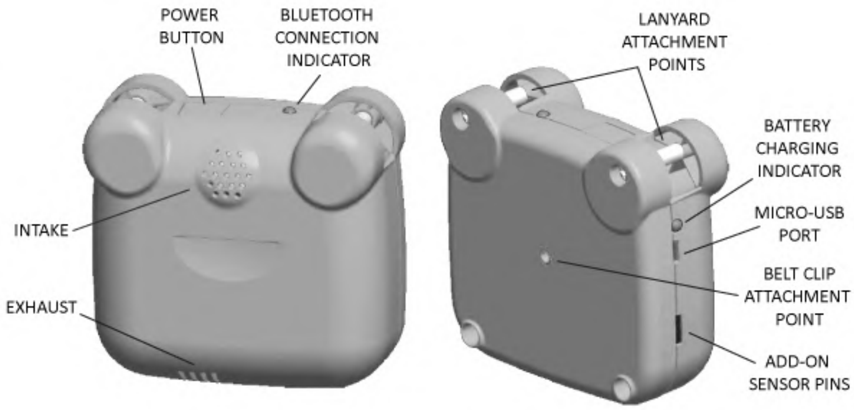


Figure 8 - Air Beam tool

The other tool mainly used for the participatory sensing was the noise box. The noise box sensors are sound level meter apparatus provided by an android smartphone, a lavalier microphone and a waterproof enclosure (Figure 9). These are used to collect a data every 10 minutes, but the time laps period can be modified by the user. As the device is calibrated with an official class 1 level meter it is possible to compare the data collected by it with the official ones. To compare the data is it necessary to work on the raw data to obtain the weekly day and night data, as required by law.

The sound level meter software used for the Sound Level Meter apparatus is the OpeNoise Android app developed by Arpa Piemonte. The App allows the user to store the A weighted equivalent level in a .txt file. In the .txt file is it also possible to store the third octave band log. In the settings, it is possible to calibrate the microphone and to change the time step of the logging in a range which goes from one second to one hour. As per the AirBeam sensor, an Android smartphone is mandatory and the price of the apparatus depends on the type of hardware chosen but it can be less than € 150,00.

Figure 9 - Noise Box kit

***Interactive map for data co-visualisation***

To enable the co-visualisation, the visualisation tool needs to be as user-friendly as possible. For this reason the number of different subjects to whom the information is addressed has led to the design of a simplified interface strongly oriented to reduce cognitive overload. To do so a first classification of collected data and information to be displayed was done by distinguishing institutional (high-accuracy datasets) from those collected in a participatory way (high temporal and spatial resolution but medium-low accuracy). This first aspect determined the structure of the layer panel in four different sections: institutional/official data, participatory sensing, stakeholders feedback and report, public databases (in Figure 10 only three sections are shown as data from public databases are to be uploaded as the paper is written). Again to avoid cognitive overload, layers are shown one at a time; map controls only include the base layer selection (natural or road map) and the zoom level; click event fires the details info-box but double-click is not provided; mouse-over event (only non-touch devices) shows the label of the map feature. As for the type of collected data, there are three specific cases: vector georeferenced data (points, lines or areas) mostly collected with a mobile-friendly geo-tagging tool; data series related to static monitoring points ("measuring spot") coming from continuous measurement campaigns carried out using static sensors; GPS point tracks with scattered measurement campaigns carried out with mobile sensors and data loggers.

Vector georeferenced data are qualitative data with a quantitative field that is the level of relative importance (rating) of the phenomenon reported using a 5-classes scale; therefore we chosen a graphical representation with a rating-based colour ramp (from green to red to cases ranging from optimal to the most critical). The data series collected with static sensors are instead related to the location of the measuring box; for those points, users can view firstly the campaigns list and then, with a second click, look at the details of the specific campaign (Figure 11 ). Lastly, GPS tracks with measurements are the only data that must be treated as whole area coverage, therefore the visualization technique is based on a hexagonal mesh made in 4 different size levels, from 25m to 250m and a dynamic calculation of average values carried out per single cell (Figure 10, Figure 13). In any case the complexity does not affect user interface that provides intuitive and effective 4-dimensional (x, y, time, value) browsing functions (see the widget at the bottom left of Figure 10).

