Università Iuav
di Venezia

School of Doctoral Studies
PhD in New Technologies and Information for the Architecture, the City and the Territory
XXXII° cycle - A.Y. 2016/17 - 2017/18 - 2018/19

Scuola di dottorato
Dottorato in Nuove Tecnologie e Informazione per l'Architettura, la Città e il Territorio
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THE LOOPER CO-CREATION METHODOLOGY: ENHANCING URBAN TRANSFORMATION THROUGH PARTICIPATORY SENSING AND URBAN LIVING LABS IN LEARNING LOOPS

Chiara Scanagatta

Supervisor (Supervisore): PhD. arch. Massimiliano Condotta
Co-supervisor (Correlatore): PhD. arch. Giovanni Borga

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ABSTRACT

My research aims to test how the participatory co-creation methodology can help to solve different urban issues, and wants to show some practicalities to organisers about how to set up a Urban Living Lab to involve stakeholders in a co-creation process. This research involved both the study of the state of the art, but also some practical work to experience which are the positive results and found criticalities.

The study of the state of the art gave me a more complete comprehension of the situation in which my research is framed, and it included: the Scandinavian 'cooperative design' in the '60s; De Carlo participatory design of the Terni project; the concept of 'Participatory design' in the USA during the '70s; Siza and the SAAL process in the '70s; the 'User-centred design' concept by Donald Dorman in the '80s; the idea of 'Participatory budgeting' in Portugal from the 2000 on.

The methodology has been that of 'practice-led'. In my work, I applied the co-creation methodology in different urban environments to: check which practices can be considered good or bad; cross data collected from the state of the art and the field research; compare collected data.

The research I have done focused on an European Research Project, funded under the JPI Urban Europe, called LOOPER (Learning Loops in the Public Realm) which applies the learning loop to the co-design process. A comparison background case was used as well: the planning of the City of Sports in San Donà di Piave (Italy).

This research has the ambition of creating a new way of decision-making which brings together all stakeholders, including policymakers, that iteratively learn how to address urban challenges. This then results in an implemented co-design process since stakeholders in the end are called to evaluate what they have done.

Future implementations of my research would allow the creation of a complete set of guidelines that can be used to solve different urban issues, by triggering the co-creation methodology applied within Urban Living Labs.

Keywords: city challenges, co-creation, co-design, participatory sensing, learning loop, air quality, urban issues, urban transformations

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For Alessandro

introduction

introduction

I. PREFACE

The aim of the School of Doctorate Studies 'Architecture, City and Design', and in particular of the curricula 'New Technologies and Information for the Architecture, the City and the Territory', is to focus on the multiple aspects of technological innovation of design at different scales and applicational as:

> *"The training course offered to the PhD student aims to build the profile of a researcher expert in the fields of new materials and construction systems, information technologies and environmental monitoring systems, in which the knowledge is oriented to the management of architectural project at different scales, to sustainability design and energy efficiency of buildings and cities, and to the protection of the environment and of the territory.*
>
> *The most significant references of the research activity are constituted not only by the consolidated European scenario of Smart Cities - Smart Communities, but also by the paradigms of inclusivity at architectural and urban scale, of innovative solutions for energy efficiency of artefacts and systems, and of circular economy"* [I-1]

Within these topics, my research hypothesis fits itself in the PhD curriculum aims as it investigates how IT, environmental monitoring systems and collaborative approaches can be used to solve city challenges - such as air quality, noise pollution, traffic and quality of urban spaces - and to face other aspects related to urban transformations. The main purpose of the thesis is in fact to investigate how to face urban problems using a co-creation process, based on the learning loop concept and supported by different technologies.

The scale of solving such issues goes from the city to the neighbourhood one, and the methods that can be used involve both information technologies and monitoring systems. All of this is also done by involving the stakeholders of the urban system - i.e. citizens, administrators, schools, traders and every other stakeholder - in order to obtain better results by including them in the direct analysis. This draw in of all stakeholders allows a full and real understanding of urban problems making the difference between perception and measurement of a specific issues obvious.

Indeed, for example, factors such air quality and noise pollution, influence the choosing of the spaces where ones decide to spend time and live, and both define peoples quality of life. As a matter of fact, if the presence of lower or higher levels of noise influence both living choices and building value on the market, it is also true that the presence of greenspaces, factories and traffic - elements commonly referred as air quality indicators by citizens - influence citizens choices as much as, or even more than, the presence of noise.

An example of what abovementioned is the 'soundscape' idea, term coined in 1969 by Michael Southworth in the book 'The sonic environment of cities'. Soundscape indicates how it is necessary to approach at everyday reality using a perceptive model which does not consider the visual factor as the only element, but considers also senses usually called as minors - e.g. hearing and smell. On this basis there is an evolution of the concept of sensoriality as

[I-1] Here a quote from the page of the PhD curricula "New Technologies and Information for the Architecture, the City and the Territory" of the Iuav University of Venice. Full description of the PhD can be retrieved from: http://www.iuav.it/SCUOLA-DI-/ENGLISH/DOCTORATE-/NEW-TECHNO/index.htm

Full presentation of the School of Doctorate Studies "Architecture, City and Design" of the Iuav University of Venice can be retrieved from: http://www.iuav.it/SCUOLA-DI-/ENGLISH/SCHOOL/PRESENTATI/index.htm

main element to comprehend the urban environment which surrounds us in a more complete way, this to plan and create better urban spaces.

Within this framework the objective of my research is that of reaching, through a whole process, a systematic approach and practise for a theoretical model that indeed foresees a technology supported co-creation process based on the learning loop concept i.e. the Looper Model. To reach the hereabove mentioned objective there is the need to:

- design of the application of the model;
- implement it based on the real context and environment;
- test and analyse it to check if all used tools and methods work, to allow the validation of the process itself;
- discuss on how to further implement the methodology.

Furthermore, the systematic approach could allow a future realisation of an handbook that supports future organisers in the application the co-creation process to gather the best results.

The research work have been developed, tested and validated inside the framework of an European research project called Looper (Learning Loops in the Public Realm) that has theorised the Looper methodology. The project is co-funded under the JPI Urban Europe, that tests such methodology in three different environments (Brussels, Verona and Manchester) to face different urban challenges and to solve different urban issues.

Just to support the purposes of planning and creating better urban spaces, the parallel aim of the research is thus to produce material for a handbook to address urban challenges raised by different urban issues in built environments through a co-creation process. The first draft of this handbook tackles issues such as air quality, noise pollution, greening and traffic as it is based on the experience done with the Verona and Manchester Looper Living Labs. The research work saw an analysis of the different methods and tools that have been used, who can use them and how can they help the co-creation process in order to ideate solutions to solve problems linked to the two case studies.

II. FIELDS OF RESEARCH AND RESEARCH QUESTIONS

The research work here presented inserts itself in a quite wide set of topics and features. The main topics considered within the research are: urban challenges that designers and citizens need to face; the concept of participatory approach and how it changed the concept of powers within an urban environment; Living Labs and Urban Living Labs, how they differ and why the difference is significant within the co-creation process; co-design and how it evolved since its introduction in the '60s; how the learning loop concept raised, in which field it was first applied, its evolution towards the urban framework and how it ca be applied and integrated in a co-design process.

Among - and across - these topics, the two main features that will be more deeply analysed, and that can actually make a difference in the success of the co-creation process are the co-design aspect and the learning loop method.

Within the co-design aspect what is needed is to understand its roots and analyse how to link it in a profitable way with the other steps of the full co-creation process, this because having a participatory co-design without having a participatory factor in the other steps undo the benefits given by the community and local knowledge on the topic. Since the concept started within the '60s in Scandinavia there is a whole evolution of positive results and found criticalities that have already been analysed while undertaking this single step, and this has been taken into account within my research. The idea of a 'cooperative design' raised almost contemporary in Scandinavia, in Italy with De Carlo [II-1] and in Britain, but the strongest basis were given by the Scandinavian examples. Later in the '70s in the States the term 'participatory design' was coined as evolution of the cooperative design idea, and it evolved up to the 'user-centred design' by Donald Norman in the '80s. in the same period in Europe another main important example started to raise, as in the '70s the architect Alvaro Siza participated in the SAAL process in Portugal, that is now one of the most worthwhile examples of participatory design as since the beginning of the 2000 some Portuguese cities started to have a 'participatory budget', and since a couple of years it is a budget item at national level. All of these historical examples taken into account are linkable to the European or Western model as the application of the methodology is done within Europe, meaning that if there is the need to set up a Living Lab for a co-creation process in a different context the handbook might be, or might not be, as useful as if it was used in a Western cultural context.

The other main feature analysed is the concept of the single- and double-loop learning process, developed by Chris Argyris at half of the '80s. The loops of learning concept is of extreme importance to improve the co-creation process. The importance of the loops of learning can be explained by considering that, within the examples given by literature, as soon as the co-creation process is ended all the knowledge acquired thanks to the participation of citizens gets lost and each time there is the need to start again from the very beginning. Because the double-loop learning process was developed within an academic framework to help people to acquire and integrate new knowledges and new skills, the idea of applying the same concept within a co-creation process helps participants in creating a solid knowledge base within the first loop of the process that serves as basis to redo the whole process within the second loop. This allows to store knowledge instead of losing it.

[II-1] Terni's Villaggio Matteotti is a social housing estate commissioned in the early 1970s by the Società Terni for workers in its steel mills. It has been designed by the architect De Carlo, and it is one of the first examples of participative planning in Italy. The final design is the results of the active participation of local residents during the various phases of planning and design.

As abovementioned, within this research the practicalities on some good practices to have a successful co-design are analysed and considered. This analysis is done to allow a switch from the idea of co-design as a single activity, to a more complete consideration of co-design as part of a more complete co-creation process. Here the main hints that can be acknowledged as starting point for my research are: find the linking point to bring together groups of stakeholders that would not usually collaborate; raise awareness and sensitivity towards important issues; create a safe and secure space for the sharing of ideas; create a common understanding; empower minority groups by involving them in the process and by giving them the opportunity to express themselves.

This is the framework within which this research starts *to find better ways to develop a co-creation process to improve urban transformation to get better results in complex and different, urban scenarios*.

Furthermore, to validate the 'Looper co-creation methodology' some research questions have been addressed. Such questions are related to: how to successfully link the steps of the co-creation process with the idea of having the stakeholders participating within the full cycle; how to use the double-loop learning to bring beneficial results in the process; and how to successfully replicate the whole and complete process to address different urban challenges due to urban issues in different socio-cultural-economic contexts.

III. STRUCTURE OF THE THESIS

This thesis, on the basis of previous premises, firstly focuses on the theoretical framework that is at the basis of the Looper co-creation process, allowing a better comprehension of what are the challenges that are to be faced and better explaining what have been done until this point by other academics. My work then moves forward to the explanation of the Looper methodology, where it is possible to better understand the worldview that characterise my research. Afterwards the findings of the application of the methodology within two real environments - Verona and Manchester - are expressed, showing what went as expected and what can be improved. Following the analysis of the findings, a discussion about the methodology can be found and here, based on the previous parts, related possible improvements are drafted. Then some conclusions on my research are outlined.

The structure of this thesis shows some peculiar and original characteristics due to its research aim and contribution. On one hand there is the validation of the Looper co-creation methodology, and consequently its functional value through a practice-led approach, on the other it gives the basis to further development of possible operational guidelines. Nevertheless, its structure is still ascribable to a standard academic research, as it can be seen in following figure III-1. To complete this thesis, a 'Glossary' and some 'Annexes' can be found after the conclusions.

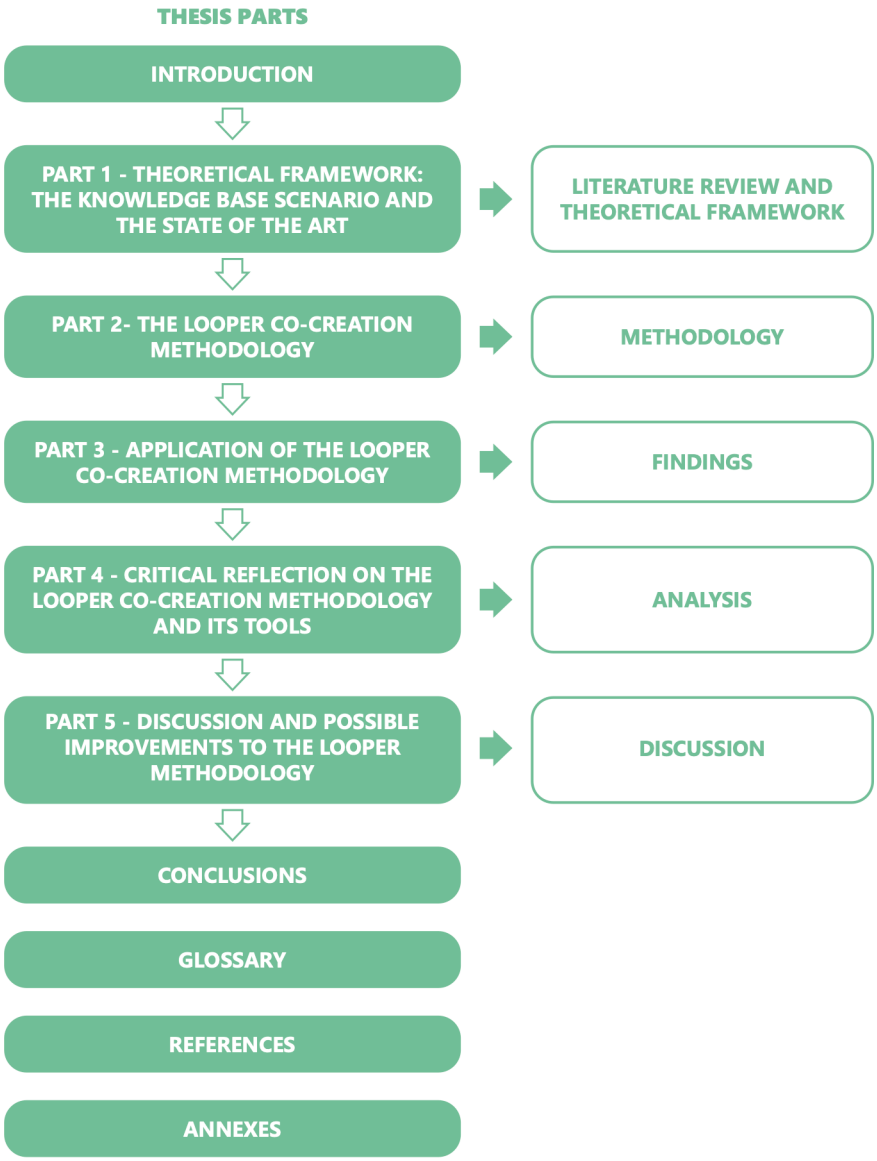
As mentioned above, one peculiarity of this thesis is its 'handbook side', thought for organisers willing to trigger a co-creation process with a Urban Living Lab. Despite the fact that this is an academic research, some practicalities were found during the practice-led research that can be autonomously read and used as practical support by other organisers, and these practical aspects can be later further implemented to draft a separate handbook for people who would like to apply the Looper co-creation methodology. The idea is that of helping, as further explained, organisers to start to set up a Urban Living Lab and the co-creation process. The data that they need are the ones to be found in the sections of findings and discussion. This can be explained as within the findings it is also possible to better understand the methodology as applied to two real life cases that faced two different environments - i.e. single neighbourhood (small scale in Manchester) and multiple neighbourhoods (larger scale in Verona). In addition, thanks to the discussion on different aspects, they can learn from the practical work done by other and they can avoid previously done mistakes.

Below a more complete description of each part of the thesis is to be found.

'Part 1 - Theoretical framework: the knowledge base scenario and the state of the art' frames the thesis by doing a literature review and by analysing the theoretical framework as it focuses on the knowledge base scenario and on the state of the art. It concentrates on the main thematic of city challenges and urban transformation in modern times, while considering why to achieve these goals it is necessary to use the participatory approach, co-design (or participatory design), Urban Living Labs and learning loops. This part aims then to create a base knowledge for the reader to better understand the starting scenario of the work done. The topics faced here, that are the basic points of the work, are:

- city challenges and urban transformations as tackled in modern urban

Figure III-1 parallelism between thesis parts and standard academic research



environment;
- the participatory approach method, also in comparison with the bottom-up approach, and how it is necessary to use it to solve city challenges and to trigger urban transformations; co-design and its evolution based on the European and Western model, with the idea of it as best method to be used to trigger the participatory approach;
- the concept and definition of Urban Living Labs, their differences with a Living Lab, and how they are the right tool to apply co-design to solve city challenges and to trigger urban transformations;
- the learning loop concept, and how it can be applied to a urban framework to bring the 'validate and refine' ability that is lost by shifting from Living Labs to Urban Living Labs.

'Part 2 - The Looper co-creation methodology' describes in detail the Looper methodology and the research strategy used to apply, test and validate what abovementioned through a practice-led research. This part focuses on:
- the methodology approach and perspective of the research, including the ontological and epistemological worldview that underpins it;
- the methodology of the Looper co-creation process, which findings will be checked with the Verona and Manchester case studies as described in the third part. The methodology described in this second part is based on the theoretical framework analysed in the first part, but goes a step further as it develops each concept to create a new, and more reliable, co-creation methodology;
- different stages and activities, to analyse how they are to be implemented in a real environment while defining and devising the process behind

the Looper methodology;
- the drafting of possible and supposed results;
- expected benefits of the application of the learning loop method to this process;
- an analysis on possible technologies - and how to build them - is done to give a more complete overview.

Technologies here have a standalone section as they are of extreme importance for the co-creation process itself when it comes to face city challenges and urban transformations.

'Part 3 - Application of the Looper co-creation methodology' shows the findings gained with the practice-led research work done in Verona and Manchester, and focuses on the benefits of the Looper co-creation methodology. Here it will be analysed:

- the application of the Looper co-creation process to real urban environments;
- what issues an organiser need to face while carrying on the process itself;
- the strengths and weaknesses that are to be found in the Verona and Manchester case studies, to create a deep enough knowledge for the reader to understand the following critical reflection.

Within 'Part 4 - Critical reflection on the Looper co-creation methodology and its tools' a discussion on the work is done. The reader will be able to understand, in a critical way, different aspects of the co-creation process. Tackled topics here will be:

- how the learning loop worked in its innovative application to a co-creation process;
- what issues raised from the perception of the urban environment, and how perception can be shifted in understanding the real situation to solve city challenges and to trigger the best urban transformation;
- why technologies are important and how they helped the process; how the absence of a bottom level can significantly influence the co-creation process; a comparison with other examples - e.g. San Donà di Piave and other literature examples, to analyse why - and if - the Looper co-creation process is better than a normal participatory approach and co-design process;
- reflection about technologies, by considering the differences between low-cost and official sensors, and also by analysing ICTs linked to data visualisation and data collection platform.

'Part 5 - Discussion and possible improvements to the Looper methodology', wants to:

- have an open discussion about the results obtained throughout this practice-led research;
- give an hint on the future steps that can be undertaken to further improve the Looper co-creation methodology;
- show theoretical and/or practical future applications -e.g. possibility to apply the Looper co-creation methodology to other real life case, chances to implement the handbook by applying the methodology to solve other issues.

'Conclusions' part, then, summarises the conclusions and results obtained within this research.

'Glossary' and 'Annexes' parts can be found, as they are meant to further integrate the thesis. The 'Glossary' presents some already known terms, but wants to define them as per the final conclusions - e.g. co-creation as a whole process rather than as a single activity. In 'Annexes' some documents are presented to better understand the methodology and the findings - e.g. before and after surveys.

III.1 Practicalities and future implementation for an handbook

As aforesaid my research work aims to find positive results and found criticalities within the co-creation process applied to solve various issues linked to the urban environment. Therefore, it was mandatory to have counter-

checks - especially as regards to the perception of the quality and liveability of urban spaces - through a direct contact with citizens and their places of living. Because of this, the logical choice was to do some practice-led research on different case studies in order to analyse how the co-creation, and co-design, process could improve the conditions that define an existing urban area.

Because the data collected for my research are both theoretical - state of the art - and practical - case study - the best solution to express the found results was that of organising this thesis to allow its usage also as practicalities on the Looper co-creation methodology.

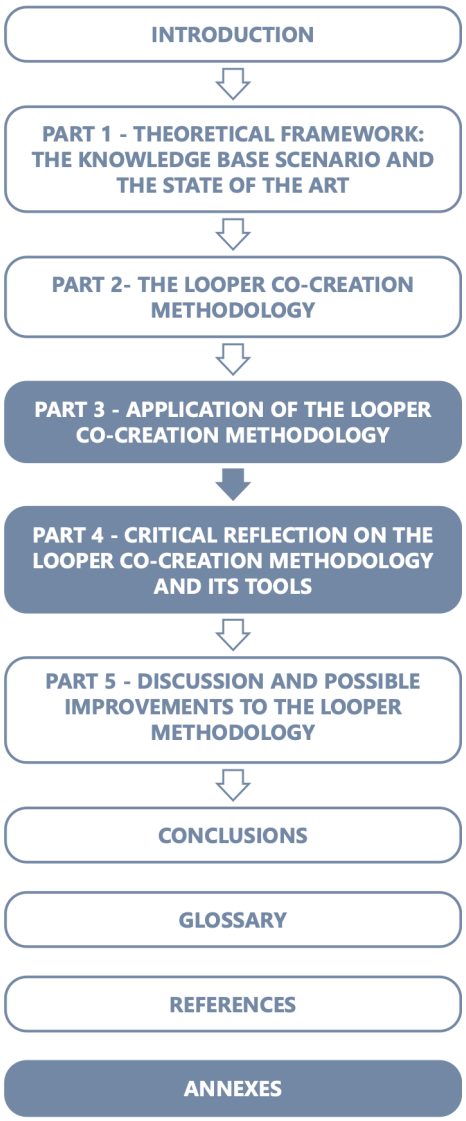
The practical aspects of this work are written for the ones willing to trigger the co-creation process as organisers - e.g. NGOs, city councils or other official bodies, citizens associations or single citizens, and its aim is to help them to obtain the best results for the stakeholders they are addressing. Independently if the process is raised from the bottom-up level or the top-down one, the handbook wants to give guidelines on how to implement a successful co-creation process. Due to the aim of this thesis, there is the need to find ways of capitalise on the work done. Therefore, a further implementation could be to transform this thesis in a proper handbook with both a paper and digital version, that could allow a wider circulation of the tips on how to set up a co-creation process.

This document represents the basis on which to draft an handbook that can further be implemented - since it is about an evolving subject - with other instalments based on other case studies that can be found and can give results on other urban issues that weren't considered within my work and my case studies.

The digital version, on the other hand, could later give the opportunity of having an open option, that can be implemented more easily in the future as soon as other case studies are found. The digital version could be an interactive version of the paper one and should be organised with a common theoretical basis from which hyperlinks can send to the different pages where a certain topic is explained in more detail, by also giving examples of different case studies. This would allow to compose a whole co-creation process guideline on urban related issues by merging the good practices of different case studies.

In the next sub-section some hints on how organisers can already read and use this thesis to solve some practical aspects while setting up the process is described.

Figure III.2-1 where to find practicalities



III.2 How to use the practicalities

Beside the traditional way of reading an academic research work, here future organisers of Urban Living Labs can gather some practicalities to help them in their work. The first option is to read it as a whole to gather the complete work process that occurred during the Ph.D. period. This way of reading does not show the chronological order, but follows a more logical order that categorise all different activities undertaken within the research period. The other possible way of reading this thesis is by flipping through some parts to focus only on the practicalities(figure III.2-1). This is helpful for people willing to solve urban issues - that in this work are linked to urban transformation and air quality, noise pollution, greening and traffic related issues - trough a co-creation process.

If someone decides to use this work as support to start a complete co-creation process, information that are needed to implement it can be extrapolate by reading about the application of the Looper co-creation methodology on different case studies ('Part 3 - Application of the Looper co-creation methodology') and what was possible to learn from real life situations ('Part 4 - Critical reflection on the Looper co-creation methodology and its tools'). This comparison between the application of the Looper co-creation methodology to different case studies, and the critical reflection on what happened, is crucial for organisers to better understand how to approach different socio-cultural-economic-urban contexts that have different issues and challenges. Furthermore, to help organisers in the setting up of their Urban Living Lab, one

section in ‘Part 4 - Critical reflection on the Looper co-creation methodology and its tools’ gives some hints on what to consider when using different tools and sensors to involve participants, collect data and built a constructive dialogue between different stakeholders.

In short, the final aim of the practical side of this thesis is that of allowing organisers to be able to easily read the parts that they need to start set up the process - e.g. how to set up an Urban Living Lab, how to involve stakeholders -and successfully bring it on - e.g. which tools to use during the scoping of issues, which sensors/technologies to use, how to allow participants to co-design, with the future idea of writing a more complete handbook document.

IV. PRACTICE-LED RESEARCH

The work here presented wants to test and analyse how the Looper Methodology - a functioning co-creation process supported by technology - can solve city challenges and allow more feasible urban transformations, and it investigate this topic by doing a theoretical work. Since it requires much empirical evidences, one or more case studies to compare theory and practice were an essential condition to write the practical side of my research. The practical work was also needed to see how to implement the process itself as a theoretical work, when considering all of the variables given by an urban environment and different participants, is not complete enough.

Because there was this need of moving from theory to practice, in order to refute the ideas on positive results and found criticalities, some different options were analysed and the most suitable ones were practice-led and action research. While practice-led research is typical from arts, design and architectural fields, action research mostly focuses on educators. Therefore practice-led research and action research overlap in most aspects, and only few differences - linked to the typical field of application - can be found.

> *"Practice-led research is concerned with the nature of practice and leads to new knowledge that has operational significance for that practice . [...] The primary focus of the research is to advance knowledge about practice, or to advance knowledge within practice" (Candy, 2006).*

> *"[...]a comparative research on the conditions and effects of various forms of social action and research leading to social action" that uses "a spiral of steps, each of which is composed of a circle of planning, action and fact-finding about the result of the action" (Kurt Lewin, 1946).*

Indeed, practice-led research seemed as the most suitable one given what explained until this point. Practice-led research is already used in the professional disciplines of art/design/architecture came in handy as it already have a tradition of situating learning and scholarship - my theoretical study and idea - into a professional practice setting - that in my research covers the application of the theory in a real life case study. Practice-led research in art, design and architecture can also be thought of as a natural extension of the theoretical work, this because many academics in these fields see practice as the natural arena to make inquiries on the chosen topic.

The expression practice-led in literature, does not describe a single set of ideas about research. Its meaning varies within different disciplines, locations and people and it varies depending on the questions that are to be investigated. In general it indicates research practices, and its aim is to complement methods of research adopted from the humanities and sciences fields which are more theoretical and/or see practice as laboratory research.

Given that, there is no established or accepted widely diffused definition of practice-led research. Some researchers struggle to define the concept of practice-led, even though it is a difficult task due to its application in many fields. Indeed, other researchers set out some conditions that needs to be met

by practice-led research, but they do not attempt to actually define it. Given this lack, a basic definition which starts to set some form of boundary can be:

> *"Practice-led research is a research in which the professional and/or creative practices of art, design or architecture play an instrumental part in an inquiry" (Rust, Mottram and Till, 2007).*

This definition given by Rust, Mottram and Till (2007) indicates that practice-led is an alternative that can be employed while doing research. This means that practice-led is not a methodology, as it does not include an explicit understanding of how practice contributes to answer the questions posed by the research.

Christopher Frayling (1993), British educationalist and writer, started to work on his theory basing it on the Herbert Read's (1943) framework of education through art. Frayling's model wanted to describe different ways of thinking about research.

To better understand Frayling work a brief analysis of Read's work is necessary. Read noted that research could be *for* practice, if research aims are subservient to practice aims, *through* practice, if practice serves a research purpose, or *into* practice, such as observing the working processes of others. Read's model has been widely cited by practice-led researchers, but it was only cited as a touchstone. On the other hand, none of the researchers that used Read's model tried to work it out to apply its theoretical implications for each individual project.

Frayling then wanted to better position, and reflect, on the shortcomings of Read's work. To do such thing, Frayling analysed a distinction between 'research' and 'Research'. Frayling associate the use of first term ('research') to a more common inquiry, while the latter ('Research') is associated to the academic field and to a legitimation of the research itself. Because the work done by Read was only focused on art, Frayling states that Read's concepts are to be extent to the design - and architecture - field, and established the major criteria to validate a research in art and design. Frayling criteria then are: Research needs to follow the cognitive tradition; Research outputs need to create new knowledge and understanding about design, that goes behind the iconic and imagistic comprehension. Read and Frayling's work to define what later became practice-led research, was essential to understand how to link theoretical and practical work.

After analysing the ideas of Read and Frayling, and within the very broad description, it is possible to describe some forms of practice-led research. One approach is to propose that a design (artefact or urban) can provide new insights, leading to the principle that an exhibition or other public result of practice may have the same role as a journal article. This approach has some characteristics in common with other fields of research - there is a purposeful process of production, which may include experiments or other investigations, followed by a form of review. However it can become problematic, for example if it is not clear whether the 'reviewers' are party to the research agenda or assessing the work from some other standpoint entirely. There is also a difficulty if the results of the practice-led research are not recorded and transmitted in some relevant permanent form.

Another, and maybe more purposeful approach, is that of clearly making practice subservient to research. This approach proposes that any definition of practice-led research should concentrate on how issues, concerns and interests can be examined and brought out by production of an artefact. In a research setting, the knowledge associated with the artefact is more significant than the artefact itself. This can be applied to an urban design scenario as the knowledge associated with it is the one given by local communities.

The analysis done on the issues linked to the 'practice-led' research allowed a deeper comprehension on why some boundaries needed to be set. This also meant that to link the practical work done in the writing of this thesis to the theory behind it, to confute the theoretical aspects, the setting of abovementioned boundaries is compulsory. From the first approach it is possible to understand that the first thing to be understood is who is going to evaluate the

work done, and there is the need of a storage system where all the work done is collected to allow a more feasible evaluation in the end. From the second approach is then possible to understand the importance of the knowledge and learning concepts, underlying the importance of involving participants.

The practice-lead research that was done within the framework of my research is applied to the Looper co-creation process. Furthermore, within Looper two other methods are used: co-creation process and Urban Living Labs. These within Looper, again, are not direct methodologies used for my research work, but are research methods used in the framework of the project itself. Indeed, to further understand the case study approach used by Looper - that is typical from social work field - a common definition is that of Onah and Ejiofor (1978):

> *"A case study is a collection of facts, opinions, judgments relating to an actual business or social situation in which a problem exists and a decision must be made. It is a study of the exact situation in a particular business or other entity" (Onah and Ejiofor, 1978).*

To summarise, my work of implementation and validation of the Looper project is done with a practice-led approach, while the Looper project itself applies a co-creation process in a real environment by using case studies.

Moreover, while developing the Looper project case study approach - further described in next section - other projects that already tackled some of its topics were taken into account: GUST and Urb@Exp. Both projects used Urban Living Labs around Europe to address complex economic, social and environmental challenges, and in these Urban Living Labs local governments had the chance to experiment innovative solutions together with other stakeholders in urban development.

GUST project focused more on researching on the ways in which Urban Living Labs are being designed and how they vary between urban contexts. Final outcomes of the GUST project saw a systematic framework for evaluating the design, practices and processes of Urban Living Labs to enable the comparative analysis of their potential and limitations, and gave new insights into the governance of urban sustainability and improving the design and implementation of Urban Living Labs in order to realise their potential.

Urb@Exp better focused on the chance of creating guidelines for Urban Living Labs, drafting how they can be organised, they can be integrated into urban governance systems by reviewing experiences of urban labs, and conducting transdisciplinary action research in urban labs. Results from the Urb@Exp project also showed how - independently to the addressed topic - Urban Living Labs offered critical space for experimenting with new forms of collaborative governance. Plus, their hybrid position - between local administration, research and society - is proved beneficial for activating and facilitating urban stakeholders.

It is possible to say that GUST and Urb@Exp both used the case study approach that have been used for the Looper project as well, but they differ from Looper since this last one uses Urban Living Labs as one method to tackle a more complete process.

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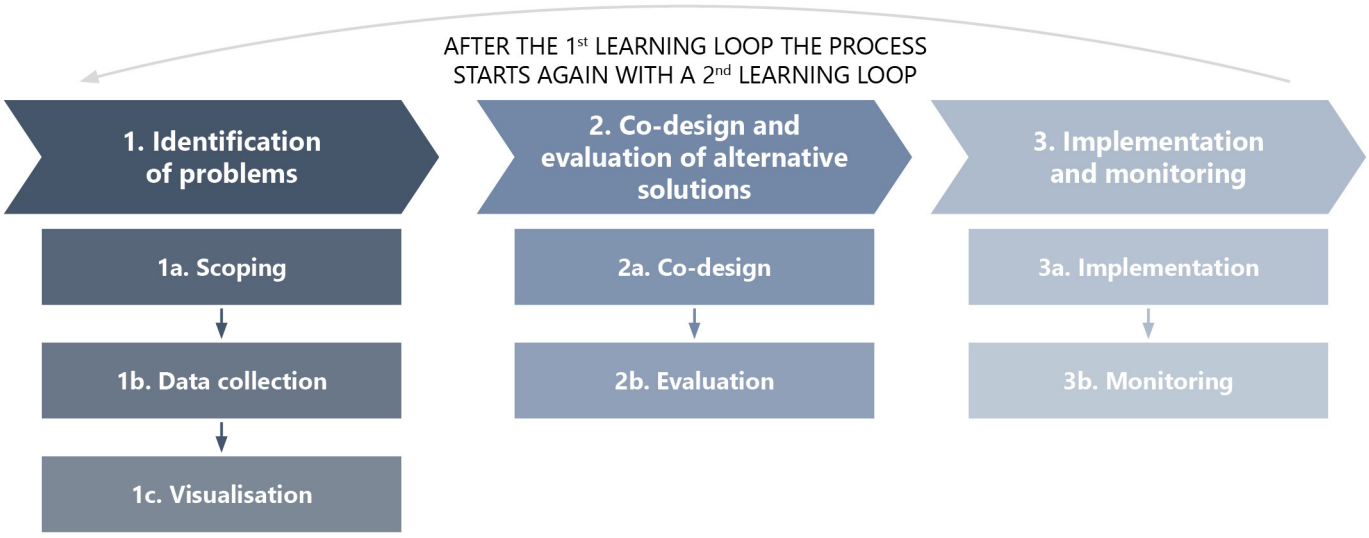
V. THE LOOPER (LEARNING LOOPS IN THE PUBLIC REALM) PROJECT

Looper is an European project co-founded under the JPI Urban Europe program. The project works within three pilot cases: Brussels (Belgium) working on traffic safety; Verona (Italy) addressing air quality and noise pollution related issues; Manchester (Great Britain) working on greening and traffic safety. The Looper project kick-off was on July 2017 and is due by October 2020, during the drafting of this thesis the project itself is still ongoing.

The idea and concept of Looper starts within the framework of the public realm - place where urban stakeholders interact and, because of these interactions, they often come into conflict - and is linked to urban issues that are of difficult handling as they involve multiple stakeholders coming from different backgrounds. Because multiple stakeholders are affected by urban related issues, it is becoming a more common practice that of involving them in the decision-making process by using the co-design process. Nevertheless, examples of stakeholders involved in the whole process - triggering in this way a co-creation process - are extremely rare as it is of difficult management. The aim of the Looper project is then to build a participatory co-creation methodology and platform to demonstrate that the application of the 'learning loop' - i.e. new ways of decision making that brings together all the stakeholders to iteratively learn how to address urban challenges - in the co-creation process allows to gain better results.

The co-creation process - and set of loops - that is proposed by Looper (figure VI-1) starts with a collective debate to choose what topical issues to address, then the work proceed by framing the problem and it moves to the data collection. The co-design phase takes place after the visualisation of the data collected in a participatory sensing way, and the selected solutions, produced during the co-design activity, are then implemented. The loop than is concluded with the monitoring of the effects produced by the selected solutions that triggers a second loop which starts from what was learned during the first one.

Figure VI-1 Looper co-creation process schema



The loops of the co-creation methodology use both online and offline tools to integrate a prototype platform which aim is to facilitate the learning in each stage of the process. Since the three Living Labs will focus on different topics, the platform needs to be flexible to integrate and test the different spatial, cultural and thematic contexts - i.e. traffic calming in Brussels, traffic and greening in Manchester, air quality and noise pollution in Verona , this to enable an improved decision-making process within the three cities.

V.1 Looper project objectives and targets

In modern ages more and more symptoms are appearing to indicate the conflicts over the use of shared spaces within the public realm - e.g. traffic congestion, noise pollution, air quality, lack of greenspaces, and this conflict often persist due to the application of a top-down approach to solve these issues that limits the involvement of final users to a staged participation that only sees a formal consultation process (Boonstra and Boelens, 2011). Because the top-down process is showing its lacks, there is the need to move to a bottom-up co-creation process that provides the opportunity to involve citizens within the decision-making by allowing them to share their non-expert local knowledge, creativity and sense of democracy into urban planning (Brabham, 2009). The examples of bottom-up approach seen until now, on the other hand, showed us that participatory approaches focusing only on a certain step of the decision-making process for planning - e.g. data collection (Evans, Crowley, 2010), co-design (Horelli *et al.*, 2015), participatory monitoring and evaluation (Connors *et al.*, 2012) - limit the chances of a successful ending result. This is due to different things depending on the stage in which citizens are asked to participate, i.e. during data collection - used during the process as a tool to better understand the issue - there is often a lack of interest by participants as the topic addressed is usually of little relevance for local communities. Furthermore, a disconnection between planning and implementation can be found between planning and implementation as a link is missing between the output of qualitative co-design processes, formal evaluation methods - e.g. multi-criteria analysis - and decision-making processes (Horelli *et al.*, 2015). Since there is a proper fragmentation between the steps that compose the co-creation process, there is no sufficient evidence on how co-creation helps citizens, and how cultural and governance factors influence the process itself (Voytenko *et al.*, 2015). Because of this a cross-country comparison is needed (Voorberg *et al.*, 2015) as the different cultural and governance factors influence the way of behaving of every stakeholder and participant. Moreover, as more participatory approaches use digital and online tools, there also is the risk of excluding disadvantaged citizens that do not have internet access and/or computer literacy (Baek *et al.*, 2012). Because of this risk of excluding stakeholders, and as a complete literature it is still lacking, a more holistic approach in order to integrate the quickly emerging multitude of online and offline tools is needed (Wallin *et al.*, 2010).

The main goal of the project is than that of building a participatory co-creation methodology and platform that demonstrates the beneficial effects of the learning loops concept applied to the co-creation process. Furthermore, as the platform will integrate different steps of the project - i.e. identification of problems, data collection and co-design of alternatives, implementation and monitoring - into a cohesive co-creational process.

The basic concept for the platform is that it needs to be generically for co-creation, in order to be adaptable depending on the diverse problem that stakeholders want to address, and this is to be tested in the three Looper Living Labs. The presence of three different Living Labs, with different urban and cultural contexts, allows to have parallel learning processes that can improve planning. Within the general framework, three dimensions are included for learning loops: multi-mode learning that covers different types of learning (Argyris and Schon, 1995); multi-level learning loops to demonstrate direct learning, on neighbourhood issues, and indirect learning, for the policy level; multiple helix learning loops dealing with users and the learning across the stakeholders community. Following to the triple helix concept, Looper want to cross-fertilise between learning processes in public policy, businesses and

research (Etzkowitz, 2008). The Living Learning Lab approach that takes place into Looper is based on the high involvement of users and/or stakeholders, a continuous form of monitoring of the environment and its changes, and the direct consideration of their impact on the implementation process combined with the learning loops at several scales. The inclusive approach that Looper that uses face-to-face meetings and workshops to allow the participation of citizens with no IT knowledge or access to internet, avoids the reduced impact of many Living Labs that is due to the under-engagement with disadvantaged communities and key stakeholders.

The three Living Labs have different cultural frameworks and different topics. The Brussel Living Lab focuses on traffic calming and pedestrianisation to reduce the impact of road traffic on the well-being of urban residents, and to increase the liveability of the neighbourhood through the redesign of public spaces. Pedestrianisation became a hot topic in Brussels recently as the city centre received shortcomings of participation since the closure to car traffic. The Brussels Living Labs focuses on a neighbourhood in one of the municipalities of the city, and is the only one which data are not from a hands-on research work, therefore it is not used for comparison in this research.

The Verona Living Lab focuses on urban planning measures and possible actions to alleviate the problem of air quality and noise pollution in the south part of the city. This because targets for local air quality in the city were exceeded for the years 2012-2015, and some debated extensive renovation plans were authorised recently. Due to this, an appropriate air quality monitor, diagnosis and abatement strategies are to be adopted. The Verona Living Labs has the wider project area as it covers almost half of the urban area of the city, meaning that the possible mitigation solutions are to be evaluated considering the replication opportunities to possibly cover a wider area in the future. This laboratory is the main object of the research, and is later on compared with the Manchester Living Lab and another case study.

In the Manchester Living Lab the initial idea was that of focusing on issues of road safety and security in public spaces in the inner residential area of a neighbourhood with council housing built in the ‘60s-‘70s. After the scoping of issue done with the stakeholders the topic of the Living Lab slightly shifted towards road safety and making the area greener, as residents did not feel their neighbourhood to have security in public spaces issues. The area of focus is the main road that cuts in half the area and is used by commuters as an high streets to connect the city with one of the main traffic arteries. It was possible to make some hands-on research work within this Living Lab to gather first person data for a better comparison with the Verona Living Lab to draft a more reliable handbook of positive results and found criticalities for the co-creation process.

The innovation of the Looper project idea is given by the implementation of the co-creation process in the full planning cycle without focusing only on one of its stages; it finds evidences on how a combination of qualitative and quantitative methodologies, and of online and offline tools, can realise an inclusive process; it operationalise social learning in multiple dimensions through learning loops; it find empirical evidences of how citizens can gain environmental, social and economic benefits from co-creation in different cultural and governance contexts and how policy can benefit from hands-on knowledge given by citizens; it links the informal co-creation process to a more formal system of evaluation methodologies to improve the feasibility of implementation and ensure the support of policy makers towards the solution proposed by citizens and other stakeholders. Looper wants to enhance the methodology with a bottom-up approach, and wants to investigate the basic conditions for a solid and robust participatory monitoring of indicators combined with a rigorous application in the urban planning domain.

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VI. THE SAN DONA' CASE STUDY AS COMPARISON BACKGROUND

The San Donà example is one of the case studies considered within my research. It applies a participatory approach, and a co-design approach, that can be considered as 'basic' compared to the implemented co-creation method of the Looper project that will be shown further on. For this reason this case study was used with the purpose of better understanding how the co-design approach worked in a real life environment, and how to better carry out and approach an implemented co-creation methodology, such as the Looper project one. During the work in San Donà it was also possible to countercheck the guidelines previously analysed in literature to implement the co-design process at its best.

San Donà di Piave is a city with 42.000 inhabitants, located in the north-east part of Italy close-by the city of Venice. Due to the major damages of the bombings during World War II the city was heavily reconstructed in the '50s, and within the new urban planning the city was divided into areas with a specific purpose. In one of the zones the 'City of Sports' was built, and the area was equipped with soccer fields, rugby fields, tennis fields and an indoor stadium for volleyball, basketball and a space for boxers to practice. As the '50s planning was designed when the city had 15.000 inhabitants, the dimension and organisation of the 'City of Sports' area is now not sufficient for the volume of people using it, resulting in the need to redesign the spaces.

To plan the area, with at least a 25 years perspective, it was chosen by the city council to involve all possible stakeholders to consider their desiderata, also based on the past 10 years trend of people using the spaces. The participatory process that was followed was: presenting the idea to all stakeholders; interviewing all the stakeholders and final users; design a future planning of the area on the basis of the data collected during the interviews and on the basis of the local and national regulations; meeting to present the project to stakeholders, final users and all citizens; modify and finalise the future planning project on the basis of the feedbacks given during the last presentation meeting.

As it was not possible to call all the stakeholders for interviews - some sport associations had more than a hundred members - it was set up a presentation meeting open to everyone and then the interviews were made with representatives of every sport club based within the city area. Therefore, the stakeholders involved were not only the ones already using the area, but also every other sport club who might be interested in being based in the 'City of Sports' area if the facilities were implemented.

Some of the stakeholders contacted decided not to participate as they declared to be satisfied with their actual locations. In the end out of 100 sports club contacted, 44 expressed the will to participate to the interview phase and only 26 showed up to give their feedback on the area and their future desiderata.

When the future implementation project was presented after the interviews, only minor negative feedbacks were raised from two sports associations and were mostly related to the future management of the spaces of the indoor stadium. One of the most interesting results from this participatory approach and co-design process was that, during the final meeting with all stakeholders, representatives from other sports associations explained why

the project was developed in that certain way to people giving negative feedbacks. The other reached goal is that now associations are looking for national and European founding to start the development of the renewed 'City of Sports' area, refuting the success of the process itself.

A further analysis of the San Donà case study can be found in 'Part 1 - Theoretical framework: the knowledge base scenario and the state of the art', where it is better explained why the San Donà case study works as basis knowledge that I needed to build to better face the practice-led work done within the Looper project, and thus does not have to be compared with the case studies of Verona and Manchester that are properly of the Looper project.

VII. MY CONTRIBUTION

The innovation I'm giving with my research is linked to the intrinsic novelty given by the Looper project, that wants to implement the participatory sensing idea within the framework of the co-design, and, at the same time, wants to apply the double-loop learning idea to the co-creation process in order to evaluate the work done with stakeholders to improve the implemented co-designed solutions.

My contribution within the Looper project was on different levels - that are the application, the testing, the validation and the analysis of the methodology - due to the first hand work done on every activity of the whole co-creation process. The activities done mainly concerned the management of the Verona Living Lab, in collaboration with the NGO Legambiente Verona, where I worked during each step and every meeting to keep the process going on smoothly. Besides, I assisted in the selection, with participants, of which of the proposed solutions to implement, and I collaborated in giving participants the right tools to take the best, and more conscious, decision. After the co-design activity, I co-operated in the prearrangements needed - from a more technical and regulation point of view - for the implementation activity, and it was done together with the employees from the Municipality of Verona. I could then plan the set-up of each participatory sensing and monitoring campaign, done to collect before and after implementation data, in order to monitor and evaluate the goodness of the implemented solutions to check if they had positive, null or negative effects compared to the initial situation. Furthermore, after the end of the first loop, I worked within every step of the second loop by helping participants to take advantage of the knowledge gained during the first loop, and by assisting new participants in gathering the same level of knowledge already obtained by the others during the first loop. By the end of the second loop, I worked in the analysis and comparison of the results from both loops in order to validate the 'Looper co-creation methodology'. All this work was done first hand for the Verona case study, but, starting from the evaluation step of the fist loop, I contemporaneously worked with the University of Manchester team with the Manchester case study.

From a more technological point of view, my contribution was linked to the analysis, development and test of the possible sensors and tools to use in order to gather the right data needed for the issues to be tackled, and allowing to help everyone participating in the process. The sensors to be chosen were low-cost ones to collect different pollutants and qualitative data with the peculiarity to be user-friendly in order to allow the participatory sensing step. The other topic tackled under the technological aspect was related to the visualisation of the data collected with the participatory sensing, and a user-friendly data visualisation platform was developed to overtake this question, also allowing the set-up of an online storage of all the data collected in the three Living Labs. My input to the data visualisation platform was the co-design, with the team from the Università Iuav di Venezia, of the functionality of the platform itself, and the development of the interface mock-up.

Moreover, there are some aspects of innovation and of original personal contribution within my research. The novelty and personal contribution aspects can be divided between theoretical and practical ones.

One innovation aspect is given by the devising and drafting of some practicalities for a future implementation of a handbook of guidelines on good practices to trigger a successful complete co-creation process, that can be repeated to other cases wanting to address urban issues. These practicalities, as abovementioned, are based on the study of the state of the art and on an hands-on work done on different socio-cultural contexts addressing different urban issues. This was possible thanks to the comparison on different case studies on which a practice-led research work was done. The comparison to validate the positive results and found criticalities was done by analysing the correlations and differences between the Verona Living Lab and the Manchester Living Lab, that show two different topics and frameworks while applying the same methodology.

Furthermore, it is also open to implementation by analysing other case studies on different urban related topics and issues. This allows for it to become a living and adjustable tool, able to cover a wider framework and capable of giving the opportunity, when approaching new cases, to start from a pre-existing knowledge base.

1

THEORETICAL FRAMEWORK: THE KNOWLEDGE BASE SCENARIO AND THE STATE OF THE ART

PART 1
THEORETICAL FRAMEWORK: THE KNOWLEDGE BASE SCENARIO AND THE STATE OF THE ART

1. CITY CHALLENGES AND URBAN TRANSFORMATIONS

The framework within which this thesis is set is the one of city challenges and urban transformations, as it is one of the tackled topics. The idea of using new technologies and methods for architecture to solve the emerging - and quickly evolving - city challenges and to transform the urban and built environment, is something that became more urgent in recent times.

This urge to use new technologies is linked to the evolution of communities living, working and using urban places. European communities nowadays are becoming more and more complex, as different groups share the same urban spaces. This complexity is also driven by digitalisation, that might create bigger gaps between these different community groups, that might have access to different information.

The different methods and approaches - i.e. participatory approach, co-design, Urban Living Labs, learning loop - that can be used to solve these challenges, and to transform the urban environment in a more liveable one, are better described in the following sections of 'Part 1 - The knowledge base scenario and the state of the art'.

These methods - that are considered to be new technologies for architecture - are then grouped and used within the framework of the Looper project, in order to create a better process to solve city challenges and have better urban transformations..

1.1 Sustainable and liveable cities

The main focus of urban planning nowadays is to have more sustainable and liveable cities, and this have to be done by improving the situation of the existing urban environment.

Sustainable Development Goals by United Nations

The United Nations faced the issue of having a more sustainable development around the globe by giving a set of goals to be reached by 2030 ('United Nations General Assembly Draft outcome document of the United Nations summit for the adoption of the post-2015 development agenda', 2015). The Sustainable Development Goals (SDGs) are a collection of 17 goals, with a total of 169 targets that have a set of 1 to 3 indicators needed to evaluate the progresses made toward the 2030 target. The United Nations Development Programme provided easily understandable lists of targets, facts and figures for each of the 17 Sustainable Development Goals, together with a short description to identify each of them. The 17 goals are:

- GOAL 1: No Poverty
- GOAL 2: Zero Hunger
- GOAL 3: Good Health and Well-being
- GOAL 4: Quality Education
- GOAL 5: Gender Equality
- GOAL 6: Clean Water and Sanitation
- GOAL 7: Affordable and Clean Energy
- GOAL 8: Decent Work and Economic Growth
- GOAL 9: Industry, Innovation and Infrastructure
- GOAL 10: Reduced Inequality

- GOAL 11: Sustainable Cities and Communities
- GOAL 12: Responsible Consumption and Production
- GOAL 13: Climate Action
- GOAL 14: Life Below Water
- GOAL 15: Life on Land
- GOAL 16: Peace and Justice Strong Institutions
- GOAL 17: Partnerships to achieve the Goal

This thesis work falls under different goals due to the various aims that wants to reach. The goals that frame my research are: 'GOAL 3: Good Health and Well-being' as there is a will to use the co-creation process to create better spaces where to live, and there is the need to create good behaviours and a new urban textures in existing neighbourhoods to reduce pollutants; 'GOAL 4: Quality Education' linked to the use of the double-loop learning to allow participants in develop a knowledge basis to face the urban issues that are tackled; and the 'GOAL 11: Sustainable Cities and Communities' that is the main umbrella under which all the topics of my research fall.

The definitions of the GOAL 3 and GOAL 4 are as follows:

> *"We have made great progress against several leading causes of death and disease. Life expectancy has increased dramatically; [...]*
>
> *Good health is essential to sustainable development and the 2030 Agenda reflects the complexity and interconnectedness of the two. It takes into account widening economic and social inequalities, rapid urbanization, threats to the climate and the environment, [...]" (Sustainable Development Goals - GOAL 3, 2015).*
>
> *"Achieving inclusive and quality education for all reaffirms the belief that education is one of the most powerful and proven vehicles for sustainable development." (Sustainable Development Goals - GOAL 4, 2015).*

But, as the definitions of these three goals need to be kept in mind as they define the main framework of the research, the one to be strongly remember is the GOAL 11:

> *"More than half of us live in cities. By 2050, two-thirds of all humanity - 6.5 billion people - will be urban. Sustainable development cannot be achieved without significantly transforming the way we build and manage our urban spaces.*
>
> *The rapid growth of cities - a result of rising populations and increasing migration - has led to a boom in mega-cities, especially in the developing world, and slums are becoming a more significant feature of urban life.*
>
> *Making cities sustainable means creating career and business opportunities, safe and affordable housing, and building resilient societies and economies. It involves investment in public transport, creating green public spaces, and improving urban planning and management in participatory and inclusive ways" (Sustainable Development Goals - GOAL 11, 2015).*

Moving deeper within GOAL 11 different targets, and indicators for each target, are to be reached by 2030 in order to fulfil the goals set by the United Nations ('Technical report by the Bureau of the United Nations Statistical Commission (UNSC) on the process of the development of an indicator framework for the goals and targets of the post-2015 development agenda - working draft', 2015; 'SDG Indicators. Global indicator framework for the Sustainable Development Goals and targets of the 2030 Agenda for Sustainable

Development', 2017). The targets and indicators for GOAL 11 are as follows (table 1.1-1).

The last report from 2018 showed that some progresses have been made to reach the 2030 goal, even though right now many cities around the globe face stressing challenges in the trial of managing the every year more rapid urbanisation - e.g. adequate housing and necessary infrastructures due to the rapid grown of the population, urban sprawl environmental scenario, reduction of vulnerability to disaster -. One of the points expressed in the 2018 results report about the GOAL 11 is of extreme importance for this thesis work:

> *"[...] 91% of the population in 2016 was breathing air that did not meet the air quality guidelines given by the World Health Organisation about PM2.5. more than half of the population was exposed to a PM2.5 level 2.5 times higher than the safety standard. Around 4.2 million people died in 2016 due to health issues related to high pollutant levels" (Progress of GOAL 11, 2018).*

As the UN report itself underlines the high percentage of population breathing polluted air, it can be seen how one of the important challenges to face is that of creating a more sustainable, liveable and also breathable urban context to reduce pollutants health related issues which are becoming more and more an hot topic for urban planners as well.

My research places itself within target 11.3 (underlined in table 1.1-1) as it tries to improve the sustainability and the liveability of cities by implementing a co-creation process that allows all urban stakeholders to express their ideas to solve urban problems, and it considers the indicator 11.3.2 (underlined in table 1.1-1) as it wants to implement the rate of participation by citizens and final users in the decision-making process when it comes to urban planning and general management of the existing urban texture. the aim of my research, towards the SDG goals by the UN, is then that of using the implemented co-creation method as a tool to help other researchers, and people working within this field, to be able to more easily reach the UN desired goals by 2030.

1.2 EU approach to urban challenges

The European Union (EU) approach towards urban challenges takes into account the Sustainable Development Goals produced by the United Nations. This can be seen in the research program for project related to urban issues that always mentioned SDG 11 as ground point. With this meaning the three main topics that the European Union is trying to face are:

- Reduce the adverse environmental impact of cities, paying special attention to the quality of air, water and soil, and municipal and other waste management.
- Access to safe, affordable, and sustainable housing, transportation and basic services.
- Integrated policies towards inclusion, resource efficiency, mitigation and adaptation to climate change and resilience to disasters.

Sustainable and Liveable Cities by JPI Urban Europe

Within the EU framework the JPI Urban Europe program position itself under the Horizon 2020 agenda, and its aim is to transform European cities into more sustainable, resilient and liveable places.

JPI Urban Europe, a founding program branched from Horizon2020, focuses on Sustainable and Liveable Cities ('Sustainable and Liveable Cities and Urban Areas', 2018) and wants to face the following challenges:

- Climate change and new urban economies.
- Transformation of energy systems and strengthen urban circular economies.
- Urban public administration and services innovation.
- Urban data management.

The climate change and new urban economies challenge does not take into

Table 1.1-1 targets and indicators for the SDG 11 by United Nations. Target and indicator in yellow are the main ones for this research

Targets		Indicators	
11.1	Ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums.	11.1.1	Proportion of urban population living in slums, informal settlements or inadequate housing.
11.2	Provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons.	11.2.1	Proportion of population that has convenient access to public transport, by sex, age and persons with disabilities.
11.3	Enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries.	11.3.1	Ratio of land consumption rate to population growth rate.
		11.3.2	Proportion of cities with a direct participation structure of civil society in urban planning and management that operate regularly and democratically.
11.4	Strengthen efforts to protect and safeguard the world's cultural and natural heritage.	11.4.1	Total expenditure (public and private) per capita spent on the preservation, protection and conservation of all cultural and natural heritage, by type of heritage (cultural, natural, mixed and World Heritage Centre designation), level of government (national, regional and local/municipal), type of expenditure (operating expenditure/investment) and type of private funding (donations in kind, private non-profit sector and sponsorship).
11.5	Significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations.	11.5.1	Number of deaths, missing persons and persons affected by disaster per 100,000 people.
		11.5.2	Direct disaster economic loss in relation to global GDP, including disaster damage to critical infrastructure and disruption of basic services.
11.6	Reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management.	11.6.1	Proportion of urban solid waste regularly collected and with adequate final discharge out of total urban solid waste generated, by cities.
		11.6.2	Annual mean levels of fine particulate matter (e.g. PM2.5 and PM10) in cities (population weighted).
11.7	Provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities.	11.7.1	Average share of the built-up area of cities that is open space for public use for all, by sex, age and persons with disabilities.
		11.7.2	Proportion of persons victim of physical or sexual harassment, by sex, age, disability status and place of occurrence, in the previous 12 months.
11.A	Support positive economic, social and environmental links between urban, peri-urban and rural areas by strengthening national and regional development planning.	11.A.1	Proportion of population living in cities that implement urban and regional development plans integrating population projections and resource needs, by size of city.
11.B	By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels.	11.B.1	Proportion of local governments that adopt and implement local disaster risk reduction strategies in line with the Sendai Framework for Disaster Risk Reduction 2015-2030a.
		11.B.2	Number of countries with national and local disaster risk reduction strategies.
11.C	Support least developed countries, including through financial and technical assistance, in building sustainable and resilient buildings utilizing local materials.	11.C.1	Proportion of financial support to the least developed countries that is allocated to the construction and retrofitting of sustainable, resilient and resource-efficient buildings utilizing local materials.

account the whole range of issues, but it specifically address urban equity and urban circular economy development i.e. how local urban ecosystems are made resilient. This challenge raises from the significant socio-economic changes and restructuring that urban areas faced, and links itself to the new ways in which are faced environmental issues due to climate changes, demographic shifts and a changing financial climate. These new urban economies will have to shift towards a circular economy model, by using at their best the resources already available and by involving all possible urban stakeholders. To have a more resilient environment, nature-based solutions are to be investigated and implemented in order to respond to the idea of adapting and mitigate climate change. The scope of this challenge is that of understanding the role of new urban economies, in terms of urban management and innovation, to allow urban areas adaptation to, and mitigation of, climate changes. Furthermore, it investigates how nature-based solutions can restore or manage natural ecosystems to support resilient responses to climate change.

The second challenge, i.e. transformation of energy systems and strengthen urban circular economies, addresses overall urban sustainability as circular economies and energy systems are mutually reinforcing in complex ways. The scope of this challenge then is that of preparing an integrated approach the helps in transforming energy systems and in fortifying urban circular economies. This can be done by finding innovative and transitioning strategies for the urban development of low carbon and renewable markets, focusing mostly on new digital tools that can trigger urban transition. This needs to be done by making end users understand why these changes are needed in order to have a more integrated system that considers changes, digital tools and socio-political factors.

The third challenge focuses on urban public administration and service innovation, and this one shifts from sectoral and infrastructure trans-sectoral issues to urban policy implementation. This is due to the need of shaping new urban policies in order to allow transformation of the urban environment, as these are the one setting the future goals in urban transformation. Its scope is to improve knowledge and manageability of ongoing situations and processes to find the best way to trigger institutional reform coordination to implement new integrated policies and scenarios to better face future urban issues. Furthermore, as urbanisation processes need to address different factors, including the socio-political ones, there is need for an integrated development and management system that include collaborative decision-making within multi-sector scenarios.

The fourth and last challenge tackle the topic of urban data management, and this topic is strictly linked to the Sustainable Development Goal 11 from the United Nations program. New forms of urban data management are needed as quickly as possible as there are the ground base to analyse the current situation and see what can happen in the future to deliver feasible and sustainable decision-making processes and evidences for policies. The scope of this challenge is that of contributing to create urban data lab for integrated approaches for smart and sustainable city development. These labs will aim to identify pressing data management issues in digital transition, and to prototype a feasible practice to support urban development. The results will also have to consider administrative and functional boundaries, and have to implement ideas for a feasible data platform that works as a catalogue of data and methods addressed to researchers, innovation actors and practitioners.

1.3 Urban context and social issues

As abovementioned in the Introduction part, there is the need to remember that my research work is framed within the Western and European model, this because the case studies are located within the geographical area of Western Europe. This also means that the Sustainable and Liveable Cities by JPI Urban Europe fully suits my research, while some of the targets of the SDG goals are not completely linked with the framework within which I work as the United Nations operates on global scale.

When talking about urban contexts we need to consider that cities are crucial actors in national systems as they are the engines of economic growth,

but at the same time they are 'the location of some major problems and future challenges' (Dodgson and Gann, 2011). These problems, and future challenges, emerge when there is even the minimum change in the power relationships in the institutional-technological-human system that builds urban areas. Furthermore, in order to address global crisis and challenges, cities have become a self-governing field of policy intervention and, at the same time, the notion of urban smartness, associated with a 'model of a technologically advanced, green and economically attractive city' (Vanolo, 2014) has attracted much attention from both policymakers and academics. This framework allowed the growth of the theoretical and institutional debate on the smart city concept, and it raised the need to diversify the debate by going over the criticism on the IT dominance in urban smart city strategies. At the same time, the multi-dimensionality of the smart and sustainable concepts, well pair with the typical complexity of the city system, and it calls for more specific assessments that can distinguish between different types of urban areas.

In this urban and social context, a revitalized effort to undertake a sustainable urban development was done by the European Union. Therefore, 'new measures have been put in place in order to promote urban sustainability by leveraging on industry-led urban technology applications in different sectors: energy, transport, education and ICT' (Manitiu and Pedrini, 2015). This effort falls under the objectives of the Europe 2020 Strategy, which aim is to smarter up European urban areas while acknowledging cities' central role in achieving such goals. The sustainability concept is then a cross-conceptual criterion that interacts with different dimensions linked to the smart city idea, both in an implicit and an explicit way, and allows a comprehensive assessment of smart city strategies within the framework of the Europe 2020 agenda.

In order for cities to become smart and sustainable, there is a need for a fertile environment combined with responsive administrators. This fertile environments has to be combined with a new set of indicators able to provide conceptual novelty to understand the relationship between economic crisis, sustainability objectives and inequality issues within the urban context. These indicators have the role of facilitating a comparative assessment considering that policy solutions should 'circulate, migrate and mutate on an international scale and with growing speed' (Vanolo, 2014), but at the same time there is the need to remember that to evaluate urban areas other factors are to be taken in account -e.g. local context, administrators' vision and distinctive city challenges.

Therefore, this is why it is of extreme importance to consider the urban context and social issues when setting up a Living Lab to trigger a full co-creation process. If the urban context it is not taken into account, it is not possible to correctly analyse the social issues that participants ask to solve with the co-creation process, and the involvement of citizens and stakeholders is going to be reduced resulting in a failure of the process itself.

Urban transformations

As expressed by Sustainable Development Goals - GOAL 11, to implement and improve sustainable cities and communities there is the need to:

> *"Enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries" (Sustainable Development Goals - GOAL 11, target 11.3).*

and this can be done with:

> *"Proportion of cities with a direct participation structure of civil society in urban planning and management that operate regularly and democratically" (Sustainable Development Goals - GOAL 11, indicator 11.3.2).*

To apply in a real environment these indications, some punctual urban transformations - that can possibly be repeated and applied on a larger scale - that are designed and shared with citizens - can be implemented. The term

punctual here has a double meaning, since punctual urban transformation are localised - with the meaning of circumscribed - and specific ones - with a clear goal. The raised need to co-design punctual solutions, instead of larger scale ones, is due to the impossibility of having all citizens - and stakeholders - participating at the same time.

The concept of urban transformation changed in the past century, as it shifted from an idea of mere urban growth to a more multidisciplinary approach that considers different aspects and not only the needs of a wider built environment (Zeren Gulersoy and Gurler, 2011). The need to redefine the urban transformation concept into a more interdisciplinary one, raised in past decades both at an organisational level and at a spatial level. Therefore, issues such as sustainability and creativity should be integrated within the urban transformation process, this to create more liveable spaces in the built environment when it comes to plan and manage this metamorphosis process.

Within this thesis different declinations of this urban transformation process will be mentioned, and this term will not always be directly mentioned. This does not mean that tackled issues are not to transform the urban environment, it just confirms how the urban transformation process nowadays cannot be handled by a single urban planner that only considers urban growth as final goal.

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2. PARTICIPATORY APPROACH

As mentioned in the previous section, participatory approach is one method to be used to solve city challenges and have successful urban transformations. This idea is forecast also by indicator 11.3.2 of SDG 11, as expressed by United Nations. The idea of transforming the built and urban environment, to make it more liveable, by having a more participated approach is now almost completely accepted even if there are still minor concerns about involving anyone within the process.

This section better analyse the literature and theory behind the participatory approach, to check its usefulness in a more complete co-creation process such as the Looper one.

2.1 State of the art

The participatory approach applied to the urban environment, or participatory planning, focuses attention on the involvement of the community as a whole in strategic and management processes linked to urban development as Lefevre, Kolsteren, De Wael, Byekwaso and Beghin (2000) state. Its aim is that of bringing together to a shared ground all point of view of its participants, this to avoid conflicts that usually take place between opposing parties and to allow the participation of usually hard-to-reach groups as seen in McTague and Jakubowski (2013) work.

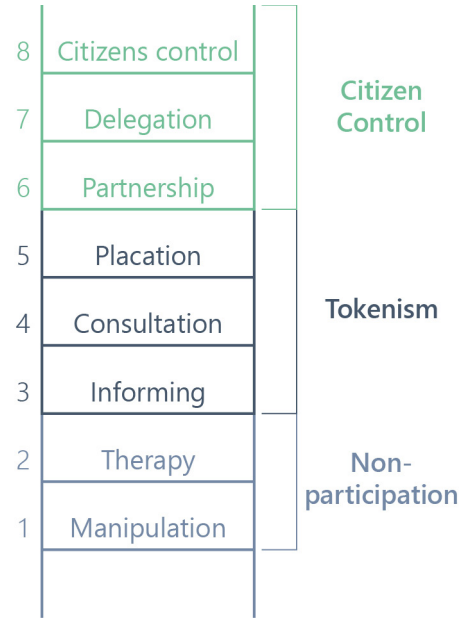
Various activities can be used to trigger a participatory approach, but all lead to the same main principle of allowing citizens in participating to, and possibly influence, the decision-making processes that directly affect their lives. This was an important shift from what was happening before the introduction of the idea of participatory approach, as citizens could not directly influence their environment.

The participatory approach can be applied to different settings and environments - e.g. urban, rural, wealthier, poorer - and to every country without any problem. The most important thing to keep in mind is that participants need to feel comfortable while participating, so the meetings locations need to be changed according to the environment in which the participatory approach is applied. The participatory approach can be applied to different situations and to various project cycle stages - e.g. analysis, collective decision-making, planning, reflection - to help in improving the final result, in the same way it can trigger citizens engagement also with regards of political processes.

The participatory approach started around the end of the '60s with the definition given by Arnstein, (1969), when there was a need to shift from the well-established development practice that saw a linear and top-down process, with result that citizens were not able to express their ideas with regards of the development of their neighbourhood.

Arnstein's 'A ladder of citizens participation' (figure 2.1-1) pioneer work allowed to give some basis to the idea of citizens participating in development processes and made it to show that there can be different grades of citizens involvement. Knowing Arnstein's concept of different grades of involvement of citizens still allows to better understand why there still is an increasing demand of participations by local community, and why policymakers are not always able to answer to it.

Figure 2.1-1 representation of Arnstein's ladder of citizens participation



To make more clear the concept of different grades of participation of citizens within the process, Arnstein uses the image of a ladder to simplify and explain the participatory concept, each step of the ladder indicates a level of citizens participation and the lowest the step on the ladder the lowest the involvement of citizens in the process. Therefore, going up on the ladder citizens, and generally communities, are given more decision-making faculty in the process.

The first two rungs of the ladder show the 'non participation' levels, that can be considered armful to citizens to a certain degree. One is 'manipulation' and the other is 'therapy' and they show a situation in which citizens are not involved, not considered and the top-down process wants to educate people on what to think and do. The 'manipulation' rung usually see the creation of community committees and associations that are officially involved in the process, but that are given no power to express their point of view or to change the final result of the process. The 'therapy' rung is overlapping on a certain degree with the manipulation one as community associations are created, but differs as meetings with associations are organised to explain citizens how they should think and behave by telling them which set of values and attitudes they should keep in mind during everyday life to be in line with the general society agenda given by policymakers.

The next two rungs can be classified as 'tokenism' [2.1-1] level, this allows communities to hear and have a voice within certain boundaries. The two rungs are 'informing' and 'consultation', but as much as citizens are allowed to hear and be heard this does not imply that their though will be taken into account as they still lack power. The 'informing' rung is based on the idea that information are given to the community at a very late stage of the process when changes are no longer possible. This is considered as a participatory approach as communities are able to participate in the process, but their inputs are not taken into account as they do not have the ground information to give a real support to the process. With this approach communities are defined as the bottom level of the social pyramid formed by the power relationships within the urban and city system. But this negative idea of the bottom level, evolved in the past decades transforming the bottom level, and its insight knowledge on the issues and strengths of the area where they live, as a focal point when talking about participatory approach. Proceeding with the ladder, the 'consultation' rung is mostly common in English speaking countries where surveys are a quite spread and common form on data collection. At this level of the participatory process communities have an high rate of participation as they answer to survey, questionnaires and so on, but they do not see any implementation in the decision-making process triggered by their answers. This level of 'apparent participation', led to a wide spread situation of distrust of citizens towards policymakers that can be found nowadays, and this resulted in the unwillingness of possible users and stakeholders to participate in further citizens participation processes.

Rung 'placation' is a link between 'tokenism' and 'citizens control' as the basic rules allow citizens to advise powerful, but policymakers still have full freedom of choice, and can choose to ignore citizens' voices. This level is meant to give citizens a stronger impression of having the opportunity to make changes in the decision-making process. To do so policymakers ask to few citizens - the so-called worthy community members - to represent citizens associations and committees in the decision-making board. This allows community to have a stronger voice when talking to policymakers, but it is only one voice amongst many other on the board, meaning that can be more easily overtaken during final decisions. The 'placation' rung then gives the illusion of a stronger citizens participation, but in reality allows policymakers to keep the decision power to themselves.

The last three rungs of the ladder constitute the 'citizens control' level and going further up always give more decision-making power to communities. From bottom to top citizens can enter in a 'partnership' level that allows them to negotiate with policymakers, or in a 'delegated power' level where they have the majority of the decision-making power, or in a 'citizens control' level where they have full control on the decision-making process. Up to this level there is also a stronger presence of well organised neighbourhood associa-

[2.1-1] Tokenism as defined by the Cambridge Dictionary is: "Actions that are the result of pretending to give advantage to those groups in society who are often treated unfairly, in order to give the appearance of fairness." This definition allows us to understand why Arnstein considers this level of participation as an "apparent participation" one, due to the lack of decision-making power given to citizens.

tions with actively involved citizens that are more keen in changing their situation. The 'partnership' rung is the first example of some degree of power and control given to citizens, and this is done in the form of e.g. joint policy boards, planning committees, systems to solve conflicts. Here the power is equally shared within neighbourhood associations and policymakers. The 'delegated power' rung sees a shift in the power balance as citizens start to have more power over the decision-making process than the one policymakers have. This allows citizens to have a ownership feel towards their environment and is applied to the participatory approach as neighbourhood associations are involved in the decision process since the very start. The last rung is the 'citizen control' one, and it allows them to have full control over their neighbourhood. In this scenario above them there is only the founding body and they have direct dialogue with it.

Based on Arnstein's concept, one of the first structured participatory approaches was the Rapid Rural Appraisal - i.e. process of learning about rural conditions in an iterative and expeditious manner - by Robert Chambers (Crawford, 1997) that focused on how it was possible for outsiders to quickly learn from inhabitants about their realities and challenges. From the Rapid Rural Appraisal there was then a shift to the Participatory Rural Appraisal which was more focused on the ideas of facilitate the process, empower citizens, allow behaviour change, enhance local knowledge and find sustainable actions to implement. Moving forward the last step made was that of the Participatory Learning and Action, based on all the principles of Participatory Rural Appraisal, that include the idea of reflecting on what there is now, learning from others experiences and understanding the links of powers and relationships taking place in the spaces where the participatory approach is taking place before making any interventions.

When talking about participatory approach there are some key principles (table 2.1-1) to consider, the first is that all people have the right to participate to the decision process that takes place to choose something that affects their lives. It is then necessary to engage as many participants from the hard-to-reach groups in order to have a more complete view of what is the working scenario. Linked to the first principle, the second one wants to put a major focus on the need of using this approach as a mean to engage people that are usually left unheard, this can be done by creating a dialogue space that can be felt as safe and in which people feel to have the right to express their ideas. A third principle should be that of always seek knowledge and diversity by analysing locals experiences and their community. This principle should be a starting point when organising participatory meetings, but there is always the need to remember that there can be different point of view within the same community and these differences have to be considered. Furthermore, the basic idea of participatory approach is that of learning something new thanks to the knowledge and experience that citizens can bring in the discussion, this means that organisers and other stakeholders need to be open at the possibility that some preconceptions might be wrong. As different participatory approaches exist, it is important to be able to change approaches

Table 2.1-1 participatory approach key principles

Key Principle	Description
1	All people have the right to participate to the decision process that takes place to choose something that affects their lives.
2	It is necessary to engage as many participants from the hard-to-reach groups in order to have a more complete view of what is the working scenario.
3	Always seek knowledge and diversity by analysing locals experiences and their community as there can be different point of view within the same community.
4	Learn something new thanks to the knowledge and experience that citizens can bring in the discussion.
5	As different participatory approaches exist, it is important to be able to change approaches if organisers see that someone of the stakeholders is left out from the discussion.
6	The participatory approach is not a fixed method, it is always evolving and adapting to different scenarios and communities.

is organisers see that someone of the stakeholders is left out from the discussion, this to allow everyone to feel equal to the others while learning and dialoguing.

Nevertheless, the participatory approach is not a fixed method, it is always evolving and adapting to different scenarios and communities to give the best opportunities to citizens to develop a more liveable and feasible environment.

Since Arnstein's 'A ladder of citizens participation' publication, many discussions raised about the usefulness of allowing citizens in participating within decision-making processes, and when the participatory approach is fully active. In the following paragraphs an excursus on more recent literature about the participatory approach, and its discussions is analysed.

2.2 Discussions about participatory

Arnstein's ladder of participation was quite discussed after its publication, with both a positive and a negative meaning. Collins & Ison (2006) say that the focus of Arnstein on power does not give enough inputs at practical level to allow the shift from its 'Non participation' level to the 'Citizen power' level, and recall some of its limitations such as the assumption that that participation is:

> *"hierarchical in nature with citizen control held up as the 'goal' of participation - an assumption that does not always align with participants' own reasons for engaging in decision-making processes" (Collins & Ison, 2006).*

This means that one main concern when talking about participation is the reason why participants engage in the decision-making process, that might not be for altruistic reasons but for more selfish motivations. Furthermore, some concerns are expressed on the limitations that Arnstein herself mentions. Arnstein says that each problem - or decision - is unique and can require different levels or types of participation that are not reflected in the broadness of the ladder. Indeed, this is a useful self-critique that she does on her work and that opens up to the more modern idea of a multidisciplinary approach that is needed to face various topics where a participatory approach is used - i.e. urban transformation. To apply a participatory approach, participants need to be open to different situations that can trigger an overlap of the different ladders supposed by Arnstein.

Moreover, Sen (1999), following Arnstein's idea of a participatory ladder, expressed some concerns about allowing participation in the decision-making process since:

> *"people's own assessment of their own condition can overlook their objective an can be biased as a result of limited information and social conditioning" (Sen, 1999).*

This concept of people's incapability to assess their own condition, was also later used as basis for Collins & Ison (2006) idea that citizen participation cannot be objective. Furthermore, the capability approach expressed by Sen implies that it is better to put a focus on the effective abilities of citizens rather on what they feel. Sen's ideas need to be carefully considered when analysing its ideas about participatory, since he is an economist and its ideas are oriented on the maximum economical result.

Others expressed contrary ideas about the participatory approach, suggesting that one main limitation is the impossibility to involve everyone in the process (Davies, 2000; Coen and Katsaitis, 2013), leading to an incorrect statistical sample (Parker and Street, 2015), and transforming the process in a time consuming one that cannot be available at national level. Arampatzi (2017), just as Swyngedouw (2014), puts a focus on progressing adversarial forms of activism that might alter the ending result of a participatory process as they need to engage in extra-governmental forms of participation to express their adverse idea. Holdo (2016) then emphasises on how participation, when in the form of co-produced governance, suggests somehow that there is a form of legitimacy exchange between governance partners, that - conversely - makes the governance itself contradictory.

But despite all these discussions about the disadvantages of a participatory approach, many others showed how beneficial participation can be in the decision-making process. Taylor (2007) analysed how power, within a complex modern community, is a form of social production if not social control. This means that if citizens are actively engaged, they can be considered participants of the process itself, involved through the adoption of resources, alliances and institutional provisions. If then these new challenges, raised by the participation of active citizens, are transformed in confirmed institutional processes, it means that it is possible to create new governance spaces that allows the exploration of new opportunities (Belda-Miquel et al., 2016).

Another positive insight for a participated approach to solve city challenges and to allow better urban transformation, is that by involving citizens there is a deeper knowledge sharing about the built environment that needs to be implemented. Local context analysis - and its definition - is of extreme importance when willing to allow more sustainable and liveable designs. Furthermore, it is crucial to better understand each case to be examined (Martinez, 2011). This deeper analysis and definition of the context, is necessary to better understand community dynamics (Doering, 2014), that can then lead to a better organisation of the participatory process. This analysis also allows to have more cost-effective proposed solution, that at the same time are more sustainable, since all actors brings knowledge and interventions are better focused. Indeed, a participatory approach, even if it is more time consuming in the beginning, it then gives better results on a long term basis since there is no need to further changes - or there is the need for only minor changes - in the implemented solutions.

Indeed, the discussion about the goodness of the participatory process is still undergoing, but a decision about its usage was made for the sake of this research. Seen the various advantages and disadvantages of a participatory approach, and considering the framework within which it needs to be applied, the advantages are more than the disadvantages. Since the application of this approach is meant to be on small/medium portion of a built environment, it is possible to better face citizens participation and to gain the maximum amount of knowledge by also allowing a continuous participation of actors interested in the urban transformation.

Furthermore, if the urban transformation needs to work on a whole city area, citizens participation might not be the best solution since it would not be possible to consider all people's necessities and desiderata.

2.3 Bottom-up approach to implement participatory approach

The bottom-up approach and concept is widely used in the management field, but was only in the past few decades that it started to be used in other fields as well. Nowadays it is closely linked to the planning an decision-making processes within communities. The bottom-up approach is defined as:

> *"Progressing from small or subordinate units to larger or more important units, as in organisation or process" (American Heritage Dictionary of the English Language, 2016).*

This definition is opposite to the top-down one, that is defined as:

> *"Hierarchical structure or process that progresses from a large, basic unit to smaller, detailed subunits" (American Heritage Dictionary of the English Language, 2016).*

The bottom-up approach then works as opposite of the top-down approach, this because the bottom level does not undergo to top level ideas and objective, but instead sets the goals to be reached and is called to propose ways of reaching the goals. This means that in an urban environment citizens become the leader within the decision-making process instead of only being informed in the changes already decided by policymakers. Ultimately, policymakers are the ones making the final decision, and have to take into account all the infor-

mation received by citizens and they have to analyse them in an objective and professional way. This allows to take more wise and informed decisions at the end of the process.

Indeed, to allow a bottom-up approach that supports the participatory approach, some conditions are necessary and Pissourios (2014) expresses some of them:

> *"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).*

Different advantages have been encountered when applying the bottom-up approach in the financial sector. But when it comes to topics of wider interest such as climate change, Pinker (2018) states that transformations can be successful only if people generally think that a certain approach - e.g. clean energy - is the solution to make the world more peaceful and stable. This again shows the importance of the bottom level, without which it is not possible to trigger a successful change in citizen's behaviour - and way of thinking - toward the most different topics.

When being applied to the participatory approach the bottom-up approach becomes almost essential, this is due to the intrinsic idea of participation that is meant to give voice to the bottom level in the decision-making process. If a top-down approach is used when working within the participatory approach boundaries, citizens and all other bottom level stakeholders will not give their contribution as they will feel as their ideas are not listened to. Instead, if they are asked on what aspects of, or on what, urban issues they want to work they will have the feeling of effectively being in charge of the decision-making process and will be more willing to participate.

Another way in which the participatory approach is implemented by the bottom-up approach is that resources are better used as it is possible to focus on issues that are actually found in the urban environment by users and citizens that have a first-hand knowledge of the area interested by the participatory work. This avoids possible complains on the use of resources by the actual users of the urban environment.

To implement a successful co-creation process there is then the need of a 'bottom level' without whom it is not possible to gain results. The need for the bottom level is due to the intrinsic local knowledge that citizens have about the urban texture of the neighbourhood where they live, and the ability of knowing which issues to tackle first in order to solve bigger problems first. The reason why top-down initiatives usually fails in urban scenarios is usually because policymakers ask help from citizens, final users and other stakeholders, on topics that are of no interest for them. A bottom-up approach allows the bottom level to feel empowered as they are the ones proposing on what to focus.

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3. CO-DESIGN

Co-design is an important method in applying the participatory approach to solve city challenges and allow a more efficient transformation of the urban and built environment. The implementation of co-design with possible city stakeholders, allows the definition of a new - or improved - built environment developed into a more sustainable and liveable one.

The concept of co-design is then one of the activities needed in the framework of the Looper methodology to create a more inclusive and effective co-creation process.

3.1 What is co-design

In this work it will be considered the co-design European based model - or Western Countries model - as the field work and case studies uses it. Examples of co-design that can be found in Asia, Africa and South America are not useful for this research as the socio-economical-political situation differs from the one analysed with the research field work.

Co-design - contraction of cooperative design, and also called participatory design when there is a political root triggering the process itself - is an approach to design based on the idea that all stakeholders - e.g. citizens, users, policymakers - are to be actively involved in the process, this to ensure that the final result reflects the needs and wills of everyone. The co-design process cannot take place if the final users - e.g. citizens, community groups, NGOs, city councils - are not involved. As it is an approach focused on processes and procedures, it is widely used in a variety of fields - e.g. architecture, urban planning, landscape architecture - to create more responsive environments that are able to respond to the needs of their users and inhabitants. Recent researchers show how more innovative ideas and concepts are created in the frameworks of co-design environments, rather than when designing in a more traditional way (Mitchell *et al.*, 2015; Trischler *et al.*, 2018). Co-design has been widely used in different fields starting from the '60s and '70s, e.g. work with trade unions in Scandinavian Countries, but there still are opposite views on it. For some, the user empowerment within a political frameworks makes it desirable, while for others it is only a way designers use to avoid responsibilities.

The main idea for the co-design is that all possible stakeholders are called to cooperate with designers, architects, planners, researchers, policymakers and developers throughout an innovative process. Participants ideally cooperate to every step of the co-design process, but can also be called to participate to only certain steps depending on the final aim of the co-design. Ultimately, participants can cooperate to the scoping of issue to define the problems and to focus on possible solutions, but they can also help during the evaluation of the possible solutions found either by designers or by stakeholders (Trischler *et al.*, 2018). Indeed, co-design becomes an essential step of what then becomes a more complete co-creation process (Pieters and Jansen, 2017).

Different ideas on the term co-design can be found, this because this term is used interchangeably with the participatory design term. While Sanders and Stappers (2008) suggest that the term participatory design is an 'ancestor' of the more modern co-design term, Szbeko and Tan (2010) state that co-design

and participatory design differ in meaning as the co-design, on opposite to the participatory design, involves all possible stakeholders related to the analysed issue and not just the final users of the tackled topic. Despite the contraposed ideas that can be found in literature, the two terms are still used as interchangeable synonyms by the wider community. Within the framework of this thesis work the term that will be used is the co-design one to avoid possible misconstructions with the term participatory sensing. Furthermore, as said by Szbeko and Tan (2010), this research sees the involvement of all possible stakeholders which position it closer to the idea of co-design as work done by involving every possible user of the city systems, and not only the final ones.

Co-design took over many applications when talking about development and changes in urban environments, and it is used by planners and architects with particular focus on community regeneration projects due to the need of adapting the existing urban fabric to the requests of a society that went through major changes in the past decade. The co-design, if applied with a bottom-up approach when addressing urban planning, shows a more democratic approach compared to other top-down decision-making approaches, this thanks to the intervention of all, or at least most, interested stakeholders. This integration of different point of views results, almost always, in more successful outcomes as innovative points of view on the topic might get raised from a more open and inclusive dialogue.

In modern cities co-design has become a well-established approach, mostly used by the public sector. It shows how the traditional relationship between designers and clients changed from the '70s to now, as it is no more a one way dialogue in which designer imposed to a certain grade their ideas to users, it has allowed users to give their feedbacks and inputs to obtain solutions better shapes on their needs. Users - referring to all the possible stakeholders affected by a certain urban issue that are involved as they 'use' the final product of the co-design process - , citizens - usually residents of the area where the co-design process takes place - and stakeholders - referring to the sum of users, citizens and every other person or organisation that might bring knowledge, or might be interested in the co-design process - in this way become experts of their own experience, as they have a better knowledge of the situation and environment where designers and architects have to works, and this results in users being central in the design process.

The role of organisers, usually given to designers, becomes essential as well to obtain a successful co-design project. Their job is that of facilitate stakeholders engagement, to find ways of involving hard-to-reach groups to the process, to communicate with stakeholders to allow them to be creative, to share insight and to find how to test stakeholders ideas. Organisers are the ones with the knowledge necessary to choose and use the right tools to facilitate the co-design process depending on the stakeholders and the issues to be addressed.

The co-design process, to conclude, have a wide set of long- and short-term benefits in the general process. Benefits that can be found immediately are:

- Generation of better ideas as many point of views are taken into account while designing a solution. This means that the originality of the ideas is higher because inputs to the design arrive from different people with different expertise, and user value is expressed.
- Solutions and final design are based on an effective improved knowledge of users' needs and desires as expressed by them. This differs from the traditional design solution where designers work is based on their idea of what users want.
- There is a real time countercheck on the goodness of the ideas and the concepts, meaning that there is no need of effectively implement a solution to have a user feedback. This avoids the risk of implementing ideas that are later not liked by the public opinion.
- The decision-making process becomes more efficient as all stakeholders work together. This is opposite to the traditional process that sees a top-down approach where, starting from the top, each level needed to design or propose ideas that had to answer to the directive given by the top level,

with the risk of undertaking the whole process multiple times if the proposals of the bottom level were not accepted by the top level. By having all stakeholders, and levels, working together possible different ideas are evaluated and solved on the go.

- A better cooperation takes place because all stakeholders are called to cooperate in a neutral environment with a moderator, the organiser, that has the necessary expertise to help different people or organisation in having an open and constructive dialogue to reach results that satisfy all of the parties.
- There are lower costs and reduced times for development. This because the process only takes place once with all stakeholders at the same time, rather than having a series of meeting. The possible outcome of the multiple meetings with a different stakeholders is, indeed, that either everyone likes the designed idea or, in most cases, someone does not like it and the process have to start again.

Benefit found on a long-term basis are:

- Users and stakeholders have an higher degree of satisfaction towards the solution implemented as they have a feeling of ownership towards it.
- The levels of support to project increase as participants see tangible results after the work they do during the co-design process.
- Better relationship between stakeholders as they learn how to dialogue to obtain positive results.

3.2 The evolution of co-design

The concept of co-design started in the '60s as there was a growing community demand of considering their opinion in the main decision-making processes of the public sector. In that period the lack of citizens and community groups consultation started to make grown the feeling of distrust toward policymakers that is more common in modern days, this because all the decision-making processes to change the urban environment affected citizens and users who could not say a word to express their needs.

The born of the co-design process is thanks of Scandinavians in the '60s with the so-called cooperative design, but the term to recognise the process soon changed to participatory design as in other countries the term cooperation had a slightly different meaning compared to the idea of cooperation that Scandinavians had - e.g. in the US co-design started in workers-managers dialogue environments so the term cooperation was not feasible as per the strong distinction between workers and managers, hence during first cases of face-to-face meetings workers were participating and not cooperating -. Later on the term co-design started to appear to re-establish the idea of the need of cooperation within stakeholders to trigger a successful process, and the term participatory design turned into a synonym losing the different meaning.

Scandinavian projects related to co-design allowed the development of the action research approach - term coined in 1944 by Kurt Lewin that defines a research method in which the researcher intervenes in, and during, the research -, that saw the collaboration of researchers and workers to improve the latter's working condition. This action research approach gave positive results as both parties obtained something from the project: workers got better working situations thanks to the project; researchers obtained data on the process itself thanks to the application in a real-life environment and situation. The process itself was built starting from workers personal experiences and the researchers work was that of providing them the tools they needed to improve their current situations (Ehn and Sandberg, 1979). During the late '80s the evolution of the process allowed the creation of experience-based design methods, developed focusing on hands-on experiences - e.g. Utopia project (Ehn, 1988) - and by bringing attention to the need for practical and managing alternatives (Bødker *et al.*, 1987).

Almost in parallel with Scandinavia, in Britain the idea that citizens and urban environment users should participate in decision-making process was raised in 1965, but there still was an issue when coming to the level of participation that citizens had in the process, i.e. in modern days citizens are at least involved for consultation during workshops and hearings at the beginning

(Wheeler, 2004) but it does not guarantee participation as in certain cases it only means informing citizens that some change will take place. As Taylor (1998) argue, an involvement that 'recognise an active part in plan making' is not always straightforward to achieve.

Portugal, as well as Scandinavian countries, was one of the main promoter of co-design. In the '70s the architect Alvaro Siza participate in the SAAL process. The SAAL ideological program aimed at addressing the urgent need for new housing in the underprivileged communities of urban Portugal. The Service was modelled around a series of technical teams, known as Brigades, who were to support residents' committees, facilitating housing projects that were, critically, conceived with the local communities rather than for them. Led by architects, the Brigades consisted of professionals from a range of fields including sociologists, engineers and lawyers, who surveyed the current conditions, gave legal support in land ownership issues, and acted as listeners, negotiators and facilitators. Ultimately they were also there to produce buildings.

The final result of this co-design development is that nowadays more and more designers and planners use co-design to better understand the socio-cultural framework of their users or of the environment they need to work within. And as Feldman, Palleroni, Perkes and Bell (2011) say, the result directly related to the integration of co-design into existing frameworks is that:

> *"Researchers and practitioners have seen that co-creation practiced at the early front end of the design development process can have an impact with positive, long-range consequences" (Feldman et al., 2011).*

Considering then what happened in the '90s and in more recent years, the real challenge that the co-design methodology is now facing is that of technology development. This is due to the fact that design and urban development are now strictly linked with new technologies, and this then influences communities in a more wider sense (Beck, 2002). While developing the handbook of the good and bad practices while setting up a co-creation process, an important amount of time was spent while studying the possible offline and online tools, as well as the face-to-face and digital tools, in order to understand how to approach participants and involve the so called hard-to-reach groups. Technologies are now becoming a difficult topic to deal with as the tendency for first world countries it to use new and updated technologies in every work, while the number of digital illiterates is still quite high in cities and urban environments. Because of this in 'Part 5 - Sensing, collection and visualisation technologies' of this work it is possible to see the work done to choose the sensors and to develop the framework for the data visualisation.

3.3 Co-design examples

Many examples of co-design can be found in real-life environments, but not always there is enough literature to study them as the main focus in literature are good and bad practices given by the examples rather than describing the complete process and detail.

United Nation Global studio

One example of co-design application in relation to community regeneration - topic of particular interest to architects and planners, due to its inclusiveness that differ from traditional planning as abovementioned - is the United Nation Global studio. This project, that took place between 2005 and 2012, involved different Universities from around the world - i.e. Columbia University, University of Sydney and Sapienza University of Rome - to provide possible solution to reassess the downtown east side of Vancouver, area that suffered from problems related to alcohol and drugs. During the project, it was possible to see an interesting interdisciplinary collaboration as architects, planners and industrial designers participated and worked together to share ideas (Kuiper, 2007). The co-design process here saw a series of ideas proposed to citizens, that then were able to choose which ideas to implement

in their neighbourhood. The outcomes of this co-design experience was a series of events - e.g. food stand to encourage people to stop-by, proposal for a pocket park on a vacant lot, stop animation movie on the side of a building within the project area - to create the community feeling in order to allow inhabitants to take back the neighbourhood that they live in.

Public Interest Design

Another movement is the 'Public Interest Design', born in the late '90s as manifesto collecting several architects from across the world, that focuses on design and architecture, and has the goal of making design revolve around the needs of the community by using the co-design approach. All of their works are focused in allowing every single citizen and user to have a say during the designing of the urban built and environment, and they aim to address wider issues linked to the urban environment in which the community lives. They want to have a more systematic and structural shift of the architectural practice concept, to allow architecture and planning to serve the needs of the community and not only of the individual, because they say that most of the modern urban issues are due to a planning and building that merely focused on individuals rather than thinking widely to communities. They also want to change the common idea that design and planning done thinking to the community are more expensive and less feasible than the ones done thinking to individuals, as many architects around the world already started to disprove this wrong conception. The Public Interest Design movement is setting and expanding the use of co-design, collecting valuable data, via the actual works they carry out, on the effectiveness of the process and on the better way to implement it within a community.

One example of a co-design project realised by Public Interest Design movement is the 'Comunidad Ecologica Saludable' in Lima, Peru. The issues they needed to tackle there were empowerment of the community, possibility to create some green gardening spaces for the community, improving the health and wellbeing in Lima's informal urban 'slums', higher food access for the community and optimise water drinkability, and allow access to nature. The project involved the residents of the Eliseo Collazos, one of the 19 neighbourhood of Lomas de Zapallal in Northern Lima, with the goal of designing and implementing 29 home gardens, to do so fog waters were investigated as an alternative resource of drinkable water, for household use and for the irrigation of home gardens. The use of fog waters could also serve community parks to allow their reforestation. After implementing the different home gardens and its corresponding designs, there was an improvement in the wellbeing of the community itself.

TILT agency

Another good example of co-design in action is that done by the design agency TILT in London inside the Whittington Hospital. The TILT agency implemented a co-design process to improve the hospital's pharmacy service with a wide set of hospital's stakeholders: patients, staff, doctors and senior-management. The aim was that of improving the pharmacy service and they managed, by using the co-design process, to reduce the service waiting times, boost the staff moral thanks to users positive feedbacks and improve patient experience due to the shorter waiting times and the easiest service use. The co-design process was so appreciate in its results by the management level of the hospital, that the agency was later called to use it again to set the base for the design of the new same-day acute treatment centre.

Conclusion

It is possible to see how there are no big examples of co-design in literature, but there are a set of movements, organisation, agencies and practices that help different stakeholders in using the co-design to improve future development. It can also bee see how this willingness of using co-design can raise from different levels - i.e. form a bottom-up need in Vancouver, from designers with some movements, and from top-down in London - meaning that the process itself is becoming always more recognised around the world, and that

it can be applied in many design processes.

A further evolution is the one that can already be seen in Portugal, where a participatory budget have been instituted at National level for every Municipality because the value of co-designing with final users have been recognised. The Portugal Participatory Budget (PPB) is a democratic, direct and universal process that allows civil society to decide on public investments in different governmental areas. Through the PPB, the Portuguese population is having a voice to decide where to invest part of the National State Budget. In 2017, 3 million euros were invested in the areas of education and adult training, culture, science, agriculture and justice. In 2018, the PPB budget consisted in 5 million euros. The Participatory Budget is deliberative. This means that the Portuguese people are presenting investment proposals and they will be the ones to choose, through voting, which projects are to be implemented. It is a democratic, direct and universal process through which citizens have the opportunity to propose projects and ideas, in a complete collaborative and participative way, effectively contributing to real social impact.

3.4 The San Donà experience

As presented in the 'Introduction', the San Donà experience showed a participatory approach, and a co-design approach, that can be considered as 'basic' compared to the co-creation method of the Looper project, but nevertheless it gave some good hints on the practical application of the Looper process.

To summarise what said in the previous part, the aim of the process was that of re-designing the area called 'City of Sports' in San Donà di Piave. Data were collected through interviews with representatives of the sport clubs that already use the area, and with the ones willing to have a space in the area in the future. A first masterplan was drafted by practitioners, and it was presented to all stakeholders to gather feedbacks. Based on the comments given by stakeholders, the design of the new area was further implemented and accepted by the city council for further research of founding to allow its development.

Even if the San Donà process is to be considered an overall successful, organisers found that it could have also be improved with some ideas that are to be found in the Looper co-creation process. Since the process started as a top-down initiative only 26 sport associations, out of 100, participated to the co-design activity. This was something that could be implemented by trying to turn a top-down initiative into a bottom-up one, as can be further see in following sections. To turn the process into a bottom-up one, one tip would be to involve citizens since the beginning, rather than asking their support only when co-designing, meaning that it could have been a good idea to start asking them what they thought about redesigning the 'City of Sports', and what needed to be improved, during an open table with the city council.

Furthermore, the negative feedbacks raised from the lack of knowledge about public administration founding, boundaries given by law, and some level of worrying raised by the ones leading sport organisation not on volunteer basis that might not be ok with spaces organisation. This could be solved by having some short lectures and open tables with city council employees, meant to explain bureaucratic aspects to citizens and to answer possible questions about processes.

Indeed, another implementation that could be done to the process, would be that of doing a second round of interviews about the proposed planning - together with the city council rather than collecting their idea after - with all people involved during the first round of interview, possibly by grouping them by sport. This would allow a more complete understanding of all aspects of future organisation of spaces, to better understand if structures are actually enough or not also based on data participants provided at the start of the process- e.g. club members trend in past ten years.

This process showed how the implementation aspects proposed by the devised Looper co-creation methodology - i.e. participants involved since the very beginning, usage of Urban Living Labs to allow a more open dialogue, knowledge sharing since the very beginning, call for evaluation on data col-

lected thanks to participants and on ideas they proposed, retake of the process for at least a second time to check for possible improvements - could be useful to overcome possible process issues and to implement final obtained results.

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4. URBAN LIVING LABS

The decision of implementing the Living Lab concept within a more complete co-creation process, as it will be further discussed in the following parts, is because they allow a participatory approach as they carry out a co-design process. Furthermore, the switch from Living Labs to Urban Living Labs, as explained in the following sections, was a natural consequence since the main framework of the topics tackled are city challenges and urban transformation.

Urban Living Labs can be considered as a 'tool' to engage in a participatory approach (Menny et al., 2018), and that are also able to allow - and facilitate - the co-creation process and not only the co-design activity. It is possible to say that a key characteristic of Urban Living Labs is the participation of different stakeholders, this to achieve the goal of tackling urban challenges (Juujarvi and Pesso, 2013; Voytenko et al., 2016), thus it is not possible to separate Urban Living Labs from the idea of participatory approach.

4.1 What is a Living Lab

Living Labs (LL) are design strategies focused on the experimentation and on the end user, and have been defined as user-centered, open-innovative ecosystems which integrates coincident research and innovation processes within a public-private-people partnership (Von Hippel, 1986; Chesbrough, 2003; Bilgram et al., 2008; Pallot, 2009; Admiral and Wareham, 2011).

The term 'Living Lab' emerged at the same time within the intelligence research community context and the experience and application research field. The turning up of this term starts from the base of the user experience (Csikszentmihalyi *et al.*, 1987; Csikszentmihalyi and Larson, 1997; Garret, 2002; Gaver *et al.*, 2004) and ambient intelligence (Aarts and Marzano, 2003; de Ruyter and Pelgrim, 2007; de Ruyter *et al.*, 2007) concepts.

The integration between the research aspect and the innovation processes is triggered by using co-creation approach, scoping, trial and evaluation of innovative solutions, different settings, ideas and technologies in real user cases. Another important concept is that, when talking about Living Labs, user communities are involved in the process not only as observed subjects but also as active party in the creation process. This means that all involved stakeholders are able to simultaneously consider both global performances of products/services and the potential adoption by users (Kusiak and Tang, 2006).

It has been demonstrated that user centred research methods (ISO 13407:1999) - i.e. action research, community informatics, contextual design, user-centred design, participatory design, empathic design, emotional design (Schuller, 1997; Beyer and Hotlzblatt, 1998) - already exist but do not empower sufficiently addressed users to allow them in co-creating into open development environments. On the other end the integration of the Web 2.0 concept in user centred research methods showed a positive impact in the involvement of user communities in mass collaboration projects to collectively create new contents and applications.

Living Labs aim is to empower involved users and stakeholders to turn their traditional position of observing subjects, into creator of value that are able to contribute to the co-creation and investigation of possible ideas and solu-

tions, to the general process. For this reason, a Living Lab represents an experimental environment, which can be compared to the 'experiental learning' concept by Kolb (1984), where stakeholders are absorbed in a social space where they can design and try their own future possibilities. Furthermore, Living Labs can also be used to design, scope, trial and refine new policies and regulations in real-life settings by policymakers and users/citizens, this to evaluate the possible impact of such policies/regulations before implementing then on larger scale.

A research group of the Massachusetts Institute of Technology (MIT) is credited to be the first one analysing and investigate the Living Laboratory concept. They asserted that:

> *"a Living Lab represents a user-centred methodology to sense, mould, validate and refine elaborate solutions in various and evolving real life contexts" (Mitchell et al., 2010).*

Nowadays it is possible to find different definitions of what a Living Lab is (Niiatmo et al., 2006; Shumacher and Feurstein, 2007; Kusjak, 2007; European Commission Information Society and Media, Unit F24 New Infrastructure Paradigms and Experimental Facilities, 2009) but the basic definition remained the one developed by MIT.

In 2010 the MIT research group make up by Mitchell, Larson and Pentland , formed the first Living Lab research consortium and their mission, according to their website, can be summed as:

> *"The convergence of globalization, changing demographics, and urbanization is transforming almost every aspect of our lives. We face new choices about where and how we work, live, travel, communicate, and maintain health. Ultimately, our societies are being transformed. MIT Living Labs brings together interdisciplinary experts to develop, deploy, and test - in actual living environments - new technologies and strategies for design that respond to this changing world. Our work spans in scale from the personal to the urban, and addresses challenges related to health, energy, and creativity" (Mitchell et al., 2010).*

As Pallot (2009) says, the Living Lab process integrates both user-centred research and open innovation, and it is based on involving a multidisciplinary team to trigger the following four activities:

- Co-creation: bringing together technology and application -i.e. crowdsourcing - into a variety of different views, boundaries and knowledge sharing to support the ideation of new scenarios and concepts;
- Scoping: engaging all stakeholders since the very early stage of the process to discover emerging frameworks and behaviours through live scenarios in real or virtual environments (e.g. virtual reality, augmented reality, mixed reality);
- Trial: implement the proper level of technologies to experience live scenarios with a large number of users while collecting data which will be analysed in their context during the evaluation activity;
- Evaluation: analyse new ideas and solutions, and related technologies, in real life situations while considering different aspects such as socio-ergonomic, socio-cognitive and socio-economic. At the same time it is needed to evaluate the possible adoption on larger scale of the proposed ideas/solutions by confronting with stakeholders value models.

4.2 From Living Lab to Urban Living Lab

When moving forward in the definition of Living Labs it is necessary to make a distinction between Living Labs and Urban Living Labs (ULLs), this as Urban Living Labs specifically address urban issues and are therefore direct in using methodologies and technologies which can be applied in urban environments. It is important here to consider the aspects of 'sense, mould, validate and refine' (Mitchell et al., 2010) that are typical of Living Labs, since

Urban Living Labs only have a 'sense and mould' feature but lose the 'validate and refine' aspect as further explained below.

Despite this clear distinction between Living Labs and Urban Living Labs, when it comes to the literature there is no univocal definition of what a Urban Living Lab is (Steen & van Bueren, 2017). Schliwa (2013) states that the Urban Living Lab concept expands its activities on a wider urban territory, and this also affects which stakeholders are considered to be the key ones to be engaged. Furthermore, Urban Living Labs have a specific focus on knowledge and learning, which are used as mean to successfully achieve the interventions chosen by the Urban Living Lab itself (Bulkeley *et al.*, 2017), in table 4.2-1 some definitions given in literature can be found.

Lund and Juujärvi (2015, 2016) work is of extreme importance for this research work as they start to add the concepts of bottom-up and top-down approaches as fundamental concepts within the work done with a Urban Living Lab. But the most fitting definition is maybe the one by Chronéer, Stahlbrost and Habibipour (2018). Hereinafter there is an analysis of some of the definitions, as it is considered the framework of the thesis work.

From table 4.2-1 it is possible to see how there is a wide range of definition on what a Urban Living Lab is, and reason to this is that it is an emerging concept which refers to a Living Lab applied in an urban environment (Juujärvi and Lund, 2016). The reason of this difficult definition on Urban Living Labs is then linked to the very variable definition of the urban context to which it is applied, because urban spaces always have different geo-morphological characteristics, specific complex problems, and generally different socio-economic-political situations (Juujärvi and Lund, 2016) with which a Urban Living Lab needs to face itself.

Lund and Juujärvi (2015) declared that there are at least three different types of Urban Living Labs:

1. Ones representing an ecosystem - or networks - that involve various stakeholders driven by different aims and objectives but that would profit from cooperating;
2. Ones providing tools to enhance and implement public and user participation;
3. Ones that can be seen as an innovation management tool to build networks and user participation in urban development.

Linking to the ecosystem idea, others focus on the concept of the Urban Living Lab as a cooperative apparatus that allows the co-creation of sustainable innovations, that can continue to be innovative in the future and that can improve the city environment by supplying Smart City targets (Baccarne *et al.*, 2014). this then means that Urban Living Labs objective is to act as 'reuse enabler' to help central governance in using in a more appropriate and 'sustainable' way their resources. Voytenko, Mccormick, Evans and Schwila (2016) describe how one aim of Urban Living Lab is to bring together different actors involved in the urban environment in new ways to create more cooperative and experimental ways of 'doing' urban development. They can also be seen as vehicles to foster communication in public space (Gaiddon *et al.*, 2013). The most important thing is then to manage Urban Living Labs in the best possible way to avoid loss of their potential.

To sum all the different definitions given by literature, Mulder (2012) describes Urban Living Labs as ways to engage urban stakeholders and residents in innovation, and offer them chances to develop their environment in a real-life context in a way that responds to users' needs. Again another difference on Urban Living Lab definition rises as different traditions have different ideas on the level of involvement in decision-making residents should have (Buhr *et al.*, 2016). Furthermore, it is still unclear what the objectives of an ULL are, what challenges it aims to solve, what it is considered to be an urban context, who should be involved and how to do so. This uncertainty shows why it is necessary to clarify the Urban Living Lab framework.

Chronéer, Stahlbrost, Habibipour (2018) identified the following as the

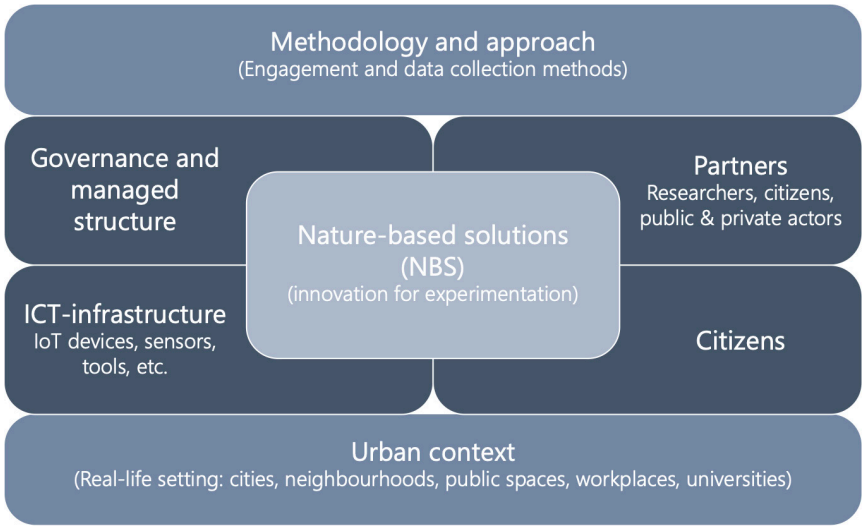
Table 4.2-1 Urban Living Lab (ULL) definitions by literature

Author	Year	ULL definitions
Westerlund and Leminen's	2011	A "virtual reality or a physical region" in which different stakeholders form public-private-people partnership acting in a real-life contexts.
Juujärvi and Pesso	2013	An Urban Living Lab can be seen as a special type of regional innovation network that puts emphasis on residents and their communities as users.
Nevens et al.	2013	An Urban Transition Lab as the locus within a city where (global) persistent problems are translated to the specific characteristics of the city and where multiple transitions interact across domains, shift scales of operation and impact multiple domains simultaneously (e.g. energy, mobility, built environment, food, ecosystems). It is a hybrid, flexible and transdisciplinary platform that provides space and time for learning, reflection and development of alternative solutions that are not self-evident in a regime context.
Juujärvi & Pesso	2013	A physical region in which different stakeholders form public-private-people partnership of public agencies, firms, universities, and users collaborate to create, prototype, validate, and test new technologies, services, products, and systems in real-life contexts.
Gaiddon et al.	2013	ULL are vehicles to foster communication in public space.
Baccarne et al.	2014	ULL is a cooperative apparatus that allows the co-creation of sustainable innovations, that can continue to be innovative in the future and that can improve the city environment by supplying Smart City targets.
Friedlich et al. Lund and Juujärvi Bulkeley et al.	2013 2015 2016	A ULL is a forum for innovation, applied to the development of new products, systems, services, and processes, employing working methods to integrate people into the entire development process as users and co-creators, to explore, examine, experiment, test and evaluate new ideas, scenarios, processes, systems, concepts and creative solutions in complex real contexts.
GUST	2015	ULL can be seen as a phenomenon by which forms of innovation and experimentation are being marshalled as a means through which to govern particular (urban) conditions.
Juujärvi and Lund	2016	ULL provide a promising approach to redefining and tackling complex social and economic issues, that characterise urban areas, in novel ways by enabling bottom-up innovation with various actors. The successful management of a ULL combines bottom-up and top-down approaches.
Voytenko et al.	2016	ULL aim is to bring together different actors involved in the urban environment in new ways to create more cooperative and experimental ways of "doing" urban development.
Buhr et al.	2016	ULL definition change as different traditions have different ideas on the level of involvement in decision-making residents should have.
Nesti	2017	ULLs represent a good example of methodology based on co-production and aimed at coping with policy challenges occurring at the local level.
Chronéer et al.	2018	The components that constitute a ULL are: a novelty to experiment with; citizens to engage; various methods to engage stakeholders and data collection; a clear management and organizational structure of the Urban Living Lab; the right infrastructure to support the real-life experimentation; different partners with stable and dynamic relationships.

six main components that constitute the ground of a Urban Living Lab (figure 4.2-1):

1. A novelty to experiment with;
4. Citizens to engage;
5. Various methods to engage stakeholders and data collection;
6. A clear management and organizational structure of the ULL;

Figure 4.2-1 Chronéer, Stahlbrost and Habibipour's six components that constitute the ground for Urban Living Labs



7. The right infrastructure to support the real-life experimentation;
8. Different partners with stable and dynamic relationships.

The components abovementioned are not enough to ensure a successful Urban Living Lab, these are only needed in order to set up and manage it properly. Again the need of a clear objective raises in order to have high chances of success.

From the literature can be seen that the objective of Urban Living Labs is to help the sustainable development process of urban environments on a long-term basis, this to create value for its stakeholders. Furthermore, it needs to be considered that the challenges to be found in an urban environment spread on three different levels: global challenges e.g. urban resilience to climate change; common challenges e.g. greenspaces; local challenges e.g. flooding. As challenges on the three levels differ a lot, also the Urban Living Lab needs to carefully consider what level of challenge it is facing, this is needed in order to better define the appropriate actions to implement considering the possible outcome also on the other levels. This wider point of view Urban Living Labs have results to be the opposite of what happens in a Living Lab, where all of the innovation is aimed towards individuals rather than towards the city and the sustainability on a overall scale. This results in a more complex work for the Urban Living Lab, as when a local challenge is faced the actions aim more or less indirectly in solving the global challenge as well.

Linked to this concept of local, common an global changes another difference between Living Labs and Urban Living Labs can be seen. While Living Labs are mobile and dynamic, Urban Living Labs are strictly connected to the place where they are activated. This strict correlation with the environment allows a better engagement with the possible stakeholders as citizens feel more aware on the issues to be faced with it.

Citizens themselves have a different role in a Urban Living Lab other than the one they have in a Living Lab. In a Living Lab the outcome is something to use, and thou citizens are users, while in Urban Living Labs the outcome can be how citizens are affected by the solutions implemented in the urban environment (e.g. a street closure have no plain user, but citizens have a better experience of the urban environment and they have been positively affected by the intervention). The active participation in the co-design of the urban environment in which they live allows citizens to be empower by the process, this as they get the chance to be engaged in their living space, they become more responsible about what happens around them and they get the opportunity to take action to solve issues that might affect them.

When taking into account all the definitions given to Urban Living Labs and the six key components, the definition of Urban Living Lab given by Chronéer, Stahlbrost and Habibipour (2018) suits:

"ULL is a local place for innovative nature-based solu-

tions that aims to solve urban challenges and contribute to long-term sustainability by actively and openly co-constructing solutions with citizens and other stakeholders" (Chronéer et al., 2018).

The nature-based solutions concept, as defined by the IUCN (International Union for Conservation of Nature):

"Actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits" (IUCN).

adds to the bottom-down and top-up concept by Juujärvi and Lund (2016), the idea that it is possible to use nature to solve certain problematics linked to the urban environment. This concept becomes handy when the issues that citizens wants to tackle are related at the well-being of a certain area, meant as possibility to have aggregation spaces and a more liveable idea of the neighbourhood. From this set of definitions it is also possible to see how Urban Living Labs can be strictly related to co-design, as their purpose lays in implementing the urban context on different levels to create a better space for living in the present and in the future for citizens and other stakeholders. It is to notice that nature-based solutions are just one of the possible ways to trigger urban transformations to have better liveable spaces. Indeed, most of the time it is difficult, due to timings or budget issues, to implement nature-based solutions.

4.3 Discussions about Urban Living Labs

Despite a wider usage of Urban Living Labs, even though there is still no common definition, some concerns about them can be found in literature.

Urban Living Labs promise a completely inclusive participation through the decision-making process, but there is the need to keep an eye on the possibility of having an 'organised irresponsibility' (Beck, 1998) when Urban Living Labs are set-up. This can take place because participants might think in selfish ways and might not have enough knowledge about the topics to be tackled by the Urban Living Lab. To avoid this 'organised irresponsibility' there is the need to held participants responsible for the outcomes produced by the Urban Living Lab itself, and this can be done - as further discussed by this thesis - by implementing the learning in loops concept within Urban Living Labs activities.

Kronsell and Mukhtar-Landgren (2018) point their attention on how there is the need to be careful when making interrelations with formal and institutional structures. This because Urban Living Labs structure are more flexible ones, and to gather positive results there is the need to have the Municipality - from the investigated area - participating as stakeholder to allow a better comprehension of how to implement urban transformation in the framework of the formal process.

Some other findings and studies then prove Urban Living Labs to give more benefits than drawbacks. A more inclusive study showed how Urban Living Labs can be considered as active sites where new ideas can be investigated, allowing an implementation and sharing of knowledge and where different solutions can be tested to validate different aspects of city challenges (von Wirth et al., 2018). Furthermore, Urban Living Labs' goal is not necessarily to transform, since often there are not enough resources to implement urban transformation - that are long term and expensive ones, and new actors might be needed to coordinate and carry out changes. This means that it is important to carefully consider Urban Living Lab context and participants, while trying to bound urban actors' expectations towards Urban Living Labs.

Other discussions about Urban Living Labs are linked to the issues that have already been found while talking about the participatory approach, this because Urban Living Labs are framework within which the participatory approach is applied. Such discussions where about the problems of how to in-

Table 4.4-1 List of the ULL examples analysed

Initiative	Enabling of the action	Year	Location
Pop-up Cleaning Day	Bottom-up	2012	Helsinki
Participatory Local Community project	Started top-down but begun bottom-up	2012	Herttoniemi
Manor House PACT	Top-down	2013-2016	London
iSCAPE	Research project	2016-2019	Bologna, Bottrop, Dublin, Guilford, Hasselt, Vantaa

volve everyone and how to include hard-to reach groups, and what if tackled topics are too specific. Such questions are still open to be answered, and some of these issues found an answer within the Looper co-creation process that is further explained within this thesis.

4.4 Urban Living Lab examples

Not many examples of 'official' Urban Living Labs can be found in literature as the definition of them is still uncertain. Furthermore, throughout the many Living Labs activated in Europe some actually can be framed as Urban Living Labs. This because the idea of involving citizens and other stakeholders to solve urban issues is becoming more and more an hot topic, and various case studies can be found nowadays showing some possible positive and avoidable practices to take into account when talking about this idea of moving from Living Labs to Urban Living Labs.

At the same time some bottom-up approaches can be seen in literature showing how different can the outcomes of an Urban Living Lab be depending on who activated it. When it comes to the bottom-up approach the process is different as citizens gather themselves around a topic, an in a second moment the Urban Living Lab is activated as policymakers and other stakeholders are called to participate by citizens.

This is the opposite of what happens with Urban Living Labs activated by research projects, or with a top-down approach, as everything is framed and then citizens are called to participate using different engagement methods.

Here in table 4.4-1 two examples of bottom-up initiatives and two research projects concerning Urban Living Labs are analysed to better frame the process that there is behind it. These four examples of Urban Living Labs, all starting from different stakeholders, have been chosen - i.e. bottom-up, top-down that evolves in a bottom-up movement, top-down and research project. Furthermore it is possible to analyse how a different begin in the process lead to different results, more or less positive.

Pop-up Cleaning Day

The idea raised by a status update on Facebook by an activist asking if someone was interested in arranging a 'recycling day'. Starting from this idea a group of active people started developing a platform for citizens to transform Helsinki into a flea market for one day (figure 4.4-1 and table 4.4-2).

The online platform was implemented to have a better map of where the stands were and what they sold and stand owners identities were verified to have a more secure online environment. The Facebook page allowed to scale-up the size of the event as linked organisers with volunteers. Some participants also produced a 'how to' guides, price tags for the stand owners and recorder promotional videos for the event to post online.

During the first event the website mentioned the need of official permit to have a stand, but it was mostly asked people to choose a spot and to do not cause any damage to the chosen location. For the second event an agreement was found with the Public Work Department, by registering on the online interactive map on the official website the permit was gathered. This joint forc-

es work between the Public Works Department and the organisers was due to the positive impact of the first event.

This experience ended up in being a great example of bottom-up raised Urban Living Lab. This can be said because in the following years the experience continued, ICT tools were further developed, and the number of participants - both creating stands and participating - improved significantly. This Pop-up Cleaning Day is a clear example of how, if the topic is of interest for citizens, bottom-up initiatives - supported by a bottom level - result in being more successful than most traditional top-down ones.

Figure 4.4-1 Pop-up Cleaning Day

Participatory Local Community project

This project was a study on the sustainability of glocal everyday life through new planning approaches i.e. e-planning, time planning, community development, co-governance. This project started with a top-down initiative but, as the participation was enhanced successfully, it transformed into a bottom-up initiative as residents actively participated not only in the planning process but also in the production of urban space (figure 4.4-2 and table 4.4-3).

This reversing from top-down to bottom-up approach only took place when the second phase of the local development begun. When the second phase started some active residents expressed their will to open a website for local management and communication. To do so researchers provided digital and internet-based tools to be embedded in the website. The process was transformed in e-planning and the digital platform allowed a wider participation bringing citizens in charge.

This example of Urban Living Lab did not start well, since involvement from citizens was not relevant as the experience started. Indeed, once citizens realised that they liked the topic, and they asked how to implement the experience by themselves, involvement raised within the neighbourhood. Furthermore, as citizens - and participants - implemented 'autonomously' an e-platform, there was involvement from also outside the neighbourhood. This somehow showed how, if citizens are the stakeholders to be involved, bottom-up initiatives are of greater success as they are more prepared in involving their peer.

Figure 4.4-2 Participatory Local Community project

Manor House PACT

The aim of the Manor House PACT was that of help in shaping a more sustainable future for the people living in Manor House in London (figure 4.4-3 and table 4.4-4). This project was part of the wider program of The Big Lottery Fund's Communities Living Sustainably, introduced to make climate change more visible and relevant across England.

The main goals reached during the three years project were: promotion of a range of pro-environmental behaviours including forest gardening, nature conservation, reduce waste and increase the capacity of community members to take action on climate change; reduce the effects of fuel poverty through a program of energy and water efficiency; providing a comprehensive employment, training and skill program helping people into work and self-employment; improvement of community wellbeing and addressing the social dimensions to climate vulnerability; creation of new community spaces for people to grow food.

Results from this experience showed how, even if stakeholders were clearly set, there was different involvement based on different stakeholders. In particular there was an over-representation of BAME (Black, Asian, Minority, Ethnics) backgrounds, an under-representation of employed people, an over-representation of unemployed people, an over-representation of females and a slight under-representation of people with a disability, resulting in poorer achievements at the end of the three years. This means that if topics and goals are set-up on a top-down basis, results are not going to be positive due to a lack of interest by citizens in the work done by the Urban Living Lab.

Figure 4.4-3 Manor House PACT

iSCAPE

The iSCAPE project aims to integrate and advance the control of air quality and carbon emission through the development of sustainable and passive air pollution remediation strategies, policy interventions and behavioural change

Figure 4.4-4 iScape

initiatives (figure 4.4-4 and table 4.4-5). It tackles the problem of reducing air pollution at target receptors with an innovative SME-led approach, focusing on the use of 'Passive Control Systems' in urban spaces. Improvements in air quality, microclimate and behavioural aspects of urban dwellers are achieved by applying real-world physical interventions on the urban tissue to alter ventilation rates and dispersion patterns for future climate change scenarios. Some applied interventions that were reached by the project were: estimation of the role of trees as a Passive Control System to control the air quality inside urban environments; application of photocatalytic coatings on a building to lower pollutants levels; temporarily green inner-city streets by using potted 'Wandering Trees'; providing evidence on the effectiveness of low boundary walls; how green infrastructural interventions (such as trees and hedges) can be used to combat pollution exposure; triggering and analysing behavioural changes, after providing data about their pollutants exposure, by providing a dedicated app; establishment of a platform for stakeholders to combine efforts for better city planning.