As for the interaction design, the features of quantitative data collected with low-cost sensors in participatory mode required the insertion of a special panel to allow user to choose the thresholds and defining custom intervals between optimal and critical situations; in this way it was possible to show both accurate official data and less accurate data relating to the same phenomenon avoiding direct quantitative ratio of measures that cannot be properly compared due to the different sensing systems.

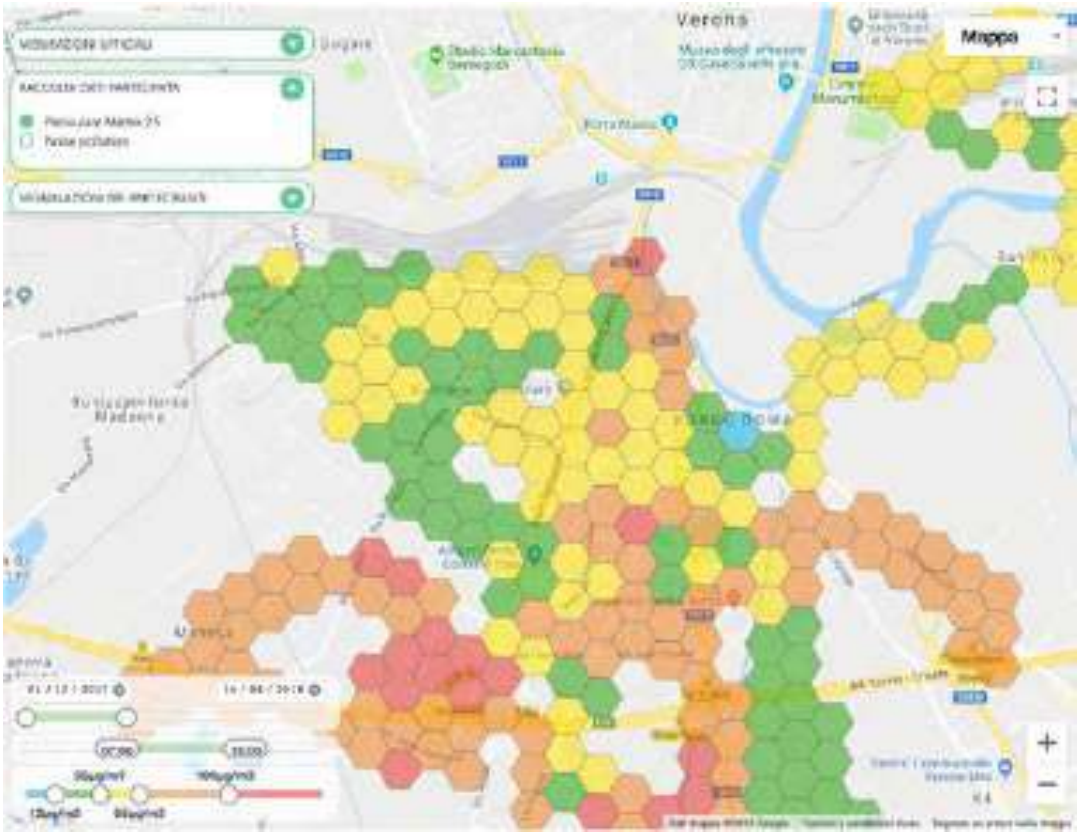


Figure 10 - Co-visualisation platform screenshot

**Participatory sensing improvements in co-creation**

To comprehend how the participatory sensing actually improved the co-creation process, it is necessary to understand how citizens were empowered by the co-operative data collection. It allowed them to better “sense” urban issues and to have the right tools to interpret (sense) official data.

***Comparison of official data and participatory sensing data***

The distrust that citizens feel towards policymakers and official bodies when talking about environment, is mostly raised by the lack of knowledge they have about both the tools used to collect data and the way these sensors work. Because of this it is of extreme importance to use participatory sensing when applying a co-creation bottom-up approach.

When talking about PM2.5 and PM10 data analysis the first thing to keep in mind is that data collected with official bodies sensors consist on the weighting of a tampon which was exposed for 24 hours to a certain volume of air controlled by using a pump, meaning that a single data in a specific position is given for each day. This means that a single data will be given for each day of the campaign (Figure 11). The way in which these data are then approached, from a law perspective, is of counting how many days are over the daily limit value of 50 μg/m$^3$ during the year – if it is more than 35 days there are sanctions - and if the annual limit of 40 μg/m$^3$ has been exceeded – again if this is the case there are sanctions.

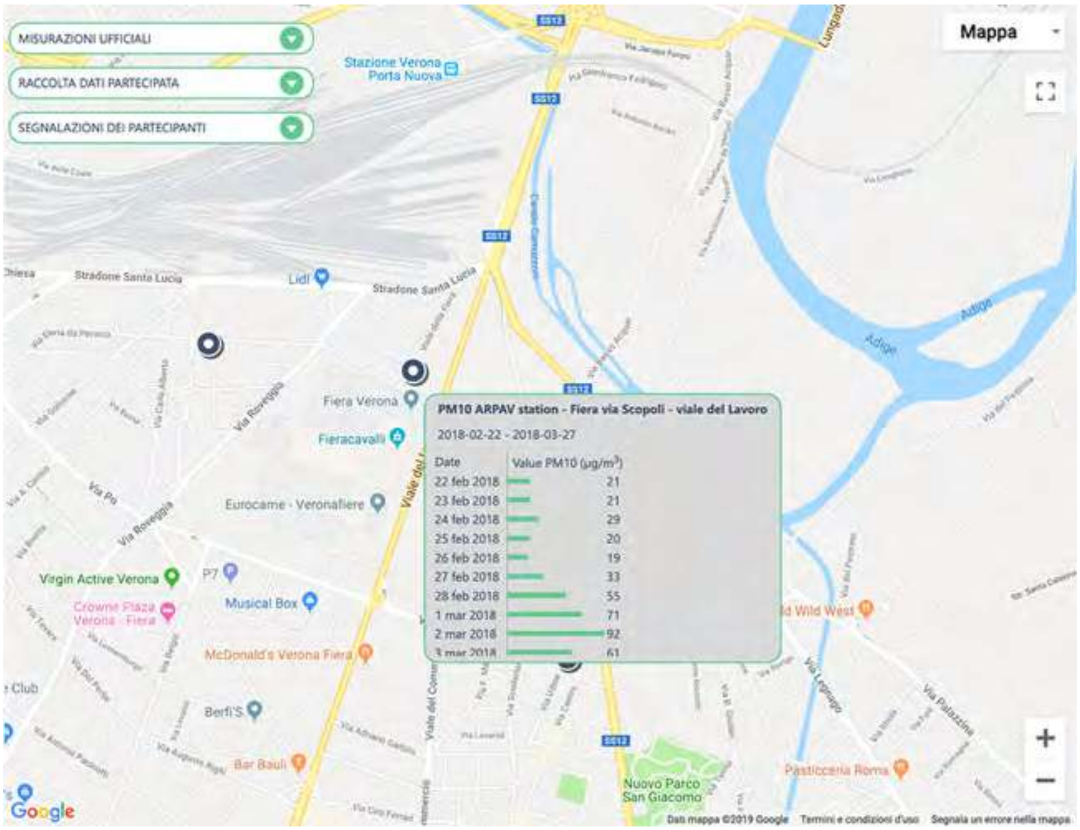


Figure 11 - Visualisation of static monitoring point

AirBeam data, on the other hand, are rather different as the sensor is meant to show the instantaneous exposure to PM that the person is facing, meaning that multiple data are collected within a one second timeframe and the method with which are collected is that of the light scattering.

The data then are not comparable with the ones obtained with the official sensors, even if the AirBeam is positioned in a specific spot for 24 hours, as the collection method is different. The main problem with the data collection done with the light scattering method is that high levels of humidity (>80%) have a negative impact on the accuracy of the sensor. Therefore, the AirBeam sensor has the main purpose of showing, mostly on a larger scale, the PM levels to which people are exposed during the day (Figure 13), rather that functioning as control group for official sensors.