The iSCAPE project showed how Urban Living Labs can have a learning curve, but it was shown how an higher maturity level was reached within participants. A strong effort was made by researchers to enhance Urban Living Labs lives behind the project itself, and it was taught to participants the need of opening up multiple opportunities to allow the sustainability of the activity in following times. This example shows how having an external neutral Urban Living Lab organiser allows to have better long term results, that can be mostly enhanced if there is a strong bottom level.

Conclusion

After analysing the literature, and the different discussion on the advantages and disadvantages of Urban Living Labs, it was possible to state how a bottom-up approach is to be preferred to a top-down one. This does not mean that the process cannot start as top-down, indeed it means that there is the need to be flexible in the topics to be tackled, since if these are of wider interest of the bottom level then the Urban Living Lab is going to have higher involvement. Furthermore, if the process has a stronger bottom level results are going to last longer and there are more chances for the Urban Living Lab to continue in time.

Another found result is about ICTs (Information and Communication Technologies), that can be analysed from two different points of view when it comes to Urban Living Labs. In order to trigger a bottom-up approach it can be useful to take advantage of ICTs, this because they can simplify some procedures needed to keep the process going, but also because they can allow the involvement of some hard-to-reach groups and of some people that cannot physically participate at meetings or events organised by the Urban Living Lab. In the same way ICTs are necessary for wider scale projects, since they allow the distribution of a possible idea that might affect something more than a single neighbourhood. Moreover, ICTs can also be useful as they can be repository of the activities done within a Urban Living Lab, allowing its continuing in time without losing the knowledge gained until a certain point.

To conclude it is also possible to say that the co-design activity better works within the framework of Urban Living Labs, since co-design cannot be a completely democratic approach. Co-design needs to be developed within an environment that allows its success, and an Urban Living Lab can serve to this purpose due to its intrinsic trade-off nature. Indeed, within Urban Living Labs there are multiple stakeholders that work with a participatory approach, and to gather results from the co-design there is the need to find a meeting point between parties.

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Table 4.4-2 Pop-Up Cleaning Day summary

Items	Description
Spatial and temporal focus	Many parts of the city were engaged, but for only one day at time.
Interventions within action research	Bi-annual city-wide flea market event, Hackathon, tinkering with digital tools to support the event.
Actors	A group of friends; self-organised citizens; Public Works Department; public-private-people partnership; city authorities; entrepreneurs.
Research and enabling tools	Participatory observation; focus groups; interviews; website; interactive online maps; Public Works Department form; Facebook and other social media.
Outcomes	Continuation and dissemination; new permission model; collaboration with different partners.
Nature of co-governance	Informal meets the formal in the mixed sphere; lacking links to formal decision-making.
Intersection of self-organisation with urban planning	Through deliberation in the mixed sphere.
The role of ICTs in the intersection	Temporary appropriation of public spaces and branding new bottom-up places.
Production and use of space	Integration of planning processes with everyday life. Lacking links to decision-making. Multiple ICT-assisted participations; self-organisation.

Table 4.4-3 Participatory Local Community project summary

Items	Description
Spatial and temporal focus	Long term development of the whole neighbourhood.
Interventions within action research	Several physical and socio-cultural interventions concerning urban planning and its implementation.
Actors	Self-organising citizens; Local Committee; Neighbourhood Assembly; Youth Centre; Service Centre for Elderly people; Local Council; politicians; public-private-people partnership.
Research and enabling tools	Participatory observation; focus groups; surveys; interviews; Urban Mediator; participatory e-planning methods; local website; social media.
Outcomes	Local, self-organising networks; building and managing the environment; service innovations; a neighbourhood yard; a new culture of shared governance; CI-tools.
Nature of co-governance	Co-governance as a deliberative system but weak links to formal decision-making.
Intersection of self-organisation with urban planning	Through deliberation in the mixed sphere.
The role of ICTs in the intersection	ICTs enhancing the actual planning process and the balancing of the formal, semi-informal and informal in various ways.
Production and use of space	Many small improvement, but conflicts with big solutions; new methods to plan, produce and maintain urban space.
Application of expanded urban planning	Integration of planning processes with everyday life, with planning and implementation; lacking links to decision-making; multiple ICT-assisted participations; self-organisation.

Table 4.4-4 Manor House PACT summary

Items	Description
Spatial and temporal focus	Neighbourhood area for a three years period of time.
Interventions within action research	New sustainable development of the area to improve the quality of life of residents.
Actors	Manor House residents; Big Lottery Fund; Manor House Development Trust; Transition Finsbury Park/Edibles Landscapes London; Groundwork London; London Wildlife Trust; Genesis Housing Association; Green and Castle.
Research and enabling tools	Surveys; interviews; local school projects; focus groups; outdoor work with groups of residents.
Outcomes	Residents most vulnerable to fuel poverty have better access to the physical and social resources they need to; residents are inspired and supported to work together; residents are more able to access the growing employment opportunities in the green economy and social enterprise sector; resident will make better use of their local outdoor environment to grow healthy food, live sustainably, exercise, gain employment and promote their health and wellbeing; two local sites are to be identified for public management which residents will be empowered and inspired to take responsibility for and participate in influencing its use.
Nature of co-governance	Co-governance did not take place, this because the process was a full top-down one were policymakers involved citizens only to educate them on a certain topic.
Intersection of self-organisation with urban planning	Resident s gave feedbacks in the mixed sphere. The only moment they deliberate about urban planning was when they were asked on where to position the spaces to grow food.
The role of ICTs in the intersection	ICTs were not used. Everything was done in a face-to-face way and only few surveys were undertaken using an online version combined with the paper one.
Production and use of space	Two local sites have been identified for public management by residents to grow food.
Application of expanded urban planning	No expanded urban planning.

Table 4.4-5 iScape project summary

Items	Description
Spatial and temporal focus	Six cities around Europe (Guilford, Bologna, Bottrop, Hasselt, Vantaa and Dublin) within a three years period of time.
Interventions within action research	Control of air quality and carbon emission to reduce their levels.
Actors	Citizens, policymakers, planners.
Research and enabling tools	Surveys; interviews; focus groups; workshops; low-cost sensors.
Outcomes	The integrated approach include the development and assessment of a framework aimed at changing the mobility behaviour of people by studying processes and dynamics that lead to more resilient, healthy, and sustainable cities, by bringing together theory from urban planning, public policy, urban and environmental sociology and urban geography
Nature of co-governance	Informal meets the formal in the mixed sphere; lacking links to formal decision-making.
Intersection of self-organisation with urban planning	Through deliberation in the mixed sphere. One of the interventions chosen should be experimented with the living labs.
The role of ICTs in the intersection	ICTs are used to gather data using low-cost sensors to enable a network of data, and to engage citizens to let them become more aware on the topic.
Production and use of space	Six cities are involved considering the whore area.
Application of expanded urban planning	The project aim is to be able to replicate the model within the whole European area.

5. THE LEARNING LOOP

The learning loop method is usually unrelated to the afore said processes. Within the framework of this research is therefore linked to the participatory process, to co-design and to Urban Living Labs since it brings something extra to the co-design process as it is usually meant.

During a co-design process users - or participants - give an input and then there is an application done by organisers. Learning loops can bring something more since participants are called to evaluate their inputs. This is mostly useful when co-design is applied by Urban Living Labs. This because when it comes to urban design, it is not possible to apply the 'validate and refine' (Mitchell et al., 2010) approach that is typical of the product design strategy and that can be found in Living Labs. The learning in loop method allows to restart the co-design process again with acquired knowledge, and it means that the learning acquired brings back the experience aspect that is usually lost when moving from Living Labs to Urban Living Labs.

The learning in loops also allows the cooperation of different stakeholders that usually would not collaborate. This working together happens because they find, in Urban Living Labs, a neutral ground where to share knowledge.

5.1 What is the learning loop

The idea of the learning loop is that of a feedback loop which aim is to increase the learning acquired by the users. The general workflow of a learning loop sees a first step during which assumptions are made and goals are set, then users are asked to build something by participating in activities, they later have to give a feedback on the work they have done and end the loop by giving feedback comparing what was the initial idea with what was actually implemented in the end. This concept was first developed by Argyris and Schön (1978) and it started with a first single-loop learning that was later on implemented with a double-loop learning to arrive at the triple-loop learning.

Single-Loop Learning

Single-loop learning is a concept by Chris Argyris and Donald Schön an the end of the '70s. They based their theory on the 'theory of action' perspective that was designed by Argyris (1957, 1962, 1964).

Single-loop learning (figure 5.1-1) is one kind of organizational learning process. In single-loop learning, people, organizations or groups modify their actions according to the difference between expected and reached outcomes. Meaning that, when something goes wrong or does not happen like we would like, most of us would consider how the situation could be fixed. Single-loop learning can also be described as the situation in which we observe our present situation and face problems, errors, inconsistencies or impractical habits. After observing we adapt our own behaviour and actions to mitigate and improve the situation accordingly.

There are few problems with single-loop learning. The biggest problem with it is that by acting in this way we only remove the symptoms, while root causes are still remaining. This will lead in having new problems in the fu-

Figure 5.1-1 single-loop learning

ture. Instead, it is needed to examine and find out the root causes and also challenge the underlying beliefs and assumptions. By using only single-loop learning the final result is to only make small fixes and adjustments. This is why a double- and triple-loop learning is needed, and these will be later better explained and analysed.

The other problem with single-loop learning is that it assumes that problems and their solutions are close to each other in time and space. However, this is not generally true. In this kind of learning, individuals or groups are primarily observing their own actions and methods. This will lead to small changes in specific practices, behaviours or methods which are based on what have or have not been working before.

In conclusion, it can be said that single-loop learning is an operative level.

Double-loop learning

Double-loop learning is, as well as single-loop learning, a part of 'a theory of action' designed by Chris Argyris. Single-loop learning is characterized by the concept that we changed our action or behaviour to fix or avoid mistakes. Whereas, in double-loop learning it is also corrected or changed the underlying causes behind the problematic action.

There could me many different underlying causes, e.g. organizational norms, policies, ways to work or individuals' motives, assumptions or even informal and ingrained practices which prevent inquiry on these causes.

In double-loop learning (figure 5.1-2) participants and stakeholders are forced to think about their actions in the framework of their operating assumptions. That is an important point because they need to start thinking and analysing their own processes. Participants and stakeholders should ask themselves 'what is going on here?' and 'what are the patterns?'. These information are to better understand the pattern. Double-loop learning will lead to deepen understanding of the assumptions and better decision-making in everyday operations. It is also need to notice that double-loop learning leads to organizational learning. That is an important point, as organizational learning is one of the most important factors in modern processes. In order for double-loop learning to work, three basic skills are required in the process:

- self-awareness:
- honesty;
- taking responsibility.

At first self-awareness is needed to identify what is often unconscious or habitual. After that honesty is needed to recognize mistakes and discuss with other people to find out and establish root-causes. Finally is need for stakeholders to take responsibility for how to change action or methods and how to learn from the incident. Chris Argyris himself has described the process of single and double-loop learning in the context of organizational learning as follows:

> *"When the error detected and corrected permits the organization to carry on its present policies or achieve its presents objectives, then that error and correction process is a single-loop learning. Single-loop learning is like a thermostat that learns when it is too hot or too cold and turns the heat on or off. The thermostat can perform this task because it can receive information (the temperature of the room) and take corrective action. Double-loop learning occurs when error is detect-*

Figure 5.1-2 double-loop learning

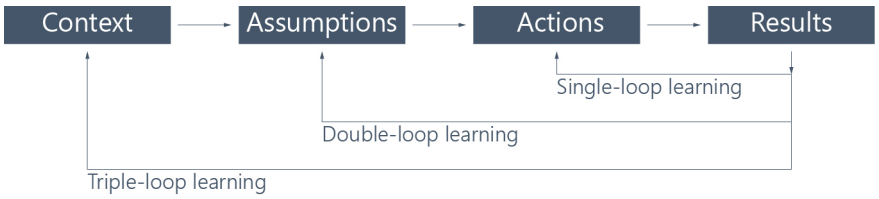

Figure 5.1-3 triple-loop learning

ed and corrected in ways that involve the modification of an organization's underlying norms, policies and objectives"

In summary, by using double-loop learning the underlying assumptions behind the actions and behaviour are examined, and there is learning from those mistakes and incorrect methods. By doing this it is possible to remove the root causes that makes stakeholders behave or act in a certain, poor or costly way.

While single-loop learning was more like an operative level, double-loop learning is rather a tactical level. This concept of a tactical level within the double-loop learning will be found afterwards when reaching the second loop within the Looper co-creation process, as in the second loop the organisers approach towards participants is changing from a 'tactical' point of view.

Triple-loop learning

The origin of the triple-loop learning is not as well-known as the one of single- and double-loop learning. It is clear that triple-loop learning is inspired by Argyris and Schön, but the term does not appear explicitly in their published works. In triple-loop learning (figure 5.1.-3) stakeholders learn how to learn by reflecting on how they learned in the first place. In this kind of learning organizations, individuals or groups should reflect on how they think about rules and not only think that rules should be changed. Triple-loop learning helps stakeholders to understand more about themselves or their organization. One definition for triple-loop learning is 'double-loop learning about double-loop learning'.

Triple-loop learning focuses on the ability to utilize both single- and double-loop learning. It challenges existing learning framework as well as models and assumptions. The learning goes beyond insight and patterns to context. With triple-loop learning it is possible to known new ways of learning and new commitments.

This kind of learning challenges stakeholders to understand the overall picture and how the problems and solutions are linked together even when separated widely by time and place. It is also important to notice that with triple-loop learning stakeholders should able to understand how their previous actions created the conditions that led to current situation and problems. Organizations can benefit from triple-loop learning in many ways:

- The relationship between organizational structure and behaviour will change fundamentally because the organization learns how to learn;
- Organization learn new ways to comprehend and change its purpose;
- Organization get a better view of understanding of how to respond to its environment;
- Get a deeper comprehension of why organizations chose to do things they do.

While single-loop learning is all about correcting errors without questioning underlying assumptions, and double-loop learning detects errors, questions underlying assumptions behind the actions and behaviour and also learn from these mistakes, triple-loop learning is operating at a higher level; it develops the organization's ability to learn about learning.

5.2 The evolution of the learning loop

When talking about the learning loop process there is the need to remember that there have been a shift from the single- and double-loop learning, as defined by Agyris and Schon (1978), towards the definition of organizational learning given by Garrant (1987). The organisational learning term was then

Table 5.2-1 academia's definition for Organizational Learning

Researchers	Years	Organizational Learning Definitions
Senge	1990	An organization where people continually expand their capacity to create the results they truly desire and continually learn how to learn.
Pedler, Burgoyne and Boydell	1991	An organization that facilitates the learning of all of its members and continually transforms itself in order to meet its strategic goals.
Garvin	1993	An organization skilled at creating, acquiring and transforming knowledge. Also skilled at modifying its behaviour to reflect new knowledge and insight.
Marsick and Watkins	1993	An organization characterised by continuous learning for continuous improvement. Also characterised by the ability to transform itself.
Gephart *et al.*	1996	An organization in which learning process are analysed, monitored, developed, managed and aligned with improvement and innovation goals.
Pedler *et al.*	1997	An organization that facilitates the learning for all its members and consciously transform itself and its context.
Marsick and Watkins	1998	An organization that emphasises three keys: system level, continuous learning; created in order to create and manage knowledge outcomes; which lead to the improvement in the organisation's performance, and ultimately its value.
Dowd	1999	A group of people dedicated to learning and improving forever.
Rowden	2001	An organization in which everyone is engaged in solving problems, enabling the organisation to continuously experiment, change, improve and increase its capacity to grow, learn and achieve its purpose.
Armstrong and Foley	2003	An learning organization is a consciously managed organisation with learning as a vital component in its values, vision and goals as well as in its everyday operations and their assessment

by Senge (1990). In table 5.2-1 it is shown the different definitions given by academia in the past three decades to better understand what is the meaning now.

As it is possible to understand from the definitions, the organisational learning, as well as the single- and double-loop learning, idea is closely linked to the enterprise field. Within the different definitions it is possible to notice how changes are only minor ones, and the basic concept did not change since the '90s. The most fitting definition of organisational learning when applying it to different fields is then the one given by Rowden (2001) as it considers the possibility of having everyone engaged to solve problems to enable a continuous experimentation to achieve goals.

The main thing for the development of the improved co-creation method is then to consider the double-loop learning process as applied to the stakeholder system as if it was an enterprise. If different stakeholders groups are considered as branches of an enterprise is then possible to allow and evaluate the knowledge exchange and storage. As the different definitions always consider organisational learning as a tool to share knowledge for improvement is then easier to translate the idea and process from one field - e.g. management - to another - e.g. urban planning.

Conclusion

Urban Living Labs lost the 'validate and refine' (Mitchell et al., 2010) approach since it is not possible to validate solutions within the framework of urban transformations, since these implementations are of too long terms. To complete a transformation in a build environment it can take years, if not decades, and data about the change can only be acquired after a certain period of time after its completion. This inability of validating and refining then means, within Urban Living Lab, that there cannot be defined and univocal solutions, and consequently that there cannot be immediate solutions. On the other hand this means that there can be multiple successful solutions in urban co-design, and it is possible to evaluate which is the most feasible solu-

tion by doing multiple learning loops.

Since Urban Living Labs only keep the 'sense and mold' (Mitchell et al., 2010) approach of Living Labs, the application of the learning loop concept allows to restart the activities with an higher knowledge basis, that brings the 'validate and refine' approach back into Urban Living Labs.

The goodness of implementing the learning in loops concept to the co-creation process will be further discussed in the following parts of this thesis.

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2

THE LOOPER CO-CREATION METHODOLOGY

PART 2
THE LOOPER CO-CREATION METHODOLOGY

6. OVERVIEW AND CONSIDERATIONS ON THE RESEARCH METHODOLOGY

6.1 Methodological approach of the research work

Technologies for architecture can be seen both in a traditional way - e.g. materials - and in a more complex and wider view - e.g. methods to solve city issues by new ways of designing and with new tools. Since modern urban environments are getting more and more complex, designers are asked to work in a more interdisciplinary way to face multiple challenges that can influence urban transformations. In this framework the participatory approach is becoming more and more important, despite the critiques, meaning that designers and policymakers have to consider different stakeholders' points of view and wills before proposing new solutions.

To allow this (almost) comprehensive sharing between designers and stakeholders, the co-design method have been developed and implemented in the past decades, and tries to put together all stakeholders desiderata to reach more feasible solutions. Co-design is applied in a wide variety of frameworks, but one solution is that of having it within Urban Living Labs where - thanks to the presence of organisers - it can be easier to propose feasible solutions and a better dialogue between the parties thanks to the presence of organisers. Still, simple co-design within Urban Living Labs is not sufficient to reach the best solutions, and sometimes can result in unfeasible ideas because participants might not have the full picture, or might propose impractical ideas since they are not called to answer for it. Because of it the learning loop approach can help within the process, as it allows the evaluation of the work done, but it needs to be applied to a more comprehensive process and not only to the co-design activity.

Starting from this, the Looper methodology hereby described shows a possible way to face city challenges, that have been studied by many academics (Kahn, 2006; Soule, 2006; Bullard, 2007; Couch *et al.*, 2007; Glaeser, 2011), and how to design urban transformations. This methodology triggers a co-creation process within a Urban Living Lab framework, and it uses different methods - as co-design and learning loop - to implement feasible solutions, shared by different stakeholders, that can solve such issues. To do so, stakeholders work together throughout a three stages process, that is repeated in loops to refine the implemented - or implementable - solutions by monitoring them in an open participated way with quantitative and/or qualitative data. Depending on the tackled challenge each loop can last months or years.

As described in the introduction, to test and 'operationalise' the Looper Methodology my work follows a practice-led approach. Nevertheless in this Part of the thesis, the methodology of the Looper co-creation process in its whole is analysed as it has been the means by which I could test out the theoretical aspects of my research. While looking for the best methodological approach to apply within my work, one key point that I considered was the 'usability' of cultural settings and contributions to the means of the research. This because nowadays reality can be quite complex and there can be many different point of views, meaning that researchers need to set the best ground to allow stakeholders - and stakeholders' social actions - to be visible within the decision-making process. Therefore, considering all of the above, for the means of the research, a social constructivist perspective has been followed.

This structuralist approach is been used to take a photograph of the current state of reality and to collect initial data, but it then evolved throughout a more complex situation given the practical aspect of the work itself, allowing the use of social capital to produce action (Lin, 2001). Furthermore, the whole work has a participatory aspect that is based on the idea that knowledge is developed through interactions between stakeholders, and this knowledge is the one that builds up the reality within which to work (Kim, 2001; Taylor, 2018).

Indeed, to better understand why this perspective was chosen, it is necessary to briefly explain it. The central idea is that both human learning and knowledge are constructed through social interaction (Berger, 1966), and that this knowledge is a shared experience rather than an individual one (Vygotsky, 1978). Furthermore, it allows to study how the development of knowledge is done through the interactions that individuals have within others. Therefore, it is possible to say that truth is constructed by social processes, and is historically and culturally specific. Moreover, as Archer, (1995) states with her elionist theory, individuals both shape society and are shaped by it, reinforcing the need to study the socio-historical-cultural context to understand reality. This is one key point for the research, since the study and practical work for this enhanced co-creation process has been done analysing three different socio-cultural-economical contexts - that are the three case studies of Verona, Manchester and Brussels from the Looper project - meaning three specific base conditions. The social constructivist approach then allows to emphasize the social contexts of learning, and anticipates that knowledge is mutually built and constructed.

In other words, there are specific assumptions about reality, knowledge and learning. This further means that is believed that human activity constructs reality, and members of a society are the ones that invent the characteristics of the world itself (Kukla, 2000). Moreover, there is no prior existing reality, there only is the one that is created by historically and culturally specific events. This explains why the socio-cultural context in which a co-creation process is triggered needs to be carefully considered. It is not possible to apply in exact same way a co-creation process, since every time the real world changes based on previous events.

Talking about knowledge, this as well becomes a product of humans. There is no pre-existent knowledge, as it is again constructed by its socio-cultural environment (Ernest, 1999; Gredler, 1997; Prat & Floden, 1994). The interactions that individuals have within others, and with the environment, are the ones creating meaning and knowledge. This justifies why in a more complete co-creation process stakeholders need to participate to every step to bring their knowledge on the table. The more knowledge at stake, the better are the results.

Learning therefore is again a social process. This implies that it does not take place within individual and that the learning aspect is not some sort of passive development of behaviours shaped by an external force (McMahon, 1997), but it can only occur when individuals are engaged in social activities. Thus, to gather knowledge from the learning it is necessary to also have it in a shared environment - as Urban Living Labs, not to disperse it. Indeed, it is possible to gather even more knowledge on the changing - and perceived - real world by using the learning in loops concept, that is based on the concept that the learning and knowledge gathered from a first loop can build the basis to increase knowledge during further loops.

Consequently, the ontological and epistemological worldview that are considered by the research work are also based on the social constructivism ones (Saunders *et al.*, 2015). My position is then an idealist, stating how reality can only be understood by socially constructed meanings and by human mind, and interpretivist - or to better say a constructivist - one, that identifies the basic principle that reality is socially constructed, and further state that there is no external reality independent of human consciousness (Robson, 2002).

This idealist position is opposite to the realist and materialist ones - as defined by Snape and Spencer (2003), where the fist states that there is an external reality independent on people's thinking and understanding, and the

latter one that accepts the presence of an original world as in realism, but only considers as real the material and physical part, while phenomena as values or experiences are caused by the real world but do not shape reality. This idealist position allows to better understand the differences that arise from different contexts. Examples of this are brought by both Putnam (1993), that talks about the case study Italy, and Rifkin (2004), that speaks of Europe. Putnam (1993), while talking about Italy undertakes an historical and cultural analysis explaining how Italy is not divided between North and South - as usually in stereotype, but it is rather divided between the mostly industrialised area - Lombardia, Veneto, Emilia-Romagna and Marche - and the rest of the country. This can be explained due to strong historical indicators that forged a different reality and social environment compared to other parts of Italy. In some similar way Rifkin (2004) explains how the European reality is different from the rest of the World since European individuals find security not through accumulation of wealth but through the society's inclusive environment based on sustainable development, cultural diversity, respect for human rights and peaceful coexistence.

Subsequently, the worldview cannot be a positivist one, but - as the social constructivist term already tells, - the epistemology here is the constructivist one. Given that an interpretivist perspective is followed, it can be noticed how it is possible to refer to it with both the constructivist or naturalistic terms, even if some scholars (Guba and Lincoln, 1994) say these terms are used in an inconsistent way to refer to interpretivism - nevertheless is now easier to find constructivism or naturalistic as widely accepted terms.

To sum up, the reality in which my research is framed is the one given by the socio-cultural context where my practice-led research is done. This means that reality is made from the project areas where the Looper project is undertaken. Furthermore, the valid knowledge is both the one shared by different stakeholders - i.e. qualitative data - and also the one given by the urban environment that needs to be transformed - i.e. quantitative data.

Given what abovementioned, the reason why this methodology part explains the Looper co-creation process, is due to the decision of using practice-led research to prove the benefits of the theory in its application in real urban environments. This is further supported by the perspective that I have, that sees the world in which the co-creation process is applied as defined by the social, historical and cultural processes and events that happened in a specific environment. Moreover, it defines as acceptable, valid and legitimate base knowledge the one that is developed through interactions that individuals have within others.

6.2 Tools and methods of the Looper Methodology

In order to reach feasible solutions for urban transformations different tools and methods are used to collect quantitative and qualitative data, that are needed to create knowledge and awareness on the existing socially constructed reality. Qualitative and quantitative data are both needed since they are interconnected. Quantitative data can be used to support qualitative data findings, and furthermore can help to overcome misunderstandings between parties. It is needed to use both data to trigger changes in the urban environment. Some of the tools and methods can be used by researchers - and organisers - to gather knowledge on the constructed reality, that creates a framework in which to work, others are participatory sensing ones to boost the knowledge and perception that individuals have about the reality where they live in, and some can be of shared use to develop even more knowledge. Possible tools and methods that can be used within a co-creation process are: face-to-face meetings; surveys; interviews; official sensors; low-cost sensors; online platforms; co-design offline and online tools; evaluation tools. It is important to understand how methods and tools are to be carefully chosen depending on the reality framework. To better understand some of the tools a section specifically about technologies can be found at the end of this part, while in 'Part 3 - Application of the Looper co-creation methodology' there is a better description of the methods and tools used in two different contexts. Further discussions about the usage of different tools and methods is in 'Part

4 - Critical reflection on the Looper co-creation methodology and its tools'. It is important to remember that here only some tools and methods are expressed, as others can be found and/or found depending on the socio-cultural environment in which the co-creation process is implemented.

6.3 Research target groups and stakeholders

Here a clarification about the term stakeholders is to be made. As Appadurai (1998) suggested, stakeholders' group raise and change during different historical and cultural times as they spread and aggregate like 'dust' depending on the addressed topic and the events that are taking place at the time. This then allows to consider citizens as stakeholders, while for most researcher this cannot be considered as possible.

Further consideration about this research concerns how existing terms and concepts have been used and improved. The 'Glossary' at the end of this work shows some (already known) terms that are better framed based on the experience gathered during this practice-led research. Here a short preview of some stakeholders for whom the Looper co-creation methodology might be addressed is show to better understand what is meant when there is a mention about different stakeholders within the text, but others can be invited to participate when setting up another co-creation process:

- Citizens: considering the application of this co-creation process to issues and challenges linked to the urban environment each citizens is a possible stakeholder. Citizens here can be considered as stakeholders as they are able to groups themselves to bring up common interests. Within the main group of citizens it might happened that only some specific subgroups might be involved. If the work considers only a neighbourhood, not every citizens might be asked to participate, maybe only residents of the neighbourhood are asked to participate.
- City Council: as this thesis and handbook wants to analyse the co-creation methodology applied to solve urban issues and challenges, it is mandatory to implement in the stakeholders' group of the city council. This is of extreme importance when it comes to the implementation of the proposed solutions because the council employees and policymakers are the ones that can allow, and help, in the implementation. People from city councils might aggregate and become stakeholders based on various interests, not necessarily traditional ones (e.g. their specific office).
- Final users: there can be individuals - or groups - that gravitate around the project area, but that cannot be classified as citizens since they not live within the area itself, and it is possible to consider them as final users. This means that a final user is a person - or organisation, or group of people - that uses an area or a service that is located within the project area.
- NGOs: when it comes to work on issues and challenges linked to the environment, it might be useful to involve at least one NGO or a structured volunteer association. This is due to the catchment area that they can cover for the dissemination of the project, but also for the capability to interact with city councils and official bodies that is due to their more formal structure compared to citizens associations.

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7. FROM CO-DESIGN TO CO-CREATION

Usually in 'traditional' co-creation processes, co-design is used as the only participated activity within the co-creation process itself, leading to a mis-use of the term co-design as synonym of co-creation. Looper, on the contrary, uses co-design as one of the activities of the co-creation process, and because of this it is possible to talk about a full co-creation process. Furthermore, its application to Urban Living Labs, and its combination with the learning loops idea, allows the evolution towards a more complete co-creation process that involves different stakeholders, including final users and citizens, since the beginning of it.

The learning loop aspect of the process is the aspect that actually triggers the switch from co-design to co-creation, and for each co-creation stage it is possible to match a learning stage (figure 7-1), each of which takes place for every loop.

The first learning stage creates awareness about urban issues and about the status of problems of their neighbourhood throughout some consciousness activities. This first stage of learning starts then by focusing on the scoping of issues, done during the Urban Living Lab meetings, and allows participants to start learning what others perceive as issues, which matters are real or perceived, and which of the issues are most relevant. The learning then moves towards the application of what was previously learnt in order to organise the data collection activity, done by using a crowd-sourcing approach. Once the data collection is completed, with the data visualisation other skills are acquired by participants as they are called to analyse the data they collected by using the online interactive geo-platform where all data are stored and shown with a user-friendly interface (described in 'Part 4 - Critical reflection

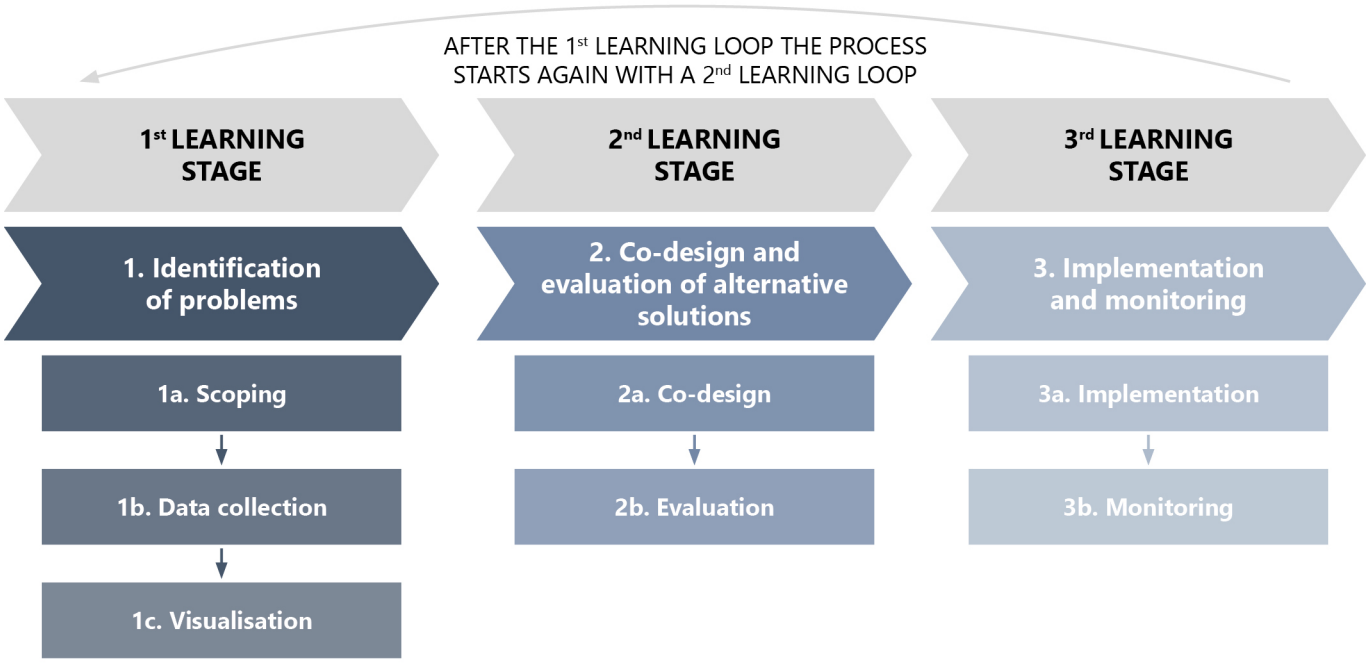


Figure 7-1 Looper co-creation process schema and learning stages

on the Looper co-creation methodology and its tools' chapter '19.2 Data visualisation and collection platform design').

The second learning stage covers the activities of co-design of possible urban improvement solutions and the evaluation of what solutions are worth to implement. The strength of this co-design activity is that participants - final users, citizens, policymakers, NGOs, city council employees and every other stakeholder - are asked to work together, with the idea of doing this participated design activity starting from the knowledge they gathered while collecting specific data on the environment for what they are proposing ideas. Having all the stakeholders working together allows to have a more open dialogue and to obtain feasible, effective and sustainable solutions. Here the learning is linked to the sharing of knowledge that is triggered by having people with different socio-cultural-educational backgrounds and different points of view collaborating. The stage moves then to the evaluation activity where each of the solutions chosen by participants are assessed by using different methods - i.e. multi-criteria analysis (MCA) and multi-actor multi-criteria analysis (MAMCA), further explained in following sections - to have a more formal evaluation. The usage of a formal analysis method that refutes the solutions, or prove them wrong, allows participants to consider every aspect and to learn something more about what can be feasible in a urban environment - citizens' learning - or what is considered as important - policymakers' learning.

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

Furthermore, the co-creation process based on the Urban Living Lab and the learning loop methods, 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 that citizens have when talking about urban issues, leading to a form of inertia when improvement measures are applied by public administrations.

The latest aspect that allows to move from co-design towards co-creation is the responsibility participants need to take when moving from one loop to another - within the Looper project we talk about the shift from the first to the second loop. Participants are more willing to be involved in a considerate way if they know that they will be called to assess themselves through the evaluation of the results obtained after the implementation of the selected ideas, meaning that throughout the whole co-creation process they are more participative and more attentive to what others have to say. This final evaluation also allows a more cooperative process between participants that usually are from different stakeholders groups that in other situations tend to be in contrast.

The application of all these solutions then allows to move from a co-design method to a more complete co-creation methodology. The full co-creation process then needs to: trigger some form of learning throughout every activity; have the participatory aspect since the beginning of the decision-making process, and not from the co-design as it usually happens; oblige participants to evaluate the work they have done and the decisions they took.

In the next sections the theoretical aspect of each stage, and each activity within the stages, will be explained. In 'Part 3- The application of the Looper co-creation methodology' the application of the co-creation method to real case studies will be explained.

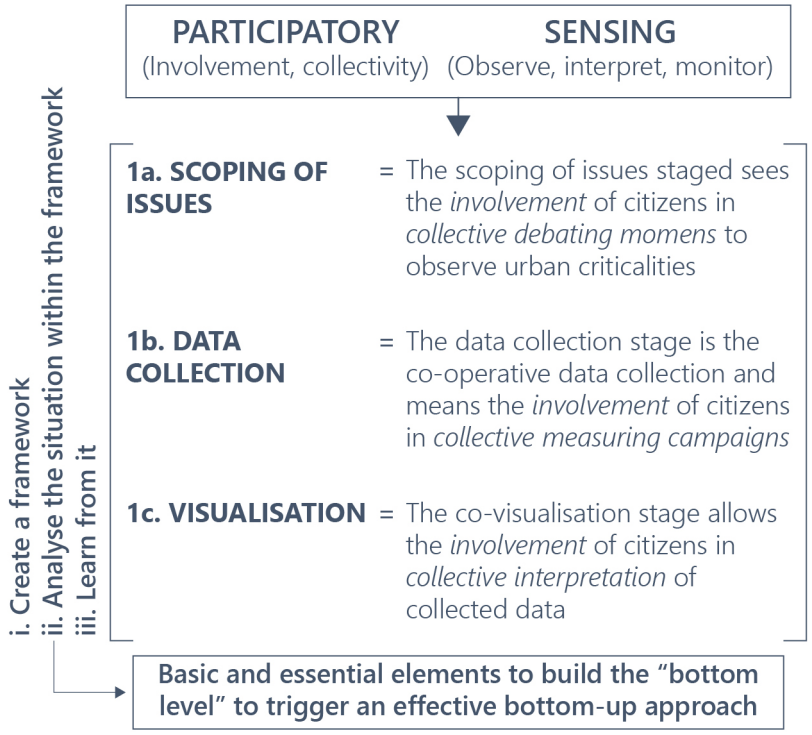
7.1 The empowerment of the bottom level

This learning side of the co-creation process, as described up to now, 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.

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 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 7.1-1 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 it is possible to say that each of the activities done during the first stage are able to give knowledge, allowing the development of participatory sensing within a community, that improves the co-creation process. During the scoping of issues activity, citizens are able to collectively interpret and create a framework within which to work, and this collective choosing allows a deeper feeling of involvement without which it would not be possible to trigger a bottom-up approach. During the co-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 7.1-1 participatory sensing activities schema



8. THE LOOPER CO-CREATION METHODOLOGY

Citizens are starting to ask for a change from urban sprawl (Soule, 2006; Couch *et al.*, 2007), that in past decades was the main urban transformation within cities, towards more pedestrian scale communities, that can suite a more diverse population with a better mixed use of the land. Until now smart growth was considered to be the solution to urban sprawl, but it mainly leaded to gentrification and displacement of low- and moderate-income residents within existing neighbourhoods, and it further isolated such part of population with wrong transport policies (Bullard, 2007). In addition to urban sprawl issues, some other questions raised on how to deal with different environment challenges raised by the wrong growth of cities (Kahn, 2006), always keeping in mind that the widely held idea is that city is the greatest creation and hope for the future (Glaeser, 2011).

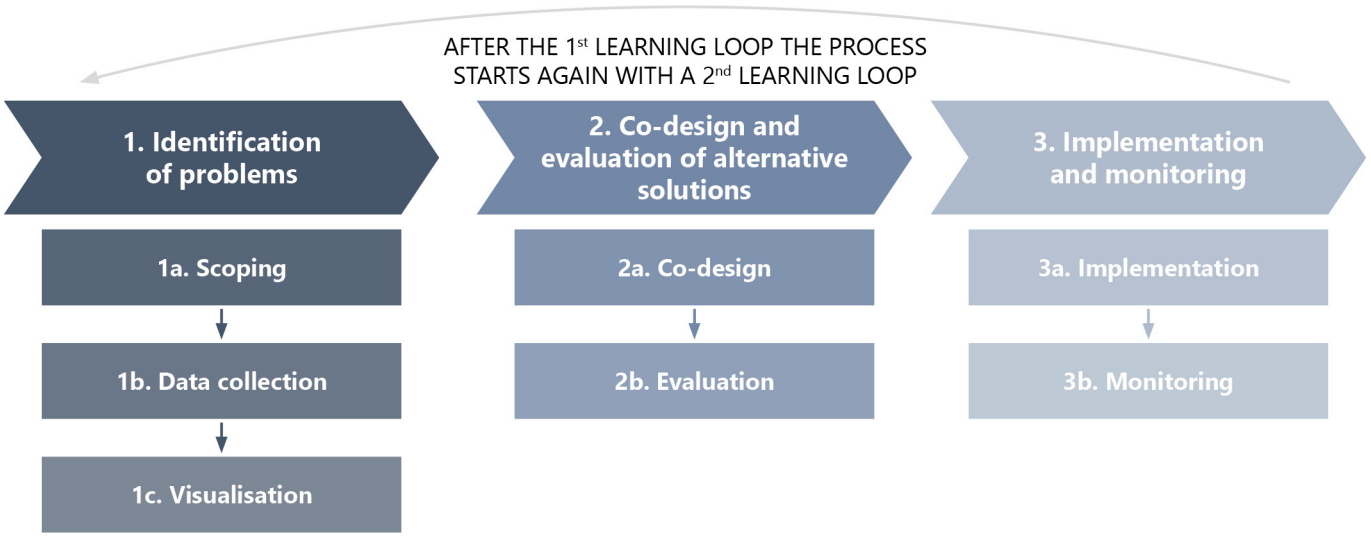
This request for better urban transformations gets along with the trend that the public now has of getting always more involved and interested in decision making process due to an higher availability to information (Harris and Browing, 2005), and it is also raised by the fact that cities are getting a more diverse socio-cultural background (Egoreichenko, 2018). Thus, there is the need to find new ways of approaching urban transformation allowing the knowledge of citizens - and of final users - to be part of the process.

Within this framework the Looper co-creation methodology (figure 8-1) wants to set up a feasible process that allows the gathering of knowledge from different stakeholders, to design more feasible solutions to answer city challenges and trigger urban transformations, with the further aim to not disperse the learning acquired to be able to use it later on.

8.1 Identification of problems

The identification of problems is the first stage of the co-creation process, and its aim is to identify the problems of a local community and its neighbourhood through a three-activities procedure. This first stage sets the basis of the

Figure 8-1 Looper co-creation process schema



co-creation process during the first loop, and for the creation of the bottom level.

The identification of problems stage can take place only if organisers already defined the main topic within which to work. This is necessary in order to give the chance to stakeholders to work focusing only on a certain macro area of issues, rather than wasting energies and knowledge to choose on what to focus. The topic to focus on is chosen between the hot topic expressed by citizens and other stakeholders in the past, this allows to consider issues that are of interest for participants rather than ones of interest only for policymakers. This is then explained to participants during the first meeting to avoid misunderstanding on why the wider topic was already chosen by organisers.

Scoping of issues

As theoretical basis, during the scoping of issues the affected communities and the context of the problems are identified to allow a better comprehension of the framework that the Urban Living Lab will analyse and work within during the co-creation process. Problems are then framed in a way to enable the tangible aspects to be identified through data.

When setting up a Urban Living Lab to trigger a co-creation process there is the need to frame the main urban issue to work on before involving stakeholders. This does not mean to decide what to work on, it is only needed in order to put some boundaries in which to work. Indeed, the main issue to work on needs to rise from the questions and needs that citizens usually ask to solve to city council. This means that, even though the main framework is decided by organisers, the process is still a bottom-up one.

Before the beginning of the scoping of issues stage, the first step to take is to involve all the possible stakeholders interested in the main urban issue that the project wants to tackle. The dissemination of the project to involve as many stakeholders as possible needs to reach all possible groups, even the so called hard-to-reach ones. To do so the dissemination methods need to be diversified, and organisers need to contact everyone throughout different communications channels - e.g. newspapers, newsletters, associations' meetings, door knocking, press conferences, presentations in different locations, stands on the street, flyers - to reach as many people as possible. This dissemination about the beginning of the co-creation initiative is one of the key things organisers need to do, as without participation the co-creation process cannot take place in a successful way. Another way to disseminate, if the area to cover is too big for a door knocking, is the word of mouth, since it is possible to ask residents to disseminate with their neighbourhood the idea of the co-creation process and the date of the first meeting.

Usually the first meeting of the scoping of issues activity is actually a presentation one, where organisers better introduce to participants the aim of the co-creation process, its activities and why stakeholders involvement is so important. As abovementioned, the reason why the main topic is already decided is explained to participants, clarifying that it was chosen based on the requests and the issues raised by citizens in the past. The knowledge aspect is presented during the first meeting, as organisers explain to participants why knowledge empowers them within the co-creation and decision-making processes and why during the first meeting some presentations on the main topic are given before the beginning of the scoping activity. Lectures are on the not only on the main topic, but also on the possible tools that can be used during the following activity of data collection.

After the presentations, that give the right tools and knowledge to participants to work within the co-creation process, the meeting than moves on with the actual scoping. The scoping activity is done in a face-to-face way, this because there is the need of having an open and constructive dialogue between all different stakeholders. This allows stakeholders to express their ideas on which are the actual criticalities to be found in the project area, and why there is the need to focus on these instead of others. This open dialogue opens participants minds to other point of views to better understand what others perceive as issues in the urban environment.

As this first activity is done in a face-to-face way, the tools to be used to

allow the dialogue are offline ones. The main tools can be e.g. satellite maps and Google Earth and Google Street View projections to help participants better navigate in the printed satellite maps. Participants are divided in smaller groups - depending on the initial number - mixing representatives of different stakeholders groups, this allow the sharing of different points of views in a more constructive situations, as having fewer people per working group allows also minorities to express their ideas. Tracing paper is used on top of printed maps to have the chance of later comparing if the criticalities found are the same within every working groups, or if different groups found different criticalities.

This activity can be replicate with other face-to-face meetings depending on the availability of participants and if they ask for more time to found every criticality linked to the main topic in the project area. Moving forward with the scoping of issues, once every criticality has been found there is the need to choose on which to focus to decide how to organise the data collection and all the other activities. Again to decide what and how to monitor all points of view needs to be considered, meaning that the face-to-face meetings move forward in considering the tools to collect data and how to use them, this part is based on the knowledge participants gained during the learning of the first meeting. Once the data collection tools are chosen, a comparison between criticalities and where is possible to position stationary tools is done. This allows participants to have a better comprehension on what is possible to do, and to evaluate what are the most important criticalities to analyse considering all stakeholders points of view.

In this phase of scoping of issues, participants start to give their availability for the participatory sensing activity within the data collection phase, that can involve both stationary and mobile sensors.

Data collection

The data collection activity is based on the idea of analysing and investigating the issues found during the scoping, this by collecting data and information in order to make those issues comprehensible and measurable with a more scientific approach. Locations and type of problems are then collected directly with the participation of stakeholders via participatory sensing, via public databases and through face-to-face discussion.

Different data collections can be used to obtain useful data i.e. quantitative (e.g. air quality sensors, noise level meter, speed radar) and qualitative (e.g. observation, survey, geotagging web app, feedbacks). Both quantitative and qualitative data are needed to understand what is the perceived situation by citizens, for what qualitative data are needed, and what the real situation is, and for this quantitative data are to be collected. Because a geotagging web app is to be used within the process, as Monteiro *et. al* (2018) state there is the need to consider the concerns of bringing academic practices of GIS to the public realm related to Public Participation Geographic Systems (PPGIS). This goes along with what Sieber (2006) already expressed. He already wrote about some important benefits of PPGIS, as he pointed out that it provides some unique approach as it allows the engagement of citizens within the decision making process by incorporating local knowledge, integrating and contextualising complex spatial information, allowing participants to interact in a dynamic way with input, analyse alternatives, this while empowering them. Furthermore, he also pointed out some limits to this practice that researchers need to overcome, as how much this practice can be generalised to any kind of project, the appropriate extent of technology and the nature of access of participants, as PPGIS can further isolate individuals that have no access or no understanding of technologies. Moreover, he said something that is still very contemporary:

> *"A full framing of PPGIS may include the most sophisticated applications; it also will need to encompass the paper map and pencil, coupled with meaningful participation that is fully cognizant of situational influences and di- verse goals" (Sieber, 2008).*

Another recent research (Saadallah, 2020) also showed the importance of depending on both quantitative and qualitative measures, as they both allow to have a more complete understanding of the existing issues, and they can more clearly show how to have a more inclusive and feasible decision making process. PPGIS then, if paired with quantitative and qualitative data - to be collected with other methods as surveys, observations and sensors - can give a reliable representation of the person-environment interaction, thus allowing a reliable geospatial representation of the use of the urban environment.

Organisers and researchers need to always take into account the diverse socio-cultural background of participant to allow a profitable data collection. That is why the first aspect of the data collection activity is the choosing of which sensors and tools to use, and where to position these sensors. This is an activity that links the scoping of issues and the data collection itself. This is due to the need of considering where it is possible to position sensors while deciding what issues to scope, otherwise the issues to scope might not allow the data collection.

Sensors are chosen based on the issue to scope, the location of the criticality and the availability of participants in collecting data. These three aspects are extremely important, as they are also linked to the possibility of later implementing a possible solution. This means that is there is no possible chance of implementing something in the chosen location, participants need to evaluate if they want to use resources they might be using on another location to collect data on a certain issue.

Sensors that can be used are of two main categories: official sensors or participatory sensing ones. This distinction shows how it is necessary to have policymakers involved in the co-creation process since the very beginning as they have the resources and possibility to use official sensors to collect data that can later be used as control group for the data collected with participatory sensors. Allowing stakeholders to decide where to position official sensors also helps in overtaking the distrust that can be found between citizens and policymakers, this because citizens might think that official sensors are positioned to collect only data that policymakers wants, rather than real ones.

Again knowledge on sensors is given to participants to allow them to position sensors in the correct way to obtain reliable data - e.g. mobile stations from an official body are fixed ones and need to be plugged as they run on electricity, on the other hand passive sensors cannot be placed higher than a first floor as pollutants stay lower on the ground - that can be used in the co-creation process. This concerns mostly quantitative data that are offline tools, while it is also possible to collect qualitative data using both digital and offline tools. For a qualitative data collection offline tools mostly include surveys and questionnaires - that can be undertaken using digital tools as well, while for the digital version tools as geotagging web applications can be used. This allows citizens to collect qualitative data about both criticalities and good practices whenever they want.

At this point, based on the availability of resources and the availability of participants to use participatory sensing sensors the data collection campaign can start. This data collection campaign is of extreme importance as it will be the basis on which to compare the data later collected during the monitoring activity after the implementation of the chosen solutions. It is important to remember that the data collection campaign needs to be done also based on the type of issues that are scoped. This means that if the topic are pollutants, or traffic, the data collection campaign needs to run during winter, while if the topic concerns the redevelopment of an area the data collection campaign can take place in every moment of the year.

The choosing on the period of the data collection is also based on the need to do the monitoring in the same period the next loop, and the duration needs to cover important events that aggravate the situation if there are any.

Data visualisation

Data that have been collected to be effective must be communicated to the participants, meaning that the basic idea of the visualisation of the collected data is to publish data on the Looper dashboard, one dashboard for each Liv-

ing Lab, to allow the dissemination and the discussion of the data collected at local workshops.

The first step for the data visualisation is that of developing a user-friendly and feasible dashboard. It needs to be user-friendly to allow digital illiterates to use it and to let everyone to understand the data uploaded on it. The feasibility of the dashboard is another focal point, this because once the dashboard is set up, it needs to be able to store and visualise every type of data that can be collected, from quantitative of every kind to qualitative that have a bigger amount of data. This work is done by organisers, and it is tested during the first data visualisation meeting with participants.

The data visualisation meeting - or meetings - have the aim of discussing with stakeholders if their ideas, raised during the scoping of issues activity, are correct or wrong. Here the perception issue starts to raise, and stakeholders learn the difference between perception and real situation.

The data visualisation dashboard is then updated based on the feedbacks given by participants during the first meeting of the activity. This because it needs to respond to different needs of participants with different socio-cultural-economic backgrounds.

The dashboard is an online one as from this point on the face-to-face meetings are combined with some digital online tools that allows the participation of people that are not able to come to the offline meetings. The data visualisation dashboard works as a storage utility as well [8.1-1], this because data from every data collection campaign of every loop will be stored and will be available for visualisation from here. This will allow some form of comparison of the data collected.

The data visualisation activity works as link between the first and second stage of the first loop of the co-creation process, meaning that the data visualisation meeting is actually part of the first co-design meeting. This is done to allow a better sedimentation of the knowledge gained by the visualisation of data that is applied to a real life situation given by the production of possible implementable solutions to solve the issues and criticalities found in the first activity.

The data visualisation activity might be shorter in time compared to other activities, but it is meant to be considered multiple times during the co-design activity. This because to choose the solutions to implement there is always the need to consider the quantitative and qualitative data found during the data collection.

Moreover, it is possible to say that the dashboard has a double function, one is that of using it during the meetings organised with participants, the other is that of allowing participants to use it on an autonomous basis. Initially the dashboard was supposed to be used only autonomously, but as there are different participants with different digital abilities, the Verona Living Lab decided to introduce the concept of these visualisation meetings to help participants to better understand the data that they are visualising.

8.2 Co-design and evaluation of alternative solutions

The aim of this stage is to assess the problems identified in the 'identification of problems' stage, co-design alternative solutions with participants and select with stakeholders the solutions to implement also using formal methods - i.e. Multi-Criteria Analysis (MCA) and Multi-Actor Multi-Criteria Analysis (MAMCA).

Co-design

In this fourth activity participants engage in qualitative and interactive online and face-to-face deliberation activities to propose solutions. To help this activity existing online and offline tools can be integrated in the Looper platform.

As abovementioned the beginning of the co-design activity is with the data visualisation. This allow participants to work on real issues rather than perceived ones, maximising the resources and time they have. This knowledge gained by the data visualisation is important for the co-design activity, as it

[8.1-1] See figures 12.2-1 and 12.2-2 in 'Part 3 - The application of the Looper co-creation methodology'.

allows participants to rethink about their points of view to put more focus on the actual criticalities that need to be solved.

The first co-design meeting is a face-to-face one, and during it the selected co-design tools are presented. During the offline meeting the tools used are the same printed satellite maps, as from previous meetings, but with focus only on the areas where the criticalities are, combined with printed maps, projections of Google Earth and Google Street View to have a better comprehension of the spaces. This allows the proposal of ideas and solutions that can actually fit the real available space. If the pilot area is too wide, participants are asked to think about solutions that can be replicated in different part of the area to solve a same issue.

An example of the online tool [8.2-1] was presented during the first meeting and it allowed both the proposal of new ideas by people not participating to the face-to-face meetings, and also the storage of the ideas proposed during meetings. This double usage of the online tools also helps to avoid having the same idea proposed multiple times, since stakeholders who cannot participate to the face-to-face meeting might otherwise not know wat was proposed.

The meetings, and online ideas collection, shall go on for as long as is necessary, but organisers better decide a maximum period of time to oblige participants to work together to maximise the time at their disposal. The idea is to work on a certain amount of locations where criticalities have been found during each meeting, this can avoid to spend too much time on the co-design activity. Spending too much time on the co-design can be counterproductive as participants might get bored and decide not to participate to further activities.

Once all the locations and criticalities have been analysed, and at least one solution have been proposed to solve each issues, stakeholders can give their preference on what to implement and it is possible to move to the evaluation activity.

Evaluation

For the evaluation activity a multi-criteria analysis (MCA) is used to appraise the sustainability of the proposed alternatives, and the multi-actor multi-criteria analysis (MAMCA) is used to evaluate the sustainable alternatives according to stakeholders' point of view. Existing online tools are integrated in the Looper platform.

The evaluation activity shows a more formal evaluation of the proposed solutions. Indeed, once the co-creation process moves to this activity, participants already presented their preferences. Unfortunately this evaluation does not take into account each aspect, and effect, of each specific solutions.

The MCA is used firstly to analyse which of the proposed solutions are the most sustainable in a general sense, this because stakeholders are not considered in the evaluation process. Then the MAMCA is used to evaluate what solutions to implement by considering also different stakeholders.

The usage of the MCA and MAMCA shows, and explains, to all stakeholders why certain solutions can give better results when implemented compared to others, and also why these can win a more positive confirmation by the stakeholders of the urban system.

This activity can also be seen as a control point of the work done until this moment. This because if the results of the MCA and MAMCA confirm the preliminary evaluation done by participants at the end of the co-design activity, it means that the co-creation process is already obtaining positive and good results.

Furthermore, it can be said that the main difference between these two types of evaluations is that MCA is meant to highlight one single choice to be undertaken, while MAMCA can be considered as an evolution of MCA but does not highlight one choice, it rather give stakeholders preferences. Therefore, if MAMCA is an operational tool, MAMCA is an interpretative instrument that sets the basis on which to work for the implementation in a real environment of the most feasible solutions.

MAMCA have been developed within the transport field by the MOBI re-

[8.2-1] See figures 12.2-1 and 12.2-2 in 'Part 3 - The application of the Looper co-creation methodology'.

search group of the Vrije Universiteit of Brussels (Macharis *et al.*, 2009) as a meaning to evaluate stakeholders preferences toward which type of public transport to implement in a pre-defined location. Indeed, it is born as a top-down tool as policymakers are the ones in charge of public transport. One example of this top-down MAMCA approach can be found within the NISTO project, were practitioners needed a feasible toolkit to evaluate small scale mobility projects and within stakeholders citizens are not to be found. On the other end, within the Looper project the MAMCA tools is to be used with a bottom-up approach as citizens are called to participate in the evaluation of ideas that they helped to design.

8.3 Implementation and monitoring

Based on the results of the 'co-design and evaluation' stage, the city council - or other official bodies - implement a range of solutions, and they monitor their efficiency with other participants. Same or comparable data as for 'scoping of issues' are used.

Implementation

The implementation activity sees less need of participation by citizens as more bureaucratic documents are needed, but they can be involved on voluntary basis depending on the type of solutions implemented.

Once the evaluation activity is done the implementation and monitoring stage begins. The first activity to be done during the implementation is to analyse how to actually execute the selected solutions in a real environment.

Once it is understood how to transpose the selected ideas into real and applicable solutions, the practical and bureaucratic aspects need to be filled, and this allows participants - that are not from the city council stakeholder group - to gain knowledge on how things need to be done, and why certain solution need more time for their implementation compared to others. During this activity city council employees prepare the papers and documentation needed for the implementation, relying on the positive feedbacks of other stakeholders that help in allowing the process to move forward.

It is important to let other stakeholders understand that positive, or negative, feedbacks can hold the shift of power. This means that even if the selected solutions have been shared and chosen together, if they do not keep in supporting the solutions while being implemented the results might be negative making policymakers decide not to participate to the co-creation process anymore.

During this activity, timing is of extreme importance as there is the need to implement the selected solutions in time to start the monitoring activity in the same months than the previous data collection activity. This means that policymakers need to inform other stakeholders groups on how much time does it need a certain solution to be implemented.

Monitoring

The monitoring of the impact of the co-designed solutions uses the same set of tools used in the 'scoping of issues', and it involves stakeholders through participatory sensing and open data.

This final activity of the first loop can be considered as another data collection, or the data collection of the second loop, and it is always done with participants. This second data collection has a different activity name as the final aim is different. If the first data collection's aim was that of having a better comprehension of the environment and its criticalities, this second campaign is called monitoring as the aim is that of observe and supervise the results - positive, negative or void - of the implemented solutions.

This monitoring activity can be implemented both as the ending activity of the loop, or as the beginning activity of the next loop. This difference is due to the presence, or absence, of a scoping of issue activity for the further loop. If the further loop is based on the knowledges acquired during the loop, and if participants want to keep going with the issues and challenges considered during the first loop, the monitoring stage will concur with the data collection

activity of the second loop. If participants want to change location to focus on different issues, that were not considered during the first loop, the monitoring activity will conclude the work done during the loop and another scoping of issues will follow the monitoring activity.

It is possible to understand if the implementation gave results as the data collected with this monitoring campaign can be compared with the ones collected during the second activity. This comparison allows participants to understand what works and what, once implemented in a real life environment, does not work, setting the knowledge basis for the second loop. This monitoring activity then obliges participants to evaluate the work they have done until this moment in a more objective way.

The second loop then starts from the scoping of issues activity again, but is going to be based on the knowledge acquired during the first loop. This means that participants are able to learn from their mistakes, and they already know how to interact with other stakeholder making the work easier.

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9. THE LEARNING LOOP TO IMPROVE CO-CREATION

As abovementioned the learning aspect, merged with the different stages of the co-creation method, is an essential aspect to consider during the work in order to obtain a successful process. But learning on each stage is not the only type of learning needed to have a complete co-creation process. To obtain a successful co-creation process it is also important to implement the learning loop concept, this to allow the co-creation process to further enact itself.

Since different learning stages are activated during the whole process, each are to be considered to gain successful results, and each are needed to implement the learning loop to take full advantage of the different learning stages, not to lose the knowledge gained by participants. Indeed, the learning loop can be triggered within the co-creation method only if other learning stages took place during the process. If no knowledge is gained during the process, the learning loop is more difficult to be enhanced.

The last activity of the third stage - the monitoring activity - is the one that allows in a more practical way the triggering of the final main aspect of the learning, which is learning by evaluating, that can be then transformed in the beginning of second loop of co-creation. This type of learning, raised by the need of evaluating the results of the implemented ideas, can be done thanks to the data collected with the final monitoring and with the chance of comparing these data with the one collected during the second activity. The ability and knowledge, given by this evaluation of the results obtained by the implementation, is the key aspect that allows the triggering of a second loop of the co-creation process.

The learning gained during the first loop then works as basis for the second loop, and this is the actual aim of the learning loop applied to the co-creation process. This means that the second loop is then implemented thanks to the knowledge gained during the first loop, allowing to learn from the mistakes and misunderstandings found during the first loop, from the experience gained on different topics, from the usage of different tools and sensors and from different interaction models.

At the end of the first co-creation process, participants should have learned:

- how to dialogue between different stakeholders groups;
- which are the actual urban issues that can be found in their neighbourhood;
- how certain ideas can be implemented in the urban environment; which implemented ideas work or not.

All this knowledge work as basis from where to start with a second co-creation loop, and participants are now not starting from zero, but are able to further implement what they have done as they already have knowledge on the topic.