For the participatory sensing, anyhow, the AirBeam was an important tool to raise awareness and trust when talking about official data. This because one of the reasons of distrust that citizens had towards ARPAV was because they thought that the fixed stations for PM were positioned away from the most polluted parts of the city. To overcome this misunderstanding, it was shown to citizens how homogeneous was the spread of PM on a large scale by showing them the daily data of all the fixed stations in the area of Verona. The graph in Figure 12 shows that there are small variations between ARPAV fixed stations, and that the changes in peaks and lows are due mainly to atmospheric conditions - i.e. rain, low pressure - within the day, and not to their position.

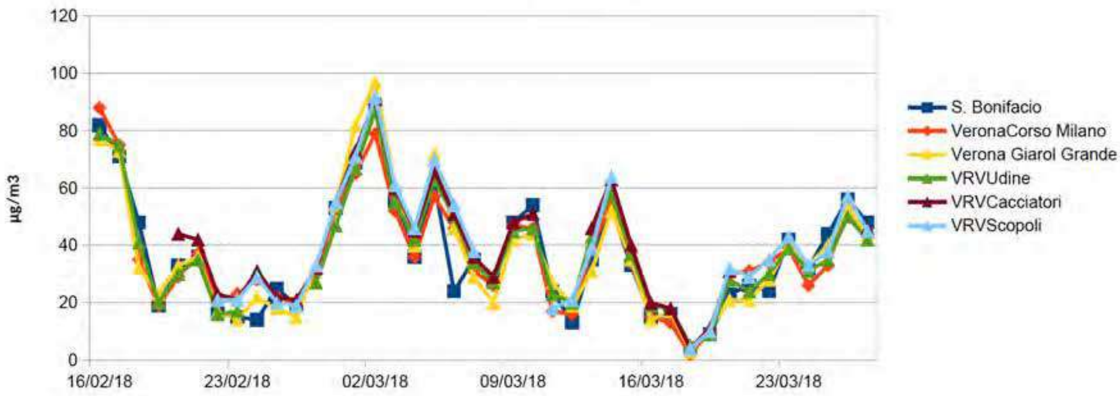


Figure 12 - Measurements of PM10 with ARPAV fixed stations

Citizens wanted to use the data collected with the AirBeams to refute this concept. After they were called to visualise the complex of the data, they found that changes could be found only on larger scales, and that variations happened in an homogeneous way as higher values could not be found close to the lowest ones (Figure 13).

As the comparison of data was done between official and participatory sensing data, it was possible to start to overcome the distrust that citizens usually have towards policymakers in order to strengthen the bottom-up process and the co-creation method.