10. TECHNOLOGIES

10.1 Sensors

The following section describes more in detail the tools used within the Looper project by the Verona, the Manchester and the Brussels Living Labs. The Verona and Manchester Living Labs sensors are better described since there has been some direct practice-led research work done on the Italian and British case studies that allowed a better knowledge on the tools hereafter described. For the Brussels Living Lab the only used sensor was a participatory traffic sensor.

10.1.I Air pollution sensors

Figure 10.1-I-1 ARPAV fixed station

ARPAV fixed and mobile station

This two types of sensors are the ones used to undertake the official data collection at national level by the ARPA official body, of which every Italian region has its own department that is in charge to collect and analyse the regional data that are then used to control the National air quality level of Italy. ARPAV (ARPA Veneto) checks the air quality in the regional territory through a network of fixed control units integrated by surveys carried out by mobile vehicles that are periodically moved to undertake air quality monitoring campaigns in areas of the territory not completely covered by fixed stations.

Fixed control units (figure 10.1.I-1) work as background stations, and are used to have a complete view of the situation of air pollution during the year. Mobile stations are often used to cover more specific areas, depending on the needs of the Municipality.

It is important to understand that all the instruments, samples, component, and the analysis made on the samples collected with these two types of stations, are completely the same. The only difference between the fixed and the mobile stations is their body shell, that in the second type allows and easier handling of the instruments.

Campaigns carried out by mobile stations (figure 10.1.I-2) last an average of 8 to 10 weeks, this is to ensure representativeness in terms of weather and climate conditions. To always have a representative amount of samples, the campaigns are divided into two periods: one in undertaken during spring-summer, the other is in autumn-winter.

Figure 10.1-I-2 ARPAV mobile station

At the end of each monitoring campaign, ARPAV technicians prepare a report describing the data collected and the conclusions on the air quality situation in the monitored area. These reports are freely accessible on ARPAV website and can be found in the local dedicated section.

Fixed and mobile station are able to collect data on multiple pollutants - e.g. NO, NO_2, NO_3, NO_X, CO, PM2.5, PM10, and others, and are alto equipped with weather sensors to compare pollutants data with temperature, relative humidity, wind and amount of rain in the days of the measurements.

This type of sensors cannot be used by participants since specific technical knowledge is needed, and data are to be analysed within a certified lab. Furthermore, this sensors' cost is starts from € 10.000,00 above depending on the model, making them unaffordable for individuals. Since these sensors are the most reliable ones, citizens have great interest in being allowed to choose

their positioning, and to actually being able to compare data with their perception.

Passive sensors

This NO_2 sensor is a low cost sensor also used by ARPAV to implement the sampling network in cities. This diffusive sampler is a closed box, usually cylindrical. Of its two opposite sides, one is 'transparent' to gaseous molecules which cross it, and are adsorbed onto the second side. The former side is named diffusive surface, the latter is the adsorbing surface (marked with S and A in figure 10.1.I-3).

If we call Q the sampling rate, and we assume that it has the dimensions of a gaseous flow, therefore, if Q is constant and measured, we can say that to calculate the ambient air concentration it is only needed to quantify the mass of analyte trapped by the adsorbing material and to keep note of the time of exposure of the diffusive sampler. It is also possible to improve Q by improving the sampler geometry to a radial design.

From this idea, the Radiello passive sampler [10.1.I-1] has been developed (figure 10.1.I-4), its cylindrical outer surface acts as diffusive membrane: the gaseous molecules move axially parallel towards an adsorbent bed which is cylindrical too and that is coaxial to the diffusive surface.

When compared to the axial sampler, Radiello shows a much higher diffusive surface without increase of the adsorbing material amount. Even if the adsorbing surface is quite smaller than the diffusive one, each point of the diffusive layer faces the diffusion barrier at the same distance.

The main issue of this type of sensor is that it is possible to have only one data per passive sensor. As these are one use sensors, and only give one data, to undertake a more complete campaign there is the need to position one sensor each week - 7 days is the minimum period of time for the data collection. If possible, it is recommended to place two passive sensor each week per each position to have a double check on the reliability of the collected data.

The price of this sensor is feasible for individuals to buy - under € 50,00 per sensor - and use it, but it still have some needs to have best results that might rise the pricing: having to pair them to countercheck the collected data; one data each 7 days; still needs lab analysis to know the actual pollutant value. Citizens on a long term basis were not so keen in continuing with this type of sensors because of the low amount of data collectable. Having a one per week data, that sometimes does not match with the paired sensor, does not correctly represent the real pollutant condition.

GPS NO_2 logger

The GPS NO_2 logger used for the Looper project is the Air Monitor device by AirCasting. The instrument is based on an *Arduino UNO* board. It provides a GPS shield *Adafruit* that include also an SD card for data logging. It is also possible to connect a CO sensor in addition to the NO_2 one, this because the *Adafruit* leaves some free digital pins of the shield. The data are then stored in the connected SD card that also registers the timestamp of the collected data (figure 10.1.I-5). If a Wi-Fi free connection is available close-by to the Air Monitor position, it could be possible to add a Wi-Fi module to automatically upload the collected data to the AirCasting crowdsourcing map.

Arduino is a flexible board that allows the user to connect many different sensors so the apparatus can be object of further developments. The software itself is made in the Arduino IDLE and it is flexible and continuously improved (figure 10.1.I-6).

Citizens were not keen in trying to assemble this type of sensor, due to its medium-high technical skills requirement. Its price - by now - is within € 200,00 for the components, plus the time requirement for the assembling. Data collection is not feasible for citizens and they needed someone else to convert raw data before visualising them. It is rather suggested to add other pollutants' sensors on the same *Arduino UNO* board to be able to check whether NO_2 data are reliable or not.

Figure 10.1.I-3 diffusive sampler functioning

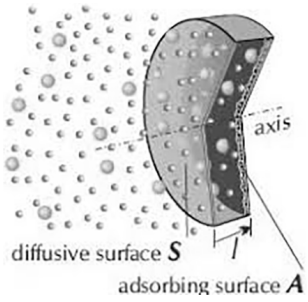


Figure 10.1.I-4 diffusive sampler schema

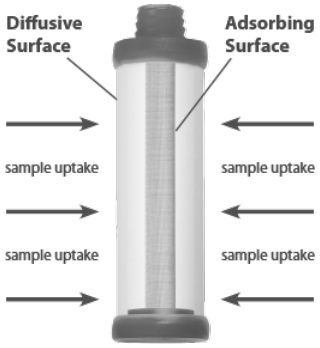


Figure 10.1.I-5 GPS NO_2 logger components

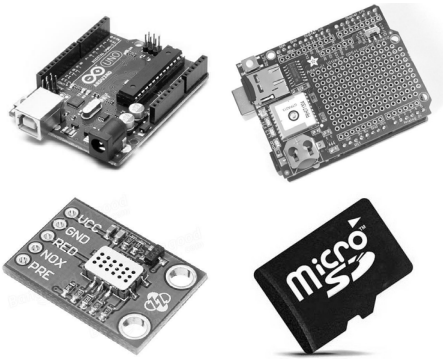
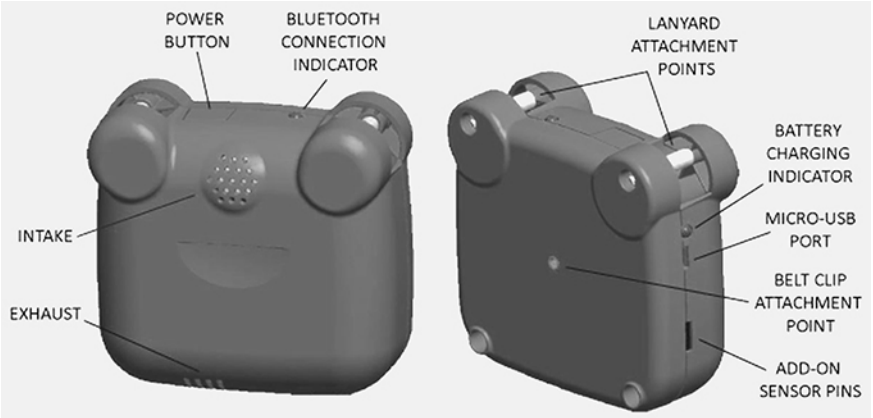


Figure 10.1.I-6 GPS NO_2 logger software

[10.1.I-1] Read how to use the Radiello sensor at http://www.radiello.com/english/uso_en.htm

Figure 10.1.I-7 AirBeam schema



GPS PM2.5 logger

The GPS PM2.5 logger used for the Looper project is the AirBeam device by AirCasting. This device is a tool used to get instantaneous data of the exposure of the person to PM2.5.

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 10.1.I-7).

The device works via Bluetooth and sends data to the AirCasting Android APP every second, the APP then maps and graphs the data in real time on the smartphone. This means that 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.

Because it is an open-source platform it is possible to modify the components to take other measurements and or to transmit the data to other websites or APPs. Because of the presence of an expansion port on the device it is possible to add sensors.

This sensor's price is within € 200,00, but contrary to the GPS NO_2 logger from the same brand, is already assembled making it more feasible for final users. Citizens liked this type of sensor during the first loop of the project and collected a wide amount of data. However, two main issues arose after the first monitoring campaign: its usage is time consuming as it needs to be carried around the area, and not everyone was willing to volunteer for it; and due to its need to be connected to a smartphone to collect data, it might not be feasible for every participant. Nevertheless, data collected with AirBeam resulted to be the most understandable ones due to their immediate exposure quality.

GPS PM2.5 and PM10 logger

Luftdaten is a tool used to get instantaneous data of the exposure to PM2.5 and PM10 (figure 10.1.I-8).

Luftdaten measure PM2.5 and PM10 by assembling a SDS011 fine dust sensor assembled with a NodeMCU firmware installed on a ESP8266 module that can be connected with a Wi-Fi router, to which a DHT22 temperature and humidity sensor can be added. The whole sensor, as the GPS NO_2 logger, is based on an Arduino system that is used to upload the firmware to allow the functioning of the module. Once the firmware is uploaded and the other components are assembled it is possible to install the sensor to update on the crowdsourcing platform the data collected continuously.

Figure 10.1.I-8 Luftdaten components

Just as with the AirBeam device the sensor here uses the light scattering method to analyse the amount of PM particles to be found in the air sucked in the sensing chamber.

Lufdaten sensors are cheaper than AirBeam ones - less than € 50,00 - even if they use the same type of SDS011 sensor. Citizens showed a wider interest towards this type of sensor, because - on opposite to the AirBeam - it is a stationary one and does not need much effort once assembled and positioned.

About its assembling, participants found it easier to follow the instructions for this sensor rather than the ones for the GPS NO_2 logger.

Figure 10.1.II-2 noise box components

10.1.II Noise pollution sensors

Android Sound Level Meter

The sound level meter apparatus used within the Looper project is carried out by assembling an android smartphone, a lavalier microphone and a waterproof enclosure (figure 10.1.II-1).

The sound level meter software used for the Sound Level Meter apparatus is OpeNoise by ARPA Piemonte, it is an open source software downloadable for free from the play Store.

Unfortunately, it is only in Italian, but it is still easy to use. In figure 10.1.II-2, the main screen is depicted. 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 from one second to one hour.

Citizens in the beginning were not interested in collecting noise data, as they thought them to be not as dangerous for health as air pollutants. Later on, as they quite understood noise pollution issues, they were more keen to collect noise data. The sensor itself is quite cheap - being under € 200,00 - and it is not difficult to set up assemble it, the most complex part is the calibration of the microphone.

Figure 10.1.II-2 noise box interface

Main screen:
Date, hour of the measurement and total length
Maximum, minimum and equivalent levels of the whole measurement.
Real-time LAeq (every second)
Logging (on – off). The measure is stored in a .txt file. The time step can be chosen from 1s to 60 minutes
The graphic shows the logging data of LAeq integrated in the whole measure (t) and in one second. *The Linear and A weighted spectrums can be also shown and stored in the log file.*

10.1.III Traffic radar sensors

Figure 10.1.III-1 Black CAT Radar sensor positioned on a light pole

Black cat radar

The Black CAT Radar unit (figure 10.1.III-1) allows to collect traffic data without the need of an in-road traffic sensors. This sensor allows to detect the lane position of vehicles, and with one sensor it is possible to collect data of two lanes at time. The algorithm that controls the sensors is also able to detect the length of the vehicles and differentiates the vehicles by groups - i.e. bikes and motorbikes, cars, vans, short lorries and lorries.

Due to issues linked to the structure of the light poles in Manchester, the device have been powered by using batteries that need to be changed on average every six days. The device is also assembled to be powered by using solar panels or by plugging it directly to an electric plug.

This device allows both real-time data download, meaning that the device automatically sends the data to the in-station, and what they call 'historical mode' so that the sensor waits for the user to manually - and physically - download the data from the device itself.

When talking about traffic safety this sensor gives interesting and reliable results, being able to collect a wide range of data. This sensor is a quite expensive one - little less than € 2.500,00 - thus it might not be feasible for participatory sensing. Data are to be analysed by skilled people before being shown

Figure 10.1.III-2 Telraam sensor positioned on a window

to citizens, overwise raw data might be misunderstood.

Telraam

This traffic counting sensor is based on a Rarpberry Pi microcomputer, sensors and a low-resolution camera and it collects data as it is able to recognize vehicles or pedestrian when analysing the captured images (figure 10.1.III-2). It can send data about traffic counting to its central database if continuously connected to a Wi-Fi source - the data upload takes place every hour. As other stationary devices it needs a power outlet within reach.

It is important to correctly position the sensor to allow a reliable data collection, it needs to be mounted on the inside of an upper-floor window with a view on the street. The idea behind this type of sensors is to have as many of them as possible around the city.

These traffic sensors are cheap ones, costing less than € 50,00, and do not need much effort by citizens.

10.1.IV Qualitative data collection

Participatory sensing technologies need to consider the need that some users might have to represent an (urban) issue by using qualitative, and not only quantitative, data.

Since there is this need to allow participants to collect qualitative data by using mobile phones or tablets, the development of an application able to get positional data as well as multimedia and textual information was required. To develop this application an essential requirement was that to make it multi-platform and as much user-friendly as possible, this to allow the wider chance of its usage.

There are several native-developed mobile apps for smartphones, but a web-based (HTML 5) customizable application accessible via standard web browser seemed to be the more effective solution both for the Looper project and for possible future applications. This web-based (HTML 5) application solution is the most suitable because:

- it is multiplatform (works with e.g. iOS, Android, Windows);
- it can be used with every device (e.g. laptop, tablet, smartphone);
- it can be used during Looper Living Labs workshops.

It is to be noticed the last point of the list that mentions the usage of the web-based app during Looper Living Labs workshops, that double the chances of usage of the tool itself. By developing it in this way it becomes both an online and offline tool.

A web applications of this kind was already hosted at the URL www.geotagging.it. The platform geotagging.it is an experimental web based application that allows you to collect geo-data in a collaborative manner on the internet. It can host an unlimited number of thematic sections (www.geotagging.it/something) each with its own configuration of content and graphics features as well as its own account database. These characteristics made greotagging.it the best choice to collect qualitative data for the Looper project.

The geotagging.it front-end tool is optimized for mobile devices whose GPS allows immediate pointing of the area where the user is located. Its user interface is based on the Italian language, but differently from the OpeNoise app it is easily translatable in other languages.

Following there is a description of the back-end and front-end sections, with a quick summary on the user interface (UI) redesign.

During the first loop it was decided to embed the geotagging app [10.1.IV-1] into an eye frame on each local webpage to allow an even more user friendly experience for the qualitative data collection.

Back-end section

The back-end section of this web-based app is a standard website providing with administrative functions (figure 10.1.IV-1), and it provides the below listed basic functions:

- Geo-tag archive explorer / manager;
- User accounts / groups manager with a 3-level permission system;

[10.1.IV-1] See Geotagging settings and use on annex 3 at the end of the thesis.

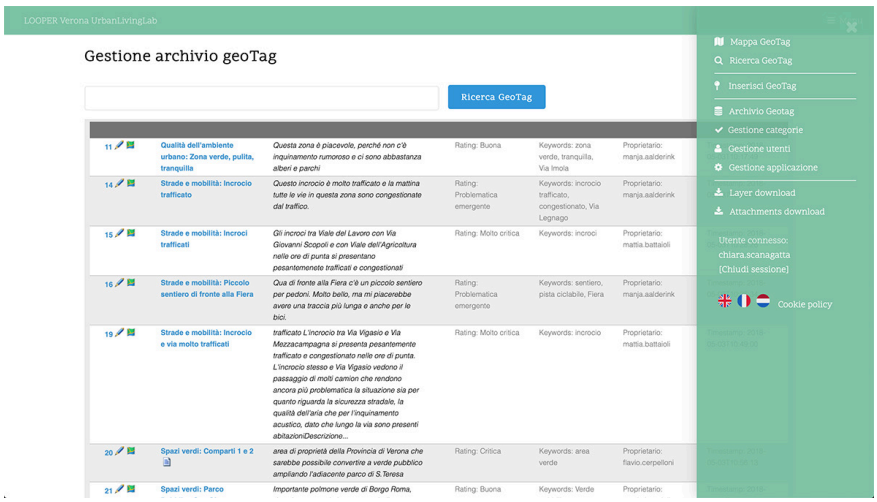


Figure 10.1.IV-1 back-end administrative functions interface

- Basic geo-tag map visualization;
- Basic geo-tag search engine;
- Geo-tag classification manager (to define custom classes for the front-end combo list);
- Overall application parameters configuration (e.g. section title, description, UI colours, etc. ...).

Geotagging.it is a lightweight web-app based on Microsoft ASP.NET framework and MS Access portable database, and it can provide direct access to the geo-tag database in geojson format.

Front-end tool

The geotagging.it front-end tool (figure 10.1.IV-2) is a frameless web-map page with a floating toolbox with which you can draw a geometry on a base map (point, line or polygon) and attach to it additional information as well as multimedia file.

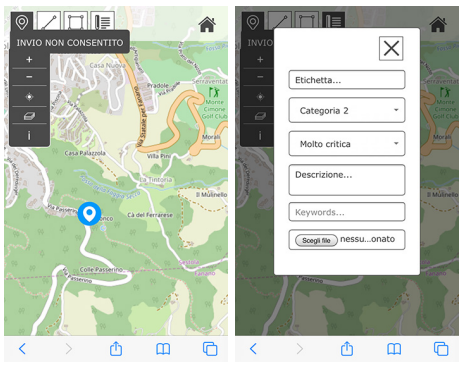
The geo-tag input form actually provides three text field, a combo box to choose a value from a pre-set list and a browse-button to attach a document, a picture or a video.

UI re-design proposal

To use the application for the Looper project, some minor changes to the user interface have been made. Some mock-up images [10.1.IV-2] of the re-design proposal were prepared at the beginning of the project. The re-design requirements were:

- Main theme re-design;
- Toolbar buttons re-design and responsive layout optimization;
- Add of a ranking value field;
- Minor changes for the back-end section.

Figure 10.1.IV-2 front-end interface



10.2 How to build sensors

10.2.I OpeNoise app

The OpeNoise app is an Android based application developed by ARPA Piemonte (like ARPAV is a regional branch of the ARPA official body) to help in the awareness campaign on the noise pollution thematic. Because the app in developed for the Android environment, it is not possible to use it with any other OS.

The first thing to be completed to build this sensor is to buy the components, and only after the assemblage it is possible to calibrate the tool. For the Looper project, as previously stated, the components used are a Wiko Lenny smartphone - chosen for price reasons, a Boya BY-LM10 lavalier microphone and a waterproof box. As these sensors were assemble to be used as stationary sensors, the smartphone needed to be a cheap one that could be left in place and the waterproof protective case was unavoidable to allow a minimum maintenance effort.

[10.1.IV-2] See Geotagging UI re-design proposal on annex 4 at the end of the thesis.

In a first try an external power-bank was used to power the smartphone but, because the sensor needed to stay in the chosen location for at least seven days, it resulted to be an inefficient solution. The latest sensors are positioned in locations that have a plug where to connect the smartphone.

The other implementation that was made to the prototype concerned the lavalier microphone, a plastic tube with an ending 89° angle element was attached to the waterproof box, this to keep the microphone dry and far from the box of at least 50cm. This technicism allows to place the box on a windowsill while the microphone collects data without the reverberation that can be by the sound waves bouncing on the wall.

To download the OpeNoise app there is the need to have an internet connection and a Google account to access the Google Play Store. While collecting the data there is no need to have an internet collection, this because the data are stored on the smartphone memory that creates .txt files that can be later downloaded using the Google account - by uploading the .txt files on the Google Drive cloud storage system - or can be downloaded using a SD memory - if before the beginning of the monitoring campaign it was chosen to store the files on the external memory.

The external lavalier microphone is an important component because it allows to bypass the noise reduction software that is installed in every smartphone. If a Wiko Lenny smartphone is used it is possible to calibrate the device without the need of a Sound Level Meter - the calibration for this model is -11.5 bB, otherwise the calibration needs to be done as further on explained in the section.

The main limitation of the OpeNoise app is that it is only in Italian, but after the initial setting [10.2.I-1] its usage is simple and intuitive. On the app setting user guide it is also possible to see the translation of each option that can be found in the app itself.

10.2.II Air Monitor

The Air Monitor sensor is an open source device based on Arduino and it is equipped with nitrogen dioxide (NO_2), temperature, and relative humidity sensors. The Air Monitor was designed to connect to the AirCasting Android app - the same used by the AirBeam - over Bluetooth. The idea behind is that when it is connected to the AirCasting app and an the AirCasting session is initiated, the app begins receiving, mapping, graphing, and enumerating the data from the Air Monitor sensors. Indeed, the base schema was modified - within the framework of the project - to allow the storage of the data collected on an SD card to overcome the need to connect the device to a Wi-Fi network.

The developers declared that currently there is insufficient data available on the Air Monitor gas sensors to characterize or calibrate their true performance. But, since the device is based on an Arduino board connected with different sensors, it could be possible to implement it with a CO sensor that would be necessary to allow a comparison with official data. However, the sensors are sensitive enough, and their detection limits are low enough, that they are capable of measuring relative changes in NO_2 concentrations within ranges that are commonly encountered in the urban environment. Reflecting the uncertain accuracy of the gas sensors, the Air Monitor is programmed to report gas concentrations using a generic response indicator (RI) scale rather than a parts per million or parts per billion unit of concentration.

The temperature and relative humidity sensors are affected by the heat generated from the operation of the Air Monitor electronics. Because the gas sensors are sensitive to changes in temperature and humidity, the temperature and humidity sensors are located in close proximity to the gas sensors. However, this proximity compromises the accuracy of the temperature and relative humidity sensors in measuring ambient air. This is still to be improved in future.

Other future implementations for this sensor are linked to the idea of having both an NO2 and CO sensor, plus the temperature and humidity ones, and have the calibration done by positioning the Air Monitor in proximity of an ARPAV fixed station to compare all data and see the reliability of this type of sensor.

[10.2.I-1] See OpeNoise app setting on annex 5 at the end of the thesis.

The components themselves to build the sensor are: Arduino Uno board; NO2 sensor (suggested model is the MiCS 2710); humidity sensor (suggested model is the HIH-4030); temperature sensor (suggested model is the TMP-36). Practicalities on how to build the sensors - i.e. assembling schema, where to find and download the software - can be found on the AirCasting website. 10.2.II-1

10.2.III Luftdaten

The Luftdaten sensor is an open source device based on Arduino and it is equipped with particulate matter (PM2.5 and PM10), temperature and relative humidity sensors. This device is designed to also have a Wi-Fi module to allow its internet connection to download the collected data on a crowdsourcing map.

Developers did not give many information about the reliability of the device, but as the sensor uses the same light scattering method to analyse the number of PM particles it is possible to say that the same issues can be found.

The main difference with the AirBeam model is that this sensor is a static one and there is no need to download an app to start recording data.

The components themselves to build the sensor are: NodeMCU ESP8266 CPU/WLAN module; fine dust sensor (suggested model is the SDS011); temperature and humidity sensor (suggested model is the DHT22).

Practicalities on how to build the sensors - i.e. assembling schema, where to find and download the software - can be found on the Luftdaten website. 10.2.III-1

10.2.II-1 Practicalities on the download of the software and how to assemble the device can be found at http://habitatmap.org/habitatmap_docs/HowToBuildAnAirCastingAirMonitor.pdf

10.2.III-1 Practicalities on the download of the software and how to assemble the device can be found at https://luftdaten.info/en/construction-manual/#feinstaubsensor-komponenten

3

APPLICATION OF THE LOOPER CO-CREATION METHODOLOGY

PART 3
APPLICATION OF THE LOOPER CO-CREATION METHODOLOGY

11. THE APPLICATION OF THE LOOPER CO-CREATION METHODOLOGY

'Part 3 - Application of the Looper co-creation methodology' wants to analyse the application of the Looper model - explained in 'Part 2 - The Looper co-creation methodology'- to real life case studies. This is needed to understand what are the possible variables that can influence the process and how the methodology needs to adapt itself. This is done by analysing its application to the Italian and British cases, and will be further refuted with this work by comparing the Verona and the Manchester Living Labs in 'Part 4 - Critical reflection on the Looper co-creation methodology and its tools'.

In this part the Brussels case study is not analysed since there was no practical and direct work done there, making it difficult to compare it with Verona and Manchester were it was possible to better understand stakeholders points of view and culture. The Verona Living Lab is the most complete experience because it has been followed from the beginning, while for the Manchester one the practical work was done mostly during the implementation and monitoring activities. However, it was possible to understand and evaluate the Manchester case with data about previous activities collected during my work with organisers.

The Italian application is located in the urban area of Verona, city located in North Italy, and more specifically works within the area of Verona Sud (figure 11-1). The area of Verona Sud 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. This particular configuration of the area investigated by the project, resulted in the creation of a distrust feeling of residents towards the city

Figure 11-1 Verona location in the North-East part of Italy compared to Milan and Venice (bottom), and Verona Sud area compared to Verona city centre

council, as they call themselves as ‘second class’ citizens due to the difficult logistic -caused by the presence of the Z.A.I. and the Exhibit Centre - and the low quality of life that residents have nowadays.

The main issues that influence this area are then air quality and noise pollution, mainly caused by heavy traffic, industries and old buildings’ heating plants. The presence of this kind of issues lead to the creation of multiple citizens and neighbourhood associations that are interested in solving these problems. The strong willingness of the groups in protesting resulted in a conflictual relationship with both policymakers and the public administration of the city (Condotta *et al.*, 2017). Furthermore, in the next section ‘12. The Verona Living Lab’ it is possible to see how, even if the main topic was already decided by the organisers, participants still had absolute freedom in the choosing of the criticalities to scope and to address throughout the whole process.

The particular socio-economic situation that can be found in this area then resulted in a massive participation to the Looper project by the biggest citizens’ association, and in a minor participation by hard-to-reach groups. The other main difference between the Verona case laboratory and the Manchester and Brussels ones is that the city council, an one NGO, were involved as partners of the project, allowing their support and participation in the dialogue since the very beginning of the co-creation process.

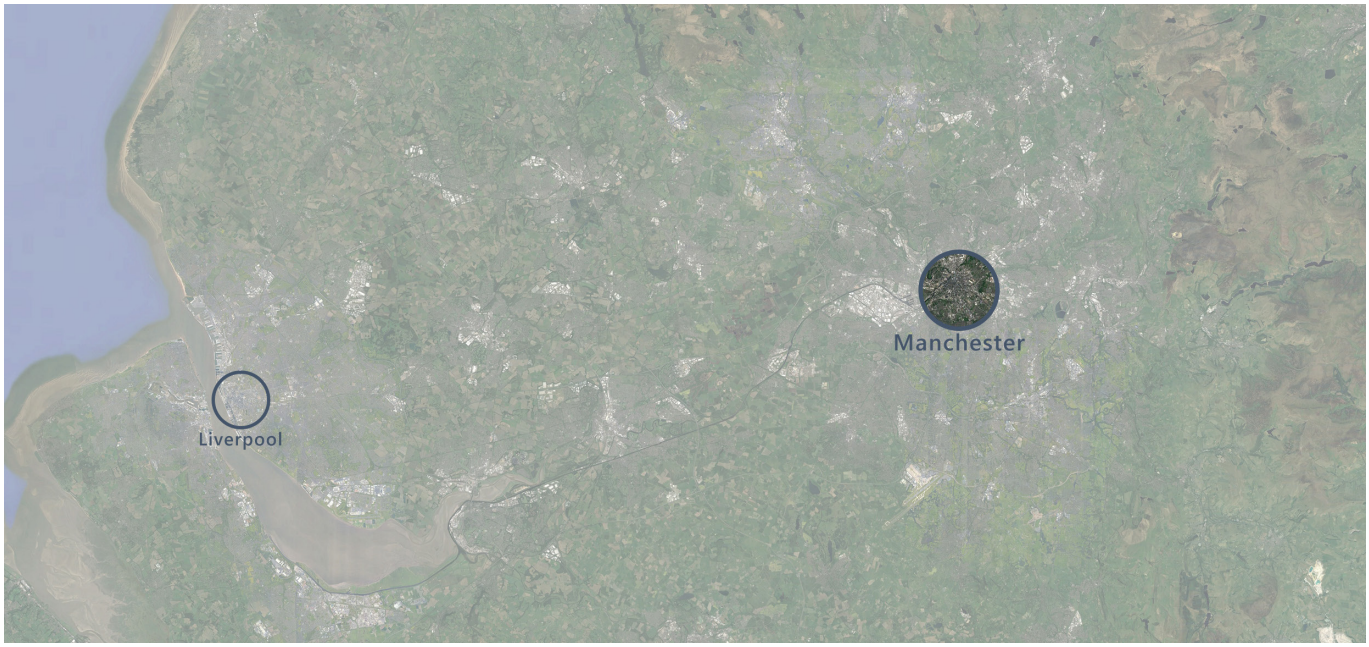
The other case study analysed within this part is the Manchester one. The case study area is the one from the Brunswick neighbourhood (figure 11-2), former social housing estate, that is located close to the University of Manchester and the city centre. There has been a 10-year regeneration and housing renewal program, that is coming to an end at the time this thesis is written, that is producing a rapid gentrification.

Figure 11-2 Manchester location compared to Liverpool (bottom), and Brunswick area compared to Manchester city centre

The area is bordered by major roads that produce high levels of noise and air pollution, and the population of the neighbourhood shows a diverse population - from a social, cultural and ethnical point of view, that is furthermore changing since many new private houses have been built.

Criticalities identified as the ones to be faced within the Manchester Living Lab were of various kinds - i.e. air quality, traffic safety, street security, community spaces and greening - because in the past decade all the resources for the implementation of the neighbourhood have gone into the housing projects, rather than on other priorities that were of higher interest for residents.

The absence of citizens and neighbourhood associations as strong as the ones in Verona resulted in a greater difficulty in involving possible stakeholders within the project, and in a different effort from organisers to reach interested people and groups to convince them in participating. Furthermore, even if the representatives from the city council and from the regeneration



agency S4B participated since the beginning, it was difficult to find create a dialogue between all the parties. Moreover, most of the residents were digital illiterate, meaning that organisers needed to put more effort in the data collection and monitoring campaign, to allow a shared participatory sensing.

In the following sections it is then possible to see how participants' groups were similar - e.g. residents, city council - but yet different between Verona and Manchester - e.g. NGO in Verona but not in Manchester. In Verona, where there was an already strong bottom level, citizens - and mostly residents - were more than willing to participate and had the digital ability to undertake a participated data collection without the need of being always supervised by organisers. In Manchester, organisers needed to invest time in collecting participation of residents and groups of people using the Brunswick area, and they also needed to give massive support for the participated data collection since most of the residents did not have smartphones with internet data or any digital ability. In the same way in Verona the presence of the city council was about having one technical expert for the each office involved in the tackled issues, this meant that at meetings there always were more citizens than city council representatives, in Manchester it was the other way around. The other main stakeholder for Verona was an NGO active about environmental issues, that helped as organisers and was seen as a neutral party. In Manchester, there was the S4B organisation that helped as organisers of the Living Lab, but that had deep interest in the area and on the renewal plan. It is then further explained how these differences between stakeholders can change the results of the Living Lab.

12. THE VERONA LIVING LAB

Figure 12.1-1 project presentation done by Università Iuav di Venezia, Comune di Verona and Legambiente

From the initial proposal, the topic of research for the Verona Looper Living Lab was that of tackling issues related to air quality within the area of Verona Sud. This area saw a main development in the late '50s with the implementation of the Z.A.I. (Industrial Agricultural Zone), with the presence of residential neighbourhoods that surround the factories. Because of this, participants were mainly concerned about the pollution issues that are caused by the presence of the Z.A.I., the Exhibition place and the related traffic.

After a first analysis air quality was confirmed as criticality by the Verona Living Lab, but it was also added noise pollution as issues that needed further analysis and comprehension. This idea raised mostly from the increasing amount of traffic that residents noticed in past years.

In Verona, as abovementioned, there was a strong bottom level that was willing to cooperate both because they feel like 'B series' citizens given the physical urban barriers that divide Verona Sud from the city centre, and because they saw the opportunity to face city council representatives. It was one main topic for organisers to transforming this idea of 'facing' the city council into an idea of 'having a dialogue'.

Hereafter the is a better description of the activities undertaken in Verona during the first loop, with some explanation about the second loop.

12.1 Identification of problems

Before the beginning of the identification of problems stage a presentation of the project took place the 22nd of November 2017, and the project was presented by the organisers - Università Iuav di Venezia - and the two other Italian partners of the project - Comune di Verona and Legambiente Verona - to involve citizens, associations and other possible stakeholders in participating to the Urban Living Lab, and within the co-creation process.

During the presentation the main aim of the project was introduced, and the co-creation method was explained to participants (figure 12.1-1). Different communication channels were used to promote the meeting and a good affluence of 60 people from different backgrounds was found.

Figure 12.1-2 lecture about pollutants before the start of the Verona Looper Living Lab meetings

Scoping of issues

The scoping activity - which means the setting of the framework of issues for the pilot case - then took place between November 2017 and February 2018. Throughout this activity period, it was possible to determine with the stakeholders which where the urban issues they though that needed to be considered.

During the scoping activity, following the broad priorities of the whole Lab setup, the focus was onto particular interventions which could solve problems - or gather opportunities - that are of specific interest to the community. Particular attention was given to the possible causes and effects. The problems found (figure 12.1-2) were later framed in order to allow the collection of data to quantify and qualify the issues chosen to be addressed.

As the Looper co-creation process is an improved one, there was also a switch from the concept of Urban Living Labs to the idea of Looper Living

Labs (LLLs), this because the way of addressing the Living Lab is different from the approach that would be used within a urban Living Lab, or a traditional Living Lab. Typical problems that could be found in the three Looper Living Labs included: air quality; noise pollution; traffic; crime; greenspaces; public services. The Verona pilot case focuses mainly on issues as air quality and noise pollution.

The response throughout the Verona Looper Living Lab meetings for the scoping of issues was good, and participants were able to discuss with employees of the city council about the possible issues to monitor. The three meeting that defined the scoping of issues activity took place the 12th December 2017, the 24th of January 2018 and the 7th of February 2018.

During the first meeting of the 12th of December about 35 people participated. Participants during this meeting got a more detailed knowledge about the workplan of the project and the activities to be done. The meeting started with some lectures on how pollutants work, how sensors work and which differences there are between low-cost sensors and sensors from the official body. After this first moment of learning the Looper Living Lab workshop started by allowing participants to analyse maps, satellite photos and street view images to explain which criticalities could be found in the project area (figures 12.1-3, 12.1-4).

Figure 12.1-3 during the first meeting on scoping of issues participants started to locate criticalities on printed maps

During the second meeting on the 24th of January 2018 about 20 people participated, most of which were present during the first meeting. After a first moment of sum up on the previous meeting, it was shown to them a layering of the criticalities they found previously and the possible sensors positioning - as per their proposal (figure 12.1-5).

The meeting later proceeded with the adding of other critical areas and possible sensors positioning to implement the map that was done during the first meeting. During this meeting the first set of chosen spots was decided.

During the third meeting of the 7th of February 2018 about 20 people participated. About half of the participants did not attend the previous meetings, this because the meeting place changed from a location in the middle of the project area to a more suburban one, showing how meetings locations are to be considered as much as the dissemination itself. This change of participants resulted in the need to explain again the purpose and goals of the project, and how the workplan would be organised. During this meeting the geotagging tool was presented and its functioning was explained to attending participants. This meeting ended with the further implementation of the criticalities and the choosing of the other sports for the data collection phase.

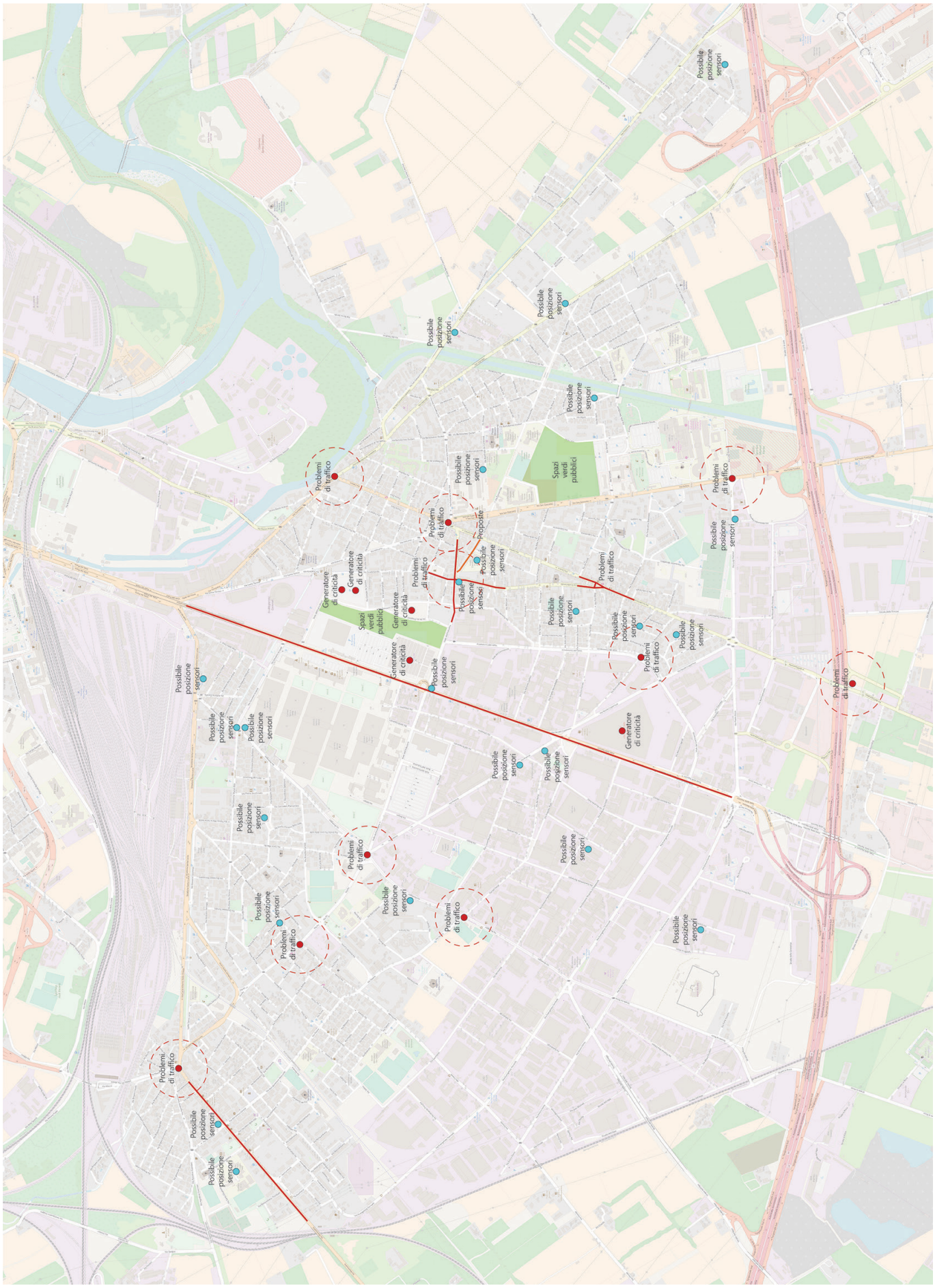
Figure 12.1-4 during the meeting on scoping of issues participants located both criticalities and possible sensors position on printed maps to check if there were overlapping

Data collection

Going through the problem scoping activity, the data collection planning started based on the idea of a participatory sensing activity. Once 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 linked to the measuring of data related to a specific issue, and decided the locations where to position the sensors available within the framework of the project (figure 12.1-6). 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) - that 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 NO2, geotagging tool for qualitative data - for the crowdsourcing activity (figure 12.1-7).

Considering the crucial importance of when and where the monitoring campaign would take place, the Verona Looper Living Lab dedicate 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. Both citizens and policymakers participated and collaborated with the aim of finding a solution that could suit the needs and wills of every stakeholder participating in the proj-

Figure 12.1-5 map that shows the results from the first scoping of issues meeting. In red (dots, lines and dotted circles) are the criticalities as expressed by participants, in blue (dots) the possible sensors position as proposed by participants



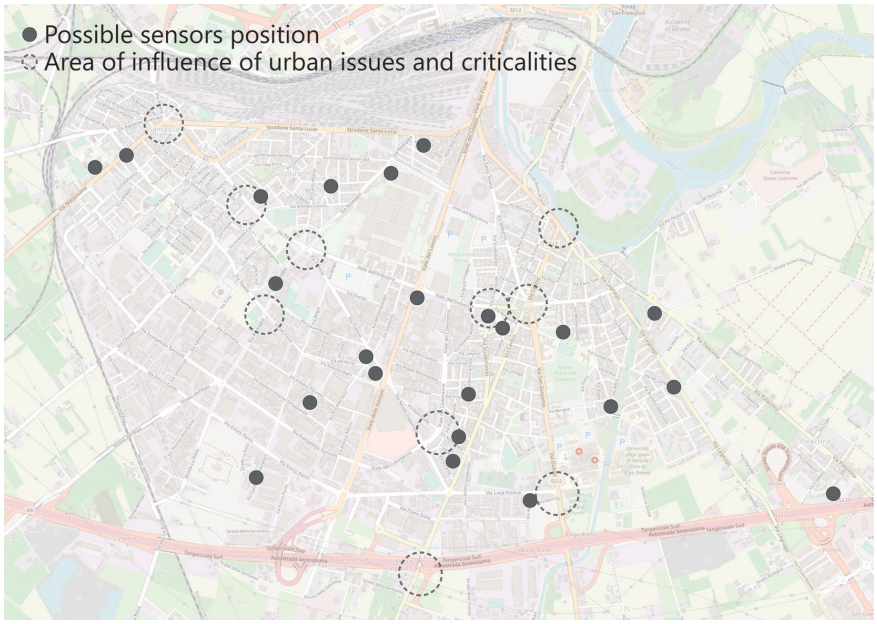


Figure 12.1-6 schematic version of the map in figure 12.1-5 used by participants to better define which criticalities to monitor and where to position the available sensors

Figure 12.1-7 examples of participatory sensing low-cost sensors-noise box for dB(A) data collection (top), Air Monitor for NO2 data collection (middle), and AirBeam for PM2.5 data collection (bottom)

ect. In figure 12.1-8 it is possible to see the locations chosen by participants where to position some sensors - locations included participants' houses as well as public buildings, and where these possible positions overlapped with the criticalities found before.

After the process of scoping of urban matters, and the questioning on where to position sensors, it was evaluated which places where suitable to locate 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 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.

One important thing was that the data collection activity started to give a sense of responsibility to participants as they had the chance to touch in first person some sensors, and to choose where to position sensors provided by the official environmental body. During the data collection there have not been meetings with the Verona Looper Living Lab, but organizers were always available to give participants support, help and news if they would made requests about data and sensors. In addition, as noise boxes changed position every two weeks it was possible to keep participants' interest alive by meeting them to install the boxes, if they were available to keep them during the data collection period.

The results obtained with the first co-monitoring campaign were needed to check the actual level of pollution in the critical spots found by citizens, more than to be used for a comparison. Furthermore, this first monitoring was extremely useful to help citizens in taking note about issues and criticalities based on actual and objective data, and not only throughout their perception.

Some interesting results were found with the first data collection. The most important input concerns PM2.5 and PM10. Participants thought that the levels could have major differences from one street to the other, but by visualising the data they collected - that were the ones they trusted more in the beginning, participants have been able to see how particulate matter levels cannot change much on a small scale. This also helped them to better understand how data acquired with sensors positioned by ARPAV in a closer neighbourhood can actually give a trustable view about the situation in their neighbourhood. In the same way, noise pollution data collected showed some expectable results - i.e. peaks during traffic jams. On the other hand, it has been found that data only had few peaks over the laws maximums, that does not result in high levels of noise pollution based on the average that is considered by law.

In the same way qualitative data gave some interesting data, because most

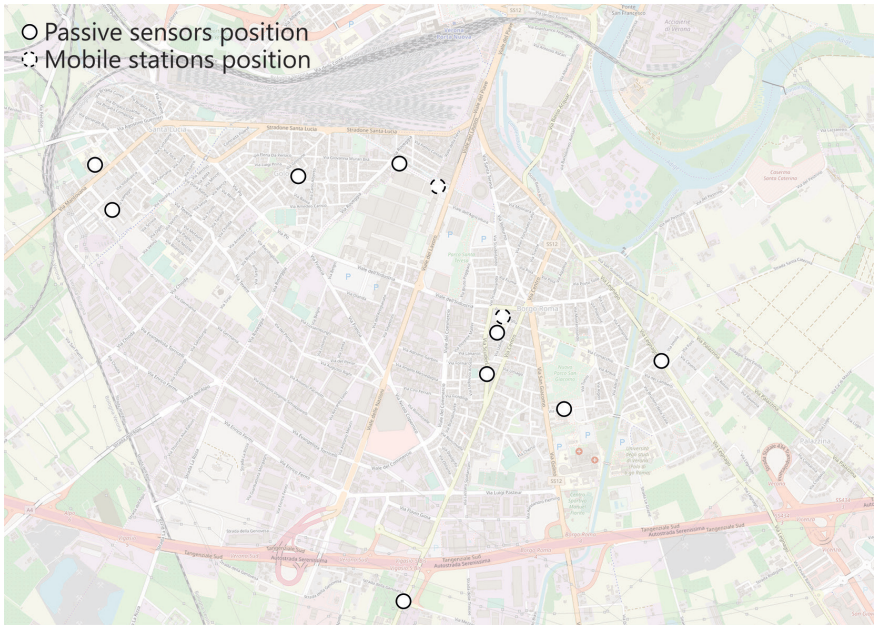


Figure 12.1-8 map showing ARPAV sensors positioning - mobile stations for official monitoring and passive sensors for participatory sensing - as discussed and decided by participants

of the data uploaded on the geotagging tool were collected by people who did not participate to the offline meetings, but despite this the criticalities presented were the same between the two different groups of offline and online participants.

Data visualisation

Moving forward, the visualisation of data was important for participants since they were able to compare the collected data in order to have a more complete view of the air quality and noise pollution situation in the area, without the need to search on multiple different sources to gather these data.

The data visualisation was mostly an individual activity done online on the local website, but it was also possible to do it offline during the first co-design meeting of the 5th of October 2018. This was possible because during the Looper Living Lab workshop of the 5th of October a first moment of visualisation of data took place to give participants the tools to better understand the data that could be visualised on the online platform.

The results of the first data collection campaign - and from the later monitoring campaign - are still available on the webpage *verona.looperproject.eu/visualizzazione/* by the time this thesis is written, and will be available for a couple of years. Data on the platform were uploaded to allow participants to compare, where possible, with e.g. official targets, scientific thresholds, risk factors, impacts on special groups. The results of the visualisation activity are publicly shared information that were discussed within the Looper Living Lab by local stakeholders, and that were analysed in terms of thresholds, targets, priorities, opportunities. To better clarify for users, 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.

For the Verona Living Lab the platform, and mostly the data visualisation page, gained a good success. Participants were highly motivated in the co-monitoring phase as they already knew that there would later be a data visualisation platform specifically built for them. The platform was seen as a neutral space where data could be collected by them and, furthermore, added by an impartial partner. This was opposite to the official ARPAV page, were data are collected by someone else and presented in a way considered as unclear by people with no expertise.

The data visualisation dashboard was realised by the Università Iuav di Venezia - further explanations on the dashboard can be found in section '19. Reflection on technologies', but it has then been implemented on the basis of the feedbacks as given by participants, this to present the data they collected

Figure 12.1-9 graph of the views of the data visualisation page, divided per month, from April 2018 to November 2019

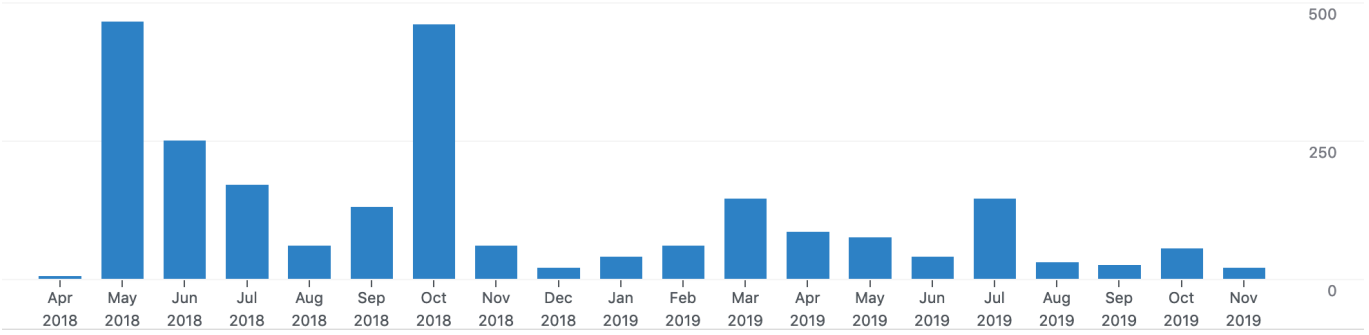


Figure 12.1-10 number of views of the data visualisation page, divided per month, from April 2018 to November 2019. May 2018 is highlighted as it is the month with the highest number of views

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2018				4	463	248	167	59	129	460	60	17	1,607
2019	38	59	145	81	73	37	142	28	23	55	19		700

in a user-friendly way. The interface has been considered clear and useful by participants within the Verona Living Lab. This can be explained because the page only have few options and it has an intuitive usability. The data considered as mostly interesting by citizens - that are the ones of PM2.5 collected with AirBeam sensors - are also the most intuitive ones, since the colours help recognise the situation of pollution, and the scrolling timeline allows to easily choose which day/month and time someone wants to see. Official data are visualised by showing the positioning of the sensor on the map and, by clicking on the related pin, it is possible to choose which campaign to see. In the same way when clicking on qualitative data, which can be a pin, a line or a polygon, it is possible to read the linked comment of the user who uploaded the comment.

Figures 12.1-9 and 12.1-10 show the graphs about the views of the data visualisation page divided per month. It can be seen how the visualisations of the pages incremented in different period of times. It is possible to notice that in May 2018 there has been the highest peak, since that month the visualisation page was launched. The lower number of visits for 2018 was then in August, and this can be explained as August it is the preferred summer holidays period for Italians. After August the visit count grew back mostly during October, when the co-design activity took place.

Timeline showing the main events from the '1. Identification of problems' stage of the first loop

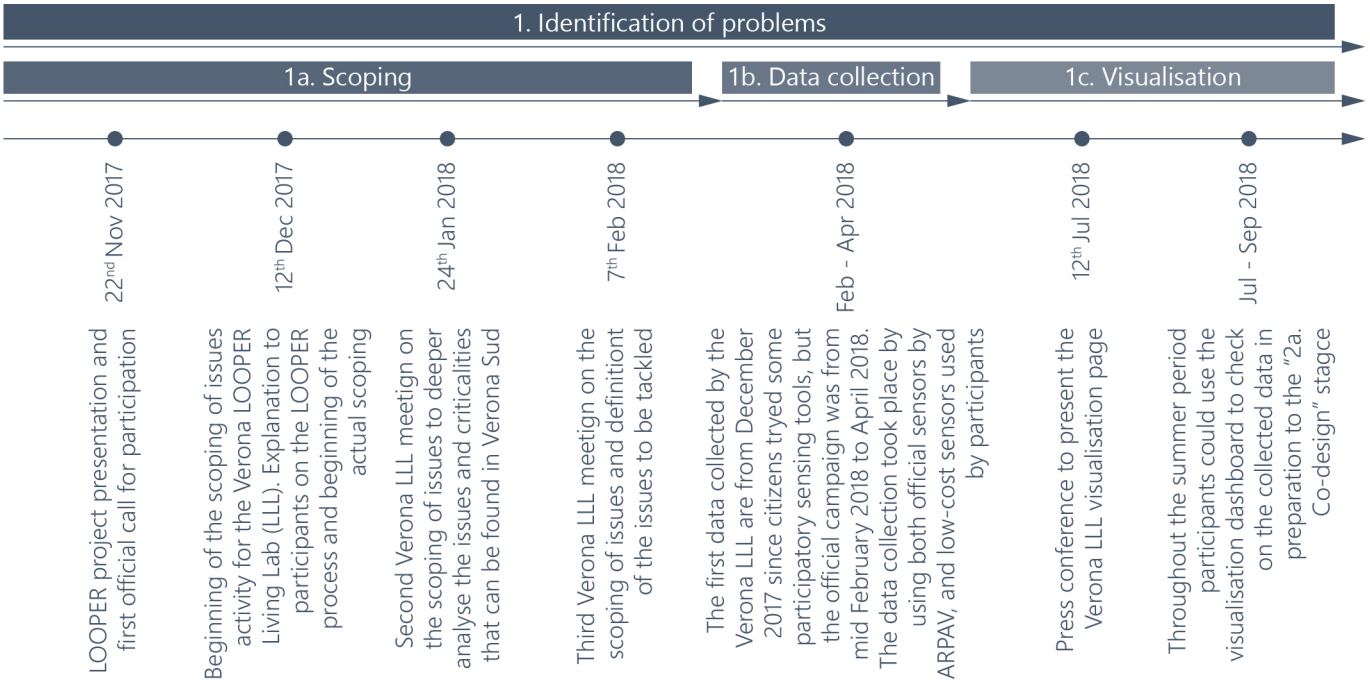
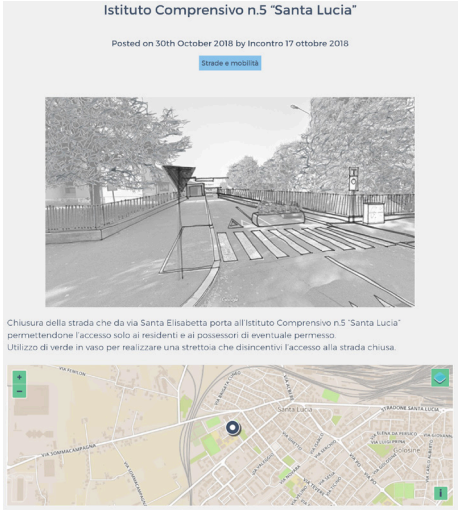


Figure 12.2-1 example of the online co-design tool. In the top part a map with the localisation of the proposed ideas can be seen, scrolling down it is possible to see a grid with an image and a short description for each uploaded idea

Figure 12.2-2 example of the ideas storage using the online co-design tool, this can be done by manually uploading the ideas proposed during the offline meetings



12.2 Co-design and evaluation of alternative solutions

The co-design activity took place during October 2018, after an initial moment of collective visualisation of the data collected with participants and policymakers. This activity was focused on how to respond to the problems found - and confirmed - during the first stage, and how to take advantage from the opportunities detected. This second stage involved a co-design activity and an evaluation moment about 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, since each of these need some form of participation and cooperation between experts, citizens, public stakeholders and policymakers.

Co-design

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. The process, though, depended on the different use-case, e.g. the co-design approach towards air quality mitigation solutions can be quite different to the co-design when talking about greenspaces. 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 contrast of powers between the community and experts/policymakers, which started as problematic but turned to be empowering for both parties moving forward with the co-designing.

The activities that took place during this stage included the ideation of possible mitigation solutions, the designing of these possible ideas and the resourcing on 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 to conclude reaching towards detail. During this activity the relationship between experts - or providers - and community - or non-experts - became very important. The last activity of this second stage was that of resourcing, meaning that during this activity participants have to found sources or other resources to transform into reality what they have done during this stage.

The process of collecting possible solutions took place both online - with the help of a co-design tool that could be found on the local website (figure 12.2-1) - and offline - through different workshops. During the co-design offline activity participants included not only citizens, but also policymakers and council-employee. The presence of different stakeholders created an even more interesting moment of sharing and discussion to propose better mitigation solutions with a stronger feasibility base as experts from the city council were participating. Ideas produced offline have also been integrated on the online tool, that was used both as a way to propose ideas for people who could not participate at offline meetings, and as a storage of possible solutions to keep participants informed (figure 12.2-2).

To better understand what happened during this co-design activity, the three workshops are hereby better described. The first workshop was advertised both online - i.e. blog post on local website, newsletters, news on Legambiente and Comune di Verona websites - and offline - i.e. press conference, flyers and word of mouth - to reach the wider audience, even the ones that did not participate to previous activities. These methods were quite effective since on the 5th of October 2018, date of the first workshop, about 20 people participated. Out of the 20 people participating both citizens and council-employed were there to work together.

The workshop started with a presentation of the data visualisation platform, even if participants said they already checked the page to take a look at the data they collected. It was explained that the timeline bar for the AirBeam data selection was recently added, and it was also explained why it was needed. Organisers asked to participants if there was something they could not understand from the data visualisation in order to better explain it (figure 12.2-3) and to further implement the visualisation platform.

Then, good practices from around the world have been presented, this was done to show participants that even with a low budget it is still possible to make a space more liveable. This was linked to the request that some participants had already make about their will to have more aggregation spaces. During this first workshop the methods used to collect the proposed ideas are again printed maps, transfer paper, Google Earth projection, Street View projections.

These methods were chosen as they were found to be effective during the first activities of the scoping of issues phase. This because transfer paper allows to work on printed maps, while having the chance to propose multiple things on the same printed map by simply exchanging the transfer paper, and in the meantime the use of Google Earth and Street View allows to better understand the spaces and positions that can, at times, be unclear by just looking at a printed map (figure 12.2-4).

During this first workshop the online co-design tool was not used, it was only explained its purpose and how to use it. This choice of separating the online and offline methods, at least for participants, was done because it would have been confusing and restrictive to use such a simplified tool during a face-to-face meeting, that is a more interactive activity. The tool is structured to be used in a more straight forward way, that does not suit an offline meeting with multiple people discussing about the topic. Participants showed a good interest in this online tool, since it would allow people - who could not participate to offline meetings - to express their ideas. It was explained to participants that ideas proposed during the workshops, once developed in a more defined structure, would be added to the online tool to create a repository of the work they were doing within the workshops.

Since it was decided to organise the workshop to propose the ideas by discussing about the possible solutions in the different places where the monitoring took place, only 7 locations out of 19 were discussed during this first workshop.

The second workshop was advertised like the first one. The only difference was that the press conference did not take place. About 15 people participated to this workshop, and again there were policymakers attending it to help participants in evaluating the possible technical difficulties of the ideas they were proposing. The beginning of the workshop was a recap of what happened during the first one, with some time spent to go through the list of ideas proposed during the previous meeting. During this second meeting ideas proposed via the online platform in the timeframe between the two workshops were checked as well.

After this activity, participants went back on discussing about the possible solutions to be implemented in the monitored locations that were not discussed during the previous workshop. The methods used to collect ideas where the same ones from the first co-design workshop: printed maps, transferable paper, Google Earth and Street View projections (figure 12.2-5). Again, it was not possible to conclude the discussion and to propose ideas for every place left, so it was decided to finish the discussion about the monitored locations during the third workshop.

The third workshop was advertised as the second one, using both online and offline ways. About 15 people participated at this workshop and again there were policymakers attending it. The beginning of the workshop was, as before, a recap of what happened during the first and second meetings. This was done to help the few new people participating to better understand what happened previously. There was again some time spent to go through the list of ideas proposed during the previous meetings and with the ones proposed on the online platform. The methods used to collect ideas where the same ones from the first and second workshop, as these were found to be the most effective.

The online co-design tool collected, by the end of the co-design workshops, 37 ideas. 11 out of the 37 ideas were proposed during face-to-face meetings. This means that 26 ideas where proposed directly through the online format, and were then discussed during face-to-face co-design workshops. Citizens encountered some technical issues when trying to attach pictures to the ideas

Figure 12.2-3 collective data visualisation moment before the beginning of the first co-design meeting

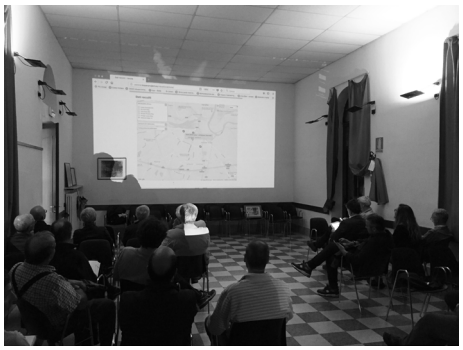


Figure 12.2-4 participants analysing a possible location where to implement one of the proposed ideas by using a map projection that was combined with a Street View visualisation to better understand the area conformation and the idea feasibility

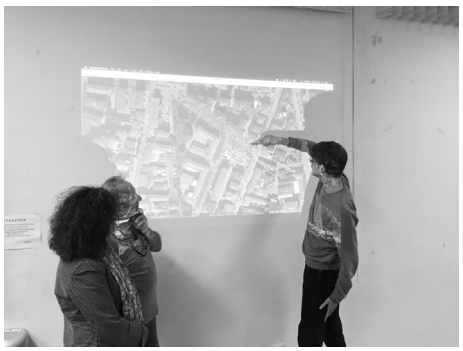


Figure 12.2-5 participant analysing various possible location where to implement the proposed ideas by using printed technical map and printed satellite maps to understand proposed ideas feasibility

they were proposing via the online tool. The solution that was found was that of having them send to the staff of the Università Iuav di Venezia to upload them from the administrator page in a second time. These issues were due to a bug in the Urbanista tool - developers of the co-design online tool, that still have not been solved by the time this research work is written.