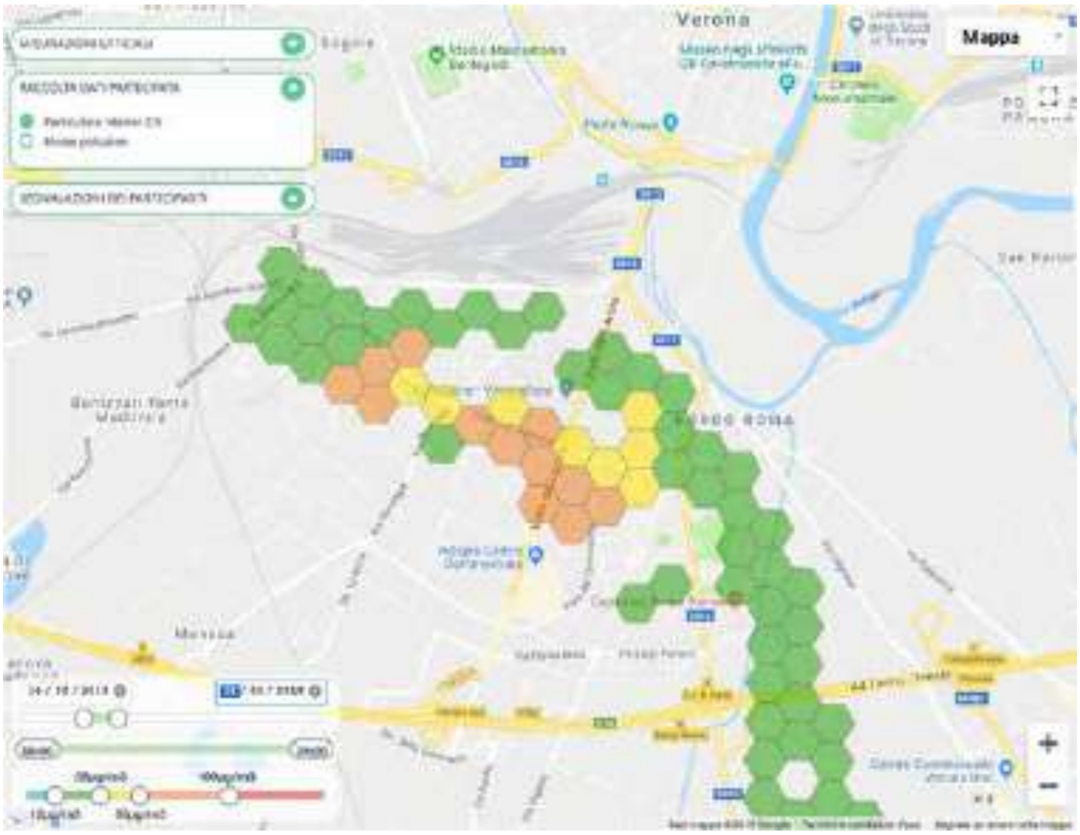


Figure 13 - Measurements of PM2.5 with AirBeam

During ULL meetings, moreover, it was found that urban noise pollution is a less recognized issue by citizen compared to other air pollutants, such as PM10, as cause of the increased risk of running into serious diseases. Furthermore, it was not recognised that a constant background of high noise drastically lowers life quality. Indeed, the World Health organization considers noise pollution as a one of the causes of “annoyance, effects on sleep, cardiovascular and metabolic effects, adverse birth outcomes, cognitive impairment, mental health, quality of life and well-being, hearing impairment and tinnitus and any other relevant health outcome”. (World Health Organization, 2018)

The use of low-cost sensors for noise measurement has made possible to obtain both an extended picture of the noise levels distributed in the territory and to train citizens on the importance of noise monitoring and the need to accurately position sensors in such a way to obtain the most accurate results (Ruggeri *et al.*, 2018). Within the meetings of the working groups, the noise from vehicular traffic was identified as the main responsible for urban noise pollution. Later on, sensors were positioned close-by to critical infrastructures nodes which could be compared with Class IV area, which limits are 65 dB (A) in the daytime period (6:00 AM to 10:00 PM) and 55 dB (A) for the night period. These law values should be detected with a sound meter level placed near a façade facing the street with a microphone placed one meter from it, and the data collection should last at least one week, as it must consider the daily variations of urban traffic.

Noise boxes were used to monitor different locations distributed within the pilot area (Figure 14). The graph in Figure 15 shows the results of the survey of a typical week distinguished by day and night period, in comparison with law limits. The use of low-cost sensors, though, is not meant to quantitatively define noise levels, but is needed to identify criticalities to be investigated more accurately, i.e. by using class 1 instruments, and to raise awareness towards the possible dangers which are now less considered.