No online debate took place, as people were more willing to talk about the ideas when they had the chance of meeting in between workshops. Later they were taking the discussion about the online ideas to the offline workshops. One main use of the online co-design tool was that of using it as a storage of the ideas proposed during the workshops to keep track of the work done. This was possible since, at the end of each workshop, the proposed ideas that could have already been evaluated as feasible by participants and council-employed would be uploaded on the co-design online tool awaiting for further implementation.

Evaluation

The final part of the third co-design workshop was focused on choosing the ideas on which to concentrate, that were supposed to be evaluated with both the MCA and the MAMCA. The Verona Looper Living Lab did not undertake the MCA evaluation and did straight forward the MAMCA. This happened because an informal sustainability MCA took place within the last workshop, during which participants and policymakers discussed the feasibility of the proposed ideas to better decide on what to focus. Participants then defined that the right number of ideas to be chosen in order to better focus the resources given by the project was 14. The ideas chosen took in consideration the implementation feasibility, the budget and the timing given by the project. Still, some ideas that could not be implemented in the framework of the project were listed since participants wanted to have them on official papers for future dialogue with the city council.

The proposals and alternatives shown here are the ones emerged during the Verona Looper Living Lab meetings with all stakeholders. It is extremely important here to understand the difference between proposals and alternatives since this gives a better comprehension of the MAMCA results. Proposals are ideas proposed during the workshops, these are specific and localised ones. Alternatives are group of proposals made to suit the boundaries given

Figure 12.2-6 location of the 14 proposed ideas evaluated with the MAMCA. Some of the pins localise more than one proposed idea, idea number 13 is not represented since it is supposed to be spread in the whole area

Table 12.2-1 description of the proposed ideas and their transformation into alternative to use the MAMCA. The alternatives marked in yellow are the ones linked to mobility solutions, the ones marked in green are related to greenery solutions, the alternative marked in blue is related to temporary solutions, and the one marked in grey is linked to a possible relocation for reuse

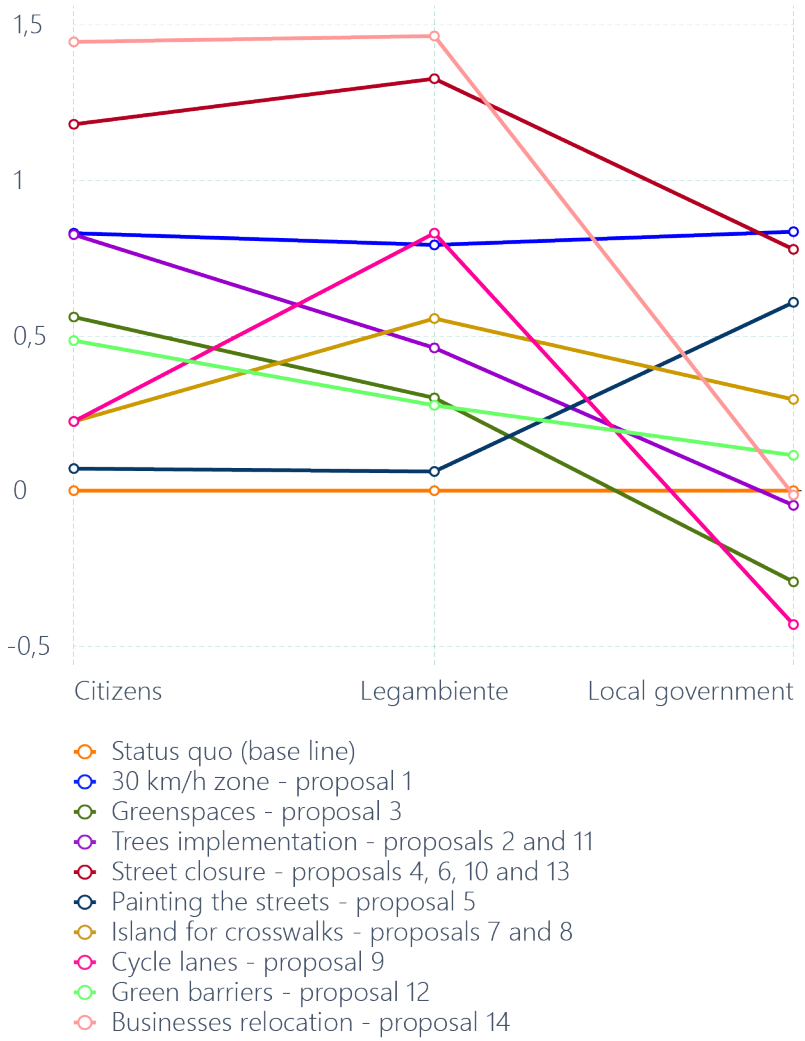
PROPOSAL	LOCATION	WHAT	ALTERNATIVE
1	Via Scopoli	As via Scopoli is a quite wide street, and as drivers here speed up making it unsafe for pedestrians and cyclist, citizens here ask to create a 30km/h zone with urban elements to oblige drivers to slow down to make the street safer.	**30 km/h zone**
2	Via Scopoli	Implement the number of trees in the parking area in via Scopoli.	**Trees implementation**
3	Via Scopoli	Transform in a public greenspace the small green area that can be found at the crossing between via Scopoli and Viale Fiera.	**Greenspaces**
4	Via Ottavio Caccia	Close via Ottavio Caccia from the via Golosine side in order to create a safe pedestrian area where citizens can aggregate. The street will remain suitable for residents vehicles only.	**Street closure**
5	Via Santa Elisabetta	Via Santa Elisabetta is already a 30km/h zone. The proposal is to paint the street's asphalt in order to make more visible the already existing limit.	**Painting the streets**
6	Via Monsignor Bellomi	Closing of the dead end road to allow a more safe entrance/exit from the schools for children. Residents will still be allowed to pass by with vehicles at reduced speed.	**Street closure**
7	Via Colonnello Fasoli	Implementation of crosswalk islands outside the school with some urban furniture to slower passing cars and allowing children to have a safer crossing outside the school.	**Islands for crosswalks**
8	Via Vigasio	Implementation of crosswalk islands to avoid dangerous overtaking and speeding as via Vigasio is a quite large and long straight road.	**Islands for crosswalks**
9	Via Udine/Via Redipuglia	Implementation of the cycle lanes, where missing, in order to create a complete and continuous path for cyclists.	**Cycle lanes**
10	Via Udine	Closure of via Udine at entrance/exit hours of schools. An extra would be to make via Udine a 30km/h zone.	**Street closure**
11	Via Redipuglia	Implement the existing trees to create a more concrete barrier between the street and the school courtyard.	**Trees implementation**
12	Highway	Realise a complete green barrier on both sides of the A4 highway in the part which cuts through the area of South Verona.	**Green barriers**
13	South Verona	Street closures in different parts of South Verona on weekend days to create aggregation spaces, which are missing and wanted by citizens. This could be implemented in the framework of the Mobility Days promoted also with the Mobility Week by EU.	**Street closure**
14	Former freight yard	Persuade logistic businesses in moving their activity to the area called Quadrante Europa, realised by the Municipality for this purpose. This would help to alleviate the heavy traffic that clogs the area nowadays.	**Business relocation**

by the MAMCA online tool. This grouping was done since the MAMCA works on the base idea that the alternative solutions to be evaluate are to be implemented in the same location, and it is needed to choose which one to implement in that location. The Verona Looper Living Lab has multiple ideas to be implemented in different locations, but grouping them allows to generalise their location to get correct results by the MAMCA online tool.

The 14 selected ideas, were located as per figure 12.2-6, and are explained in the following table 12.2-1.

In the evaluation of options phase then, the positives/negatives aspects - and the costs/benefits results - of each solution produced in the previous

Figure 12.2-7 graph showing the results of the MAMCA. The straight line in grey is the base line setting the starting condition. To find the best solutions it is needed to choose the ones in the higher position in the graph, and that are as straight as possible - e.g. the pink line (proposal 14) is not feasible since it is not feasible for the local government, the blue one instead (proposal 1) is to be preferred since it is above 0,5 and it is almost straight.



phase were compared in order to prioritize in a list the proposed solutions that were already globally shared within different stakeholders. One of the most important criteria that were considered was the cost/funding and feasibility. This was because, when working in a real environment, there is the need to take 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 was applied in order to gather confirmation on the chosen ideas to be implemented. As the area of the Verona Sud case study 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 again because the MAMCA method evaluates, and compares, different solutions among which to choose the one that would gain the highest approval by stakeholders in a specific location. As the MAMCA is a multi-actor analysis, the different group of stakeholder that were taken into account are citizens, Legambiente 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 be implemented.

With the results gained thanks to the MAMCA analysis, it was possible to evaluate the interests of the different group of actors who decided to participate into the Looper project. What was missing within this multi-actor analysis are businesses associations, who were called to participate in the project but rather preferred not to be involved. One of the aims for the second loop is then to find a way to involve businesses into the project to have a more complete MAMCA analysis.

Within the MAMCA, experts were called to evaluate the criteria that de-

scribed the different needs. Later the system included the weights given by stakeholders to obtain the final results. This made it possible to objectively evaluate what was said by experts and what was said by stakeholders.

The results of the MAMCA analysis showed that the solution that should encounter more approval from all stakeholders (figure 12.2-7) is the one proposing the possibility of improving, and implementing, 30km/h zones in the whole project area. This because it is seen as a quick solution to begin with, and that can have multiple benefits such as: pollution reduction; street safety implementation; creation of aggregation spaces for children.

Another proposed alternative that encountered mutual agreement in between stakeholders was that of realising crosswalk islands to implement the safety of streets in front of schools. This solution was already in the city council agenda and business plan, indeed it was autonomously proposed by citizens associations that did not know this public planning. This was an example of why a more strict dialogue is needed between citizens and policymakers.

To conclude this stage, the third commonly approved solution was that of possible street closures. This proposal could have different declinations such as: all week street closure; weekends only street closure; closure only for entrance/exit from the schools hours. Here the local government is the stakeholder that usually pinpoints that the alternative is not always feasible, as it is not always possible to rearrange the mobility of the neighbourhood to permanently close a street. Nevertheless, policymakers claimed to be open to a dialogue to see what was possible to do as they would have liked to create

Timeline showing the main events from the '2. Co-design and evaluation of alternative solutions' stage of the first loop

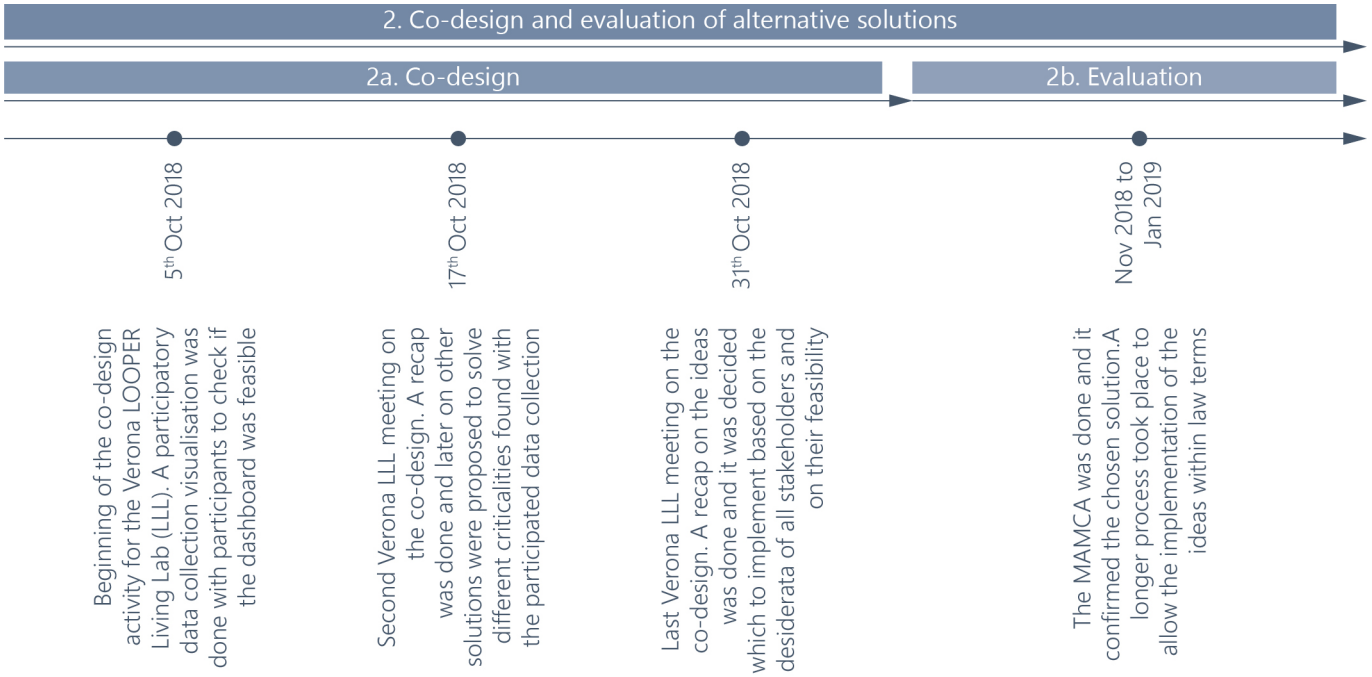


Figure 12.3-1 crosswalk pedestrian island implemented in via Colonnello Fasoli in front of the primary school

aggregation centres for the community in the area of Verona Sud.

12.3 Implementation and monitoring

This last stage, that took place between December 2018 and April 2019, included the implementation of the best options - produced inside Looper Living Labs during the co-design activity - and the monitoring feedback of the results/effects obtained by the implementation of these solutions in the real urban environment.

Implementation

In the area of Verona Sud the implementation activity worked on some physical actions on the ground. Mitigation solutions asked by participants concerned the creation of 30km/h areas around schools with streets closure at entering/exit school hours, the closure of some streets to create outdoor gathering space for residents and the positioning of a crosswalk island to allow a more secure environment in front of a primary school (figure 12.3-1).

Because the implementation had a first part - from December 2018 to January 2019 - of organisation only, the solutions were officially implemented after February 2019. This indeed allowed to have the solutions in place during the second monitoring campaign. This meant that it was possible to check if there were any changes in comparison with the starting situation monitored in the same period during the previous year.

The solutions then implemented before the monitoring campaign were:

- implementation of a temporary crosswalk island that was to be later converted into a permanent one (Via Colonnello Fasoli);
- closure of one street to create an outdoor aggregation space (Via Ottavio Caccia).

It was not possible to implement the other solution selected with the MAMCA - the 30 km/h zone in via Udine with programmed closures during the day to allow a safer enter/exit from school for students - since there was not enough time to find the needed resources and to have the proper surveillance to implement the idea.

During the implementation activity some participants learned that a timeframe of three months is not enough to implement the selected solutions, and this then leaded to the decision of having the co-design activity for the second loop earlier, possibly at the beginning of September 2019 to have an extra month before the second loop implementation.

Monitoring

The monitoring campaign then took place between February 2019 and April 2019, covering the same timeframe (February - April 2018) of the first data collection campaign, to collect data throughout the implementation period.

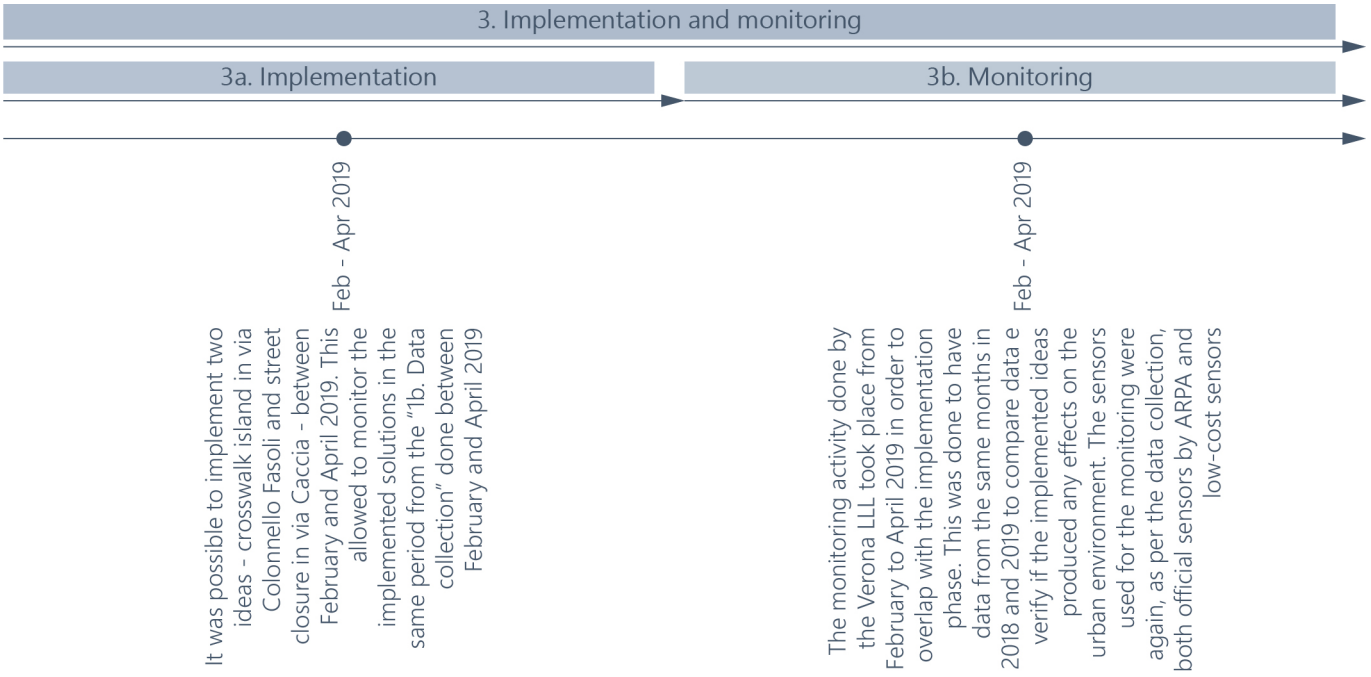
The implementation of a temporary crosswalk gained some positive - direct - and less positive - indirect - feedbacks. The aim of the implementation was that of creating a more secure space in front of a primary school, by obliging drivers to slow down in proximity of the crosswalk that children use to enter and exit in mornings and afternoons. The main positive feedback was given by residents that actually found cars to slow down due to the presence of the signals and the island itself. A noise box and two passive sensors were positioned on a balcony right next to the crosswalk, and results from their data analysis showed that there were no tangible changes in the air quality and noise situation. The indirect negative feedback was due to the presence of the school bus stop that was moved to allow the positioning of the crosswalk island. Moving forward the school bus stop of a couple of meters without changing the footpath structure then obliges children to walk for a couple of meters on the street - between the footpath and the bus itself - due to the presence of rails that protect the footpath in front of the school from the street itself. This minor issue could be easily solved by moving the school bus stop a couple more meters forward towards the intersection, and by removing the last piece of rail to allow children to get on and off the bus straight

from the footpath.

The other implemented idea was the closure of Via Ottavio Caccia to create an outdoor aggregation space, to stimulate the willingness of citizens in reducing the use of cars, and to create new better habits. Unfortunately some misunderstandings and problems were faced during the implementation. Due to some bureaucratic issues, mainly linked to the difficulties in organising the implementation in a short period of time - the idea was chosen in December 2018 and needed to be implemented in March 2019, the public feedback was not completely positive because the street was closed for just one day without surveillance to enforce this temporary change. The closure of the street for one day, that overlapped with the 'Mobility Day' events in the city centre, created further misunderstanding between city council and citizens. After the event, some meetings were organised with both parties to solve the raised misunderstandings. Citizens later explained to policymakers that what they wanted was a closure of the street reiterated for multiple days. The city council, on the other hand, explained the bureaucratic issues that resulted in a street closure done for just one day, that was then done during a 'Mobility Day' event with the hope to be able to further implement it in other streets around Verona Sud. Due to these misunderstandings, it was decided to further evaluate during the second loop if participants still wanted to continue with this street closure solution with some modifications - e.g. starting to organise more in advance the closure to have enough time for the bureaucratic needs - or if they would rather prefer to focus on a different solution.

To summarise about the first loop it was possible to say that in the Verona Living Lab, due to the wide application area, some issues linked to the bureaucratic work emerged during the process. This is because many steps and different levels of evaluation, done by different local and neighbourhood bodies, are needed in order to obtain permissions to implement something that might affect the urban environment. Despite these issues, and even if only few ideas were implemented, it was possible to see that all stakeholders became more willing to listen to other parties' points of view. This meant that the work done during the first loop to open a communication line between different stakeholders was starting to work.

Timeline showing the main events from the '3. Implementation and monitoring' stage of the first loop



12.4 Second loop

After the end of the first loop participants decided to continue, throughout the second loop, to work on the criticalities found at the beginning of the process. This choice then meant that there was no need to do a second scoping of issues, and that the data collection done to monitor the implemented ideas would then become the basis for the co-design of the second loop. In other words, for the Verona Living Lab the monitoring activity of the first loop then coincided with the data collection activity of the second loop, allowing to start straight away with the second data visualisation and co-design.

Given the experience and knowledge gained during the first loop, Verona Living Lab participants than decided that it would be better not to focus on small scale localised solutions, because these would only affect one street and not a whole neighbourhood. Participants understood that it was better to focus on solutions that can be easily replicated, or ones that are on a longer term implementation basis. Both type of solutions can be considered as localised ones, but these have a greater impact that a small solution that is not replicable.

The second co-design activity then resulted in a list of requests that participants of the Living Lab presented to the city council, and that the city council would accept with some public press conferences.

Due to the Covid-19 emergency - that in Italy resulted in closures from the end of February 2020 - the co-design activity for the second loop was still to be concluded by the time this thesis is presented in May 2020. Still it was possible to draft a first request list, and one of the requests made by the Living Lab were already accepted. The proposed ideas to be implemented are:

- creation of outdoor aggregation spaces done by closing different neighbourhood streets;
- creation of a dialogue table with the highway society to implement the existing noise barriers;
- implementation of other crosswalk islands in the project area;
- development of a urban forest within the area of Verona Sud.

The request of creating outdoor aggregation spaces wants to further implement the street closure done during the first loop, but with the aim of doing it in more streets at once and with a more structured format. To gain better results participants requested to have street closures in the same dates in different locations of Verona Sud, that lasted for at least two days at time, that the solution could be repeated with a weekly or monthly basis, and with the aim of a wider involvement of residents and businesses. Participants also gave their availability to find possible activities that could take place during these closures, this to boost citizens presence during closures.

The possible implementation of the existing noise barriers for the highway, chosen as long term solution, was a topic dropped during the first loop because in the beginning participants wanted to work on quickly implementable solutions. Participants decided to ask for a meeting with the people in charge for the highway via official channels, with the support of the city council. The final aim of this idea is that of finding ameliorative solutions to reduce the noise produced by the highway - that cuts in half part of the area of Verona Sud, and to maybe use solutions that could help in reducing the impact of pollutants caused by vehicles.

Linked to the crosswalk island implemented during the first loop, participants asked to implement the changes already discussed to allow the transformation of the temporary solution into a permanent one. Because the overall result was positive, participants also asked to implement other crosswalk islands around the area to have more secure pedestrian crossing. This, combined with the idea of creating outdoor aggregation spaces and street closure, would be beneficial for the whole area since it would more easily allow a change in residents mobility habits.

The development of a urban forest was another long term request that participants made. They wanted to be involved in the design of the future enlargement of the existing Parco Santa Teresa, and their idea was that of converting one part of the park expansion in a urban forest, instead of having

all the area designed as meadow. This proposed solution was the only one that was already officially accepted in the city council agenda before February 2020, allowing to gather some results from the second loop and setting the basis for the Living Lab to continue even after the end of the project.

Since the project deadline have been extended from the end of June 2020 to the end of October 2020, the hope is that of being able to have more solutions officially accepted by the city council before the end of the project. This would allow a continuation of the work done since the beginning of the project, and would set the basis to have more co-creation processes triggered in the future.

13. THE MANCHESTER LIVING LAB

In the initial proposal, the topic of research for the Manchester Looper Living Lab was that of exploring issues of road safety and security in public space in the inner area of New Brunswick. The Brunswick area is a neighbourhood with mainly council housing built in the '60s-'70s, and that is undergoing - as the thesis is written in December 2019 - an aggressive regeneration process to raise the neighbourhood quality. The Manchester Looper Living Lab wanted to raise both technical and socio-political issues and conflicts between users or providers, and the data to be collected were supposed to be about road accidents and hazards.

Despite the road safety topic remained, the security in public space issues was not fully tackled because residents were not as concerned about it as it was expected in the beginning. There was indeed a shift towards the idea of working on traffic safety - as planned in the beginning - and on the concept of creating a better neighbourhood by using greening expedients.

Opposite to the Verona Looper Living Lab, in Manchester there was no strong bottom level to work with. Other difficulties raised because in the end, given the ongoing renewal works, the project area shifted from the whole neighbourhood towards working only on the main road that cuts the area in half. To stimulate participation organisers and researchers tried to involve the associations already active in the area - e.g. residents' association, women group, youngers' group. Despite organisers efforts, citizens participation was inconsistent and it was hard to keep residents working on the topics. Opposite to this, the Manchester City Council (MCC) was somehow 'too' involved since employee from different offices were willing to help in the process and were participating to every meeting. The massive presence of MCC's representatives, in the beginning, was intimidating for citizens willing to participate in the Looper process, and organisers needed to involve them as much as possible during meetings to let them understand that their opinion was as important as the one from other stakeholders.

In Manchester, just like in Verona, citizens felt like 'B series' ones, and this feeling discouraged them from participating to Looper events. After the low attendance of the first events, the approach was then changed and organisers saw how handling goodie bags - or other free items - would raise citizens participation to events. The goodie bags and/or free items were usually provided by S4B, MCC or other corporate stakeholders. The reason why the handling of goodie bags - that came with small items such as chocolate, a pen or something similar - boosted citizens' participation can be found in the socio-economic situation of residents, that on a majority are people living in council housing.

Furthermore, as abovementioned, the particular socio-economic situation of the Brunswick area resulted in a massive participation by housing associations and MCC, but citizens and residents could be considered as hard-to-reach in almost all cases. This condition changed after the 'hanging baskets event' that can be considered as the beginning of the implementation phase for Manchester first loop. It is then possible to say that Manchester needed more time, compared to Verona, to start having participation since they needed to build a form of bottom level with whom to dialogue.

Another difference between Manchester and the Italian Looper Living Lab

is that, in Verona, the city council and an NGO with a strong presence on the territory, were partners since the beginning of the project. Manchester, on the other hand, needed to convince MCC employee in participating by finding common interest between the Municipality agenda and the aims of the project. This meant that organisers could not completely focus on involving Brunswick residents, but they also needed to involve the city council. Later on, the lack of balance between the city council and citizens lead to the focus on some topics that were of less interest for citizens and of greater interest for policymakers. Furthermore, there was not as much support and participation in creating a constructive dialogue to trigger the co-creation process at its best.

Hereafter the activities done in Manchester during the first loop, with some explanation about the second loop, are to be found.

13.1 Identification of problems

During the phase of identification of problems some flyers have been handled to residents and associations in order to disseminate about the beginning of the project and to find possible participants. Flyers were given door-to-door on Brunswick street, and posters were positioned in S4B offices and on residents boards in high rise buildings (figure 13.1-1).

The door knocking activity was the preferred one by organisers because it both allowed to undertake surveys and to advertise meetings, and it was the most suitable one due to the low digitalisation of residents. This door knocking activity later during the process created some issues in the relationship between organisers and participation because, after a couple of surveys, from the residents point of view that asked questions were too similar and they sometimes asked not to knock on their doors again. However, it was possible to identify the problems thanks to some meetings that took place with residents and other stakeholders, and the information collected with the door knocking.

Participants, during the scoping of issues, already started to propose possible mitigation and implementation solutions, showing how organisers need to be flexible when applying the co-creation methodology and always have to explain why there is the need to collect data before the proposal of ideas. Residents showed higher interest in the chance of making the street look better by using planters and other greening expedient, with the double aim of also reducing the speed of cars that cut through the neighbourhood. On contrary, they did not feel that the neighbourhood was unsafe, meaning they did not want to focus on this topic.

Figure 13.1-1 poster on a residents' board advertising the Greening Brunswick event

The qualitative data collection was done both with surveys and also in a collaborative way. Surveys were undertaken with door knocking, as for the initial scoping of issues, and by also interviewing people passing by Brunswick street. Other qualitative data were collected by using the geotagging tool developed by the Italian team. This geotagging use was a collaborative moment because most of the participants did not have or were not able to use a smartphone. To overtake this issue, organisers organised walks with participants around the neighbourhood, during which the collected feedbacks about the criticalities and good practices around the area, and would then upload all discussed things on the geotagging tool. These collective walks were also used to collect data about air quality because the sensor to collect data about particulate matter also needs to be connected with a smartphone with data connection. Other data about traffic were collected by using a traffic radar that did not request participation from citizens in the data collection.

Figure 13.3-1 people participating at the Greening Brunswick event activities. The event saw the participation of residents, associations and the city council

While undertaking the surveys an interesting point of view was raised by parents of the children attending the primary school close by Brunswick street. They pointed out that children from Brunswick Primary School follow 'cycling classes' and usually ask to their parents if it is possible to go to school by bicycle. This unfortunately is not possible due to the poor conditions of the cycling infrastructure in the Brunswick neighbourhood. Parents were then interested in the possibility of lowering the speed limit of the street, and if there was the opportunity to create visual barriers to change drivers' behaviour to have a safer environment that would result in the chance of bringing their

Figure 13.3-2 goodie bags given at the Greening Brunswick event to people who answered at the 'before' survey

Figure 13.3-3 city council stand at the Greening Brunswick event where residents could collect info and gadgets on how to recycle their rubbish

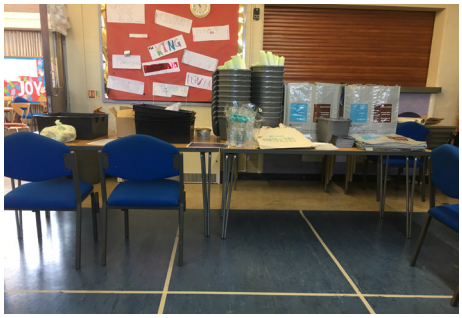


Figure 13.3-4 participants of the Greening Brunswick event learning how to set up their own compost with worms

Figure 13.3-5 during the Planting Day event residents of Brunswick St could collect their personalised hanging basket for free

children to school by bike.

13.2 Co-design and evaluation of alternative solutions

Since residents showed an higher interested in having a greener street - in order to have a better place where to live and to make it clear to drivers that Brunswick street is a neighbourhood street and not an high street, the co-design activity was mostly done using surveys. The surveys were used to ask what type of greenings residents would better prefer to see in the street. Surveys were mainly based on multiple choice answers - e.g. choose between: 1. Planter 2. Tree planted on the asphalt 3. Hanging baskets or opinions on the speed limit that there should be on the street - to make it easier and quicker for respondents and to have better collaboration.

Since both the scoping of issues and the co-design activities were done in a already evaluative way, it was than difficult in Manchester to use the MAMCA tool to evaluate the different options to be implemented. This meant that organisers of the Manchester Looper Living Lab needed to do the evaluation activity in an offline was, creating a comprehensive survey - undertaken during an offline collective workshop with all stakeholders - that tried to apply the MAMCA principles to obtain a more objective evaluation of the possible solutions, that would consider every stakeholder and their preferable criteria. The decision of having an alternative offline MAMCA was also due to the high level of digital illiteracy of the citizen stakeholder group, that requested specifically designed solutions also during the data collection activity. Again, as for the Verona case study, the use of online tools was not always easy because they need to be calibrated on the most possible illiterate stakeholder to be user-friendly.

Ideas chosen for the implementation were, in the end, decided based on the limits of time, cost and risk.

13.3 Implementation and monitoring

After the co-design activity and the non-technical evaluation moment, different ideas - some more effecting than others - were implemented:

- hanging baskets to make the street more green and to improve the community feeling of the space for residents;
- planters to make the street more green and to create some 'solid obstacles' that might help in reducing vehicles speed;
- banners to make drivers understand that the street is a neighbourhood street and not an high speed one;
- temporary 20mph signs to enhance a speed reduction;
- a mural to improve the community feeling of the street, and to make more clear that this is a neighbourhood street.

To implement the co-designed ideas that were more participatory since they were linked to the community feeling, two events took place between April and May 2019. One event was the 'Greening Brunswick' and the other was a 'Planting Day'.

The 'Greening Brunswick' event (figures 13.3-1, 13.3-2) was organised to show citizens how they could embellish their front garden or terrace - because all houses/apartments have either one or the other - by using small pots with seasonal flowers and/or edible plants. During the event 'before survey' [13.3-1] were carried out to better understand what residents wanted, and how much effort they were willing to put in the implementation and maintenance of some greening along the street.

Results from the surveys showed that citizens wanted plants on the footpath, but would not collaborate in watering them as they thought it is someone else duty. To convince people in participating to the event, and mostly to fill out the survey, a goodie bag was given to anyone undertaking the survey. The low participation to surveys was understood to be due to the high amount of door-knocking done by organisers before the event.

Throughout the event some activities for children were organised - i.e. link the name to the corresponding edible plant and draw your banner - to involve youngers in a funny way. For adults some workshops on how to prepare a

small pot with combination of seasonal and edible plants was organised, an a small stand on the new differentiate rubbish collection (figure 13.3-3) was set to better explain to residents the benefits of differentiating their trash. The last activity done during the event was an explanation on how to set up your own compost with worms (figure 13.3-4) to recycle organic waste.

The second event encountered more success than the first one. The 'Planting Day' event was based on the idea of giving to Brunswick St residents - for free - two hanging basket composed with seasonal flowers to be placed outside the front door - one per side. This event was quite successful in creating socialisation between neighbour, because they helped each other in choosing which flowers to use, and in collecting the baskets for elder residents (figure 13.3-5). Once again children were involved because they had the chance of playing with the table tennis table next to the hanging baskets preparation desk (figure 13.3-6).

Lot of people stopped by, and many residents of the Brunswick area requested other similar events to make the whole neighbourhood, not only Brunswick St, more green. In November 2019 it was possible to see how most of the hanging basket were still bloomy (figures 13.3-7, 13.3-8).

Other implementations took place between June and July 2019. Planters, that were supposed to be positioned in spring, due to logistic issues were positioned in June 2019, but they did not have the best feedback from the public. Indeed, the initial idea was to have some small planters all along Brunswick St to create visual obstacles for drivers and safer walking spaces for pedestrians. Unfortunately, it was only possible to reuse planters that were too big since they had been relocated from another neighbourhood - the dimension was 1,5x1,5x1,5 m. Due to their dimension, these planters could only be positioned in front of the S4B office, and at the beginning of the street on the S4B side. This meant that residents did not benefit from the planters and later

Figure 13.3-6 the Planting Day event saw some activities, such as table tennis, to involve children living close-by

Figure 13.3-7 hanging basket, outcome of the Planting Day event, on the event day

Figure 13.3-8 hanging basket, outcome of the Planting Day event, after 6 months

[13.3-1] See example of 'before' surveys on annex 1 at the end of the thesis.

Figure 13.3-9 banners along Brunswick St to create more of a community feeling

Figure 13.3-10 Brunswick welcome sign at one side with a high street

Figure 13.3-11 temporary 20 mph speed limit signs along Brunswick St

said that they were not willing to replicate this implementation during the second loop.

Banners and temporary 20mph signs were positioned between June and July 2019, and they gave different results. Banners had more positive feedback than the 20mph signs, because the designing of the banners was done with residents and children from the close-by school,. This preference in co-designing the images to be printed on the banners can be explained because banners are meant to present Brunswick St as a neighbourhood street, rather than an high street, and are meant to also create a community feeling within the two sides of the area (figure 13.3-9). Banners then obtained such results. The only concern that residents had was mainly about possible noise pollution, because standard banners create loud noises when flapping due to the wind. To avoid such issue organisers ordered banner's supports with noise reduction systems. In combination with the banners, a welcome sign was also implemented to remark the importance of Brunswick St as a neighbourhood road (figure 13.3-10).

On contrary, 20mph signs needed to undertake an extremely long process as it was needed an MCC authorisation, and from the first results obtained with the traffic radar drivers did not lower their speed since the placing of the signs (figure 13.3-11). This shows how, for speed reduction as for air quality improvement, there is need for more long term and structured solutions in order to solve this type of issues.

In July 2019 another implemented idea was that of the mural along the biggest building site in Brunswick St (figure 13.3-12). This mural was made by a famous Mancunian artist that collaborated with students and youngers living in the Brunswick area. Again the mural idea was that of creating something visually impactful to remark Brunswick St as a neighbourhood street.

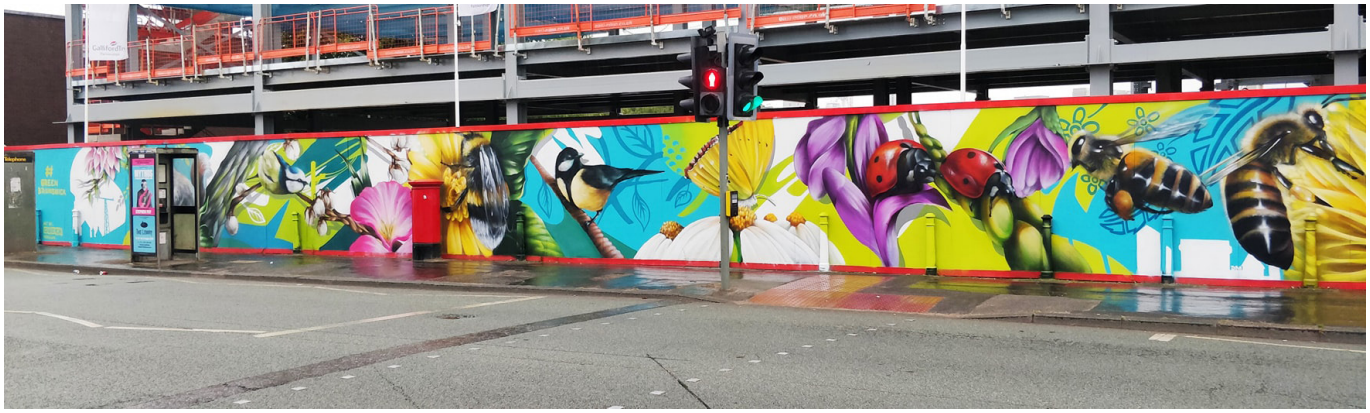
After implementing such solutions it was analysed in Manchester - just as in Verona - that it is better to work on punctual ideas that can be repeated on a larger scale, and that it is better to focus on issues that are of wider interest for residents and local stakeholders in order to have a strong bottom level that can support the process.

Based on these results, the idea of the Manchester Looper Living Lab for the second loop was that of better focusing on road safety, by working on the repositioning of existing crosswalk and by creating a new crosswalk close to S4B offices that could allow children to reach the school in a safer way. This idea of implementing crosswalk solutions is indeed based on the replicability concept, and on the idea of working onto something of wider interest.

It is possible to notice how in Manchester the final monitoring was done with 'after' [13.3-2] versions of the initial surveys, and by collecting speed and vehicles volume data with stationary sensors.

[13.3-2] See example of 'after' surveys on annex 2 at the end of the thesis.

Figure 13.3-12 mural on Brunswick St implemented in the framework of the project to make the neighbourhood more liveable by making it more colourful



13.4 Second loop

Because the Manchester Looper Living Lab concluded the first loop after the Verona case study, and due to the Covid-19 emergency, organisers defined that a second loop would assess the outcomes from the first loop and set the direction for future work.

Even if the second loop is paused by the time this thesis is written, organisers are still working based on the results obtained during the first work. The Manchester Looper Living Lab showed the wide potential of a 'deep place' engagement. This 'deep place' idea could mobilise residents' visions and energies that are now lost in a strict and fixed decision-making process, and it could also allow to have access to other resources in government and public services.

The Looper co-creation methodology in Brunswick cannot solve pre-existing problems of inequality and exclusion, coming from the socio-cultural provenience or residents, it can still help in creating a stronger bottom level that could empower the community and that could give them the tools to obtain more resources to express their potential.

4

CRITICAL REFLECTION ON THE LOOPER CO-CREATION METHODOLOGY AND ITS TOOLS

PART 4
CRITICAL REFLECTION ON THE LOOPER CO-CREATION METHODOLOGY AND ITS TOOLS

14. HOW THE LEARNING LOOP WORKED

The learning loop topic was one of the main aspects for the Looper project, and it was necessary to pay close attention to how it worked to analyse its usefulness in the co-creation process. This is because the learning loop method is usually unrelated to co-design and/or co-creation processes, but within this research it has been used in order to apply the 'validate and refine' (Mitchell *et al.*, 2010) to urban design processes. The learning loop process was also used to restart the design process again with acquired knowledge, allowing a continuous cooperation between stakeholders that usually would not work together. This availability at working together happens because stakeholders find, in Urban Living Labs, a neutral ground where to share knowledge and where to build relationships thanks to the loops of the process.

14.1 The utility of the two loops

The data visualisation activity from the first loop was the earliest milestone reached to analyse the learning loop. Participants during the first loop started to analyse the general situation by mainly thinking on a small scale - as expected by organisers, and it was because they were mainly focused on what they thought was their issue instead of thinking on a wider scale. This first data visualisation then lead to the co-design of small punctual localised solutions - mostly though to solve specific issues of single interest of some of the participants - that could be implemented quickly, and only few larger scale solutions were proposed. After the implementation of the chosen ideas, and their monitoring, a second milestone was reached. Participants saw that no visible change took place as the solutions were applied on a single location and were not repeated in time. This triggered a first important learning since participants - mainly citizens - understood that it was necessary to think on a city level scale instead of focusing on a street level scale.

This then led to a different approach for the second loop, showing a change of course based on the knowledge citizens and final users gained during the first loop. The ideas proposed for the second co-design activity were actually wider urban transformations and/or transformation of the urban environment. The proposed ideas for the second loop were, in the end, larger scale punctual solutions and small scale punctual solutions to be replicated on a larger urban scale.

This meant that in both loops proposed ideas were 'punctual', but they differ when comparing the application scale within the urban environment. This meant that in the firs loop participants wanted:

- punctual solutions of easy and immediate application:
    - these solutions were localised in areas were citizens perceived a more polluted situation.

While during the second loop participants proposed:

- punctual solutions of longer term implementation, that can be used as pilot cases to be repeated in other locations within the city area:
    - these solutions were spread on a wider urban scale.

It is then possible to say that punctual solutions can have a double value since:

1. within the first and second loop the bottom level is able to bring knowledge about the territory, because residents have a deeper knowledge about issues at neighbourhood scale. This knowledge gets somehow scattered during the first loop since the implemented solutions do not mitigate pollution. This happens because the solutions designed during the first loop are based on the needs of individuals, rather than of the community, because the cooperation is still being built. Despite this the knowledge acquired is important because it allows to have a better visualisation of the whole and wide urban situation of the city;
2. it is possible to have mitigation by using punctual solutions, but there is the need to avoid general long term plans - nowadays it is possible to state that urban plans designed in the '50s were the basis that created the issues we are facing today, and it is better to favour small punctual solutions applied to a larger scale. This allows a better urban transformation, capable of faster modifications if needed.

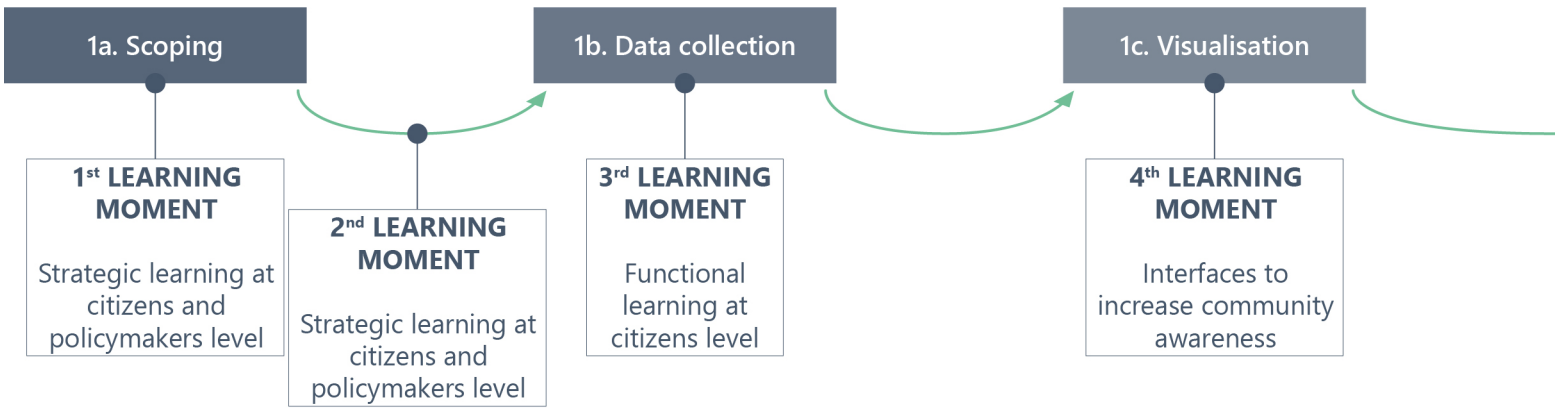
To have a deeper impression, we can say that within the first loop results from all three cities were somehow similar, but with the second loop Verona and Manchester decided to approach the process differently to Brussels. Since the Brussels case study was not followed with a first-hand work, the data gathered here are indirect ones.

However, some key results from the Verona and Manchester cases can already give a hint on the goodness of the learning loop idea.

The second loop for Verona and Manchester can be considered as a shorter one, because the last activity from the first loop - monitoring of the implemented ideas - actually overlapped with the activity of data collection in the second loop. This was due to the decision of continuing with the same issues and criticalities found during the scoping of issues in loop one. The shorter second loop for Verona was a consequence of the knowledge acquired by citizens that, mostly in Verona, understood how it was better to work on wider urban transformations rather that to focus on more immediate solutions. For Manchester it was due to the positive feedback from other residents about the implementations done in Brunswick street, and their request to do something similar in other parts of the neighbourhood.

Furthermore, it is possible to see how the co-design activity for the second loop in Verona will come to an end with the implementation of an official request, done by participants, and officially accepted by the city council that approves to update their agenda to implement the Verona Looper Living Lab proposed solutions. The official delivery of the proposed solutions started in January 2020 with a press conference were all stakeholders' representatives participated - during which it was accepted the urban forest idea - and will continue after this thesis will be presented, but before October 2020. In the same way the Manchester Looper Living Lab is working on longer term solutions, and on the opportunity to implement other greening activities in the whole neighbourhood.

The handling and acceptance of this second loop conclusive document in Verona, and the future planning in Manchester, does then mean that the co-creation process is not concluded and forgotten after the end of the project because:



- the knowledge and learning acquired by all parties remains;
- the proposed ideas are long term ones and their implementation will take place after the process itself is concluded.

To conclude, after critically analysing results from the second loop as it took place in Verona and Manchester, we can state that:

1. sticking-plaster solutions, such as punctual immediate ones, are not the best ones to solve air quality related issues. This was already well known by experts, but some work was needed with citizens to let them better understand why there is the need of a more global view of the situation rather than an individualistic one;
2. it is necessary to change people habits to solve issues like the ones investigated within Looper. To do so solutions can be punctual, but need to be applied on a larger scale - i.e. small punctual but replicated on wider scale or punctual but bigger;
3. there is the need of a more constructive dialogue. This is possible if all stakeholders participate since the beginning of the first loop, and the collaborative dialogue raises from the second loop as all participants will have a more balanced level of knowledge.

Hereafter a more detailed description of the learning levels activated within the Looper process.

14.2 Different learning levels activated inside the learning loop process

By the time this thesis is written - May 2020 - a complete learning loop is already finished and the second one already started, therefore it is possible to evaluate the different learning moments that have been activated inside the project (figure 14.2-1) and that are characterized by different types and levels of learning (Arnstein, 1969; Ravetz, 2017; Ravetz and Miles, 2016). Hereby the Verona Looper Living Lab is considered because there was the higher number of activated learning levels, and it can be explained because participants used more digital and online tools by themselves compared to Manchester.

The first learning moment happened during the '1a. Scoping' activity. Here a strategic type of learning, both at citizens and policymakers level, took place. Citizens have been forced to select and prioritize urban problems they perceive as problematic, and to divide them in concrete issues that can be measured. On the other level, policymakers learned more about what citizens think are the most important urban issues and which areas of the city are the ones to take care about.

Going from '1a. Scoping' to '1b. Data collection' a strategic type of learning was activated both at citizens and policymakers level. In fact, both had to clash with each other to learn how to work together to obtain the most out of the project. This was an intermediate learning as it took place in-between the two activities.

During the third learning moment, that took place during the '1b. Data collection' activity, a functional learning at citizens level was activated. In fact, citizens needed to learn how to use the tools chosen to collect data about urban issues they wanted to know more about.

Figure 14.2-1 learning moments throughout the first loop of the Looper co-creation methodology

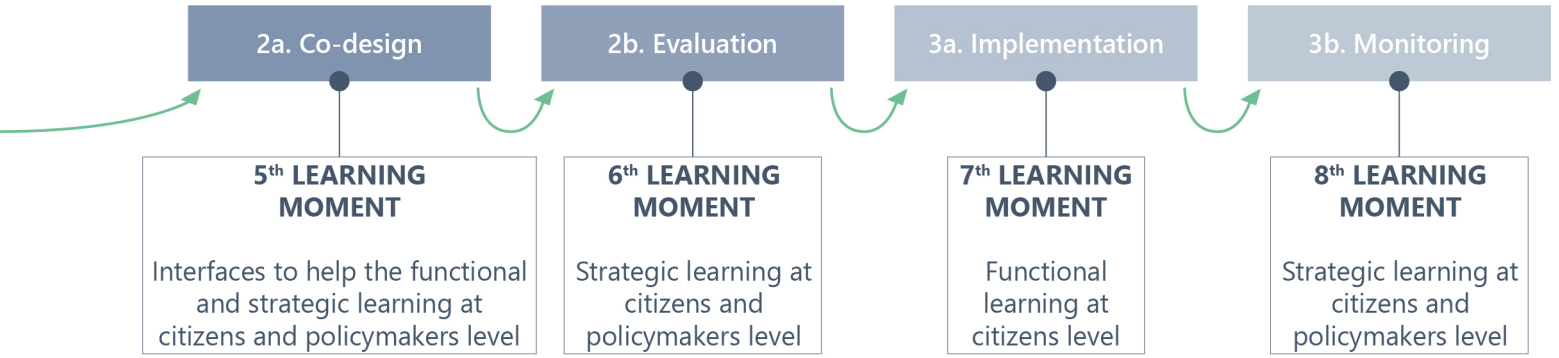


Figure 14.2-2 example of official data visualisation. It is done by using pins and a scrolling menu that shows all data for the selected pollutant in that specific location

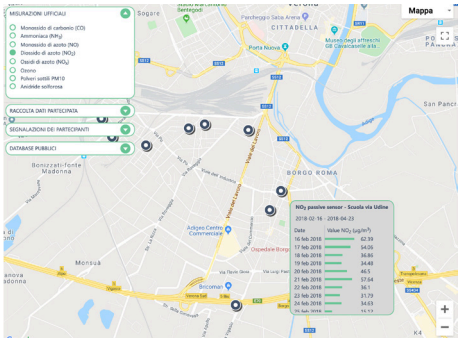


Figure 14.2-3 example of participatory sensing data visualisation. It uses hexagons to show one average data for the area defined by the hexagon itself

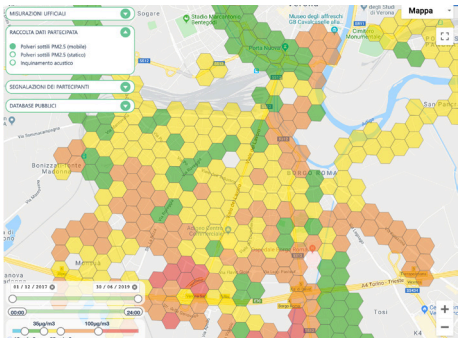


Figure 14.2-4 example of participatory qualitative data visualisation. Each pin, line or area define the location and the data is shown by clicking on the location itself

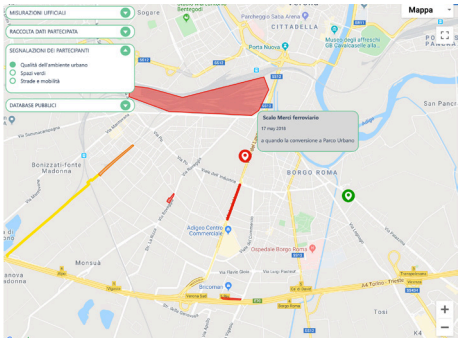


Figure 14.2-5 example of public database data visualisation. Each area show one data uploaded from an external public database

Moving forward, when it came to activities '1c. Visualisation' and '2a. Co-design' there is a fourth and fifth learning moment that is mainly linked to the use of different interfaces. Within the Looper co-creation process, interface has a double functionality: increase of community awareness and help both strategic and functional learning for all parties. This interface type of knowledge can also be linked to the need to not disperse knowledge, therefore it is necessary to store it. Moreover, if other learning loops are to be activated it is necessary to base them on the outcomes and results of the stages and work done during the first loop. In the Looper project this function was played by a public portal that supported the project activities in each different stage. Nevertheless, the most relevant aspect and role of the portal was related to the '1c. Visualization' of the data collected in the '1b. Data collection' activity. Data are displayed with different methodologies according to the urban issues they measure being transformed in this way from 'data' into 'information' (figures 14.2-2, 14.2-3, 14.2-4 and 14.2-5) as further explained below in section '19. Reflection on technologies'.

The use of interactive interfaces to communicate the results of the data collection activity increases, as abovementioned, the awareness of citizens about their urban context situation. This activates a strategic learning both at citizens and policymaker level. Citizens in fact had the possibility to see the data they acquired thought participatory sensing, but they could also see data acquired by the official environmental agency sensors that were positioned in locations suggested by citizens. This possibility of seeing, directly on a map, the data acquired without any preliminary filter on data, made citizens more involved and activated a more careful attitude on analysing the information. A functional learning is therefore also activated because, to interpret the data, citizens have to understand their meaning. At the same time, a strategic learning was triggered considering that using an interactive interface made it possible to analyse different information in the same moment allowing a strategic reading of the urban issues.

Later throughout the process, some strategic learning was activated during the '2b. Evaluation' and '3b. Monitoring' activities, while activity '3a. Implementation' saw a more functional learning. During the evaluation activity the strategic learning was possible both at citizens and at policymakers level, and this was due to the need of finding a common ground to decide which ideas to implement within the boundaries of the Looper project. Later on, during the implementation activity, the functional learning was only at citizens level due to their need of better understanding the technicalities needed to actually transform ideas in actions and real implementations, and to understand why experts might not be able to implement something in a certain way. The final activity of the loop - monitoring of the implemented ideas, showed again a strategic learning for both citizens and policymakers since they both needed to take responsibility for the results obtained with the implementation of the chosen ideas.

Because for Verona the second loop skipped the '1a. Scoping' activity, and the '3b. Monitoring' activity coincided with '1b. Data collection', it is possible to say that the learning for the second loop started from what was the fourth moment in the first loop. Furthermore, the learning from the first loop is then implemented by the added knowledge that comes from the activities done during the second loop.

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15. THE PERCEPTION ISSUE

The perception issue can be a major stumbling when it comes to an open constructive dialogue between different stakeholders working within the same Living Lab. Because Looper worked on air quality, noise pollution, traffic, greening and broadly on issues related to the urban environment, perception could be considered as the main topic organisers had to face while working with different stakeholder groups.

15.1 The knowledge base scenario

Many different variables can influence the perception that individuals have about pollutants. Studies have shown how age is one of the main variables that raise the poor perception about air quality - e.g. middle-aged population start to focus on health related issues such as air and noise pollution and seek to reach physical health, but cultural level and careers are also strictly correlated to the level of attention that is put in place about these topics (Liu *et al.*, 2019) - e.g. people with low cultural levels or employed in workplaces that do not care about the topic are not usually concerned about pollutants perception.

On the other hand the European model is showing some differences compared to other areas in the world. If in Verona and Manchester air quality perception of residents is worsen by the attachment to the place where they live, in South America it is the opposite. For example in Chile it can be seen how individuals usually perceive their neighbourhood as less polluted compared to the whole metropolitan area (Offlinger *et al.*, 2019). This is known as the 'halo effect', and it is an important variable while trying to implement new strategies to reduce pollutant levels. When this effect is to be found it is more difficult to involve citizens in developing strategies to reduce health risks from air pollution, because they don't feel threatened by the topic. Thus, organisers need to check what is participants' perception before starting.

In similar ways, possible health symptoms and thermal sensations are also features that affect the perception of air quality. Pantavou *et al.* (2016) in their research reported that, when interviewed, people reported dust or air quality as indicator for higher concentrations of pollutants. Unfavourable air quality conditions were also reported by youngers, and people living in city centres, when experiencing health symptoms or warm thermal sensations.

Another topic linked to perception is that of the trust citizens have about data and policymakers, and consequently the possible conflicts between parties that need to be transformed in consensus and cooperation.

Gidlof-Gunnarsson and Ohrstrom (2007) showed how, when talking about noise and well-being in urban residential environments, it is important to have all local authorities to be involved and to be cooperating in city planning, to protect citizen's health, so that action plans are guided by research knowledge in affected disciplines. Having all local authorities participating also allows, as seen in Looper Living Labs, to raise trust and to lower conflicts with citizens, because they can ask questions to experts about certain decisions and they feel more included in the decision making process.

About the same topic Antonini *et al.* (2015) saw how willingness to participate in public policymaking was greater when trust in government was

sufficiently high, and results from their case study in Sardinia (Italy), showed how trust can be an important connection in top-down models of collective action and citizens' participation in decision making processes.

To build trust and consensus, one method can be that of applying communication policy strategies (Karpchuck, 2018). Communication policies are a set of principles used to establish transparent relationships between governments and citizens, and this is done by listening to the needs and demands that citizens have and express, and by involving them in the decision making process. As in the Looper project, the basic principles of communication policy are transparency, honesty, equal access, reliability, high quality and coordination. These basic principles allow to create a more trustful relationship between parties, and it can be further implemented in constructive collaborations and in consensus towards solutions implemented by policymakers.

Laine *et al.* (2018) recall how trust building is a complex and sensitive process, that involves the idea of taking a risk. This means that there are no guarantee in the success of the new relationship, and the partner might turn out not to be trustworthy, and this is the reason why most of the time there are difficulties in creating a collaboration between citizens and policymakers. Furthermore, when considering the trust issue in urban transformation, there is the need to remember that trust is not a strategical tool or a variable, and it cannot help in shortening public debates, but it is created - and strengthened or lost - thanks to a continuous work of interactions and dialogue between citizens and local municipalities. Moreover, because each socio-cultural context is different, it is needed to build trust accordingly to the real world in which the trust building process takes place.

Besides, when talking about perception and consensus Butler (2018) states that when practice is justified through a conceptualisation of landscape as the perceived surroundings, the question about the transparency of the value-foundation gets raised. Once it is understood what is meant as perceived surroundings, and to create consensus, the process needs to become democratic to accept differences, to find common characteristics, and to operate compromises.

Hereafter some deeper considerations about perception issues as analysed within my research can be found.

15.2 Real situation vs. perceived situation

While working within the Looper Living Labs the first thing to face was how to explain to citizens and final users how the real situation can actually differ from the perceived one - with both a positive or negative meaning (Johnson, 2011; Purdy and Williams, 2002; Schumacher and Zou, 2008). To overcome this duality the data collection and visualisation activities - or the platform more generically - were fundamental.

Data collection campaign results

The results obtained with the first data collection campaign were absolutely essential to set a basis that could check the actual level of pollution in the critical spots found by citizens, meaning that these data were not strictly necessary for a comparison in the beginning - they were used for comparison only later at the end of the first loop. This first data collection was indeed extremely useful to help citizens to take note of the issues and criticalities with actual and objective data, and not only throughout their perception. The actual comparison of data was later done after the monitoring campaign at the end of the first loop, since the monitoring campaign that was used to check if the implemented ideas actually produced results or if nothing changed.

In Verona some interesting results could be found from the data collection and the following monitoring. The most important input concerned data on the levels of PM2.5 and PM10 in the wide area of Verona Sud, and it was due to the idea of participants that levels could have major differences from one street to the other. Indeed, as they could visualise the data they collected, and that they trusted more in the beginning of the loop, they have been able to see how particulate matter levels cannot change much at urban scale. This was

opposite to participants idea that pollutants can have major difference also at neighbourhood scale. This also helped them to better understand how data acquired with sensors positioned by ARPAV in a closer neighbourhood can actually give a trustable idea of the situation of their neighbourhood as well. In the same way the noise pollution data collected showed some expectable results - i.e. peaks during traffic jams. On the other hand what was found was that data only had few peaks over the laws maximums, and this does not give high levels of noise pollution when talking about the weekly average considered by law.

In Manchester the data collection about the traffic in Brunswick St showed how the perception that residents had about vehicles' speed was actually correct, since the hourly speed averages are always above the limit. This can be linked to the concerns about the appearance of the street itself, that looks more like a high street rather than a neighbourhood one.