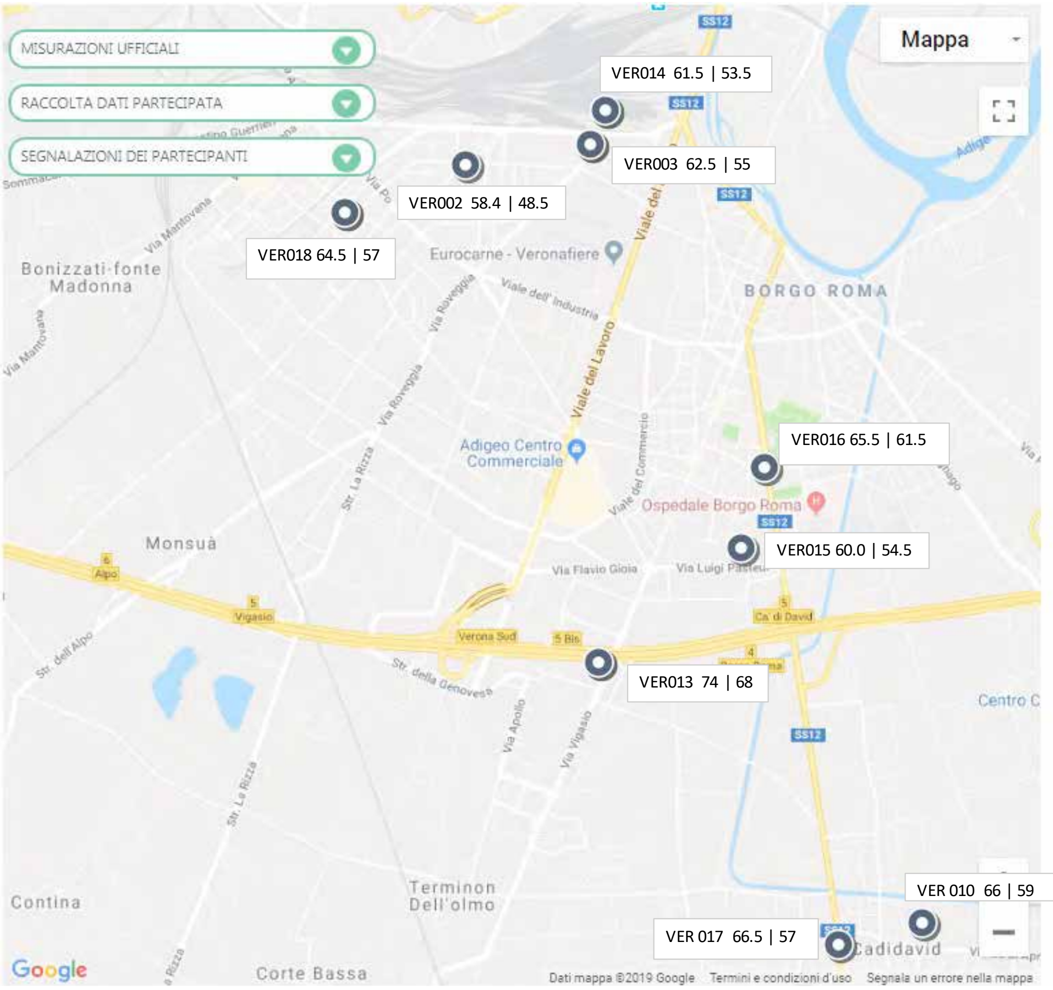


Figure 14 - Noise boxes locations and measurements

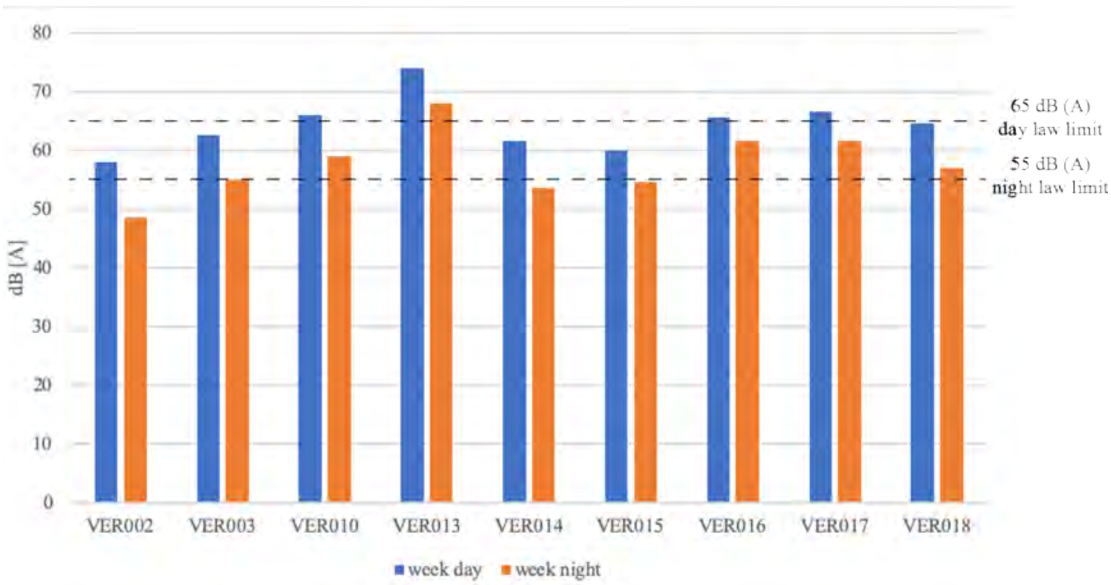


Figure 15 - Weekly noise day and night data compared with law limits

***Second Stage of the LOOPER co-creation process: Co-design and evaluation of alternative solutions.***

The co-design activity took place in October 2018, after an initial moment of visualisation of data with participants and policymakers (co-visualization). This activity was focused on how to respond to the problems investigated, and how to take advantage from the opportunities detected. This second stage involves co-design and evaluation of which options to implement. The main issue with the co-design activity was the creation of an iterative loop, i.e. from concept, to sketch, to outline, to detail as each of these need some form of participation and cooperation between experts, citizens, public stakeholders and policymakers.

During the co-design activity participants were engaged in qualitative and interactive online and face-to-face deliberation activities to propose a range of solutions. When going practical, co-design turned also be an iterative process as it went down many cycles to pass from concept to detail. It also involved a preliminary contrast between the community and experts/policymakers, that then turned to be an empowering dialogue between the parties. The activities which took place during this stage included the ideation of possible mitigation solutions, the designing of the ideas and understanding how to make their ideas real. During the ideation activity participants were called to generate creative divergent visions, ideas, synergies and possibilities. After this activity they moved to the design activity during which the iterative process started to move from a vision to a concept, then to an outline. During this activity the relationship between experts (researchers and policymakers) and community became very important. The last activity of this second stage was that of understanding how to transform in feasible solutions what was proposed until that point.

The process of collection of possible solutions took place both online, with the help of a co-design tool that could be found on the website (Figure 16), and offline, during the workshops. During the offline activity (face-to-face meetings) participants included not only citizens, but also policymakers and council-employees, and this create an even more interesting moment of sharing and discussing to propose better mitigation, but feasible, solutions as experts from the City Council were participating. Ideas produced offline have also been integrated on the online tool, which was used both as a way of proposing ideas for people who could not participate at meetings, and as a storage of possible solutions to keep participants informed.

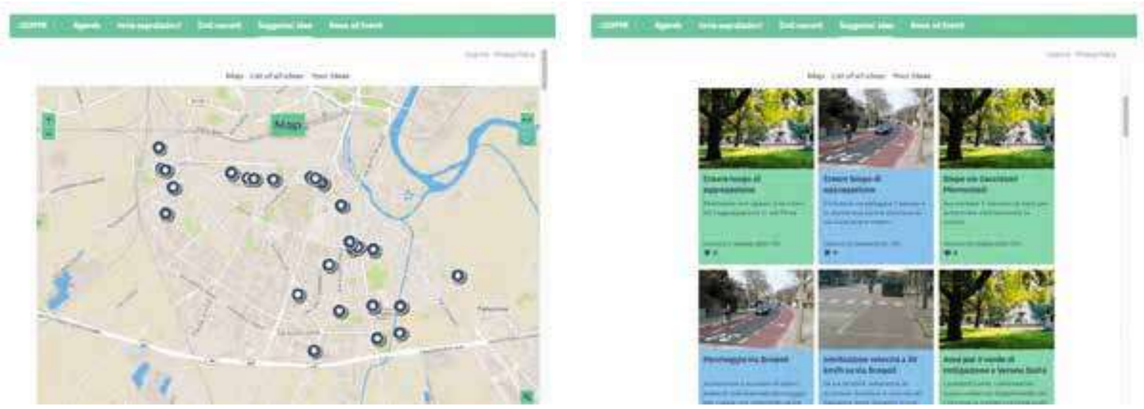

Figure 16 - Screenshot of the co-design tool on the website

In the evaluation of options phase then, the positives/negatives (costs/benefits) aspect of each solution were compared in order to prioritize the list of solutions proposed. One of the most important criteria which were considered was the cost/funding or feasibility, this because when working with a real environment it has to be taken into account if the solution can actually be implemented in a certain place, and if there is enough founding to implement and maintain it.