In the same way qualitative data gave some interesting hints. In Verona this positive feedback was because most of the data uploaded on the geotagging tool were collected by people who did not participate to the offline meetings, and still the criticalities presented were the same between the two different groups of offline and online participants. In Manchester, many data were collected with both offline surveys and with the geotagging tool. Despite the difficulties, interesting data not only about criticalities but also about good practices were collected, showing how residents' perception can also give positive results if they feel listened and involved.

Moreover, in Verona the monitoring activity at the end of the first loop showed to participants that the levels of pollutants were the same as the beginning of the process, meaning that small punctual solutions only based on personal interest were not sufficient. In Manchester something similar happened with data about traffic, since participants were more willing to switch towards more structured solutions for the second loop.

This switch to a better perception of the environmental situation then allowed participants to have a better approach for the second loop, as some preconceived notions have been reset.

Stakeholders interaction with the platform

The stakeholders interaction with the platform, that was used to have a perception of the real situation, was only successful for the Verona Looper Living Lab. This was mainly linked to the data collected during the previous campaign. Indeed, Verona collected plenty of quantitative data - and not only qualitative data, while Manchester had many qualitative data and some traffic data during fall 2019, and Brussels and mostly had qualitative data and public databases data. Furthermore, there is a difference between Manchester and Brussels that can deeper explain why the visualisation platform was not as successful as Verona. In Manchester participants were mostly digital illiterate, that would have resulted in a low usage of the online data visualisation platform regardless of the data shown. In Brussels, the platform was not used despite participants' ability with online tools, and it was mainly due to the data show that were already available on other platforms and were not collected by participants.

In the Verona Looper Living Lab the platform, and mostly the data visualisation page, gained a good success (figure 15.2-1). This can be explained because participants were highly motivated in the data collection activity since they already knew there would later be a data visualisation platform built for them. The platform was, in this way, seen as a neutral space where data could be collected by them and added by an impartial partner, rather than the official ARPAV page were data are collected by someone else and presented in an unclear report format.

Figure 15.2-1 number of views of the Verona local platform, divided per month, from April 2018 to November 2019

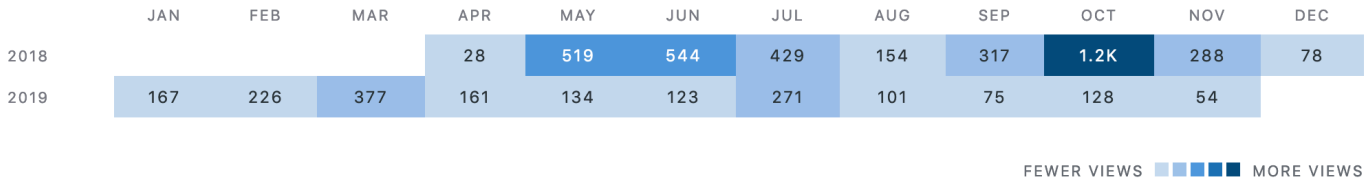

Figure 15.2-2 graph of the views of the data visualisation page, divided per month, from April 2018 to November 2019

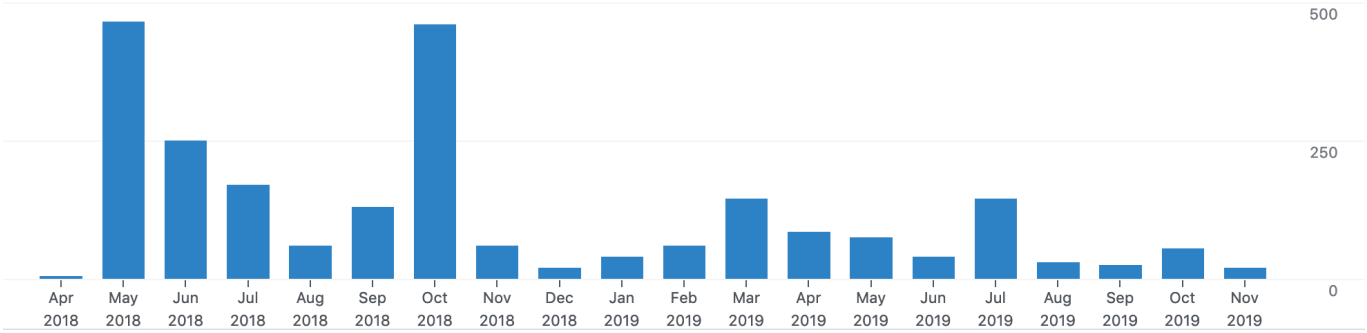

Figure 15.2-3 number of views of the data visualisation page, divided per month, from April 2018 to November 2019. May 2018 is highlighted as it is the month with the highest number of views

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2018				4	463	248	167	59	129	460	60	17	1,607
2019	38	59	145	81	73	37	142	28	23	55	19		700

The first data visualisation platform was developed and realised by the Università Iuav di Venezia Looper team for all three cities, but it was then further implemented on the basis of the feedbacks given by participants of the three Looper Living Labs in order to present the data they collected in a user-friendly way. The interface was considered to be clear and useful by participants of the Verona Looper Living Lab, because the page only has few options and it allows an intuitive usage. No further feedbacks came from Manchester and Brussels about the usability of the data visualisation page.

The data considered as mostly interesting by citizens in Verona, that were the ones of PM2.5 collected with AirBeam and Lufdaten sensors, had a double visualisation due to the different usage of the sensors. AirBeam data were some of the most intuitive data to be visualised because colours - that users can autonomously choose - helped to recognise the situation of pollution, and the scrolling timeline allowed to easily choose which day/month and time someone wanted to see. Official data, and Lufdaten ones, were displayed by showing the positioning of the sensor on the map and, by clicking on the spot, it was possible to choose which campaign to see. In the same way when clicking on qualitative data, which could be marked with a spot, a line or a polygon, it was possible to read the linked comment of the user who uploaded the comment.

By looking at the web-stat analytics of the data visualisation dashboard (figure 15.2-2 and 15.2-3) it was possible to see how the visualisation of the pages incremented in different periods of time. It was possible to see that in May 2018 there has been the higher peak, as that was the month in whichthe page was launched, and the lower number of visits for 2018 was in August, because it is the main holiday period for Italians. After August the visits grew back mostly during October 2018, when the first co-design took place. During 2019 the peaks could be found in March 2019 - in the period of the monitoring activity - and in July 2019 - when the last data from the monitoring campaign were uploaded on the dashboard.

15.3 Trustfulness towards collected data

The high levels of distrust that citizens felt towards policymakers and official bodies, when talking about environment, was mostly raised by the lack of knowledge they had about both the tools used to collect data and the way these sensors work (Purwanto *et al.*, 2020; Rapeli and Koskimaa, 2020). This explains why it is of extreme importance to use participatory sensing when implementing a co-creation bottom-up process.

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 that was exposed for 24 hours to a certain volume of air con-

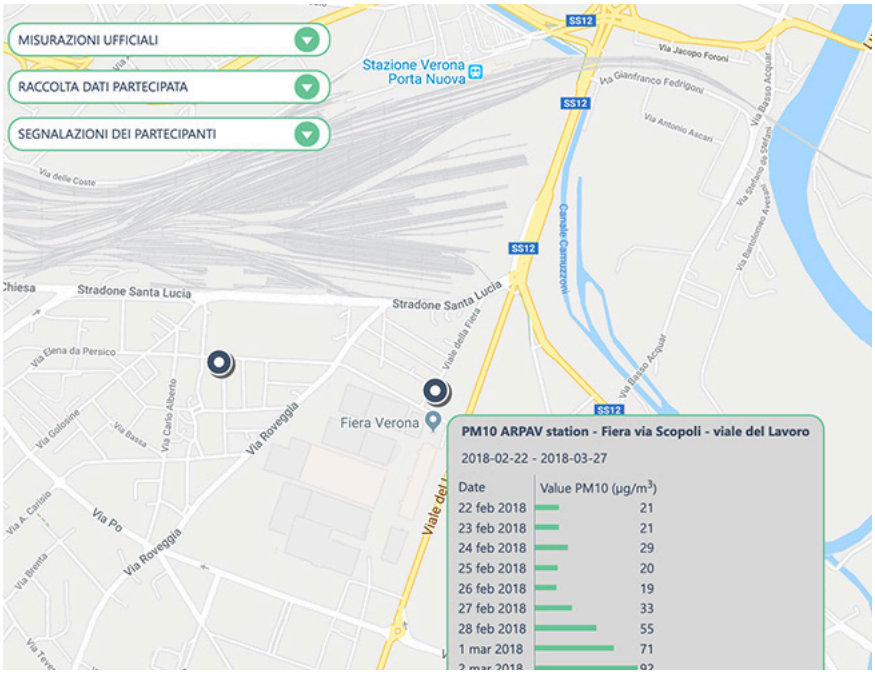

Figure 15.3-1 user-friendly interface to visualise data collected with official sensors. To visualise the scroll menu with all data, collected in that specific location, users have to: choose the pollutant, select the pin of the location they are interested in, select the measuring campaign

trolled by using a pump. This means that for each day a single data in a specific position is collected. This concurs with a single data for each day of the campaign (figure 15.3-1). The way in which these data are then approached, from a regulatory point of view, 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 is sanctioning.

AirBeam data, on the other hand, are rather different because the sensor is designed 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, because 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 15.3-2), rather that functioning as control group for official sensors. This topic is further discussed in section '19. Reflection on technologies'.

For the participatory sensing, anyhow, the AirBeam was an important tool to raise awareness and trust when talking about official data. This because

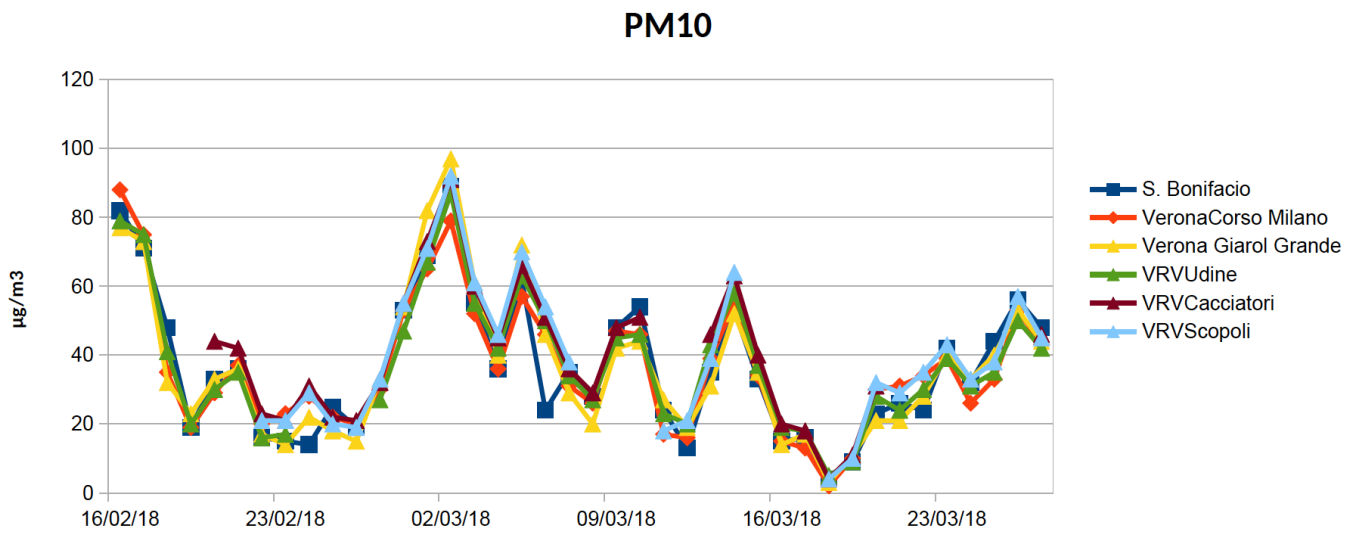

Figure 15.3-2 graph showing daily data of all fixed stations of the Verona district for PM10. It is possible to notice how levels of pollutant are almost constant on a wide area (they have the same peaks and lows). This graph better allowed to understand how PM10 levels do not have big changes on neighbourhood scale, but differences can only be noticed on wider urban scale

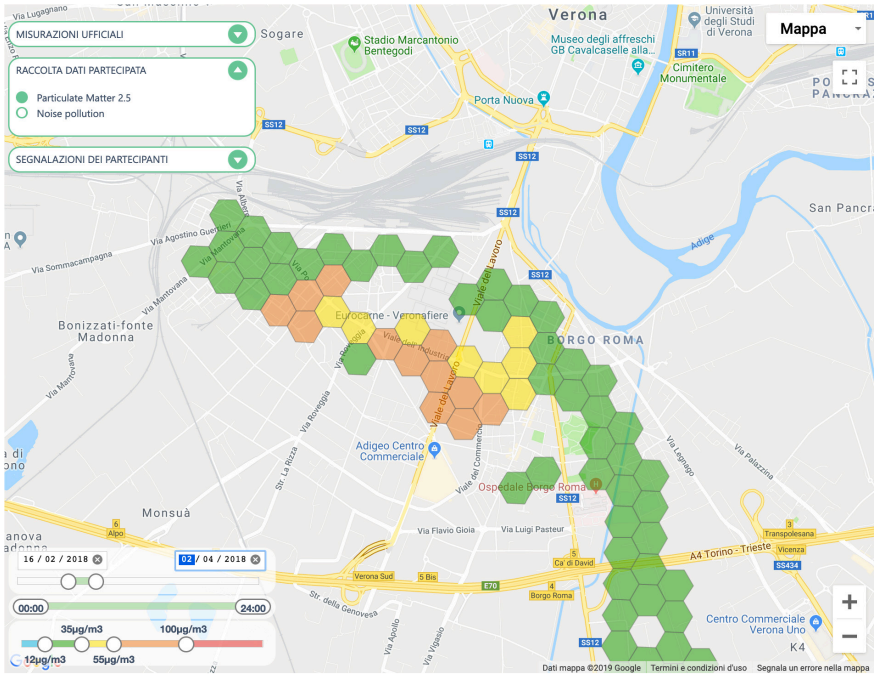

Figure 15.3-3 user-friendly interface to visualise data collected with the AirBeam sensor. With this visualisation it is possible to indagate specific periods of time to compare data with other sensors. In this example the period from the 16th of February 2018 to the 2nd of April 2018 are analysed, and data show how little differences are there on a neighbourhood level

one of the reasons of distrust that citizens had towards the official body 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 15.3-3 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 is not linked to their position.

Citizens wanted to use the data collected with the AirBeam 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 15.3-2).

Since 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.

15.4 Conflicts with policymakers

As abovementioned the perception issue was the main topic to be addressed by organisers in order to allow an open constructive dialogue that could give benefits for the Looper co-creation methodology. Indeed, perception is something that can distort the vision about pollution, but can also allow misunderstandings on other people behaviours. This is what allowed the flourishing of conflicts between citizens and policymakers (Hayward, 2015; Kaestl, 2018; Towell, 2016).

It is not always easy for citizens to understand what the city council agenda is and, vice versa, it is not always immediate for policymakers to understand what the desiderata are for citizens, because it is almost impossible to standardise such a wide socio-economic-cultural sample. Indeed, it sometimes happens that the two point of view overlap without the parties to know.

An example of this was the implemented crosswalk island in via Colonnello Fasoli in Verona, solution requested by participants and easily implemented because the city council had already budgeted the possibility of implementing new crosswalk islands around the city. The Looper process allowed to show a meeting point that citizens and policymakers did not know they had. This again confirms how it is important to use the learning loop process, and the co-creation process, to lower conflicts between urban stakeholders to

take advantage of every opportunity that can raise by having a constructive dialogue.

It is also important to explain, mainly to citizens, how important is communication with people not participating to the co-creation process. In Verona, after the closure of via Ottavio Caccia for one day - idea implemented in the framework of the co-design activity, some mediation work was requested from organisers due to some miscommunication between citizens and journalists. During the event some citizens had complained about the street closure, the duration of the event, the concurrency with the so called 'Mobility Day' and generally about its application. These statements given by citizens to journalist resulted in a misinterpreted article that implied that citizens did not like the work done by the Looper project and that the city council was still not taking care about Verona Sud. After the publishing of the article, the city council thought about not collaborating anymore within the project and organisers needed to talk with policymakers and citizens to settle this conflict. After various meetings that organisers had with the single parties, and then all together, it was possible to overcome this misunderstanding and conflict. This was then an opportunity to create consensus about the idea, since it was proposed again as possible implementation for the second loop.

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16. HOW TECHNOLOGIES HELPED THE LOOPER CO-CREATION METHODOLOGY

It is possible to say that this topic was already discussed within sections '14. How the learning loop worked' and '15. The perception issue', but hereafter a quick summary can be found to draw some conclusions.

Participation and data collection

Such use of the participatory sensing approach, as abovementioned, allowed the reduction of the distrust of citizens and final users towards policymakers. This was because they had the opportunity of deciding where the data collection - and consequently the monitoring campaign - were undertaken. Giving to participants the tools to take the decision on where to monitor was an effective conflict reduction tool because the location of sensors was the most questioned topic by citizens before the beginning of the project.

Allowing participants to choose official sensors' locations, giving them the chance of collecting data on their own, and in general giving them knowledge, resulted in a more friendly behaviour towards policymakers. This was then repeated by using different participatory tools and technologies throughout the process itself, that gave the opportunity to citizens to actually be part of the decision making process.

Participation and visualisation dashboard

When it comes to the visualisation dashboard, it is possible to say that this type of technology can help the process if it is used to visualise data collected in a participatory way. This is possible because the collected data are then linked to the participatory sensing, and with the dashboard it can possible to control if the perceptions citizens had were correct or not. However, this is valid only if participants are able to use online digital tools and if the data visualised are of interest for participants.

The base idea for the research was that this technology could help in understand, in a more immediate way, if data collected showed that citizens' perception was right - meaning that they would be empowered by it, or if their perception would differ from the real situation - result that would eventually allow in a better focus of the resources allocated for the co-creation process.

The use of data visualisation technologies would then result in a win-win situation for citizens and final user, because they are then able to better understand technical data that are usually not easily accessible. Furthermore, in either way they can demonstrate that their perception was right or they can ask for better solutions where it is actually needed.

The data visualisation would then also help in reduce conflicts between parties, because citizens are more willing to have a constructive dialogue with policymakers if they better understand with what data are they working.

Participation and co-design tools

Co-design technologies, that are both online and offline ones, demonstrate how to create an open and constructive dialogue between the parties there is needed to allow the participation to the process with both face-to-face meetings and online tools. This double approach allows a wider participation also of people that might not be able to assist at physical meetings. Therefore, this

means that when it comes to co-design tools they can allow a more inclusive co-creation process.

Again it is not suggested, when we talk about co-design tools, to only use online ones since it was possible to see with Looper that depending on the stakeholders groups participating there might be higher levels of online participation - i.e. Brussels - or lower levels of participation - i.e. Manchester.

17. BOTTOM LEVEL ABSENCE AND ITS INFLUENCE ON THE CO-CREATION PROCESS

In Verona there already was a strong bottom level, meaning that the main work done by organisers was that of avoiding that the point of view of only one neighbourhood association would take over during the process. This was done by always asking to all people participating what was their idea, and was also done by asking to people participating the most to be self-critical - e.g. by asking if they thought that their ideas was the same of the whole citizenship or if it was that of their association.

In Brussels during the first loop the issue tackled was already an hot topic, with ongoing events and a strong bottom level involved with it. This resulted in being counterproductive, because citizens were not willing to participate twice to the same kind of activities and there was poor participation to the Looper Living Lab. Since organisers learned from this experience, for the second loop there was more engagement because the topic was one of interest, meaning that there was already a bottom level basis, but there were no other associations working on it. This resulted in a high participation.

For the Manchester Looper Living Lab the initial absence of a strong and compact bottom level created, as abovementioned, some issues within the first loop. This absence - or low presence - of the bottom level then ended in the implementation of ideas that were of higher interest for policymakers, rather than those interesting residents. One example is that implementations to create a better community feeling for Brunswick street with greenings, and ways to make it safer for children, were the solutions that were of main interested for residents, but less effort and budget was spent on it for most of the first loop. This was because in the beginning policymakers tried to re-use e.g. planters from other parts of the city that in the end did not suit footpaths, and it was policymakers idea to focus on Brunswick street rather than on the whole neighbourhood.

This 'predominance' of the policymakers group at the stakeholder table lead to some resentment among residents, and it then led to the unwillingness to participate to the project circa at the evaluation stage of the first loop. But this trend can be changed, because it is possible to see how the participation level raised in the Manchester Looper Living Lab since the second loop focuses topics of interest for both parties e.g. on the redistribution and redesign of the crosswalks along Brunswick street to reduce vehicles' speed, allow safer ways to school for children, and to create a better community look for the street. This raise in the participation level is then linked to an important work done by organisers of the Living Lab that found ways to engage citizens to create a stronger presence of the bottom level.

Furthermore, in Manchester the same distrust level of Verona was found, even though it raised from different questions. Indeed, in Brunswick the distrust was mainly linked to the management and administration of the housing, that from residents' point of view was not sufficient and it was not appropriate to the needs of people actually living in the houses and apartments. The bottom level here again is of extreme importance for the positive implementation of the chosen ideas because, as seen in Verona, if there are no positive feedbacks the city council might lose interest in investing resources to implement ideas co-designed within a co-creation process.

It is then possible to say that there is not the need of having a strong bot-

tom level before the beginning of the co-creation process, but is mandatory to understand how to create it as soon as the process begins to reach positive results. In the same way, it is important to allow participants to better choose on which specific topic to work to avoid the dispersion of such bottom level.

18. COMPARISON WITH OTHER EXAMPLES

Different examples were shown in 'Part 1 - Theoretical framework: the knowledge base scenario and the state of the art' but here some short conclusions are drawn.

The Helsinki case study showed two different bottom-up initiatives that - just like Looper - resulted to be successful thanks to a wide audience participating. This was one example that showed the need to have a strong bottom level that can participate from the start of the process. This idea was then applied to the Verona Looper Living Lab that obtained high levels of engagement from participants, meaning that it is possible to say that it is mandatory to involve stakeholders in a proficient way. The absence of a strong bottom level in Brussel and Manchester during the first loop, and the difficulties they faced in having stakeholders to participate constantly in the process, again confirms the idea that the process needs to be a bottom-up one with a strong bottom level basis to gather positive results. Moreover, Brussels shows how it is not sufficient to have a bottom-up approach that starts from organisers to gather positive results, there is the need to have a strong willing and interest from the bottom level to allow a constructive co-creation process.

The bottom-up approach can still be triggered starting from the top level, but to be successful there is the need to work on topics on which the bottom level can be interested. If policymakers or organisers are unsure on the topics of interest, an option is that the top level undertakes a survey to understand the rate of interest on a certain topic within citizens and final users. This allows to understand if it can be possible to trigger the co-creation process about the main issues that organisers are willing to face.

This importance of the presence of the bottom level can be further traced back to the knowledge on local issues and history that citizens can bring to the process and that experts and policymakers might not have. This basic knowledge and higher willing in get positive results for everyday life that citizens have can make the difference to obtain sustainable and feasible solutions for the community.

Another interest example is the Portuguese one. Here we talk about co-design because in Portugal a budget for co-design is allocated each year at national level. This means that the process is a top-down, that tries to transform itself into a bottom-up one. The Looper co-creation methodology here could further implement the Portuguese idea of a budget for co-design. In Portugal anyone can propose ideas on how to spend the given budget, and then a top-down co-design process is done starting from a selection on the proposed ideas. This could be implemented by using a co-creation process rather than a co-design activity. The budget would be better allocated by only giving the wider area of interest for within which to work, meaning that different ideas could be deeper analysed if are linkable to the main topic. This would then allow a better usage of the knowledge brought by citizens, residents, final users and other stakeholders.

To conclude the comparison with other cases, it is interesting to see the differences between the Looper co-creation process and the San Donà co-design process. As mentioned in 'Part 1 - Theoretical framework: the knowledge base scenario and the state of the art' it is possible to say that San Donà can somehow work as a control group since it applies a co-design process based

on a ‘single loop’.

The use of a single loop, compared with a multiple loop process, showed a very different response from participants, because stakeholders were less willing to give their help and time since the process itself was seen as a completely top-down one. The single loop approach gives the idea to stakeholders that their contribution is only a ‘fake’ one, because they might think that in the end policymakers will not consider their opinion and the knowledge that they might bring to the table. Moreover, if citizens and other stakeholders do not think their inputs are considered, their attention in participating might be lower and the ending result of the process might be less proficient and feasible.

What could be also see by comparing San Donà and Looper is that while interviewing stakeholders from San Donà they were asking for more unlike solutions. This was mainly due to their idea of not being taken into account by policymakers, and it was because they were later not asked to check the feasibility of their ideas. In Looper, on the contrary, the ideas and possible solutions proposed by stakeholders were more realistic because they were later called to take responsibility of their proposed ideas. Furthermore, at the end of the co-design activity some participants were not happy about the final design because they were still too attached to their personal interest, rather than thinking about the sharing quality of such a public area, while within Looper participants were more open to compromises to have a shared benefit.

It is then possible to say that other examples of Living Labs, Urban Living Labs and co-design activities actually confirmed some theories hypothesised within this research. Such theories were:

- need to have a strong bottom level able to trigger a functioning bottom-up process;
- need to reach an open dialogue between the stakeholders, to solve trust issues and avoid conflicts;
- need to apply a multiple loops process, not to lose knowledge;
- need to make stakeholders responsible of their decision by combining co-design with other activities - i.e. scoping, data collection, visualisation, evaluation, implementation and monitoring - to have a more complete co-creation process.

19. REFLECTION ON TECHNOLOGIES

19.1 Low-cost vs. official sensors

This section shows and compares the differences between certain low-cost sensors and the official sensors provided by ARPAV in the Verona Looper Living Lab. The comparison done here is to better understand how data can be misrepresentative if are not read in the right way. It was not possible to compare NO, NO_2, NO_3, NO_x and CO data as either there were no low-cost sensors or data from low-cost sensors were not sufficient for a comparison. Because of this the comparison is only done between noise sensors and PM sensors. Furthermore, data from Manchester and Brussels are not compared here because they were not enough.

19.1.I Noise

Since the OpeNoise app is an Android based application that needs to be installed on a smartphone, it is mandatory to calibrate the external microphone to obtain reliable data. Once the lavalier external microphone is calibrated data are as reliable as the ones collected with an official Sound Level Meter device.

To calibrate the external microphone there is the need to have the already assembled device and to have a class 1 Sound Level Meter with which to compare data collected from the same already known sound source.

If the microphone is not calibrated, data can only be read to understand the general trend that noise have during the day, to check if there is correspondence between e.g. noise and traffic peaks.

19.1.II Air quality

When it comes to air quality sensors it was possible to notice that low-cost and official sensors tend to have the same trend during the days (see in following paragraphs tables 19.1.II-1, 19.1.II-2, 19.1.II-3). This appears to be an interesting discovery since low-cost sensors and official ones collect data with different methodologies.

Here only PM data are to be considered as it was not possible to evaluate the quality of the NO_2 data collected with the Air Monitor due to the absence of a CO sensor on the device that is mandatory to draw the comparison graphs.

ARPAV sensors for PM data collection works by weighting a tampon exposed for 24 hours to a certain prefixed volume of air, blown on the tampon by using a pump. The pump allows to control the volume of air injected to guarantee a standardisation of the collected data. Low-cost sensors, on the other hand, use the light scattering method to count the amount of PM that is injected in the device. Here again a smaller pump is used to blow air in the device but there is no tampon. The light of a LED bulb is here used to scatter off the particles in the airstream, this light scatter is then registered and converted into an estimated amount of particles in the air.

The main issue found with the data collection done with the light scattering method is linked to altered results when the percentage of relative humidity (RH) in the air is higher than 80%. Since the Po plain is mostly well known for the high levels of RH during winter time, this factor needs to be carefully considered while analysing data. In the following tables this RH matter is

considered, together with the presence - or absence - of rain in the previous days, to allow a more clear reading of the data collected both with the official and low-cost sensors.

It has not been possible to compare data collected with both official sensors - Skypost, Mobile station and fixed station - and Luftdatens with the ones collected AirBeams. This was because AirBeam sensors has been used only during 2017 and 2018 - with no comparable data collected, while Luftdatens where introduced in 2019 resulting in the abandonment of the AirBeam sensor type. The sensor type change was decided by citizens, that autonomously searched a sensor with the same characteristics of the AirBeam, and it was due both to the commitment requested by walking the AirBeam around the project area and to the need to connect it to a smartphone to upload the data on a crowdsourcing map. The Luftdaten, instead, are to be left in place and have a Wi-Fi module that remotely uploads data on a crowdsourcing map.

A more precise comparison between Luftdaten sensors and a mobile station was being done by positioning a Luftdaten sensor on top of an ARPAV mobile unit for 3 days to have more complete view of data, and it was done during the data collection campaign between the 17th of February 2020 and the 19th of February 2020. Unfortunately due to restrictions caused by the Covid-19 emergency it was not possible to collect further data.

In figure 19.1.II-1 it is possible to see where were positioned sensors compared in tables 19.1.II-1, 19.1.II-2 and 19.1.II-3 are located.

The analysis done here does not want to indicate that low-cost sensors can replace official sensor. The analysis wants to give some indication to people approaching for the first time low-cost sensors to allow them in better understanding the tool and the data collected with it.

It is possible to see in table 19.1.II-1 the comparison between the data collected during 2018 with ARPAV sensors in the framework of the Looper project, and data collected by ARPAV fixed station in the same period. The data highlighted with light yellow are the ones exceeding - or being lower - between 10 to 20 µg/m^3 from the baseline of ARPAV fixed station Borgo MI. In dark yellow data exceeding - or being lower - more than 20 µg/ m^3 from the baseline of ARPAV fixed station Borgo MI. The decision of only underlying data over - or under - 10 µg/ m^3 was due to a moment of confrontation with ARPAV employees that confirmed the idea that differences within 10 µg/ m^3 are insignificant to the means of a comparison between different sensors. In the same way differences between 10 to 20 µg/m^3 are of small consequence, but might start to show something interesting between different areas. Difference over 20 µg/m^3 are then showing some real differences that can be linked to differences in the area where the sensor is positioned, or they show some unreliability about the used low-cost sensor.

While analysing the data collected within the framework of the Looper project, it was possible to see how in at least half of the days of the data collection, the values from the background fixed station were higher than the ones from other units by ARPAV.

It is possible to notice that on average data collected with the ARPAV Looper dedicated sensors during the 2018 campaign are on average are consistent.

It is possible to see in table 19.1.II-2 the comparison between the data collected during 2019 with the Luftdaten and those collected with ARPAV sensors. Like for the 2018 comparison table, the rows highlighted in light yellow are the ones exceeding - or being lower - between 10 to 20 µg/m^3 from the baseline of ARPAV fixed station Borgo MI, while the ones highlighted in dark yellow are the ones exceeding - or being lower - more than 20 µg/ m^3 from the baseline of ARPAV fixed station Borgo MI.

Here again in at least half of the days the baseline fixed station shows values higher than the ones collected with Luftdaten in the area of Verona Sud.

In table 19.1.II-3 it is possible to see the three day comparison done by positioning a Luftdaten sensor on top of an ARPAV mobile station. Luftdaten data are hereby compared also with the fixed station of Borgo MI, allowing to have a better comparison of data, because there are no available data for the mobile station on the first day. Again, the rows highlighted in dark yellow are

the ones exceeding - or being lower - more than 20 µg/ m^3 from the baseline of ARPAV fixed station Borgo MI. It is possible to see how data are mostly reliable, but need to be checked accurately because sometimes Luftdaten values are quite different from the ones from official sensors. In the same way data from the mobile station are usually the same as the fixed station ones, but sometimes there can be punctual events that can give different values.

As aforesaid, the amount of RH can alter the collected data. While checking the highlighted rows it is possible to see how in most cases the RH was over 80%, and the values from the ARPAV stations used within Looper are just slightly above the ones from the fixed station. It is then possible to see how Luftdaten can be delicate tools. Hence, it would be better to place at least two or three of them in each location to have a counter-proof of the collected data. Like passive sensors, if two are positioned and each give a different data it might be difficult to understand which data is correct. By positioning three it would be easier to understand the reliable value.

Another interesting thing that can be seen within the comparison is that some days show way higher values from the fixed station than from the other sensors, this might be due to particular events and/or particular traffic conditions but further analysis is needed. In table 19.1.II-2 some days are missing due to the unavailability of data for those days from the fixed station, meaning that the comparison was not possible.

Figure 19.1.II-1 map showing the location of the sensors from tables 19.1.II-1, 19.1.II-2 and 19.1.II-3

Table 19.1.II-1 Looper dedicated official sensors comparison with the fixed station from ARPAV located in Borgo MI. The data collection was undertaken in 2018. In light yellow data differing from the fixed station of Borgo MI between 10 and 20 µg/m3 are underlined. In dark yellow data differing from the fixed station of Borgo MI more than 20 µg/m3 are shown

PM10 COMPARISON							
Timestamp		ARPAV			Weathercast		
Day	Date	Fixed Station Borgo MI	Skypost via Scopoli	Mobile Station via Udine	Temperature	Rain	HR
Fri	16/02/18	64*		79	3 °C	N	72%
Sat	17/02/18	88*		75	4 °C	Y	76%
Sun	18/02/18	75*		41	5 °C	Y	82%
Mon	19/02/18	35		20	5 °C	N	64%
Tue	20/02/18	19		30	4 °C	N	66%
Wed	21/02/18	29		35	4 °C	N	71%
Thu	22/02/18	37		16	4 °C	Y	72%
Fri	23/02/18	20	21	17	5 °C	Y	78%
Sat	24/02/18	23	29		6 °C	Y	75%
Sun	25/02/18	28	20		2 °C	N	58%
Mon	26/02/18	22	19		-3 °C	N	55%
Tue	27/02/18	20	33	27	-3 °C	N	62%
Wed	28/02/18	30	55	47	-3 °C	N	68%
Thu	01/03/18	53*	71	67	-2 °C	N	89%
Fri	02/03/18	65*	92	87	-1 °C	Y	96%
Sat	03/03/18	79*	61	55	1 °C	Y	95%
Sun	04/03/18	52*	46	42	2 °C	N	96%
Mon	05/03/18	36	70	63	4 °C	Y	93%
Tue	06/03/18	57*	54	50	6 °C	Y	94%
Wed	07/03/18	46	38	34	7 °C	Y	89%
Thu	08/03/18	31		27	8 °C	N	70%
Fri	09/03/18	26		45	9 °C	N	75%
Sat	10/03/18	47		46	9 °C	Y	87%
Sun	11/03/18	46	18	23	9 °C	Y	93%
Mon	12/03/18	17	21	20	10 °C	Y	87%
Tue	13/03/18	16	39	43	10 °C	Y	81%
Wed	14/03/18	39	64	58	9 °C	N	85%
Thu	15/03/18	55*		37	8 °C	Y	87%
Fri	16/03/18	34		19	10 °C	Y	76%
Sat	17/03/18	15		18	9 °C	Y	86%
Sun	18/03/18	13	4	5	8 °C	Y	78%
Mon	19/03/18	< 4	10	9	5 °C	Y	81%
Tue	20/03/18	10	32	28	6 °C	Y	76%
Wed	21/03/18	30	29	24	6 °C	N	49%
Thu	22/03/18	31	35	30	5 °C	N	51%
Fri	23/03/18	34	43	39	6 °C	N	60%
Sat	24/03/18	39	33	31	8 °C	N	58%
Sun	25/03/18	26	38	35	9 °C	N	58%
Mon	26/03/18	33	57	50	9 °C	N	63%
Tue	27/03/18	53*	45	42	12 °C	N	53%

Table 19.1.II-2 in following page

Table 19.1.II-3 Lufdaten sensor comparison with stations from ARPAV, undertaken in 2020. In light yellow data differing from the fixed station of Borgo MI between 10 and 20 µg/m3 are underlined. In dark yellow data differing more than 20 µg/m3 are shown

PM10 COMPARISON							
Timestamp		ARPAV		Lufdaten	Weathercast		
Day	Date	Fixed Station Borgo MI	Mobile Station via Vigasio	Via Vigasio	Temperature	Rain	HR
Mon	16/02/18	65		65	9 °C	N	72%
Tue	17/02/18	60	82	56	9 °C	Y	76%
Wed	18/02/18	60	58	30	9 °C	Y	82%

PM10 COMPARISON							
Timestamp		ARPAV			Lufdaten		
Day	Date	Fixed Station Borgo MI	Skypost via Scopoli	Mobile Station via Udine	66VER	67VER	68VER
Mon	18/02/19	87*		72			14
Tue	19/02/19	81*	91	89			143
Wed	20/02/19	105*	119	123			202
Thu	21/02/19	133*	120	117		41	169
Fri	22/02/19	140*	105	111			121
Sat	23/02/19	132*	46	51		13	40
Sun	24/02/19		36	39		19	23
Mon	25/02/19		69		27	19	41
Tue	26/02/19		77	74	16	67	48
Wed	27/02/19	86*	70	72	13	69	53
Thu	28/02/19	80*	92	95	104	110	96
Fri	01/03/19	109*	94	94	93	111	102
Sat	02/03/19	117*	88	87	99	112	95
Sun	03/03/19	106*	78	77	118	105	90
Mon	04/03/19	87*	90	83	191	151	134
Tue	05/03/19	104*	57	54	105	80	64
Wed	06/03/19	60*	57	57	102	86	70
Thu	07/03/19	63*	54	55	60	52	47
Fri	08/03/19	56*	41	33	22	28	19
Sat	09/03/19	45	43	38	28	27	21
Sun	10/03/19	49	46	46	42	37	30
Mon	11/03/19	48	44	35	42	35	28
Tue	12/03/19	40	18	15	8	11	7
Wed	13/03/19	20	34	32	19	18	14
Thu	14/03/19	40	52	51	41	35	27
Fri	15/03/19	57*	61	59	87	70	56
Sat	16/03/19	66*	84	82	106	92	77
Sun	17/03/19	104*	71	69	81	69	63
Mon	18/03/19	79*	17	16	17	16	11
Tue	19/03/19	17	14	12	8	7	7
Wed	20/03/19	18	20	20	12	12	10
Thu	21/03/19	27	31	29	23	24	19
Fri	22/03/19	47	43	40	40	40	29
Sat	23/03/19	60*	37	34	32	37	22
Sun	24/03/19	51*	33	33	43	38	32
Mon	25/03/19	43	52	46	48	47	41
Tue	26/03/19	61*	19	14	6	7	6
Wed	27/03/19	15	22	18	17	15	11
Thu	28/03/19	21	22	19	16	15	12
Fri	29/03/19	28	31	31	25	32	20
Sat	30/03/19	39	44	43	52	61	39
Sun	31/03/19	56*	39	40	54	54	41
Mon	01/04/19	53*	36	38	29	34	28
Tue	02/04/19	45	36	36	31	33	25
Wed	03/04/19	47	34	34	38	35	29
Thu	04/04/19	36	22	20	29	24	19
Fri	05/04/19	17	14	13	15	17	12
Sat	06/04/19	11	31	29	43	38	30
Sun	07/04/19	28	23	23	29	24	18
Mon	08/04/19	29	33		42	33	27
Tue	09/04/19	36	21		19	17	14
Wed	10/04/19	23	24	24	32	28	22
Thu	11/04/19	26	10	10	7	15	11
Fri	12/04/19	11	15	14	14	14	12
Sat	13/04/19		30	32	36	38	31
Sun	14/04/19	26	21	21	16	25	20
Mon	15/04/19	21		18	19	19	14
Tue	16/04/19	20		29	36	33	25

Table 19.1.II-2 Lufdaten sensors comparison with stations from ARPAV, undertaken in 2019. In light yellow data differing from the fixed station of Borgo MI between 10 and 20 µg/m3 are underlined. In dark yellow data differing more than 20 µg/m3 are shown

Lufdaten						Weathercast		
71VER	72VER	74VER	75VER	76VER	78VER	Temperature	Rain	HR
62				9	8	6 °C	N	64%
107					132	6 °C	N	77%
172					174	5 °C	N	89%
151					157	6 °C	N	83%
109					108	8 °C	N	69%
41					39	6 °C	N	52%
20					18	3 °C	N	54%
36			22		38	7 °C	N	60%
42			13		44	9 °C	N	64%
49					48	11 °C	N	55%
76					87	10 °C	N	67%
74					92	8 °C	N	77%
81					87	9 °C	N	69%
79					83	10 °C	N	65%
106					113	6 °C	Y	87%
56			55		57	8 °C	N	79%
65			69		66	9 °C	N	73%
42			43		41	13 °C	N	64%
17			20		18	11 °C	N	63%
20			21		20	10 °C	N	68%
26			31		25	10 °C	N	77%
21			26	2	27	10 °C	N	55%
6			7	3	5	9 °C	N	28%
12			14	11	11	5 °C	N	58%
22			24	18	22	7 °C	N	61%
46			55	44	48	10 °C	N	66%
68			81	76	73	11 °C	N	69%
52			61	42	56	11 °C	N	72%
11			12	12	10	10 °C	Y	70%
5			5	4	5	7 °C	N	60%
9			10	8	8	8 °C	N	51%
17			22	16	16	10 °C	N	44%
26			32	26	27	11 °C	N	47%
22			26	21	26	14 °C	N	45%
29			33	28		15 °C	N	47%
39			41	39		14 °C	Y	46%
5			6	4		10 °C	Y	50%
10			10	8		10 °C	N	43%
12			12	8		10 °C	N	48%
18			23	18		11 °C	N	49%
37			39	34		13 °C	N	53%
40			43	35		14 °C	N	42%
28			28	21	26	15 °C	N	41%
24		19	26	24	23	16 °C	Y	48%
24		20	29		25	14 °C	Y	64%
15	11	13	18	4	17	12 °C	Y	84%
9	5	12	12	8	9	11 °C	Y	82%
26	5	32	30	23	25	12 °C	N	79%
14	6	18	17	13	14	11 °C	N	78%
20	12	26	24	17	20	12 °C	N	75%
13	13	16	13	11	11	14 °C	N	70%
20	14	24	24	19	19	14 °C	Y	71%
8	5	11	11	7	8	12 °C	Y	87%
10	8	11	11	8	9	12 °C	Y	72%
28	28	33	32	22	27	11 °C	N	74%
17	25	20	28	11	16	10 °C	Y	69%
12	19	16		9	12	13 °C	Y	67%
23	23	26		21	22	13 °C	N	62%

19.2 Data visualisation and collection platform design

19.2.I Interface characteristics

The Looper project ICT system was developed to be a suite of interconnected web tools that need to provide several communication and collaborative functions, and that have to be gathered inside a common frame in order to allow a more user friendly experience.

The data-flow schema (figure 19.2.I-1) of the platform is intended to show the system architecture of the Looper ICT system, and the connections between each part of it. It is also shown here where data are to be generated, processed, transferred and visualized within the Looper Living Lab collaborative processes.

The two boxes in the upper part of the diagram depict the main sections of the Looper system: the general project website and the Looper collaborative platform - the so called local websites, of which one for each Looper Living Lab was developed. The general project website was thought to work as the section where all information about the development of Looper project were to be published. On the other hand the Looper platform was meant to be a collection of tools specially developed for the learning loop processes in the Looper Living Labs.

The general project website, and the Looper platform, had separate and simple hyperlinks allowing visitors to jump from one section to the other. The Looper collaborative platform was then made up of the following sub-sections:

- The participatory data collection and monitoring section;
- The data visualization section;
- The co-design and implementation section;
- General introduction about the Looper Living Lab (including location, problem description, news, events, local contact details).

Furthermore, for each Looper Living Lab a local website (collaborative web platform) was developed, and it presented each of the abovementioned sections in the local language - French and Flemish for Brussels, Italian for Verona and English for Manchester.

With regard to the participatory data collection section, its aim was that of collecting tools to support the participatory sensing data collection. At the beginning there was a direct link to the external application for the geotagging tool, but it was later decided to embed the geotagging tool in the data collection section as it was easier for participants to use it if it was within the local

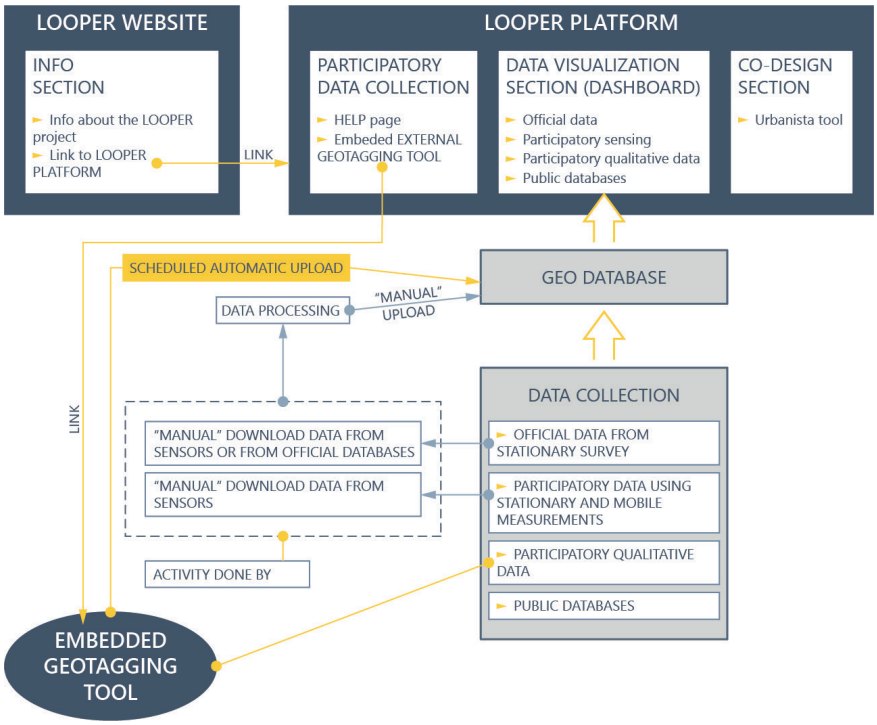


Figure 19.2.I-1 data-flow schema of the platform with different working links

platform and with the same interface. However, as shown in the diagram, data collected with this tool were stored in the main geo-database of the Looper platform via a scheduled automatic upload procedure.

The data visualization section was then a section specially designed to display, explore and better know the issues that can be found in the city. In this section, several interactive maps and reports were shown, and thanks to these data users were able to perform custom searches, to access data details and statistics, and to navigate through thematic maps that show results from all data collection campaign. The data visualization section is powered by a geo-database that store and process data coming from stationary surveys, mobile measurements as well as data from the mentioned geotagging qualitative tool. To better understand, data from participatory surveys and from ARPAV were collected and pre-processed by Looper Living Lab participants in order to upload them into the main geo-database with a blended system of manual/semi-automatic procedures that depended on the used sensors and tools.

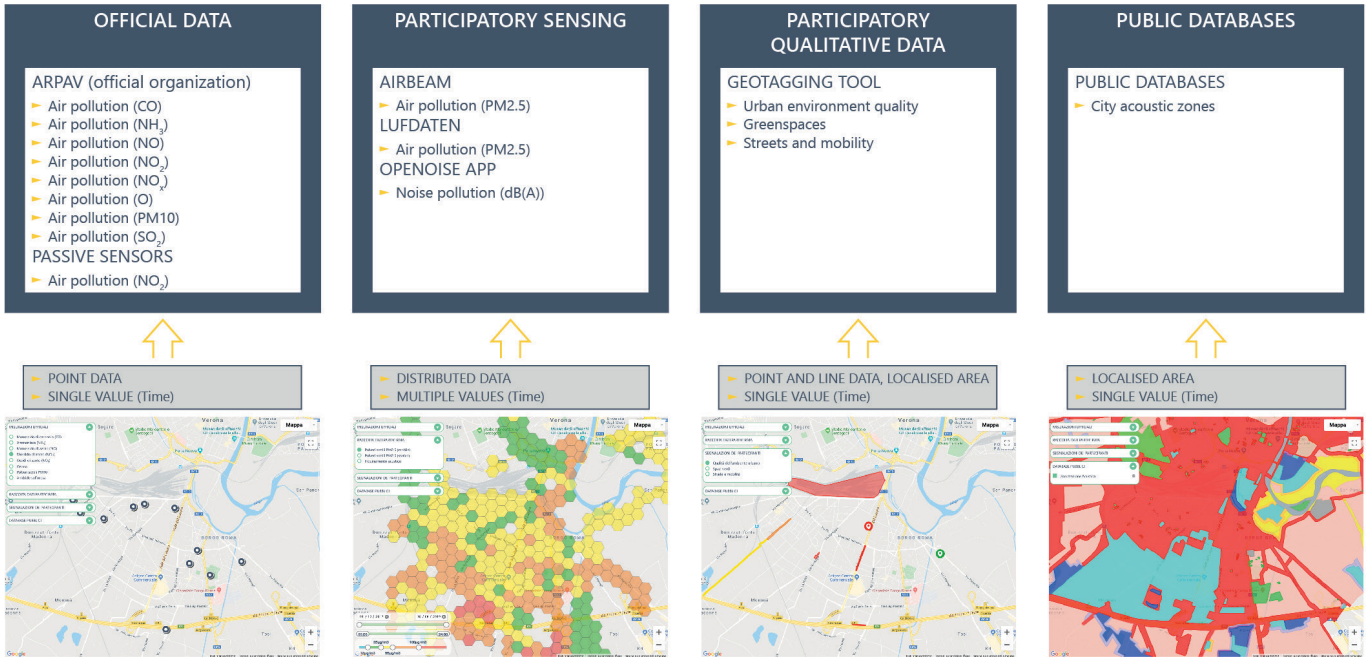
The co-design section was an external tool developed by Urbanista that was embedded in each local website after an interface re-design. The Urbanista tool allowed to upload ideas, possible solutions and feedbacks/comments on other participants suggestion, with the chance of also geolocating it. This online co-design tool was of good help during the co-design process as it allowed the participation of people that were not able to come at face-to-face meetings. The uploading process was an easy one as a simple model is to be filled in with: title of the co-design idea, description of the idea and category. It was then also possible to add a picture and the location for the proposed idea. Unfortunately due to a bug it was never possible to automatically upload images for participants, but organisers could later upload pictures if requested.

One main part of the work done for the setup of the platform was the setup a common framework for data collection and processing. It has been necessary to group the various types of samples (figure 19.2.I-2) that needed to be taken into specific categories to develop a valid conceptual data model for the Looper database and platform.

Official data

The first category of data typology classification regarded monitoring campaigns to be carried out using stationary sensors and stations undertaken by official agencies. This type of data was that of official ones, and was used to evaluate pollutants at national and European level. Indeed, a participatory approach can still be found as Looper Living Lab participants gave suggestions on where to position the sensors and on the timeframe for the monitor-

Figure 19.2.I-2 data visualisation categories



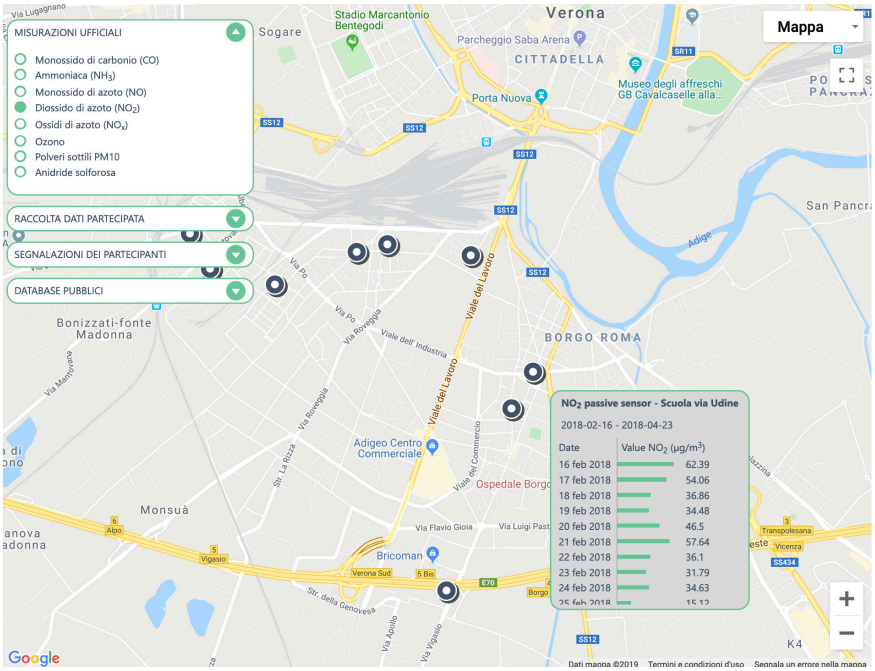


Figure 19.2.I-3 example of official data visualisation. It is done by using pins and a scrolling menu that shows all data for the selected pollutant in that specific location

ing campaigns.

Such kind of surveys produced multi-temporal/multi-sensor series of data samples linked to a single location. Data values were visualized by placing a push-pin on the map which had a pop-up info box showing firstly the list of data campaigns and then, by clicking on the data campaign, it showed the data collected during that campaign in a list format (figure 19.2.I-3).

For this kind of data, it was pointless to produce a layer with continuous coverage - i.e. the data visualisation type used for the AirBeam participatory sensing that can be seen in next figure 19.2.I-4. This because there was no scientifically valid technique to interpolate values between the spots of the surveyed points. In the case of multi-sensor survey station their info box shows summary data about all sensors related to the identified station.

Data here were uploaded manually each time there were the results of a new monitoring campaign.

Participatory sensing

Participatory data were collected both in a static and in a mobile way. Static data were treated just like official data while mobile collected data, on the opposite of the previous case, were mapped by using a coverage layer (figure 19.2.I-4), this because surveyed points have no pre-defined location and samples distribution might be irregular.

The adopted interface was based on a simple calculation on average values of concurrent measures in the same spatial unit - i.e. a hexagonal grid cell layer. This approach was preferred to the heat map style one because the AirBeam sensors give high irregularity of spatial distribution of measurements and temporal inhomogeneity of surveys, which often causes many cases of spatial samples overlapping. Since mobile surveys in this project produced large samples dataset and irregular spatial distribution of surveyed areas, the simple average values based approach remained the preferable one as initially thought.

While developing the spatial grid it was decided to stick to the 5 zoom levels by Google, this meant that while zooming in or out, the hexagonal cells readjust their dimension based on the Google zoom level. This allowed to have more accurate averages since these are linked to the map scale (figure 19.2.I-5).

To then see the data average, users could click on a cell of the grid covered with a layer and they would get a pop-up info box that showed the average data of that specific location.

The default setting was that of showing the overall average - i.e. the average of every single sample collected in that area throughout every monitoring

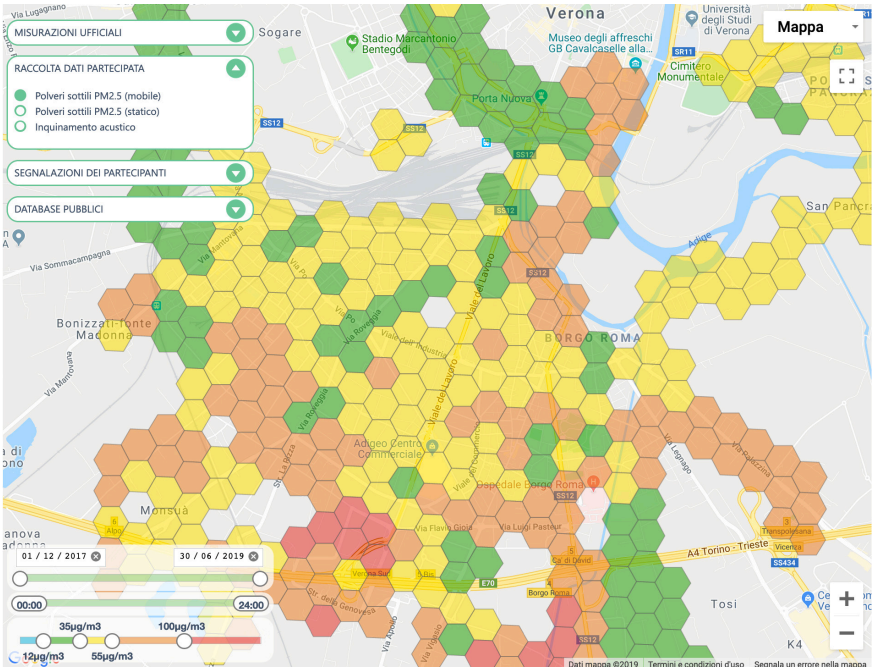


Figure 19.2.I-4 example of participatory sensing data visualisation. It uses hexagons to show one average data for the area defined by the hexagon itself. Scrollers on the bottom left side allow to choose a timeframe of data to analyse, or to set hexagons' colours to define pollutants levels to investigate

campaign, but this limited the possibility to use the collected data in a useful way. Because of it, it was later implemented a set of scrollers that allowed to define the timestamp within which to see the data. The first scroller defined the day/month/year period of time, while the second defined the hour/minute period of time. This allowed to see the average of specific days or specific timings - i.e. peak hours.

The last available scroller allowed to change the colour range of the map. Because AirBeam collects instantaneous data while moving it was not possible, and it was incorrect, to show data colour ranges based on the law limit. Hence, it was decided that it was better to give users the possibility to decide autonomously the colour range they prefer.

Data here are uploaded manually each time there are the results of a new monitoring campaign.

Participatory qualitative data

The third category of data typology classification regards surveys carried out using smartphone geotagging applications - the previously mentioned web-based geotagging app. This type of data - i.e. qualitative data - just like the ones collected with stationary surveys, were made of information related to a fixed geographical location.

When placing a tag, it was requested to users to fill out a form with some place-related information. The form to be filled out contained a basic free text input box, where to enter a title and a description, and some other more struc-

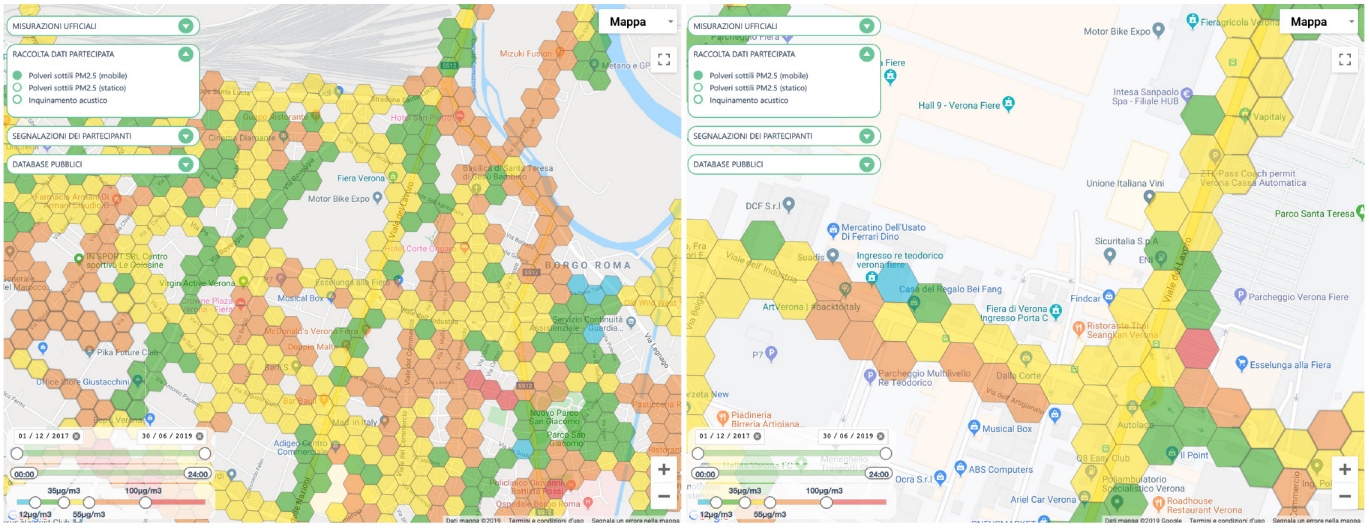


Figure 19.2.I-5 different zoom levels of participatory sensing data visualisation

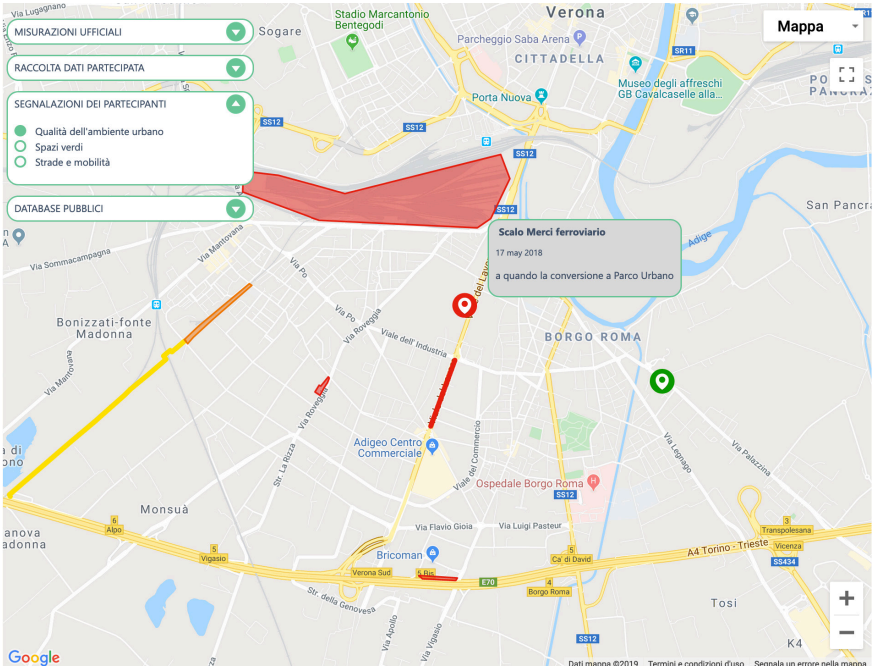


Figure 19.2.I-6 example of participatory qualitative data visualisation. Each pin, line or area define the location and the data is shown by clicking on the location itself

tured input controls, like the category or the ranking. It was also possible to attach multimedia files such as pictures or videos. Basically, tags might not contain any quantitative value to make any calculation or thematic mapping rather than a simple and user-friendly ranking tool since submitting data is mostly a kind of observed situation, not a measured value.

For this type of data, the push-pin representation technique was adopted again (figure 19.2.I-6). And the colour code was used, based on the ranking given by users, to represent the goodness or criticality of the uploaded situation.

This type of data was uploaded with an automatic upload schedule from the geotagging.it web app, and the sub-layers were picked up from the geotagging.it itself.

Public database

The fourth and last category of data was that of public databases. This layer worked more as a storage of data collected by third parties, but it resulted to be useful for Looper Living Lab participants because sometimes extra information could help in the analysis of an area. This layer was implemented to make the data visualisation experience even more user friendly, as it might be difficult for citizens to find some type of public information using official geoplatforms - each official body has its own and citizens need to look through all of them to find a single information.

This type of visualisation followed the one used for participatory qualitative data. This was because public databases might contain data shown as points, lines or areas defined by polylines. In figure 19.2.I-7 an example of acoustic zoning data - taken from the city council public database - ae shown. For this type of data, instead of having a legend it was possible to know more about the map by clicking on the interested area.

How the interface was developed

The interface development was the result of the various needs of the participants from the three different cities. The main idea was that of having the most user-friendly interface, with possibly only few options and immediate pages description.

While developing the first mock-up [19.2.I-1] some issues in making the whole interface as user-friendly as possible were found. This was due mainly to the high amount of information that were to be shown on each page. This resulted in many different changes in the interface, based also on participants feedbacks.

The big main difference in the mock-up and final interface design was that

[19.2.I-1] See initial visualisation dashboard design proposal on annex 6 at the end of the thesis.

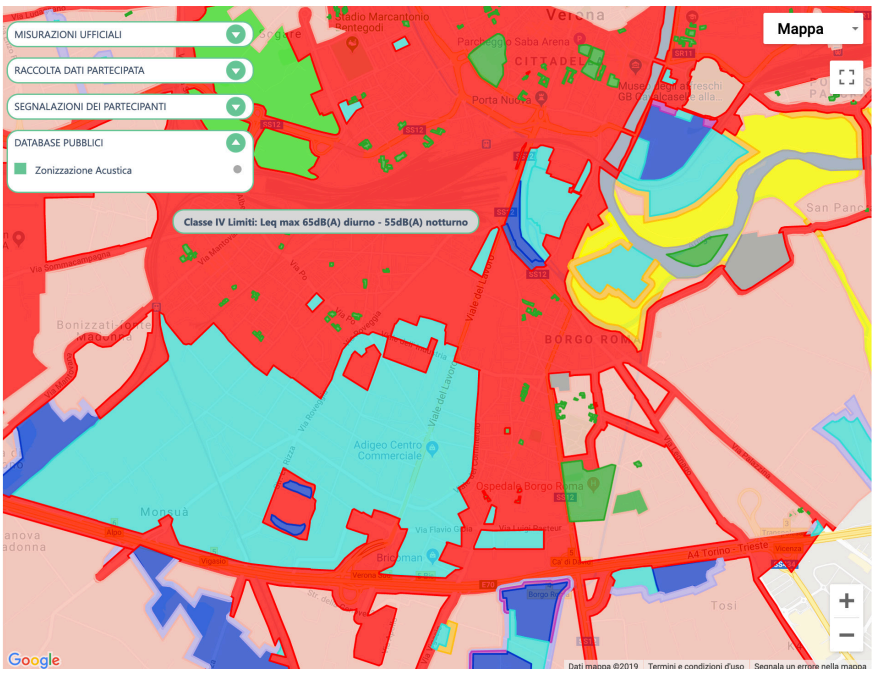


Figure 19.2.I-7 example of public database data visualisation. Each area show one data uploaded from an external public database

the data visualisation dashboard was embedded in each local website, this meant that it was possible to select from the menu the data visualisation page and the map with the different layers was directly shown.

Another difference to be found was the implementation of the scrollers for the general visualisation of data and more specifically for the visualisation of the AirBeam data. Initially the idea was of having time and ranking scrollers for each type of data to be visualised. It was then understood that it could be too confusing for users to have all of these options, and that the unit ranking colouring could led to possible misunderstanding in the reading of the data collected. Because of this, for the final interface design the only type of data that kept the scrollers were the AirBeam ones. This is due to their particularity of being the only one that worked on a diffusive idea, and because without the scroller it was not possible to select certain range of dates to see the exposure of the PM during a certain day or during peak hours. The ranking scroller have also been transformed into fully manageable ones, meaning that the change of colours of each hexagon was not indicative of higher levels of PM for law purposes, it was only used to show the indicative exposure people were having on a certain day.

19.2.II Framework for distributed data collection

The common framework for data modelling and processing was a set of rules and protocols that was initially planned and needed to manage in a unified way the data collected by all the three Looper Living Labs. The common framework basically consisted of the database conceptual data model, which defined how the data were to be stored and mutually related, and the set of procedures that was meant to be used to process data according to the output needs. The main difficulty faced while setting up the framework was the need of having somehow a flexible structure to be able to implement it with possible extra data later on.

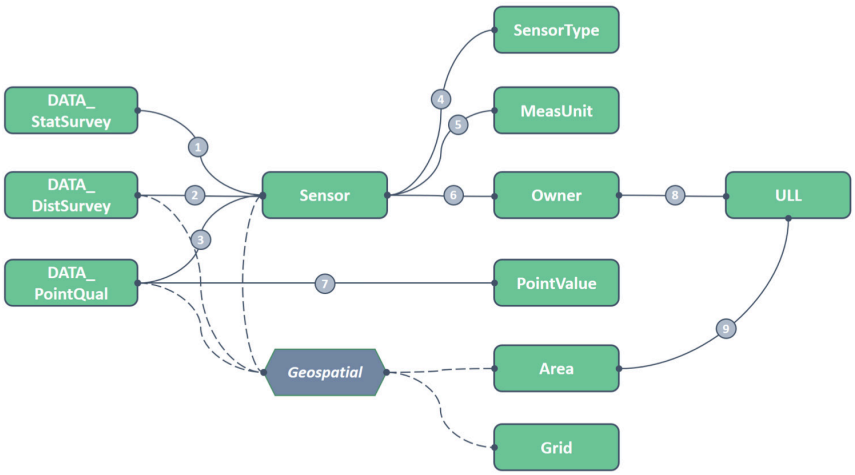
A complete guideline on how to setup raw data to be uploaded on the Looper platform was produced for the organisers of the Looper Living Lab to simplify the process. [19.2.II-1]

Conceptual data model

The schema in figure 19.2.II-1 was a simplified version of the Entity-Relationship (ER) diagram of the Looper platform database. As in any ER diagram, main boxes stands for entities - e.g. database tables - and each connecting segment stands for the relationship between two entities which will be done by linking key attribute fields - Primary Key of the master entity and Foreign Key of the child entity.

[19.2.II-1] See manual on how to prepare data for the upload on the database on annex 7 at the end of the thesis.

Figure 19.2.II-1 schema of the Looper platform database



Looper platform data model contained 4 main entities to manage data collections and several minor entities and lookup tables. The main entities were the 3 on the left of the diagram, 'DATA_StatSurvey', 'DATA_DistSurvey' and 'DATA_PointQual', that recorded the three type of data collection, and the fourth one, 'Sensor', that was used to record the devices/users that were used to carry out the surveys. The other 7 entities recorded auxiliary information and lookup values as detailed in the following paragraphs.

Entities are detaily descripted in the next paragraphs, and table 19.2.II-1

Table 19.2.II-1 description of the relationships from schema in figure 19.2.II-1

Relationships		
#1	Relationships between the data values entities ("DATA_StatSurvey", "DATA_DistSurvey", "DATA_PointQual") and "Sensor" entity.	We intend "Sensors" in a broad sense as "what is used to take samples", so sensors may be both physical devices or human observers. Relationships 1,2,3 are all one-to-many related from Sensor (one) to values data (many).
#2		
#3		
#4	Relationship between each individual sensor and its specific type.	One-to-many relationship from type to sensor since we can deploy n sensors of the same type.
#5	Relationship between each sensor and its measure unit.	One-to-many relationship from unit to sensor since each sensor provide only one type of data.
#6	Relationship between sensors and its "owner" that is the responsible of the survey carried out with it.	Theoretically one-to-many relationship since each sensor will be related to one user but virtually many-to-many if there will be groups of users owning a sensor
#7	Relationship between point data value table and qualitative classes used to express ratings.	Many-to-many relationship since same classes groups may be used by several (human) sensors.
#8	Relationship between owners and Urban Living Labs. It basically expresses owner affiliation.	Basic one-to-many relationship.
#9	Relationship between geographically defined study area(s) and related Urban Living Lab.	Basic one-to-many relationship.
#Geospatial: (pseudo-relationships)		Segments connecting "Geospatial" box indicate the "virtual joins" between all the entities that have positional/shape attributes since each of these tables can be visualized and processed as a map layer using a GIS software.

briefly explain each relationship, numbered from 1 to 9, shown in the diagram.

Data model details tables

The details of each entity are reported using the template from table 19.2.II-2.

Main entities

According to the conceptual data model, there were 4 main entities intended to store samples data and sensors descriptive information (tables 19.2.II-3, 19.2.II-4, 19.2.II-5, 19.2.II-6).

Auxiliary/Lookup entities

The entities described in tables 19.2.II-7, 19.2.II-8, 19.2.II-9, 19.2.II-10, 19.2.II-11, 19.2.II-12, 19.2.II-13 were auxiliary tables used to store data like series of key/value (known as *lookup tables*), users lists, classifications or other minor information.

Protocols and procedures

Protocols and procedures have been defined to ensure effective data flows and processing from data collection storages and inside Looper platform. Basically, protocols have been implemented as guidelines and specification, while procedure have been implemented as DBMS [19.2.II-2] *views* or *stored procedures*.

There were two phases of data processing: -pre- and -post- storage into the DBMS. The following paragraph briefly introduce the key issues that were developed once the framework model was completed.

Pre-processing protocol

Pre-processing protocols defined how data collected with many different tools were finally stored into the Looper platform database.

Devices used to carry out surveys stored data in various ways, and specific procedures to ensure easy and efficient data migration into Looper platform database were needed, and there was the need to take into account the different tools that were used and different users that have been involved during the data collection.

It was possible to assume since the very beginning that were would be two types of scenarios, making it necessary to follow two different protocols:

3. Tools based on a 'closed' data management system [19.2.II-3] that provided some standard interchange format;
4. Tools based on a connectable 'open' data management system. [19.2.II-4]

For the first scenario, the most efficient way to ensure data migration was to follow some case-specific guidelines and specifications to put collected data into a spreadsheet or delimited-text file according to a strict attribute schema.

For the second scenario, for which the needs had to be verified case-by-case, it was considered to be a good solution to establish a remote database connection through Looper server and other application servers.

Post-processing protocol

Post processing procedures were also needed to make users able to perform data visualization, reporting, searching and identifying.

There were two fundamental type of procedures to process data in a DBMS: *views* and *stored procedures*. Within Looper it was mostly needed to create views directly to output results (on the fly) from storing tables and stored procedures to perform complex processing that needs to be saved as static dataset due to long computing time.

Views were used every time real-time update of the outputs were needed - e.g. maps showing survey data changing every hour or even one time per day. Indeed, with the data collected in the Looper project there was not often this

[19.2.II-2] A database management system (DBMS) is a software package designed to define, manipulate, retrieve and manage data in a database.

[19.2.II-3] Tools whose database is closed and it is not possible to freely link it to another. This does not allow to automatically share collected data with another database. To manage the DBMS, data are to be downloaded from the first database and need to be prepared in the final DBMS format to be manually uploaded.

[19.2.II-4] Tools whose database can be freely linked to another. This allows to automatically share collected data with another database to create an open database management system.

need and it was possible to do many of the computations using stored procedures and temporary output tables.

In table 19.2.II-14 a simple schematic list of the needed procedures for the Looper platform database related to functions and data typology.

Table 19.2.II-2 report schema for the details of each entry

ENTITY NAME			
Entity description			
Keys	Field name	Field data type	*Field description and notes.*

Table 19.2.II-3 DATA_StatSurvey main entity descriptive info storage template

DATA_StatSurvey			
Data from stationary sensors. Each record is a single measure/observation; to rebuild value series filter by sensor_id and order by start_time. join with sensor positional data in order to map values.			
PK	data_id	Numeric integer	*Sequential unique identifier.*
FK	sensor_id	Numeric integer	*Foreign Key referring to Sensor entity Primary Key (see Sensor entity details table).*
	value	Numeric float	*Measured data value without unit.*
	start_time	Timestamp	*Timestamp (date + hour-min-sec) of start survey time.*
	end_time	Timestamp	*Timestamp (date + hour-min-sec) of end survey time. In case of instant sample, end_time = start_time.*
	note	Text	*Auxiliary note field.*

Table 19.2.II-4 DATA_DistSurvey main entity descriptive info storage template

DATA_DistSurvey			
Distributed data collected by participatory surveys with portable measurements tools. Each record is a single measure/observation with relative positional data; to rebuild value series filter by sensor_id and order by start_time. Related sensors will not have positional data.			
PK	data_id	Numeric integer	*Sequential unique identifier.*
FK	sensor_id	Numeric integer	*Foreign Key referring to Sensor entity Primary Key (see Sensor entity details table).*
	value	Numeric float	*Measured data value without unit.*
	time	Timestamp	*Timestamp (date + hour-min-sec) of sample.*
	pos_lat	Numeric float	*Latitude in decimal degrees of positioning data*
	pos_lon	Numeric float	*Longitude in decimal degrees of positioning data*
	note	Text	*Auxiliary note field.*

(see whether could be useful to populate a cell_id value with a scheduled/triggered procedure)

Table 19.2.II-5 DATA_PointQual main entity descriptive info storage template

DATA_PointQual			
Point qualitative data collected by participatory surveys with geotagging tools. Each record means a single observation. In this case we consider a specific topic (e.g. traffic, urban green, etc..) as a "pseudo-sensor" so to get value series by topic filter by sensor_id and order by start_time.			
PK	data_id	Numeric integer	*Sequential unique identifier.*
FK	sensor_id	Numeric integer / Text	*Composite Foreign Key referring to PointValue entity Primary Key (see PointValue entity details table).*
	value	Numeric integer	
	time	Timestamp	*Timestamp (date + hour-min-sec) of sample*
	attachment	Text	*Name/Code of attachment file (image, audio, video ...)*
	note	Text	*Auxiliary note field.*

(see whether could be better naming attachment files using a string with data_id value)

Sensor			
Sensors list. Each record of this table means both a hardware device used to acquire data and a qualitative issue observed by a human operator like traffic, urban green etc. which can also be intended as a sort of "observation class".			
PK	sensor_id	Numeric integer / Text	*Sequential or alphanumeric-mnemonic unique identifier.*
	name	Text	*Mnemonic label of the sensor.*
FK	type	Numeric integer	*Foreign Key referring to SensorType entity Primary Key (see SensorType entity details table).*
FK	measunit_id	Numeric integer	*Foreign Key referring to MeasUnit entity Primary Key (see MeasUnit entity details table).*
	pos_lat	Numeric float	*Latitude in decimal degrees of positioning data*
	pos_lon	Numeric float	*Longitude in decimal degrees of positioning data*
	stationary	Boolean	*Flag to mark stationary sensors.*
FK	owner_id	Numeric integer	*Foreign Key referring to Owner entity Primary Key (see Owner entity details table).*
	note	Text	*Auxiliary note field.*

Table 19.2.II-6 Sensor main entity descriptive info storage template

SensorType			
Lookup/detail table of different measure units of sensors. Sensors will be both hardware device and a human-perceived qualitative issue; this entity has a two-level classification (type/category).			
PK	sensortype_id	Numeric integer / Text	*Sequential or alphanumeric-mnemonic unique identifier.*
	type	Text	*Description of sensor typology (e.g. "Mobile air sampling station", "Geotagging qualitative sampling" ...).*
	category	Text	*Category (sub-type; e.g. "Nitrogen Dioxide – NO2", "Traffic" ...). To be referred to "issues".*
	note	Text	*Auxiliary note field.*

Table 19.2.II-7 SensorType auxiliary entity descriptive info storage template

MeasUnit			
Lookup table of different measure units of sensors. Since sensors will be both hardware device and a human-perceived qualitative issue, measure units may be physical dimensions or a generically named "qualitative" measure unit.			
PK	measunit_id	Numeric integer / Text	*Sequential or alphanumeric-mnemonic unique identifier.*
	measunit	Text	*Description of measure unit (e.g. "NO2", "PM2.5" ... "Qualitative").*
	note	Text	*Auxiliary note field.*

Table 19.2.II-8 MeasUnit auxiliary entity descriptive info storage template

Owner			
Auxiliary account table of owner/manager of sensors.			
PK	owner_id	Text	*Account unique identifier. Might be a nickname or an email address.*
	fullname	Text	*User full name.*
	...	...	*(other details to be defined as needed)*
FK	ull_id	Text	*Foreign Key referring to ULL entity Primary Key (see ULL entity details table).*
	note	Text	*Auxiliary note field.*

Table 19.2.II-9 Owner auxiliary entity descriptive info storage template

PointValue			
Lookup table of point qualitative sample values.			
PK	sensor_id	Numeric integer / Text	*Qualitative value composite unique identifier. Value field might be a "ranking" value (e.g. "VeryHigh-High-Medium-Low-VeryLow") or another additional quantitative component of the observation.*
	value	Numeric integer	
	value_desc	Text	*Qualitative value extended description.*
	note	Text	*Auxiliary note field.*

Table 19.2.II-10 PointValue auxiliary entity descriptive info storage template

Table 19.2.II-11 LLL auxiliary entity descriptive info storage template

LLL			
Lookup table of LOOPER Living Labs.			
PK	lll_id	Text	*Mnemonic unique identifier.*
	lll_name	Text	*Name of the Urban Living Lab.*
	…	…	*(other details to be defined as needed).*
	note	Text	*Auxiliary note field.*

Table 19.2.II-12 Area auxiliary entity descriptive info storage template

Area			
Auxiliary geographic table of study areas. May be useful to build final maps or to carry out some geoprocessing operations.			
PK	area_id	Numeric integer	*Sequential unique identifier.*
	description	Text	*Area description.*
	geom	Geometry	*Geometric shape of the area.*
	…	…	*(other details to be defined as needed)*
FK	ull_id	Text	*Foreign Key referring to ULL entity Primary Key (see ULL entity details table).*
	note	Text	*Auxiliary note field.*

Table 19.2.II-13 Grid auxiliary entity descriptive info storage template

Grid			
Auxiliary geographic table of mapping grid for distributed data. This is a polygon GIS layer of square/hexagonal cells covering all study area; grid cells will be used to aggregate quantitative data coming from participatory surveys and produce thematic maps visualizations.			
PK	cell_id	Numeric integer	*Sequential unique identifier.*
	geom	Geometry	*Geometric shape of the cell.*
	…	…	*(other details to be defined as needed).*

(grid optimal size to be defined)

Table 19.2.II-14 schematic list of need and procedures for the Looper platform database

Data typology functions	Stationary survey data	Mobile survey data	Qualitative data
Visualization and reporting	*Output of map pin layer with simple thematic symbol*	*Output of map grid layer with thematic symbol of average values*	*Output of map pin layer with thematic symbol*
Map objects identifying	*Single pin with info-box summary data about all issues*	*Single cell summary of data values about a time range (e.g. last week, weekends, peak hours etc. …)*	*Single pin info-box with attachment URLs (e.g. picture, video etc.)*
Data searching	*Output lists / reports with summary data (e.g. number of records found, average values etc.)*	*Filtered map grid layer according to search criteria.*	*Output lists / reports with summary data (e.g. number of records found, average values etc.)*

5

DISCUSSION AND POSSIBLE IMPROVEMENTS TO THE LOOPER METHODOLOGY

PART 5
DISCUSSION AND POSSIBLE IMPROVEMENTS TO THE LOOPER METHODOLOGY

20. DISCUSSION ON THE LOOPER METHODOLOGY

In the introduction of document, in section 'II. Fields of research and research questions', the framework of this work was presented, and its main aim was stated:

> *"[...] to find better ways to develop a co-creation process to improve urban transformation to get better results in complex and different, urban scenarios."*

To reach this aim, the Looper methodology and therefore its two main features, with the support of technological instruments like IT sensors, data visualization dashboards and collaborative tools, were applied, tested and analysed:

1. the co-design approach;
2. the learning loop method.

The analysis of these features was done within the framework of the Looper project, that combined different methods and tools to create an improved, and more feasible, co-creation methodology. The key aspect of the project was again its application into different urban scenarios, and this allowed to extrapolate what worked and gave results within the different cases.

After a preliminary critical reflection and analysis done following the first loop of the Looper project, fulfilled with a comparison between two pilot cases that used the Looper co-creation methodology, and also done by comparing the Looper methodology with a simple participatory process, the need to improve the two initial *features* raised. This willingness of upgrading them was to obtain a more complete and feasible process. This necessity to draft an evolved version of the features was verified within their application to the second loop of the Looper co-creation methodology.

20.1 Discussion on the methodology

During the application of the Looper co-creation process, various aspects were raised and helped in confirming whether or not the initial assumptions were correct. This then helped in understanding how to possibly improve the methodology.

As abovementioned the first considered *feature* was the co-design approach, that already sees plenty of literature and application. To overcome what was done until this point within this field, and the existing debates, there was the need to improve participants engagement and their knowledge on tackled topics. The other tackled *feature* was the learning loop method. This method cannot usually be found within the field of urban transformations, but its basic principles were of interest to bring something more to the co-design approach.

While moving forward in my research work, it was possible to see how these two features were too simplistic compared to the complex contexts that are cities nowadays. Their approach was useful, but when it came to think about a broader and more complete process they were not flexible enough to face different stakeholders and contexts. Moreover, after applying a co-design approach to the San Donà case, it was possible to have a first-hand feedback about the limits of the co-design approach.

This then resulted in the raising of different considerations, that expanded the initial research questions:

- Differences (and benefits) of Looper Living Labs compared to Urban Living Labs;
- From co-design to co-creation: how to do it;
- Strengthening of stakeholders' trustfulness;
- The problem of hard-to-reach groups;
- The usefulness of using offline and/or online tools;
- Small urban transformations to trigger the transformation of the city environment.

Hereafter it is possible to find the results that emerged while answering the initial questions and analysing the Looper co-creation methodology.

Differences (and benefits) of Looper Living Labs compared to Urban Living Labs

The theory that is at the basis of the Looper Living Lab methodology was successfully confirmed. This because it is based on the concept that working in loops creates knowledge, and that the knowledge raised can give more profitable results while applying the Looper co-creation methodology. This also supports the idea that it is better to involve all possible participants, and mostly citizens, since this helps in reaching higher levels of knowledge during the first loop.

It is then necessary to always have more than one loop. Indeed, this is due to the fact that the first loop is always needed to create the base knowledge for citizens. The Looper Living Lab solution is also useful because the first loop is the one that, as explained hereafter, allows citizens to better understand how small punctual solutions - that are usually the first ones asked within Living Labs - work and it helps in lowering the distrust level that can be usually found between different parties in urban areas.

From co-design to co-creation: how to do it

The switch from co-design to co-creation is one of the best results reached with the Looper co-creation process. This was mostly important because it allows to have more feasible solutions and to gather higher levels of participation within the process.

Within co-design processes it was possible to see how citizens' participation was somehow limited because participants did not have all the necessary tools and knowledge to bring something new and useful to the co-design activity. On the other hand, by allowing their participation throughout the whole process, and by asking them to take responsibility for their actions, the not only get empowered by the knowledge that others share with them, but they are also able to propose better solutions to solve the chosen issue.

Furthermore, the opportunity of further implementing the chosen solutions raises their willingness to participate because they feel that they are listened, and that they can actually change things.

Strengthening of stakeholders' trustfulness

One common mistake when it comes to set up a Living Lab is that trustfulness in between the parties is given for granted because they accepted to work on a collaborative basis. This is usually not true, meaning that trustfulness can be one of the crucial aspects that could make ineffectual the process. It is possible then to say that without trustfulness stakeholders are not effectively collaborating in order to reach better results. The use of loops and the presence of citizens in the process since the very beginning helped in lower the distrust between different stakeholders.

The Verona Looper Living Lab showed how citizen can, at least partially, understand that a constructive dialogue can bring better results than a strong opposition when it comes to talking with policymakers. Indeed, this can be possible only if experts, that are considered as neutral by both parties, participate to the Looper Living Lab in the guise of organisers and work as mediators.

Just like in Verona, in Manchester as well the role of organisers was extremely meaningful. In these cities the organisation of the Looper Living Lab was followed by the Università Iuav di Venezia - for Verona, and the University of Manchester - for Manchester. This shows how the expertise given by academic staff can help in mediating the point of views of different stakeholders, and can help by bringing technical knowledge that allows a more open dialogue between the parties.

The problem of hard-to-reach groups

The Verona Looper Living Lab showed that the process can be successful if there is a strong bottom level ready to participate in the process. This though can be a double-edged sword since a strong participation from a single group of citizens can discourage hard-to-reach groups in participating.

Moreover, it can be also said that there will always be a hard-to-reach group that will not participate to the process. Indeed, it might be said that when applying the Looper co-creation methodology it is recommended to work with small, more specific, stakeholders groups that are actually effected by the aim of the process. Trying to involve bigger and heterogeneous groups of people can make the process inefficient because dissemination resources are spread too thinly. Better focusing which stakeholders' groups might be interested can allow the, at least, reduction of hard-to-reach groups since stakeholders openly not interested in the tackled topic are not involved in the process. But it is important to let them know that if they change their mind, they can always decide to participate to Looper Living Labs' workshops and meetings.

Again, it is important to involve participants since the beginning as citizens - and other neighbourhood users - can bring important knowledge that can change the initial ideas of policymakers and designers that might not know as well the project area.

The usefulness of using offline and/or online tools

Linked to the hard-to-reach groups matter, there is the offline vs. online question. The Verona Looper Living Lab had a good countercheck about the online tool usage, because this was coupled with an effective offline presence - i.e. face-to-face meetings where all stakeholders could participate.

Experience in the Verona Looper Living Lab showed that, for what it concerns sensors, participants are willing to learn how to use both offline and online sensors if they are interested in the topic that is investigated by the co-creation process. By contrast, when it comes to the co-design online tool, participants prefer offline tools to trigger the co-design process. The online co-design tool was used almost only by participants that were not able to participate during face-to-face meetings, but hart-to-reach groups were still not participating.

Similarly, in the Manchester Looper Living Lab online tools did not found breeding ground and this was mainly due to the average age of citizens and the general digital illiteracy. Again online tools could be used only thanks to a stronger offline presence and great effort from organisers. Indeed, here organisers managed some offline meeting to help participants in using online tools. Here, just like in Verona, the usage of online tools was possible only thanks to the presence of organisers willing to help participants that could only participate to offline meetings and were not able to use online tools by themselves.

It is useful to remind here also the case study of Brussels, even though it was only introduced in the initial part of this work. In fact, the Brussels Looper Living Lab can be considered as another casuistry within the Looper's framework when it comes to online and offline tools usage. It was reported by organisers that there was almost none participation when talking about sensors, but there was high participation with online surveys and with the online co-design tool. Out of the three pilot cases the Brussels one has been the only one with higher online than offline participation throughout the whole first loop of the co-creation process. This might be due to the timing chosen for the offline meetings - maybe they took place too early during working days and had agendas too long for weekends - or for the socio-cultural provenience of

citizens.

The possible reason why the online tools usage in Brussels gathered more consent is that they used non-cooperative online tools, but they used online surveys that are actually peer-to-peer tools. With non-cooperative online tools it is then easier to have a wider response because they work in a sort of 'I give you something and you give it back to me' process that doesn't require much cooperation - that would require more effort and can be considered as a more difficult task.

It is feasible to say that online tools somehow were more useful for experts - that in the Looper project case are researchers as well - since they could be used to store data not to lose the knowledge acquired throughout the loops. Indeed, the Looper project then showed how it is still necessary, despite the high levels of connection and globalisation that characterise this time, to combine offline and online tools to improve Looper Living Labs results and avoid the dispersion of possible participants from hard-to-reach groups.

Small urban transformations to trigger the transformation of the city environment

One common idea that citizens have about pollution is that small punctual mitigation solutions are useful in solving these local issues. This is a quite common mistake. Because of this, the Looper project wanted to analyse with citizens if these kind of solutions they usually request can or cannot be useful to change, and possibly improve, the air quality of an urban area.

Because within the Verona and the Manchester Looper Living Labs it has been proved that this kind of punctual small solutions cannot improve the air quality of the urban environment, especially if they are designed to solve 'individuals' problems' - i.e. planting a tree in my street to solve the overall air quality issue of the city, citizens in those Looper Living Labs understood that it is better to work with long term solutions and/or small punctual solutions that are to be implemented vastly around the area to give any results. Furthermore, it has been necessary to undertake a full first loop to allow local stakeholders to understand that looking at their own local interests does not help in solving the issue.

It can thou be said that to allow urban and pollution improvements by using small punctual solutions, it is necessary to replicate on a wider scale their application to trigger a behavioural change that then allows improvements in the air and life quality. This means that, contrary to traditional urban planning, small urban transformations can produce higher benefits on urban scale - if repeatedly implemented - than bigger urban plans that change the urban texture without involving final users.

This experience allowed to understand why the loop method is necessary, and it is because the first loop is always necessary to delete some mistaken beliefs, while the second loop allows better implementations. Furthermore, the loop itself is needed to make citizens understand how to work with pollutants and why certain solutions work, then the second loop can give better results that are based on the knowledge gained during the first loop.

20.2 Sensors outcomes

Some interesting outcomes could also be extrapolated from the low-cost sensors usage, and these outcomes can be mostly reconnected to the noise and PM sensors.

The low-cost noise sensor that were used within the Looper project, after a quite wide application, can be considered reliable thanks to the implementations done by the team from the Università Iuav di Venezia. The reliability of the noise tool is to be linked to the microphone itself, because it is calibrated by using an official instrument. The class 1 sound level meter that was used to calibrate the noise box microphone is the same instrument that is used to make official measurements, and it allows to reset the noise reduction software that is embedded in smartphones. Furthermore, the outer case was improved by applying to the waterproof box a pipe to protect the external microphone. This pipe helps in both collecting noise data farther from the

windowsill, to avoid the noise return wave, and it also allows to waterproof the microphone itself. This pipe also allows to lower to the minimum the rain noise - when it occurs.

When it comes to PM low-cost sensors they cannot be considered as precise as official ones, but they can be deemed as reliable if the aim is to get a general impression about the exposure of residents and/or final users of a urban area. This unreliability on the exact data itself is linked to the data collection method itself. Low-cost sensors use the light scattering method to analyse and count the number of PM particles in the air - while official data consider the weight of the tampon after a 24h exposure - and the count can be altered by higher relative humidity levels, because above an 80% level of humidity water particles might be counted as particulate matter molecules. Due to this misrepresentation, data collected with low-cost sensors are to always be analysed by also considering the weathercast to avoid misrepresentations of the reality. Indeed, these sensors are still very interesting to be used in order to better understand the general exposure to PM2.5 and/or PM10 - depending on the sensor - that citizens face, to check possible variations during the day, and to analyse possible small differences between different parts of the city.

Another difference is between different low-cost sensors. Due to their typology, AirBeam sensors are less reliable than Luftdated ones because there is the need of using it while moving in order to map a bigger area, but then data are misrepresentative since they are collected around a wider area in different times of the day. Because of this Luftdaten can be considered to be more reliable when compared with official data, since they are static and collect data throughout the day.

Though a good amount of data has been collected, the last data collection done to check on the reliability of the Luftdaten was in February 2020. This last survey is being done differently by the past monitoring campaigns since it has been decided to position one Luftdaten sensor close-by to an ARPAV mobile station. This data collection begun in February 2020 and lasted only 3 days due to the Covid-19 emergency, and it was done to allow the comparison of data collected with the same weathercast and environmental conditions. After this data collection campaign it was possible to notice again how low-cost sensors cannot replace official body sensors, but they can indicate a wider situation in a certain area.

21. IMPROVEMENTS ON THE LOOPER METHODOLOGY

In the light of the foregoing, it is then possible to understand how to possibly implement and improve the Looper co-creation methodology. Aspects that stand out as ones to be improved or implemented are:

- find more efficient ways of explaining to possible stakeholders, since before the beginning of the co-creation process, why multiple loops are needed;
- it is not possible to create a completely trustful environment, jet it would be interesting to find new ways of reducing even more the distrust between the parties;
- possibly reduce the timeframe of the first loop compared to the following ones when it is mainly used to build knowledge and does not give direct impact results on the urban environment;
- find and implement new dissemination solutions to identify and involve hard-to-reach groups;
- better understand how to use online tools to support the whole process.

Hereafter is a deeper analysis on how to improved and further implemented these aspects.

Firstly, Looper Living Labs proved to be more effective than Urban Living Lab, but this is only possible if stakeholders and organisers are bond in committing to more than one loop. This is mandatory because the first loop will be needed to overcome misconceptions that are to be found from both citizens - or final users - and policymakers.

This then leads to the trustfulness concept. The Looper project showed how it is not jet possible to completely overcome the distrust that citizens and policymakers have towards each other, indeed it is possible to build a trustfulness basis that at least lowers the scepticism and allows a constructive dialogue. This lack of trust is mainly due to the inability to understand each other's point of view, but the learning loop allows to build enough knowledge in order to open a line of dialogue that is the basis to have a successful co-creation process. It is mandatory, if the co-creation process tackles urban issues, to have the city council as one of the active partners. This is to show citizens that policymakers are open to listen to them, and it is also necessary to convince policymakers to listen to citizens' needs.

Moving forward, it has been seen how the first loop is needed to build a knowledge base scenario that gives knowledge to citizens to better understand why certain solutions are not applied - i.e. small punctual mitigation solutions - unless it is possible to apply them multiple times on a larger scale. This also means that the first loop usually does not produce entirely useful designs and ideas. Nevertheless, in term of citizens knowledge, results at the end of the first loop are found to be positive if the Looper co-creation methodology is applied. It is then possible to state that this new knowledge gained by citizens allows them, during the second co-design activity, to ask for better solutions that can bring benefits for the whole community, e.g. solutions on a longer terms basis and requests for larger scale implementation, or smaller solutions but repeated on multiple locations and multiple times.

Furthermore, something to be surely implemented is the hard-to-reach groups approach. The Verona Looper Living Lab was not able to involve pos-

sible hard-to reach, and it was also difficult to identify who they were. This showed how, even with the strong presence of a bottom level, it is difficult to involve all the affected stakeholders despite the use of various dissemination methods. To possibly further implement the involvement of hard-to-reach it could be necessary to make better analysis of the socio-cultural presence of the affected area, who are the final users of the area - that might not be residents - and what communication tools they use. This could help to understand who to contact to ask for participation, and how to contact them.

Online tools then resulted not to be the best solution overall. When working with many different individuals offline tools are still preferable, and can be integrated with online tools if organisers see that participants might be able to use them. Indeed, online tools can, and are to, be used also in alternative ways to fill the needs of possible stakeholders - i.e. collective usage during offline meetings with organisers helping participants in their usage, and to settle the knowledge acquired during the whole process to allow its reuse in other Looper Living Labs that work in the same urban environment.

To conclude, it is possible to say that the Looper co-creation methodology gave mainly positive results, but there is still space for improvement. It would be necessary to better analyse the initial situation - compared to what was done within the Looper project - to better understand the context in which organisers will work, in order to start with a strong bottom level that can involve as many stakeholders as possible. Furthermore, technologies proposed and used within a Looper Living Lab need to be adequate to the socio-cultural context, and organisers - it is strongly recommended for organisers to be experts on the working topic - need to make the technology experience as user-friendly as possible to boost participatory sensing and co-creation within different stakeholders groups.

C

conclusions

conclusions

Some conclusions about my research are hereafter drawn. These consider the whole process undertaken, starting from the initial research questions which later evolved on the basis of the theoretical framework, raising some extra considerations and results explained in 'Part 5 - Discussion and possible improvements to the Looper methodology'.

The initial research questions pointed towards the *features* of co-design and learning loops, and how to use them with the support of IT technologies, to reach an improved co-creation process. Then the study on the theoretical framework enlarged the questions besides co-design and learning loops, towards the existing discussions about what are the benefits of the participatory approach, and the positive and/or negative aspects of using Living Labs or Urban Living Labs.

By keeping in mind the discussions on these topics it was then easier to implement the Looper co-creation methodology, going above the initial Looper project idea. This could be done by being flexible in the application of the methodology and by also trying to adjust it as much as possible to the context and stakeholders to which it was applied, resulting in different - but similar - processes in the three cities of Verona, Manchester and Brussels.

Further investigated issues linked to trust and consensus in decision making processes, on the use of online and offline tools, and on the use of low-cost sensors where then later analysed based on the findings obtained from the application of the methodology to the Verona and Manchester Looper Living Labs.

Hereafter the conclusions about the abovementioned questions, discussions and results are expressed.

When talking about participatory approach, most researchers are against it because participants might be inconstant in their engagement, and they might not have enough knowledge to be useful for the process (Swyngedouw, 2014; Arampatzi, 2017). This can be true if organisers do not take care about who they engage. Throughout my research it was possible to see that participation does not mean that everyone has to be involved, but it rather means that organisers have to involve the ones that can actually be interested in the tackled topic. This implies that organisers need to carefully examine the socio-cultural-historical context of the project area before starting with the dissemination to engage possible participants. But this initial work can then allow to a better focus of the resources that organisers have, and to avoid the presence of major hard-to-reach groups that would not be interested in the topic anyway (McTague and Jakubowski, 2013).

Linked to the participation aspect, it was possible to find that citizens involvement needs to start since the beginning of the process. This means that the fist activity of the scoping of issues does not have to be a simple findings of all possible criticalities, it needs to set up an already focused approach from participants. This can be done by having a first 'scoping' done by organisers that have to find the macro area of interest within the project area, and then local participants can better focus on the topic of higher interest rather than proposing criticalities that the co-creation process might not be able to tackle. This is the first tool that is given to participants: the ability to focus on a topic, not to disperse energies and resources, and the knowledge to do so.

Linked to the learning loop use within the co-creation process there was the question if it was possible to implement the 'validate' idea to Urban Living Labs (Mitchell et al., 2010). The two things become complimentary since the Looper co-creation process demonstrated that it is better to also implement small punctual solutions that can be replicated in different locations. This means that by working in loops, on quickly implementable ideas, Urban Living Labs can validate the work done by participants, creating a new type of Lab i.e. the Looper Living Lab.

It was also demonstrated by this research how all of this cannot be possible if there is no bottom level. This co-creation process, as already demonstrated by other co-design examples, can function if it is supported by a bottom-up approach, meaning that even if it starts from a top-down idea it needs to shift to keep the participation and obtain results (Pissourios, 2014). This was expected because local participants are more willing to participate if they feel

that they are listened to, and this is only possible if they are seen as a strong group. Furthermore, the presence of a strong bottom level also helped in overcoming the usual debates on the usefulness of co-design, because participants were feeling empowered by the presence of other individuals interested in their same topic, and then they were more focused on the work (Pinker, 2018).

This work then showed how organisers are to be seen as neutral by participants of the process. This is due to the trust issues that are typical of the citizens and policymakers relationship. If stakeholders see organisers as neutral they are more willing to listen to their hints and suggestions, and are more willing to participate to open dialogues to build knowledge and relationships since there is a mediator. This was not expected in the beginning, because organiser were supposed to be existing associations and/or NGOs that already had interests in the areas of project, but later on researchers took charge of part - or most - of the Looper Living Labs organisation to allow a more feasible process.

Furthermore, some considerations can be expressed on the debate about online tools and PPGIS (Sieber 2006; Monteiro *et. al*, 2018). This topic showed many different results depending on the city context that was taken into account, showing that online and digital tools are still not the best solutions. Even if new generations are more digital, the usage of these tools can preclude the participation of some possible stakeholders, confirming the concerns already expressed by some academics. A mixed use of online and offline tools is still to be preferred, since this can trigger interesting moment of dialogue, but organisers need to pay attention on the type of tools they propose to participants.

Moreover, some other observations were possible while undertaking my research. Since the first steps of the co-creation process it was possible to notice how the sharing of knowledge could actually change stakeholders' point of view. This was gradually implemented throughout the process itself because, in the beginning, this change was visible only when the new knowledge came from individuals of the same 'group', and it can be linked to the distrust issue that there was in the beginning. But going on with the activities it was possible to see how this knowledge sharing between the parties allowed more changes about the preconceptions that participants had. One example of this was that within the Verona Looper Living Lab, at the beginning of the process, some lectures about pollutants were done and it was explained the behaviour of air pollutants - they spread over larger areas - and noise - it can be found at local level. Local stakeholders found useful other parts of the lecture, but still did not believe that air pollutants had minor changes on local levels because it was something that policymakers and official bodies said. After the first participatory sensing campaign, the data citizens collected confirmed what was said during the lecture. Because of these results, and since it was them that used the sensors, they changed their mind and started to listen more to other stakeholders.

This then has led as well to the importance of consent about ideas. If a proposed idea is feasible and can theoretically give benefits, it does not mean that it will reach good results. To have a positive implementation it is necessary to have consent about the idea from all parties, and this goes beyond the MAMCA analysis. Organisers need to pay attention during face-to-face meeting to check if there actually is consent on the proposed idea, because a technical evaluation might not be able to give the correct outputs even if each group of stakeholders gave their preferences.

Based on these premises it is then possible to see what is the potential future avenue of my research.

In the 'Introduction' it was mentioned the chance of gathering some practicalities throughout this thesis, that wanted to help possible organisers in setting up a whole co-creation process. These practicalities can be then used as basis to further expand what was learned and found with this practice-led work to produce a proper handbook.

The presence of this handbook would then give the chance of applying the Looper co-creation methodology - improved on the basis of the previous con-

siderations - to other cities that are facing similar challenges and that need to implement urban transformations. This would give the opportunity to gather some extra information about the process and the possible differences in other contexts. This would also allow to have always better validations of the benefits given by applying this methodology, to implement feasible urban transformations for more liveable cities.

This chance to further validating the process could then trigger the shift from applying the process to single local cases, towards a more structured application that could lead to a full implementation of the refined Looper co-creation methodology in governments' agendas to design better cities.

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glossary

glossary

This glossary shows some already known terms. Its sense here is to show how these terms are understood to the means of the Looper methodology. A alphabetical order is hereby followed

City Council

A city council is the local government of the built environment where the co-creation process wants to trigger urban transformations.

Citizen

Inhabitant of the built environment that is considered by the co-creation process. Within the citizen group there is also the sub-category of 'residents', who are the group of people owning an estate within the actual neighbourhood targeted by the process.

'Closed' data management system

Tools whose database is closed and it is not possible to freely link it to another. This does not allow to automatically share collected data with another database. To manage the DBMS, data are to be downloaded from the first database and need to be prepared in the final DBMS format to be manually uploaded.

Co-creation

Co-creation is the collaborative development of new value - e.g. concepts, solutions, products, services - together with experts and stakeholders - such as customers, suppliers etc. Co-creation is then a form of collaborative innovation. Ideas are shared and improved together, throughout a complete process that involves activities of: scoping, data collection, data visualisation, co-design, evaluation, implementation and monitoring.

Co-design

Co-design as part of a complete co-creation process, which refers to the 'transparent process of value creation in ongoing, productive collaboration with, and supported by all relevant parties, with end-users playing a central role' and covers all stages of a development process.

Data Collection

Data collection is the process of gathering and measuring information on the topics defined within the scoping activity. The goal of the data collection is to capture quality evidence to allow an analysis that can lead to the formulation of convincing and credible answers to the questions that have been posed.

Data Visualisation

Data visualization is the graphical representation of information and data. By using visual elements like charts, graphs, and maps, data visualization tools provide an accessible way to see and understand trends, outliers, and patterns in data. Its goal is to empower participants by visually representing collected data, and thus by giving them knowledge for the following co-design activity.

DBMS (Database Management System)

A database management system (DBMS) is a software package designed to define, manipulate, retrieve and manage data in a database.

Evaluation

Evaluation is the process of critically examining the work done during the co-design. Its purpose is to make judgements about the proposed designed ideas, to check their likeness by all stakeholders, and to check their feasibility to be implemented in a real environment.

Final users

The final user is the person - or organisation, or group of people - that uses an area or a service that is located within the project area.

Monitoring

This term has two meanings within this research, it can either mean monitoring the process or monitoring values collected with sensors and/or tools. When monitoring the process, the acquisition of knowledge is the indicator to check. When monitoring values, data collected are showing if there are changes - and if these are positive - after implementing a mitigation measure.

NGOs

A non-profit organization that operates independently of any government, typically one whose purpose is to address a social or political issue.

Learning Loop

The learning loop is a method that allows to define how to proceed with a work based on what you did until that moment, and it provides a better perspective on how to divide urban transformations and social changes into a gradual process of iterative cycles. This iterative aspect allows to have a 'validate and refine' feature that is usually lost when moving from Living Labs to Urban Living Labs, and that enhances a more successful co-creation process.

Living Lab

A Living Lab is a user-cantered, open-innovation ecosystem, often operating in a territorial context (e.g. city, agglomeration, region), integrating concurrent research and innovation processes within a public-private-people partnership. The concept is based on a systematic user co-creation approach integrating research and innovation processes. These are integrated through the co-creation, exploration, experimentation and evaluation of innovative ideas, scenarios, concepts and related technological artefacts in real life use cases. Such use cases involve user communities, not only as observed subjects but also as a source of creation. This approach allows all involved stakeholders to concurrently consider both the global performance of a product or service and its potential adoption by users. This consideration may be made at the earlier stage of research and development and through all elements of the product life-cycle, from design up to recycling.

Looper Living Lab

A Looper Living Lab is an advanced version of a Urban Living Lab, where the 'validate and refine' aspect added by the learning in loops allows to design more feasible solutions to transform the urban environment. Within a Looper Living Lab it is possible to have a full co-creation process that empowers all stakeholders, and that can also give better long-term possible implementations.

Official bodies

Any other office and body linked to the city council that might be interested in the project, and that might help in the process. Official bodies might help for the data collection, for the implementation of for both depending on their abilities.

'Open' data management system

Tools whose database can be freely linked to another. This allows to automatically share collected data with another database to create an open database management system.

Participatory approach

Participatory approach here is meant as participatory design. In participatory design, participants (putative, potential or future) are invited to cooperate with designers, researchers and developers during an innovation process.

Potentially, they participate during several stages of an innovation process: they participate during the initial exploration and problem definition both to help define the problem and to focus ideas for solution, and during development, they help evaluate proposed solutions.

Private organisations

These might be private parties, linked to neither citizens or city councils, interested in the process if the project aim is that of working on development areas or something similar.

Scoping

The activity - or practice - of eyeing and examining what happens within the urban environment tackled by the co-creation process, this to evaluate possible criticalities to be investigated by the Looper Living Lab. The scoping can also find good examples to be found, and that might be interesting to replicate.

Stakeholder

A stakeholder is a party that has an interest in something - or somebody - and can either affect or be affected by it. The primary stakeholders in a typical corporation are its investors, employees, customers and suppliers. However, the modern theory of the idea goes beyond this original notion to include additional stakeholders such as a community, government or trade association.

UI (User Interface)

A user interface (UI) is the means in which a person controls a software application or hardware device. A good user interface provides a user-friendly experience, allowing the user to interact with the software or hardware in a natural and intuitive way.

Urban Living Labs

The Urban Living Lab term is used to refer to a wide variety of local experimental projects of a participatory nature. The aim is to develop, try out and test innovative urban solutions in a real-life context. The wide variety of forms and focuses of Urban Living Labs, however, makes more and more cities and citizens wonder what exactly Urban Living Labs are and how they can be set up. The Living Lab concept embraces an extensive range of activities and it is regarded as an approach that involves actors in a process of co-creation that potentially facilitates the construction of innovative values.

User-friendly

User-friendly describes a hardware device or software interface that is easy to use. It is ‘friendly’ to the user, meaning it is not difficult to learn or understand.

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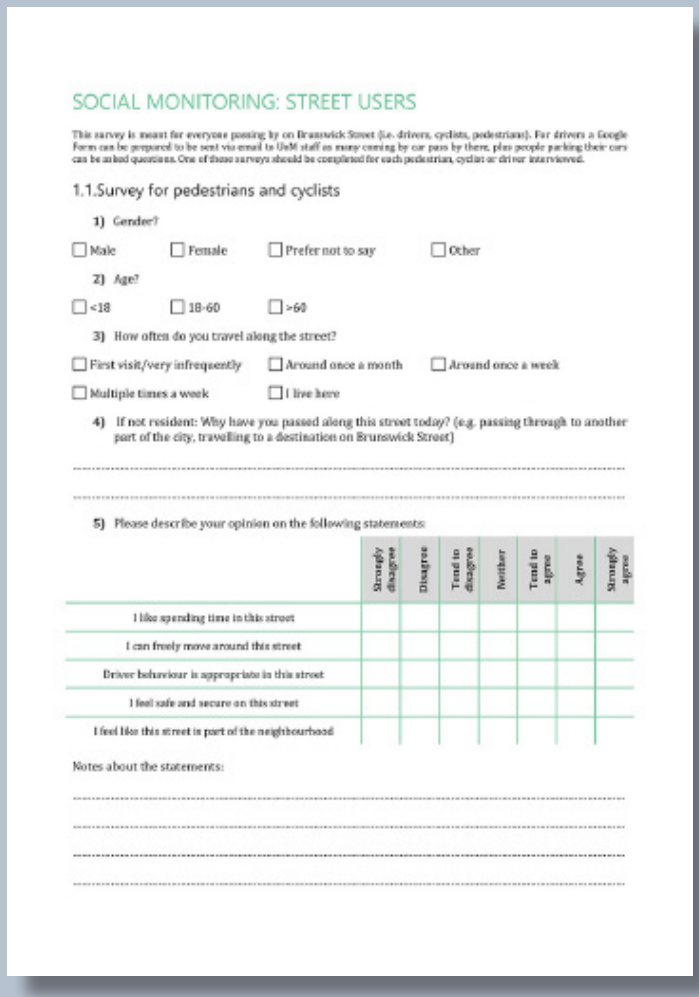
ANNEX 1
‘BEFORE’ SURVEYS FOR THE MANCHESTER LOOPER LIVING LAB



SOCIAL MONITORING: STREET USERS

This survey is meant for everyone passing by on Brunswick Street (i.e. drivers, cyclists, pedestrians). For drivers a Google Form can be prepared to be sent via email to UoM staff as many coming by car pass by there, plus people parking their cars can be asked questions. One of these surveys should be completed for each pedestrian, cyclist or driver interviewed.

1.1.Survey for pedestrians and cyclists

1) Gender?

☐ Male ☐ Female ☐ Prefer not to say ☐ Other

2) Age?

☐ <18 ☐ 18-60 ☐ >60

3) How often do you travel along the street?

☐ First visit/very infrequently ☐ Around once a month ☐ Around once a week

☐ Multiple times a week ☐ I live here

4) If not resident: Why have you passed along this street today? (e.g. passing through to another part of the city, travelling to a destination on Brunswick Street)

.....

.....

5) Please describe your opinion on the following statements:

	Strongly disagree	Disagree	Tend to disagree	Neither	Tend to agree	Agree	Strongly agree
I like spending time in this street							
I can freely move around this street							
Driver behaviour is appropriate in this street							
I feel safe and secure on this street							
I feel like this street is part of the neighbourhood							

Notes about the statements:

.....

.....

.....

.....

6) What in particular do you like about this street?

7) What in particular do you dislike about this street?

8) What changes would you make if you could?

1.2.Survey for drivers

1) Gender?

☐ Male ☐ Female ☐ Prefer not to say ☐ Other

2) Age?

☐ 18-24 ☐ 25-60 ☐ >60

3) How often do you drive along the street?

☐ First visit/very infrequently ☐ Around once a month ☐ Around once a week

☐ Multiple times a week ☐ I live here

4) If not resident: Why have you driven along this street today? (e.g. passing through to another part of the city, travelling to a destination on Brunswick Street)

5) What do you think is the speed limit here?

6) What do you think the speed limit should be here?

7) Do you think the signs and the markings on the road are visible enough?

8) Do you think that the cycle lane is visible enough?

9) Do you think this street is safe for pedestrians and cyclists?

10) Do you think of this street as part of a neighbourhood? And if no, why?

☐ YES ☐ NO

11) Is there something in particular that you like about this street?

.....

.....

12) Is there something in particular that you dislike about this street?

.....

.....

13) What changes would you make if you could?

.....

.....

.....

SOCIAL MONITORING: RESIDENTS

One of these surveys should be completed for each resident interviewed.

1) Gender?

☐ Male ☐ Female

2) Age?

☐ <18 ☐ 18-60 ☐ >60

3) Do you live in Brunswick Street or elsewhere in the neighbourhood?

☐ Brunswick Street ☐ Brunswick neighbourhood

4) How long have you been living here?

☐ <1 year ☐ 1-10 years ☐ >10 years

5) Why did you decide to live in Brunswick?

.....

6) Which is your main mode of travel?

☐ Walk ☐ Cycle ☐ Car ☐ Bus ☐ Other .....

7) If car owner/user, do you park on Brunswick street? If not, where do you park?

☐ Yes ☐ No

.....

8) Do you think there are enough pedestrian crossings in Brunswick street? If not, where would you add new ones?

☐ Yes ☐ No .....

9) Do you think the existing pedestrian crossings are safe?

☐ Yes ☐ No

10) If no, how can they be made safer?

☐ Repainting zebra crossing ☐ Pedestrian refuge island ☐ Other .....

☐ Puffin/Pelican crossing ☐ Toucan crossing (mixed pedestrian/cyclists crossing)

11) If you have children under 18, how do you take them to school?

☐ Walk ☐ Cycle ☐ Bus ☐ Car ☐ They go by themselves

12) If they go by themselves, how do they go?

☐ Walk ☐ Cycle ☐ Bus ☐ Other .....

13) Do you think air in this area is polluted? If yes, why?

☐ Yes ☐ No

.....

14) Do you think residents here have air pollution related illness?

☐ Yes ☐ No

15) What are the barriers to cycling and walking in Brunswick? Also, what needs to be in place to encourage cycling and walking in Brunswick?

.....

.....

16) Have you heard of Beelines? If yes: would Beelines encourage you and your children to cycle more?

☐ Yes ☐ No

.....

17) Please describe your opinion on the following statements:

	Strongly disagree	Disagree	Tend to disagree	Neither	Tend to agree	Agree	Strongly agree
I like the appearance of this street							
I like spending time in this street							
I can freely move around this street							
I feel like I'm part of a community							
I feel like this street is part of the neighbourhood							
Drivers behaviour is appropriate in this street							
Cyclists behaviour is appropriate in this street							
I feel safe and secure on this street							
Community groups are well known							
Community groups are sufficiently actively engaged							

Notes on the above statements:

.....

.....

.....

18) What would make Brunswick Street have more of a community feel?

.....

.....

19) What in particular do you like about this street?

.....

.....

20) What in particular do you dislike about this street?

.....

.....

21) What changes would you make if you could?

.....

.....

.....

SOCIAL MONITORING: COMMUNITY GROUPS

One of these surveys should be completed for each community group interviewed.

1) Name of the community group?

2) Number of participants in your group?

3) Average age of participants?

☐ <18 ☐ 18-60 ☐ >60

4) How long have you been active here?

5) Have you already undertaken any actions in Brunswick street? If so, which?

☐ YES ☐ NO

6) Which aspects of the street do you feel could be most improved, and why?

7) What do you think is needed to transform Brunswick Street to make it look more of a community space?

8) Do you think there is need of more community events that would bring the residents together?

9) Do you know why some residents participate in the events organised by your group?

10) Do you know why other residents do not participate in the events organised by your group?

11) What, in particular, do you like about this street space?

12) What, in particular, do you dislike about this street space?

13) Which changes would you make if you could?

SOCIAL MONITORING: PROFESSIONAL STAKEHOLDERS

One of these surveys should be completed for each professional interviewed.

1) Which field do you work in?

---

2) Gender?

☐ Male ☐ Female

3) Age?

☐ <18 ☐ 18-60 ☐ >60

4) How long have you been working in, or involved in work related to, Brunswick Street?

---

5) Which aspects of the street do you feel could be most improved, and why?

---

6) What do you think is needed to transform Brunswick Street to make it look more of a community space?

---

7) What, in particular, do you like about this street space?

---

8) What, in particular, do you dislike about this street space?

---

9) Which changes would you make if you could?

PHYSICAL MONITORING: TRAFFIC SPEED/NUMBER

These questions need to be answered for every type of sensor (i.e. black cat sensors), and need to be integrated with a map of their positions.

1) Name of the sensor?

---

2) Where is the monitor positioned in the street? (height, distance from the houses, etc.)

---

3) What type of monitor is it?

☐ Fixed ☐ Mobile

4) Does it need a person to operate it?

☐ YES ☐ NO

5) Does it need to be plugged into a socket?

☐ YES ☐ NO

6) Does it need Internet access?

☐ Smartphone ☐ Internet ☐ Smartphone and Internet

7) Is it a crowdsourcing device?

☐ YES ☐ NO

8) How many monitors have to be positioned?

---

9) What type of data does it collect?

---

10) What is the export format of the collected data?

---

11) For how long does data need to be collected?

---

12) How many data readings per day? How many per week?

---

13) What is the purpose of this sensor for the project?

PHYSICAL MONITORING: AIR QUALITY
(street and front gardens)

These questions need to be answered for every type of sensor (i.e. AirBoxes, Plume, noise boxes), and need to be integrated with a map of their positions.

1) Name of the sensor?

---

2) Where is the sensor positioned in the street? (height, distance from the houses, etc.)

---

1) What type of monitor is it?

☐ Fixed ☐ Mobile

2) Does it need a person to operate it?

☐ YES ☐ NO

3) Does it need to be plugged into a socket?

☐ YES ☐ NO

3) Does it need Internet access?

☐ Smartphone ☐ Internet ☐ Smartphone and Internet

4) Is it a crowdsourcing device?

☐ YES ☐ NO

5) How many monitors have to be positioned?

---

6) What type of data does it collect?

---

7) What is the export format of the collected data?

---

8) For how long does data need to be collected?

9) How many data readings per day? How many per week?

10) What is the purpose of this sensor for the project?

PHYSICAL MONITORING: FRONT GARDEN CHANGES

These questions need to be answered for every type of intervention, and need to be integrated with a map of their positions.

1) Type of change to be implemented in front gardens?

2) Where is the front garden positioned in the street? (e.g. middle of the street, beginning of the street, house number, etc.)

3) What type of change is it? If temporary, for how long does it need to stay in place?

☐ Permanent ☐ Temporary

4) Who has to install it?

☐ Resident ☐ Municipality ☐ Community group ☐ Others: .....

5) Does it need maintenance? (e.g. watering, cleaning, etc.)

☐ YES ☐ NO

6) If it needs maintenance, who should be in charge of doing it?

☐ Resident ☐ Municipality ☐ Community group ☐ Others: .....

7) Does it change the general appearance of the street?

☐ YES ☐ NO

8) In how many front gardens does it have to be installed/implemented?

9) Should it contribute to the community feel of the street? If yes, how?

☐ YES ☐ NO

10) What is the purpose of this change in front gardens for the project? (e.g. street appearance, reduction of pollutants, community engagement, etc.)

PHYSICAL MONITORING: STREET CHANGES

These questions need to be answered for every type of intervention, and need to be integrated with a map of their positions.

1) Type of change to be implemented in the street?

---

2) Where is the intervention positioned? (e.g. middle of the street, beginning of the street, house number, etc.)

---

3) What type of change is it? If temporary, for how long does it need to stay in place?

☐ Permanent ☐ Temporary

---

4) Who has to install it?

☐ Resident ☐ Municipality ☐ Community group ☐ Others: .....

5) Does it need maintenance? (e.g. watering, cleaning, etc.)

☐ YES ☐ NO

6) If it needs maintenance, who should be in charge of doing it?

☐ Resident ☐ Municipality ☐ Community group ☐ Others: .....

7) Does it change the general appearance of the street?

☐ YES ☐ NO

8) How many changes need to be implemented?