After the evaluation of the possible proposed ideas, the MAMCA, Multi-Criteria Multi-Actor Analysis (Macharis *et al.*, 2010), was applied in order to gather confirmation on the chosen ideas to be implemented. As the area of the Verona Sud is quite wide and the proposed ideas where to be implemented in different location, it was needed to group and generalise the ideas to be able to apply the MAMCA. This was because the MAMCA method evaluates, and compares, different solutions among which to choose the one to implement in a specific location. As the MAMCA is a multi-actor analysis the different group of stakeholder who were taken into account are citizens, Legambiente (an NGO which is active in environment related issues) and the City Council. All of these stakeholders where the ones who actively participated until this point in the process. The ending result of the MAMCA was then that of confirming that the ideas chosen for the implementation during the last face-to-face meeting with the stakeholders, where the most feasible ones to implement.

***Third stage of the Looper co-creation process: Implementation and monitoring.***

This last stage started in December 2018 and is still going on. It includes the implementation of the best options - produced inside ULLs during the co-design activity - and the monitoring feedback of the results/effects obtained by the implementation of these solutions in the real context.

In the area of Verona Sud the implementation activity is seeing some physical actions on the ground, as the mitigation solutions asked by participants were: 30km/h areas around schools with streets closure at entering/exit school hours; closure of some streets to create a gathering space for residents; positioning of a crosswalk islands to allow a more secure environment in front of a primary school (Figure 17). As the implementation actually had a first part - December 2018 to January 2019 – of organisation, the solutions were officially implemented from February 2019. This allows to have the solutions in place during the second co-operative data collection campaign in order to monitor if there are any changes in comparison with the situation monitored in the same period the previous year.

Figure 17 - Positioned crosswalk island

The monitoring and feedback activity done during this third stage has the aim to check what results, impacts, outputs and outcomes can be obtained after the implementation of the chosen solutions. To do so, where possible, the impact of the implemented co-designed solutions is monitored with the same set of tools as in the first stage and with the input of stakeholders through participatory sensing and open data. As the data collection campaign is taking place as we are writing this paper, data will be later analysed to be uploaded on the online platform for further discussion with participants. These information will then go towards feedback for the next round of problem scoping and co-design. Further activities will then include: monitoring of the 'before & after' results; evaluation of the implications, e.g. did the co-design work, can it be improved; feedback into the next round, and/or the policy system.

## Conclusions

In the paper we have emphasized the importance of bottom-up approaches to improve the implementation and effectiveness of urban transformation introducing also two levels of bottom-up approaches. The first level refers to stakeholders involved in the process, including therefore also citizens and local communities in the decision making. The second is related to the methodology of implementation of the urban transformation that, in this approach, is done by the sum of small-scale local transformation to generate an overall city improvement.

On the other hand, we have also argued that to support this double bottom-up process is essential the existence of the "bottom level". This means the existence both of a group of stakeholders prepared and fit for the co-creation activities and also the identification in the city of the places suitable for that purposes. The participatory sensing method that we presented in the paper, understood both as "involvement" and "interpretation", is a strategy to create the "bottom levels" required. The Looper project provided the occasion and the scientific environment to develop and experiment this theory but also to test the tools adopted in the project to activate the participatory sensing.

The pilot study of Verona produced on one hand promising results in the first (problem identification) and second (co-design) stages of the co-creation process; however, on the other hand, picked out some difficulties in the third stage in relation to implementation of measures produced in the co-design activities. In fact, although the direct involvement and participation of the City administration that supported the initiative and endorses the project goals, we run into difficulties in putting into action the ideas produced during the co-design activities. The issues found during the third stage were expected by researchers, this due to the difficulties for city administrations to allocate new budget in a short period of time and to the norms and regulations that limit the possibilities of rapidly execute – even temporarily – any innovative and/or alternative solution.

Despite the practical issues from the third stage, it can be seen how the co-creation process experienced within LOOPER was proven reliable to enhance a double bottom-up approach which allows stakeholders to open a more efficient round table to scope issues which are closer to citizens, and to propose possible solutions, to be discussed with policymakers, to improve the transformation of the urban environment.

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