---

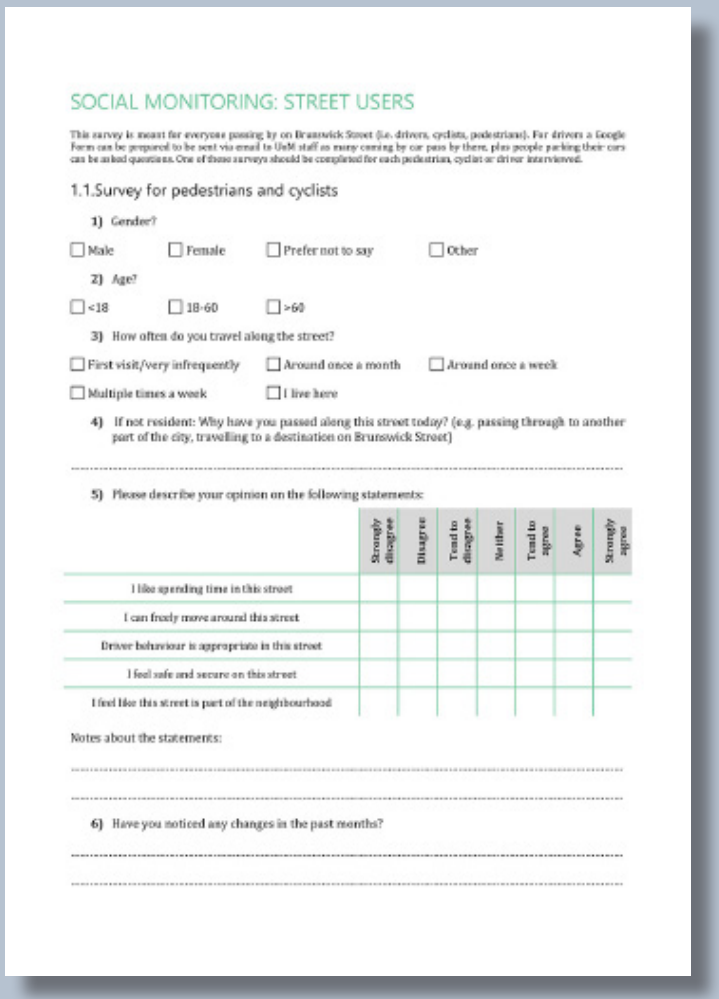
9) Should it contribute to the community feel of the street? If yes, how?

☐ YES ☐ NO

---

10) What is the purpose of this change in the street for the project? (e.g. street appearance, reduction of pollutants, community engagement, etc.)

ANNEX 2
‘AFTER’ SURVEYS FOR THE MANCHESTER LOOPER LIVING LAB



SOCIAL MONITORING: STREET USERS

This survey is meant for everyone passing by on Brunswick Street (i.e. drivers, cyclists, pedestrians). For drivers a Google Form can be prepared to be sent via email to UoM staff as many coming by car pass by there, plus people parking their cars can be asked questions. One of these surveys should be completed for each pedestrian, cyclist or driver interviewed.

1.1.Survey for pedestrians and cyclists

1) Gender?

☐ Male ☐ Female ☐ Prefer not to say ☐ Other

2) Age?

☐ <18 ☐ 18-60 ☐ >60

3) How often do you travel along the street?

☐ First visit/very infrequently ☐ Around once a month ☐ Around once a week

☐ Multiple times a week ☐ I live here

4) If not resident: Why have you passed along this street today? (e.g. passing through to another part of the city, travelling to a destination on Brunswick Street)

.....

5) Please describe your opinion on the following statements:

	Strongly disagree	Disagree	Tend to disagree	Neither	Tend to agree	Agree	Strongly agree
I like spending time in this street							
I can freely move around this street							
Driver behaviour is appropriate in this street							
I feel safe and secure on this street							
I feel like this street is part of the neighbourhood							

Notes about the statements:

.....

.....

6) Have you noticed any changes in the past months?

.....

.....

1.2.Survey for drivers

1) Gender?

☐ Male ☐ Female ☐ Prefer not to say ☐ Other

2) Age?

☐ 18-24 ☐ 25-60 ☐ >60

3) How often do you drive along the street?

☐ First visit/very infrequently ☐ Around once a month ☐ Around once a week

☐ Multiple times a week ☐ I live here

4) If not resident: Why have you driven along this street today? (e.g. passing through to another part of the city, travelling to a destination on Brunswick Street)

.....

5) What is the speed limit here?

.....

6) Do you think the signs and the markings on the road are visible enough?

.....

.....

7) Do you think that the cycle lane is visible enough?

.....

.....

8) Do you think this street is safe for pedestrians and cyclists?

.....

.....

9) Do you think of this street as part of a neighbourhood? And if no, why?

☐ YES ☐ NO

.....

10) Have you noticed any changes in the past months?

.....

.....

SOCIAL MONITORING: RESIDENTS

One of these survey should be completed for each resident interviewed.

1) Gender?

☐ Male ☐ Female

2) Age?

☐ <18 ☐ 18-60 ☐ >60

3) Do you live in Brunswick Street or elsewhere in the neighbourhood?

☐ Brunswick Street ☐ Brunswick neighbourhood

4) How long have you been living here?

☐ <1 year ☐ 1-10 years ☐ >10 years

5) Why did you decide to live in Brunswick?

.....

6) Which is your main mode of travel?

☐ Walk ☐ Cycle ☐ Car ☐ Bus ☐ Other .....

7) If car owner/user, do you still park on Brunswick street?

☐ Yes ☐ No

8) If you have children under 18, would you be more willing to let them go by themselves now? If not, why?

☐ Yes ☐ No .....

9) Do you think air in this area is still polluted? If yes, why?

☐ Yes ☐ No

.....

10) Do you think residents here have air pollution related illness?

☐ Yes ☐ No

11) Please describe your opinion on the following statements:

	Strongly disagree	Disagree	Tend to disagree	Neither	Tend to agree	Agree	Strongly agree
I like the appearance of this street							
I like spending time in this street							
I can freely move around this street							
I feel like I'm part of a community							
I feel like this street is part of the neighbourhood							
Drivers behaviour is appropriate in this street							
Cyclists behaviour is appropriate in this street							
I feel safe and secure on this street							
Community groups are well known							
Community groups are enough actively engaged							

Notes on the above-mentioned statements:

.....

.....

.....

12) Have you noticed any changes in the past months?

.....

.....

.....

.....

.....

SOCIAL MONITORING: COMMUNITY GROUPS

One of these surveys should be completed for each community group interviewed with the BEFORE SURVEY.

1) Name of the community group

.....

2) Have you undertaken any actions in Brunswick street since the last survey? If yes, which?

☐ YES ☐ NO

.....

.....

.....

3) Have you noticed any changes in the past months?

.....

.....

.....

.....

.....

PHYSICAL MONITORING: TRAFFIC SPEED/NUMBER

These questions need to be answered for every type of sensor (i.e. black cat sensors), and need to be integrated with a map of their positions.

1) Name of the sensor?

2) Where is the monitor positioned in the street? (height, distance from the houses, etc.)

3) What type of monitor is it?

☐ Fixed ☐ Mobile

4) How many monitors have been actually installed?

5) What types of data have been collected?

6) What is the export format of the collected data?

7) For how long has the data been collected?

8) How many data readings per day? How many per week?

9) Did the sensor fulfil its purpose?

PHYSICAL MONITORING: AIR QUALITY (street and front gardens)

These questions need to be answered for every type of sensor (i.e. AirBeam, Plume, noise boxes), and need to be integrated with a map of their positions.

1) Name of the sensor?

2) Where is the sensor positioned in the street? (height, distance from the houses, etc.)

1) What type of monitor is it?

☐ Fixed ☐ Mobile

1) How many monitors have been actually installed?

2) What types of data have been collected?

3) What is the export format of the collected data?

4) For how long has the data been collected?

5) How many data readings per day? How many per week?

6) Did the sensor fulfil its purpose?

PHYSICAL MONITORING: FRONT GARDEN CHANGES

These questions need to be answered for every type of intervention, and need to be integrated with a map of their positions.

1) Type of change to be implemented in front gardens?

2) Where is the front garden positioned in the street? (e.g. middle of the street, beginning of the street, house number, etc.)

3) What type of change is it? If temporary, for how long does it need to stay in place?

☐ Permanent ☐ Temporary

4) Was the maintenance done since its installation? (e.g. watering, cleaning, etc.)

☐ YES ☐ NO

5) If not, why?

6) Did it change the general appearance of the street?

☐ YES ☐ NO

7) In how many front gardens was the change made?

8) Did it contribute to the community feel of the street? If so, how?

☐ YES ☐ NO

9) Did it fulfil its purpose? (e.g. street appearance, community engagement)

PHYSICAL MONITORING: STREET CHANGES

These questions need to be answered for every type of intervention, and need to be integrated with a map of their positions.

1) Type of change to be implemented in the street?

2) Where is the intervention positioned? (e.g. middle of the street, beginning of the street, house number, etc.)

3) What type of change is it? If temporary, for how long does it need to stay in place?

☐ Permanent ☐ Temporary

4) Was the maintenance done since its installation? (e.g. watering, cleaning, etc.)

☐ YES ☐ NO

5) If not, why?

6) Did it change the general appearance of the street?

☐ YES ☐ NO

7) How many changes have been installed implemented?

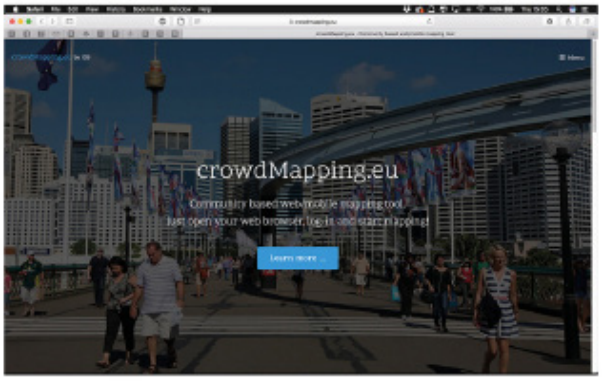
8) Did it contribute to the community feel of the street? If so, how?

☐ YES ☐ NO

9) Did it fulfil its purpose? (e.g. street appearance, community engagement)

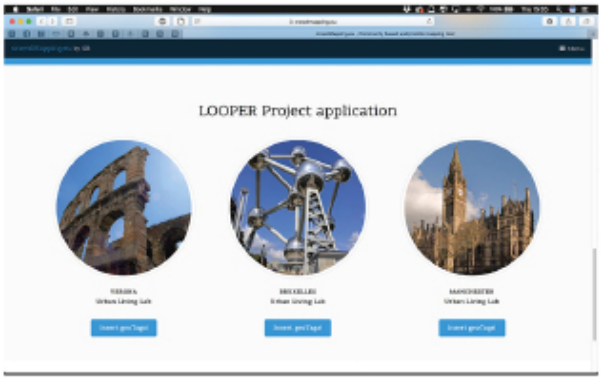
ANNEX 3
GEOTAGGING TOOL USER GUIDE

1



To start open your browser from your computer, tablet or smartphone and go to
www.crowdmapping.eu

2



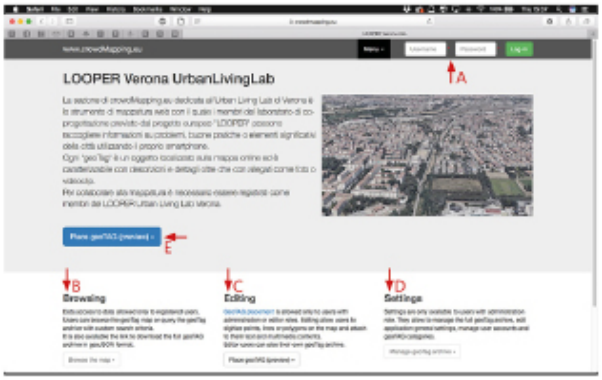
Scroll down to reach the part of the page with the link to access the map of the LOOPER Living Lab of your interest.

At this point you can either:
A. Click on the image/name of the LOOPER Living Lab and you will be redirected to the home page of the web app of the city of your interest
or
B. Click on the "Insert geoTAG!" and you will be automatically redirected to the map where you can place the tag

NOTA BENE: with option B, if you don't have your credential saved (automatic log in) you will only be able to try the web app but you will not be able to save any data.

EDITOR USERS AND ADMINISTRATOR USERS GUIDE

3

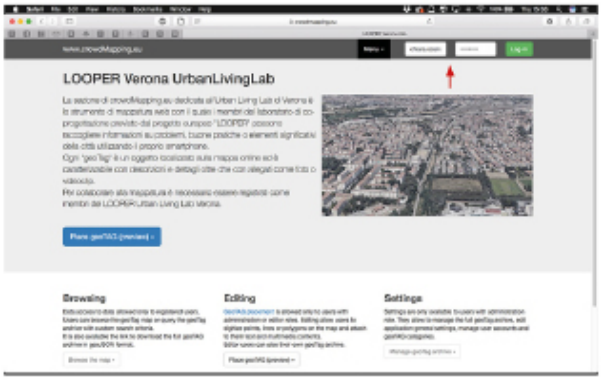


If you choosed the image/name from the previous page, you will now find yourself in the home page of the web app (Verona is used for this user manual).

In this page you will have a set of choices:
A. Log in
B. Browse the map
C. Edit your data (both editor and administrator accounts)
D. Manage every data (only administrator accounts)
E. Place a geoTAG in preview mode (saving not possible)

NOTA BENE: you always have to log in BEFORE placing your geoTAG otherwise you will not be able to save any data.

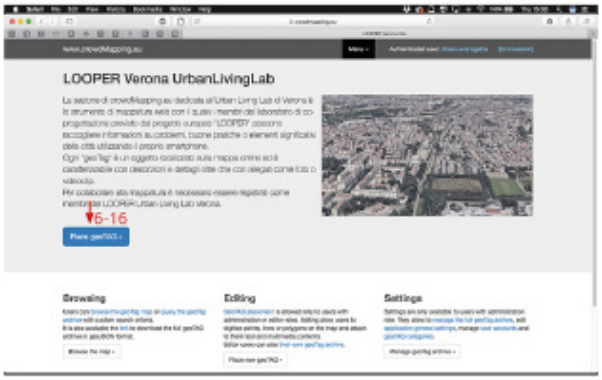
4



To log in you have to insert your credential in the top right part of the page.
Once you have filled "username" and "password" you can press log in and you will enable the various options of the app.
Some options are open both for EDITOR users and ADMINISTRATOR users, while other are open only for ADMINISTRATORS.

NOTA BENE: only participants with a log in can plage geoTAGs autonomously, all other participants can ask administrators of their LOOPER Living Lab if they can add a geoTAG to the map.

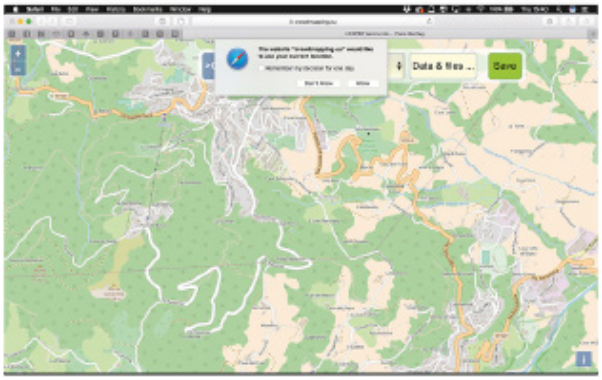
5



Once you succesfully log in the page will slightly change, and this is how it will look like.

Firstly we will talk about how to place a geoTAG (step 6 to 16), then there are other interesting options that can be found in the home page but that will be explained later in this guide.

6

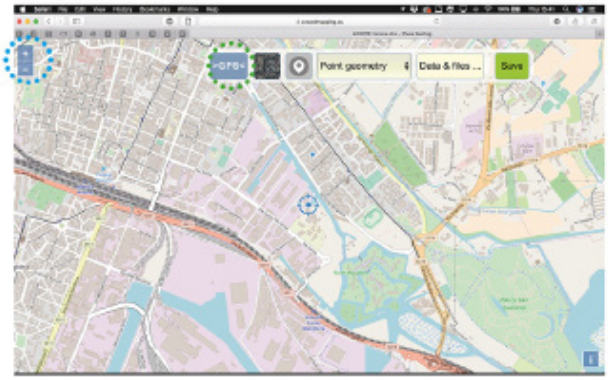


As soon as you select "place geoTAG" from the home page you will be redirected to a map that will ask you if you allow the website to use your current location (this appens only in the dekstop version).
You should allow the browser to use your location, in this way the map will automatically move the map to your position.

Once you allowed the device to move to your location, you will se a page like this (with a different placing).

As it is possible to see in the image in the next page there are a set of buttons that can be used to place your geoTAG and to add informations to it.

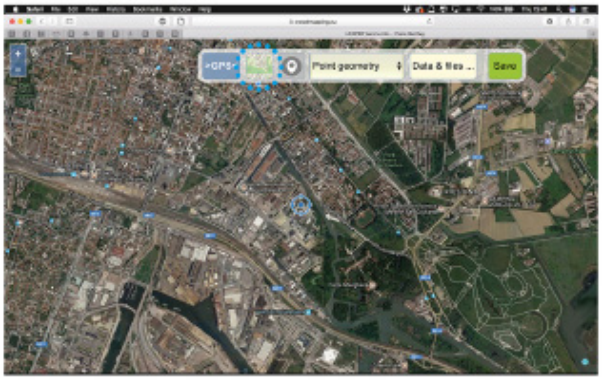
7



On top left (dotted blue circle) there is the zoom in and zoom out option.
You will find this button also in the tablet/smartphone version, but in that case you can also use your fingers to zoom.

Next to it you will have the ">GPS<" button (dotted green circle) which moves the map to show your current position, not the one of the pin that you placed.

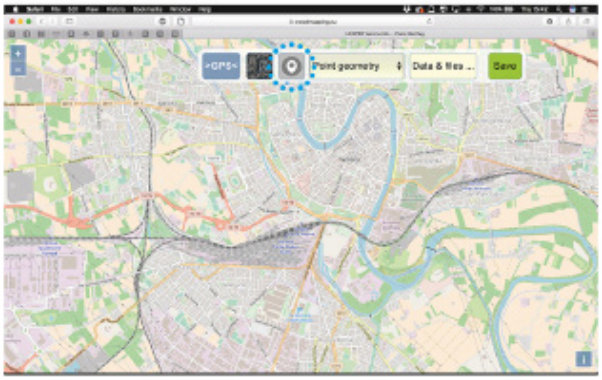
8



The the button in the dotted blue circle can be used to change from map to satellite image.

This is useful if it is needed to find a specific place using reference points (i.e. square, park)

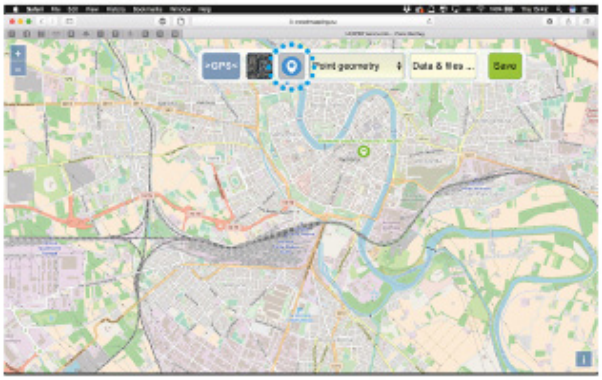
9a



The pin button (always dotted blue circle) can switch on and off the geoTAGs placed by other users.

If the button is grey it means that the geoTAGs are switched off.

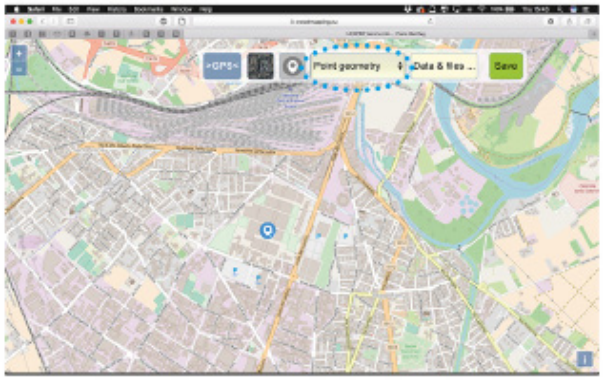
9b



If the button is blue it means that the geoTAGs are switched on.

If the option is switched on it will also show your geoTAGs, not only the ones from other users.

10

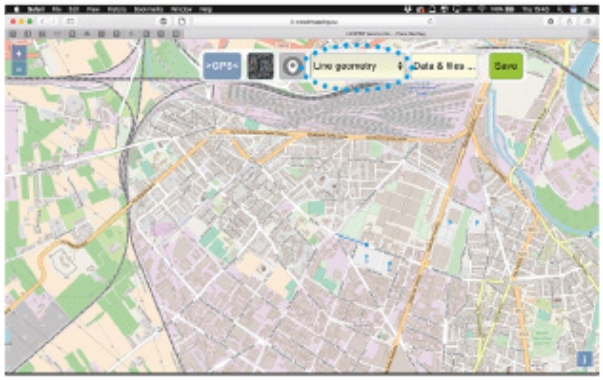


The the button in the dotted blue circle has to be used to choose the type of geometry that you want to use to place the geoTAG.

The "Point geometry" option places a simple point on the map.

To do so it is needed to click (or tap if a smartphone/tablet is used) and the geoTAG will be placed.

11a



The "Line geometry" option places a line, composed by various points, on the map.

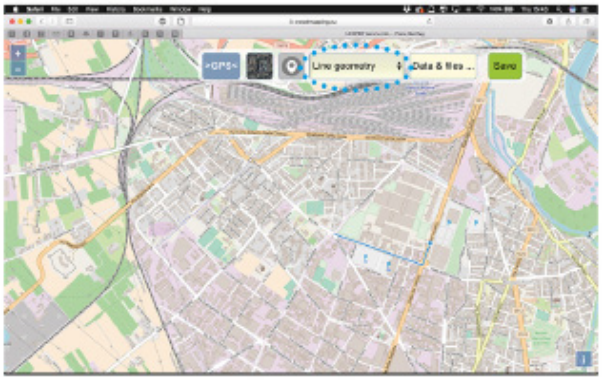
To do so it is needed to click (or tap if a smartphone/tablet is used) where you want the line to start, and where you want the line to end and the geoTAG will be placed.

If you want to draw a broken line it is necessary to click the start and end point, but also all the points in which the line changes direction.

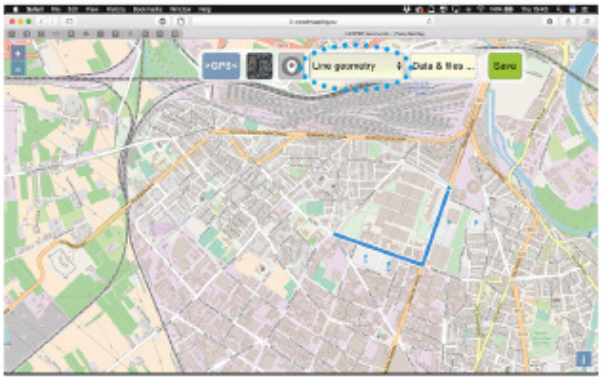
To close the line you need to double click on the ending point.

Please see images 11a-11b-11c to view how it works.

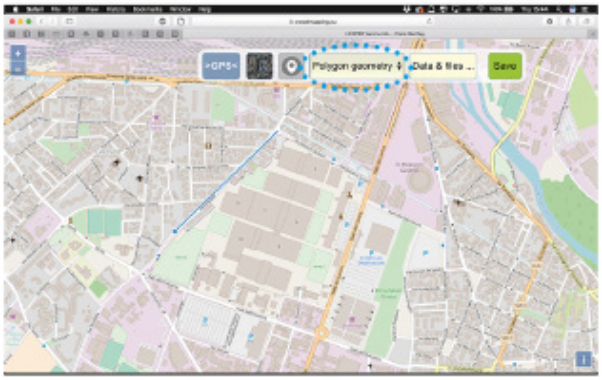
11b


GPS
Line geometry
Data & files ...
Save

11c


GPS
Line geometry
Data & files ...
Save

12a



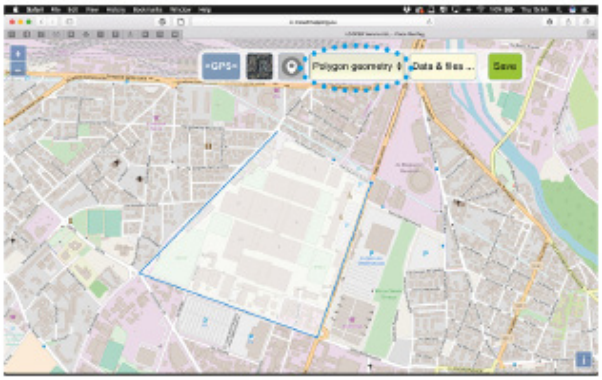
The "Polygon geometry" option places an area, composed by various points, on the map.

To do so it is needed to click (or tap if a smartphone/tablet is used) on the position of each vertex which creates the area and the geoTAG will be placed.

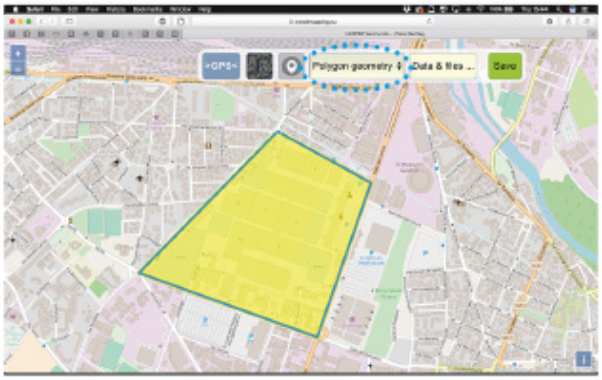
To close the polygon you need to double click on the ending point.

Please see images 12a-12b-12c to view how it works.

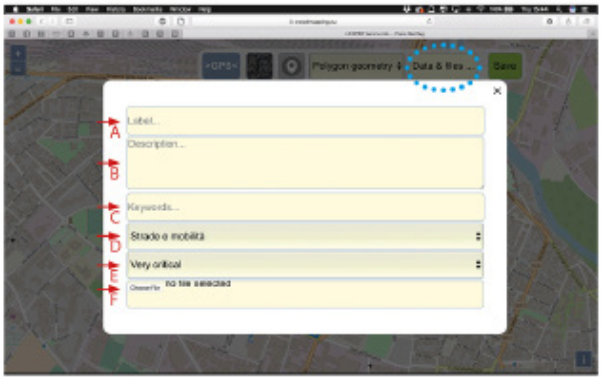
12b



12c



13

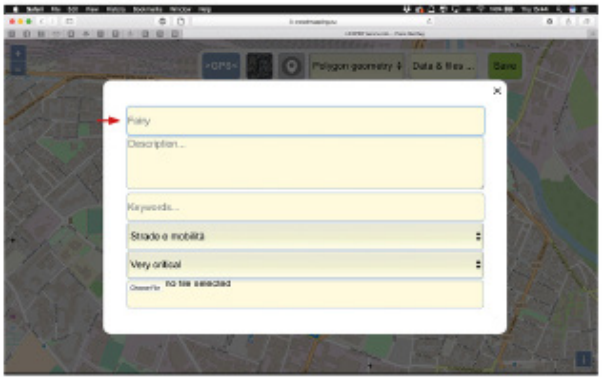


The "Data & files" button opens a pop-up with a set of fields to fill.

It is not mandatory to fill all the fields but it is kindly recommended to do so, in this way everyone will have a better comprehension of the situation.

NOTA BENE: you can go back and forward between the map and the "Data & files" at any time during the process without deleting what you have done until now.

13a



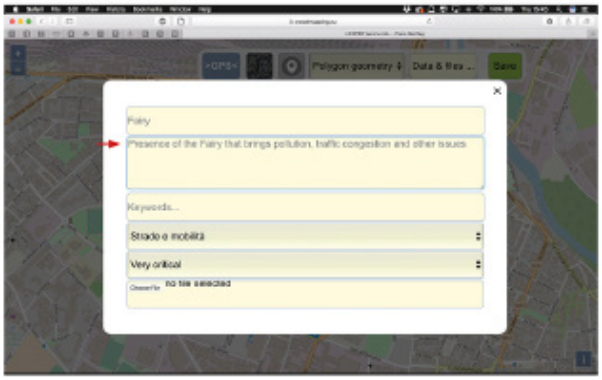
The first field is "Label".

Here you have to write an extremely short description of the issue/good practice you want to tag.

There is a limit of characters that you can write.

NOTA BENE: you will see this field on the map when you place the geoTAG, because of this the shorter the label the clearer the map will stay.

13b

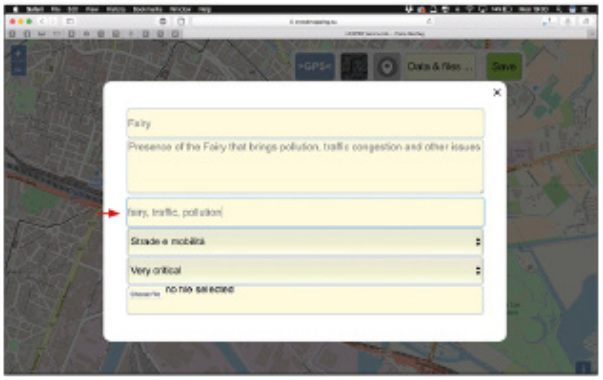


The second field is "Description".

Here you can write as much as you want to write more in detail what are you tagging.

The description can be seen when the tag is selected on the general map.

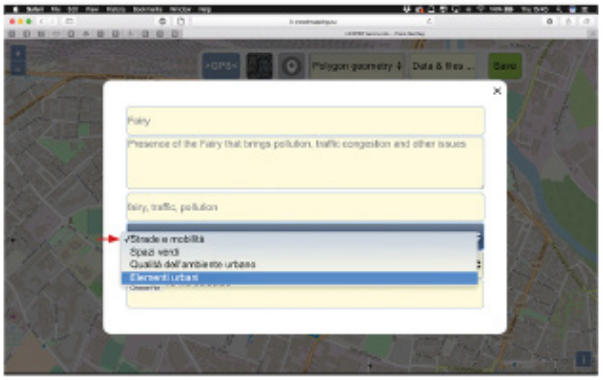
13c



The third field is "Keywords".

Here you can write one, or more, keywords that suit the tag. These can be later used to do some search with a keyword.

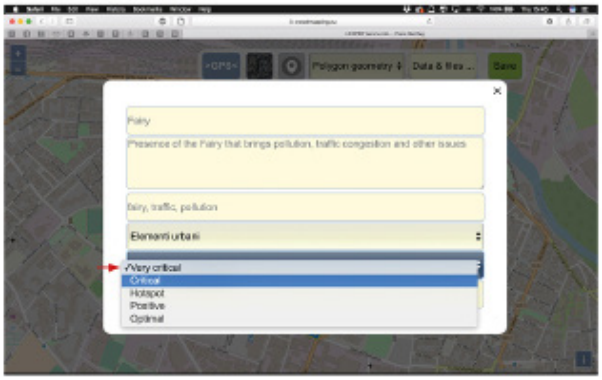
13d



The fourth field shows a list of categories that are specific of the LOOPER Living Lab that have been chosen in the beginning.

Here you have to select the category which is most suitable to the geoTAG you are placing.

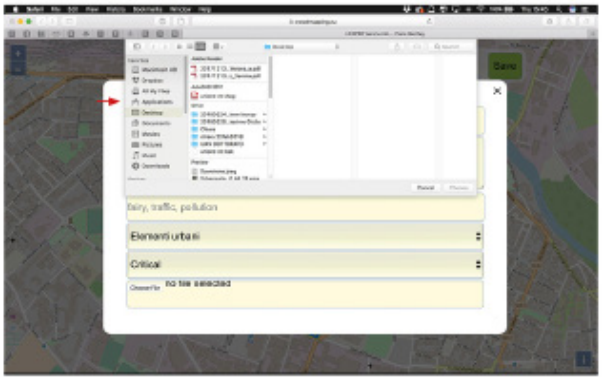
13e



The fifth field shows a rating list.

This list is needed to point if the geoTAG wants to add a criticity or a good practice (i.e. presence of greenspaces = positive/optimal, traffic = critical).

13f



The last field allows to attach a document (image, pdf, word document, etc.) to the geoTAG.

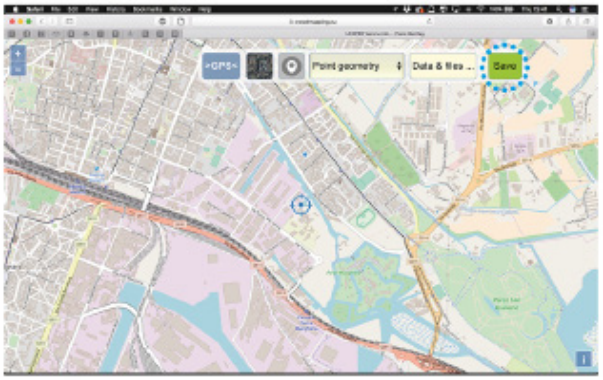
To do so you need to click on "choose file" which opens a tab from which it is possible to select the file you want to attach.

NOTA BENE: if you are using a smartphone or a tablet by clicking on "choose file" you will also have the option of take a picture with the camera integrated in your device.

13f

Once you select the file you will return to the pop-up and you will see the name of the document you choose in the last field.

14

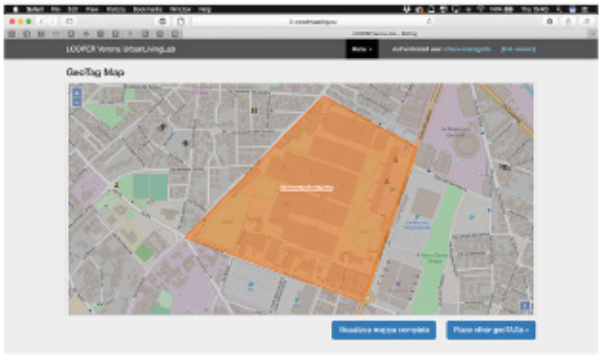


As you finish to fill the "Data & files" you can click outside the pop-up and you will return to the map.

Once you completed everything and you are ready to save the geoTAG you must press the "Save" button (blue dotted circle) and this will end the process.

NOTA BENE: THE geoTAG WILL BE SAVED ONLY IF YOU PRESS THE "SAVE" BUTTON

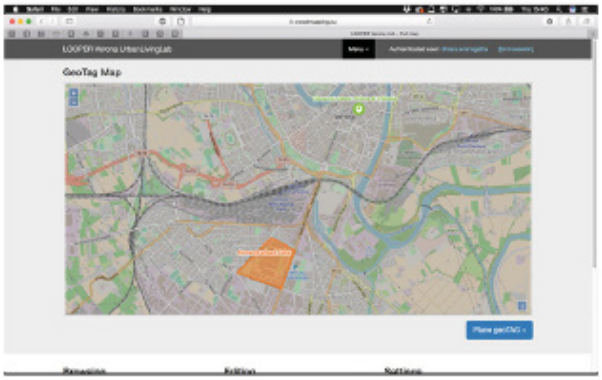
15



After pressing "Save" you will be automatically redirected to the page you can se above.

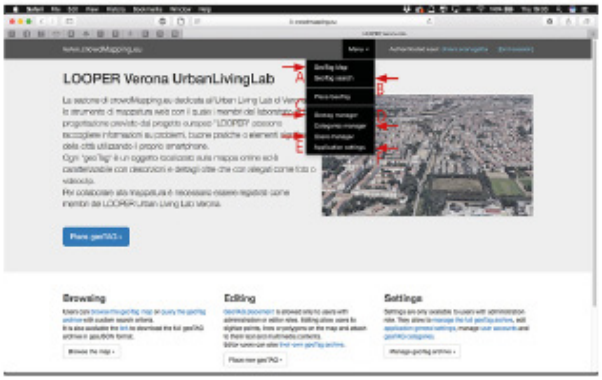
This page will show you a preview of the geoTAG you placed and here you have two option (the two blue buttons on bottom right of the map):
- Visualize complete map
- Place other geoTAG

16



If you press the "Visualize complete map" button you will be able to view a map of your LOOPER Living Lab with every geoTAG that have been placed by you and by every other user.

17



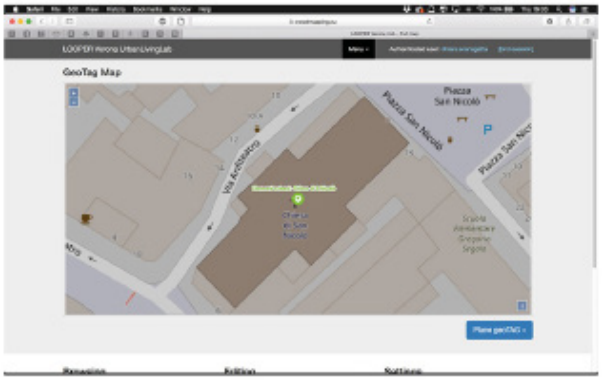
As soon as you finished with the geoTAG placement you can go back to the home page where you can find other options that can be used from Editor Account, while others can be only used by Administrator Accounts.

On the top right side of the home page it is possible to see the Menu button (blue dotted circle), which shows a wide range of options (some of which can be found in the bottom part of the home page).

Editor Accounts can use options A-B-C-D.

Administrator Accounts can use every option.

18a



As you click on "browse the geoTAG map" you will be redirected to a page in which you will see the area interested by the LOOPER Living Lab you are working with.

The map will show you every geoTAG already placed by other participants. You will also see your geoTAGs if you already placed some.

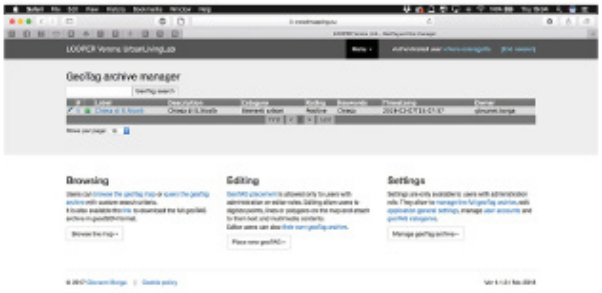
18b

If you move to the "query the geoTAG archive" you will find a set of options to find specific geoTAGs from the list of all the ones placed.

From here you can search by one of the following options:
- attachment
- description
- timestamp
- label
- keywords
- category

or you can choose to search with two or multiple of them.

18c



If you open the "geoTAG archive manager" you will see:
- your geoTAG (if you have an Editor account)
- every geoTAG (if you have an Administrator account)

Here you can modify every aspect of the geoTAGs that have been placed by clicking on the pencil in the first column of the list.

ADMINISTRATOR USERS GUIDE

18d

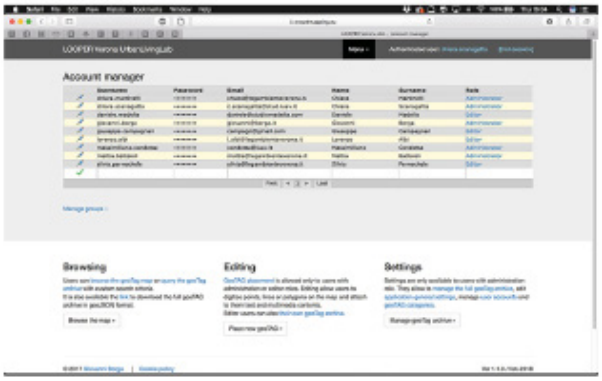
THIS OPTION IS FOR ADMINISTRATOR USERS ONLY.

The "categories manager" can be used to change the categories of geoTAGs from which Editor users can choose while placing the geoTAG.

As in the "geoTAG archive manager" to change something you have to click on the pencil.

To add a category fill the fields in the last row and at the end click on the green tick

18e



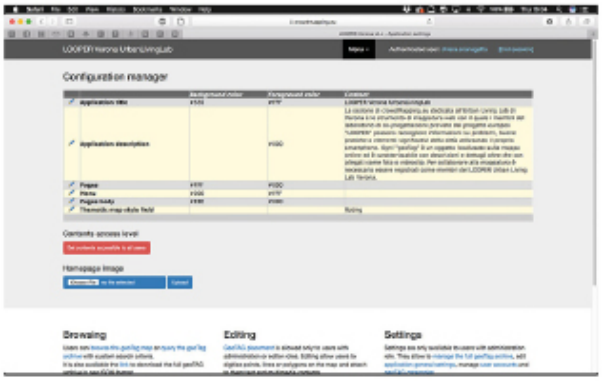
THIS OPTION IS FOR ADMINISTRATOR USERS ONLY.

Here you can add and modify users.

To modify a user click on the pencil, here you can also change the account type (Editor or Administrator).

To add and account fill every field of the last row and validate the account by clicking on the green tick.

18f



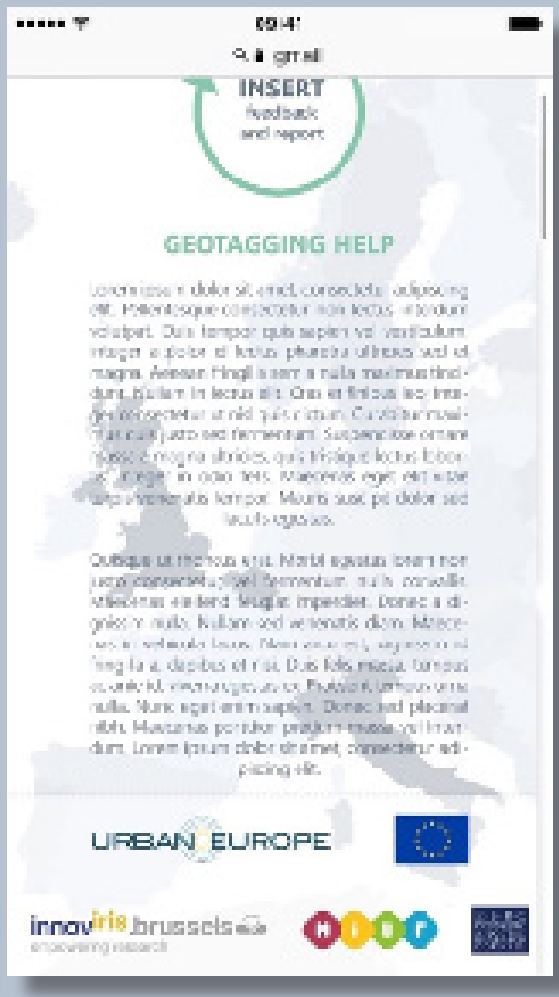
THIS OPTION IS FOR ADMINISTRATOR USERS ONLY.

The "configuration manager" can be used to change the settings of the pages of the LOOPER Living Lab that you are in.

As in the previous example to modify something you need to change the pencil button in the first column.

NOTA BENE: it is better if you do not make changes in this page to keep the layout of every LOOPER Living Labs the same.

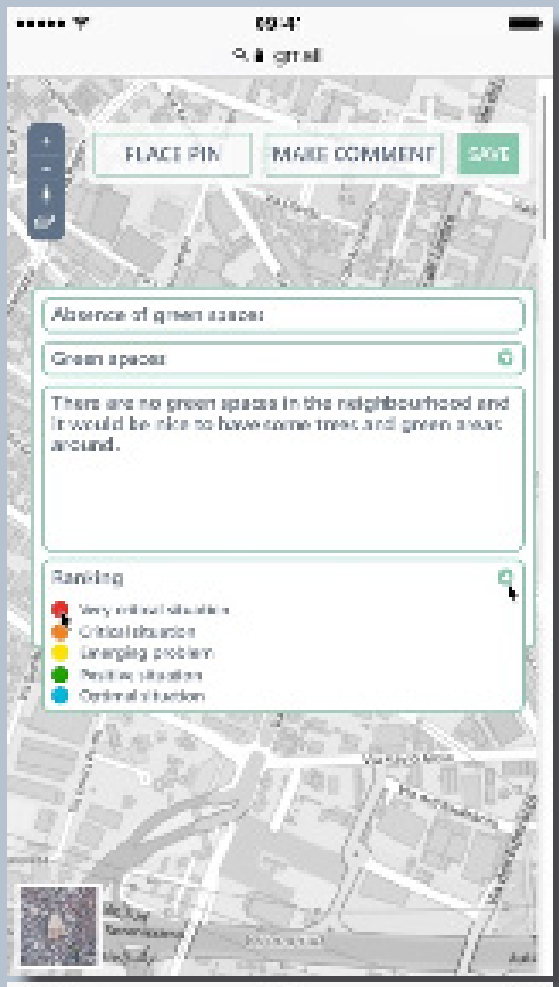
ANNEX 4
GEOTAGGING USER INTERFACE RE-DESIGN PROPOSAL

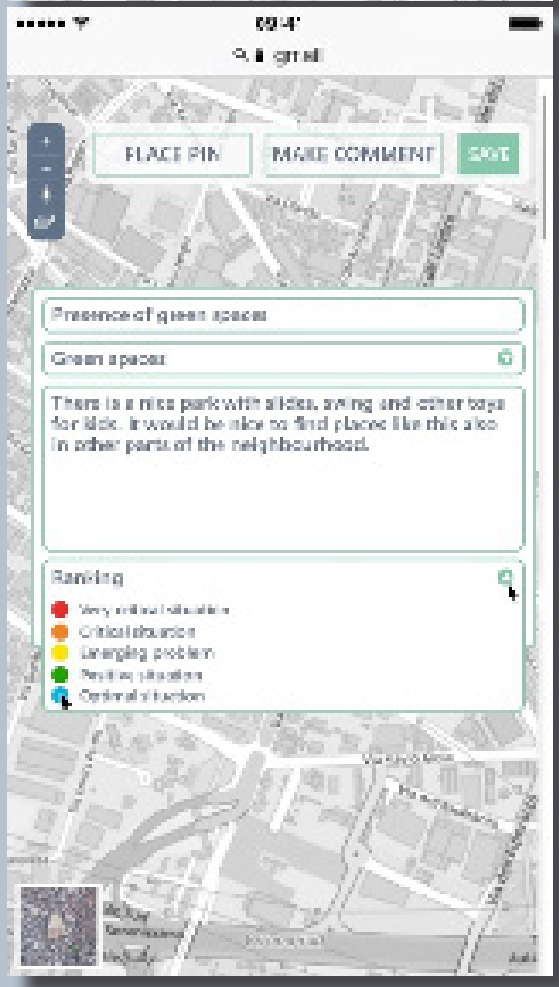



Search or enter website name
PLACE PIN
MAKE COMMENT
SAVE
PLACE PIN
MAKE COMMENT
SAVE

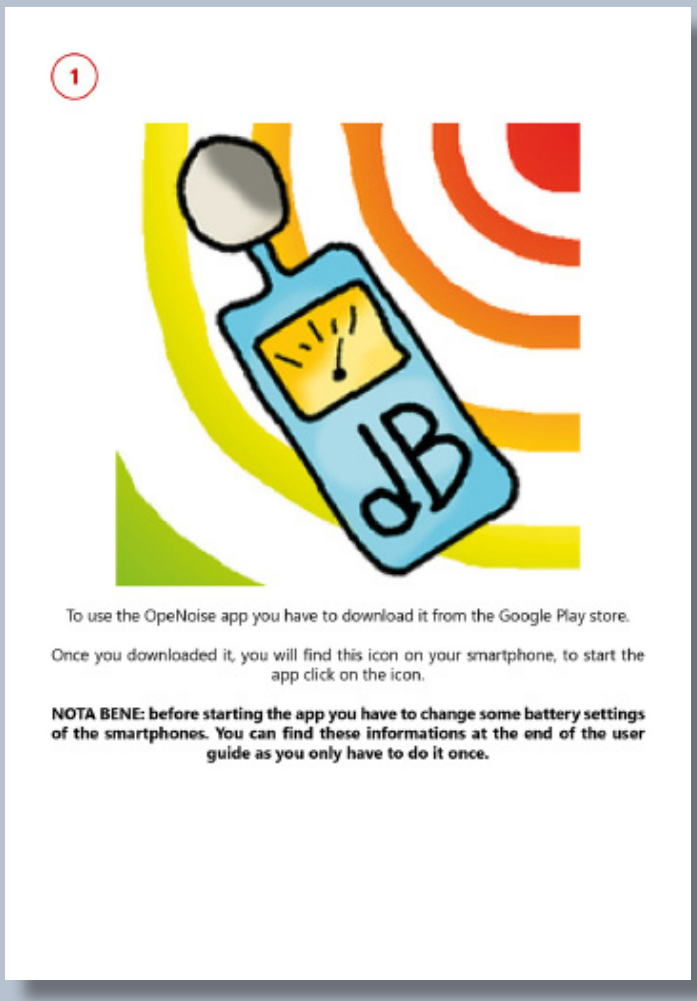

PLACE PIN
MAKE COMMENT
SAVE
Title...
Category
Ranking
Add photo


PLACE PIN
MAKE COMMENT
SAVE
Title...
Category
Ranking
Add photo


PLACE PIN
MAKE COMMENT
SAVE
Absence of green spaces
Green spaces
There are no green spaces in the neighbourhood and it would be nice to have some trees and green areas around.
Ranking


PLACE PIN
MAKE COMMENT
SAVE
Presence of green spaces
Green spaces
There is a nice park with slides, swing and other toys for kids. It would be nice to find places like this also in other parts of the neighbourhood.
Ranking

ANNEX 5
OPENOISE APP USER GUIDE



2

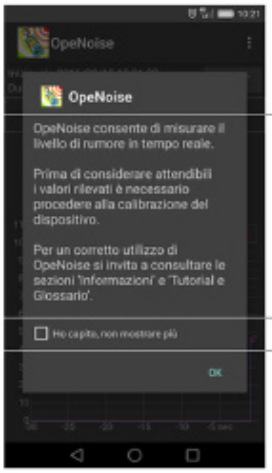
	Choose the interface option. It is possible to change the choice later in the Settings.
☐ Semplice	*Simple*
☐ Avanzata	*Advanced*
☐ Avanzata con salvataggio dati	*Advanced with data saving*

At the first opening of the OpeNoise app you will be asked which tipe on interface you want to use.

Please select "Advanced with data saving" and press "OK".

NOTA BENE: it is possible to change this option later on within the settings.

3



	OpeNoise allows you to measure the sound level in real time. *Before considering reliable the data that have been registered it is necessary to calibrate the device.* *For a correct use of the OpeNoise app please read the "Information" and "Tutorial and Glossary" sections.*
☐ Ho capito, non mostrare più	*I understood, do not show anymore*

After pressing "OK" in the previous page this pop-up will open.

Select "I understood, do not show anymore" and press "OK".

4

Menu (three dots)

Reset

Min dB level *Equivalent dB level* *Max dB level*

Real time equivalent dB level

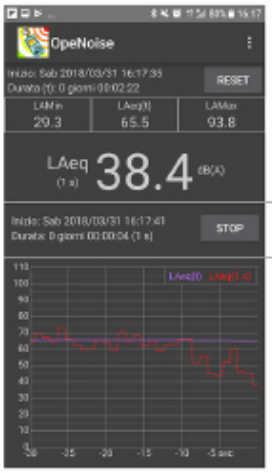
Save (on the right)
You are not saving data (top left)
You will save data every 1 sec (bottom left)

Once you have choosen the interface and accepted the information box you will be able to see the "Home page" of the app.

Here you will be able to see various data: the LAMin (minimum level) of dB(A) since the last "Reset"; the LAeq(t) (equivalent level) of dB(A) since the last "Reset"; the LAMax (maximum level) of dB(A) since the last "Reset"; the real time LAeq (equivalent level) of dB(A) that the app is measuring; the graph of the trend of LAeq in real time.

Here there also are three buttons. On top right there is the "Menu" button (from step 6), under the "Menu" there is the "Reset" button and on half right of the screen there is the "Save" button.
The "Reset" button can be used to reset the graph on the bottom of the screen, on the left of the "Reset" you will see the start of the measurement (since the last reset) on the top row and the running time on the bottom row.

5



Stop (on the right)
Start: day YYYY/MM/DD hour:min:sec (top left)
Lenght: days hours:mins:secs (every) (bottom left)

To start to collect data you will have to click the "Save" button. As soon as the device starts to collect data the "Save" button will turn into a "Stop" button.

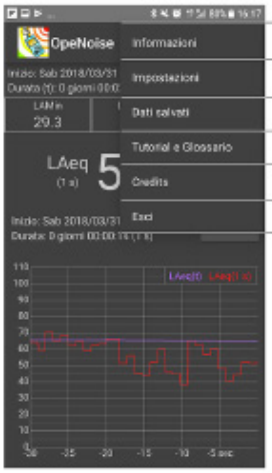
Once you start to collect data you will see (on the left of the "Stop" button):
- Start: day YYYY/MM/DD hour:minute:second of start
- Lenght: days hours:minutes:seconds (every how many sec/min) since the start

To keep collecting the data the app needs to be switched on.

If you want to stop collecting data you need to press the "Stop" button, after doing this you will see again the "Start" button instead of the "Stop" button.

NOTA BENE: if you DO NOT SEE the "Stop" button it means you are NOT COLLECTING DATA. Please always check twice.

6



Informazioni	*Information*
Impostazioni	*Settings*
Dati salvati	*Saved Data*
Tutorial e Glossario	*Tutorial and Glossary*
Credits	*Credits*
Esci	*Exit*

If you press the "Menu" button a list of options will be shown in the top right part of the screen:
- Information
-Settings
- Saved Data
- Tutorial and Glossary
- Credits
- Exit

Here we will see only the "Saved Data" option and the "Settings" option as these are the most important ones to use the OpeNoise app.

"TUTORIAL AND GLOSSARY" OPTION

8

TUTORIAL	*Tutorial*
ESEGUIRE UNA MISURA La misura del rumore inizia automaticamente con l'apertura di OpeNoise. La misura si interrompe selezionando 'Esci' nel menù principale oppure digitando il pulsante 'Indietro' del dispositivo (digitando il pulsante 'Home' la misura continua in background). Premendo 'RESET' si azzerano tutti i livelli e si inizia una nuova misura.	*How to measure* *Measurement of noise starts automatically with the opening of the OpeNoise app. Measurement interrupts selecting "Esci" from main menu of clicking the "Go Back" button of the device (if you click the "Home" button the measurement will continue in background). If you click the "Reset" button all levels will be reset at zero and you will start with a new measure.*
CALIBRARE IL DISPOSITIVO Ogni dispositivo risponde in maniera diversa ai segnali acustici, per cui è necessario effettuare una calibrazione. Per calibrare il dispositivo occorre verificare il livello sonoro misurato con un valore noto, possibilmente con un fonometro professionale. A partire dal confronto si deve inserire, nelle Impostazioni, il numero di decibel da aggiungere o sottrarre (digitando un numero positivo o negativo, ad esempio '8.9' o '-8.9') in modo che i due valori siano uguali. La calibrazione potrebbe essere reimpostata al valore iniziale di 0 dB dopo l'aggiornamento della app.	*Calibration of the device* *Every device responds in a different way to acoustic signals, this is why a calibration is needed.* *To calibrate the device you need to check the sound level, measured with a known value, possibly with a professional sound level meter. Starting with the confrontation you have to insert, in "Settings", the number of decibel to add or subtract (digiting a positive or negative value, i.e. "8.9" or "-8.9") so that the two values are equal.* *If you update the app the calibration can return to "0.0".*
VERIFICARE LA DINAMICA Seppur calibrati, i dispositivi non sono in grado di misurare correttamente al di sopra di un valore massimo e al di sotto di un valore minimo. Verificare la dinamica significa individuare questi valori. Dopo aver effettuato la calibrazione bisogna dunque cercare il livello massimo e il livello minimo misurabili, possibilmente attraverso un confronto con un fonometro professionale. Al di fuori di tali soglie le misurazioni non sono attendibili.	*Check the dynamics* *Even if calibrated, devices are not able to correctly measure over a maximum value and under a minimum value. Checking the dynamic means to identify these values. After doing the calibration it is needed to serch the max and min levels which can be measured, possibly using a confrontation with a professional sound level meter. Values outside the min-max range are not reliable.*

9

SALVARE I DATI L'opzione viene attivata selezionando in Impostazioni la configurazione di interfaccia 'Avanzata con salvataggio dati'. Viene così visualizzato il pulsante 'SALVA' che consente di salvare un file di testo con i dati misurati (non viene registrato l'audio). I file vengono salvati nella cartella 'openoise' della memoria locale (non nella SD esterna) e possono essere aperti nella sezione 'Dati salvati' o con un'altra app.	*Data saving* *This option can be enabled by selecting in the "Setting" menu the "Advanced with data saving" interface. Doing so the "Save" button is visualized and it allows to save a .txt file with measured data (audio is not registered). Files are saved in the "openoise" folder in the device local memory (NOT in the external SD) and can be opened in the "Saved Data" section or with other apps.*
GRAFICI Nella configurazione di interfaccia 'Semplice' è visualizzato un solo grafico con rappresentati i livelli minimo, istantaneo e massimo. Nella configurazione di interfaccia 'Avanzata' sono visualizzati 3 grafici nel seguente ordine: - Andamento temporale dei livelli globali - Spettro delle frequenze in terzi di ottava e livelli globali - Spettro delle frequenze in banda costante calcolato con FFT Toccando sul grafico si passa al successivo.	*Graphs* *In the "Simple" interface configuration it is only visualized only one graph which represents minimum, real time and maximum levels. In the "Advanced" interface configuration there are 3 graphs visualized in this order:* *- Time courses of global levels* *- Frequency spectrum in one-third-octave and global levels* *- Frequency spectrum in constant bandwidth calculated with FFT* *touching the graph to pass to the next one.*

10

GLOSSARIO	*Glossary*
dB E' il parametro di misura del livello sonoro.	*dB* *Is the parameter of measure of sound level*
dB(A) E' il parametro di misura del livello sonoro ponderato in frequenza secondo la risposta dell'orecchio umano (ponderazione A).	*dB(A)* *Is the parameter of measure of sound level weighted in frequency according to the answer of human ear (A ponderation)*
LMin E' il livello sonoro minimo rilevato dall'inizio della misura, espresso in dB.	*LMin* *Is the minimum sound level detected since the beginning of the measure, expressed in dB*
LAMin E' il livello sonoro minimo rilevato dall'inizio della misura, espresso in dB(A).	*LAMin* *Is the minimum sound level detected since the beginning of the measure, expressed in dB(A)*
LMax E' il livello sonoro massimo rilevato dall'inizio della misura, espresso in dB.	*LMax* *Is the maximum sound level detected since the beginning of the measure, expressed in dB*
Leq(0.5-1-2 s) E' il livello sonoro equivalente dell'ultimo intervallo di tempo impostato (0.5, 1 o 2 secondi), espresso in dB.	*Leq(0.5-1-2 s)* *Is the equivalent sound level of the last range of time setted (0.5, 1 or 2 seconds), expressed in dB*
LAeq(0.5-1-2 s) E' il livello sonoro equivalente dell'ultimo intervallo di tempo impostato (0.5, 1 o 2 secondi), espresso in dB(A).	*LAeq(0.5-1-2 s)* *Is the equivalent sound level of the last range of time setted (0.5, 1 or 2 seconds), expressed in dB(A)*
Leq(t) E' il livello sonoro equivalente rilevato dall'inizio della misura, espresso in dB.	*Leq(t)* *Is the equivalent sound level detected since the beginning of the measure, expressed in dB*
LAeq(t) E' il livello sonoro equivalente rilevato dall'inizio della misura, espresso in dB(A).	*LAeq(t)* *Is the equivalent sound level detected since the beginning of the measure, expressed in dB(A)*
LIVELLO GLOBALE Livello sonoro calcolato tenendo conto di tutte le frequenze dello spettro.	*Global level* *Is the sound level calculated taking into account of all the frequencies of the spectrum*
SPETTRO Distribuzione in frequenza del livello sonoro.	*Spectrum* *Distribution along frequencies of the sound level*

11

TERZI DI OTTAVA Rappresentazione dello spettro delle frequenze con una larghezza di banda percentuale costante. I dati rappresentati sono espressi in dB.	*One-third-octave* *Is the representation of the frequency spectrum with a costant percentage of bandwidth. Represented data are expressed in dB*
FFT La FFT (Fast Fourier Transform - Trasformata veloce di Fourier) è una tecnica per calcolare lo spettro delle frequenze con una larghezza di banda costante. Nel caso di OpeNoise le bande sono distanziate ogni 25 Hz. I dati rappresentati sono espressi in dB e dB(A).	*FFT* *The FFT (Fast Fourier Transform) is a technique used to calculate the frequency spectrum with a costant bandwidth. In the case of OpeNoise bands are spaced every 25 Hz. Represented data are expressed in dB and dB(A)*

"SETTINGS" OPTION

7

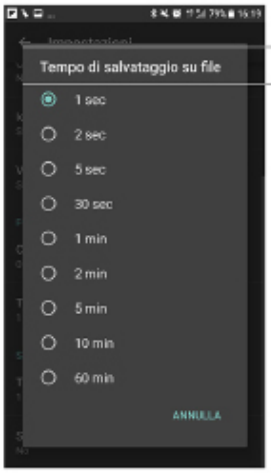
← Impostazioni	*Settings*
VISUALIZZAZIONE	*Visualization*
Tipologia interfaccia Avanzata con salvataggio dati	*Type of interface* *Advanced with data saving*
Colore interfaccia Scuro	*Colour of interface* *Dark*
Orientamento Normale	*Orientation* *Normal*
Icona nella barra delle notifiche Sì	*Icon in the notification bar* *Yes*
Visualizzazione grafico Sì	*Graph visualization* *Yes*
FONOMETRO	*Sound level meter*
Calibrazione 0.0 dB	*Calibration* *0.0 dB*
Tempo di aggiornamento del livello 1 sec	*Time of sound level updating* *1 sec*
Salvare lo spettro No	*Save the spectrum* *No*

In the "Setting" menu the only options that should be changed are the "Calibration" and the "Time of sound level updating".

For the "Calibration" if you use a WIKO JERRY smatphone you can set it to -11.5 dB, but if you use other smartphones you have to calibrate it with a known sound source.

NOTA BENE: it is necessary to use an external microphone (as explained in the assembly instructions) because modern smartphones have a noise reduction software which can alter data collected.

8



Saving time on document

If you choose the "Time of sound level updating" option a list of possibilities will open up.

The range of possible savings will be between 1 second to 60 minutes, this means that you can choose to collec data every second and up to every 60 minutes.

NOTA BENE: please choose 10 minutes as range, in this way we will have comparable collected data.

"SAVED DATA" OPTION

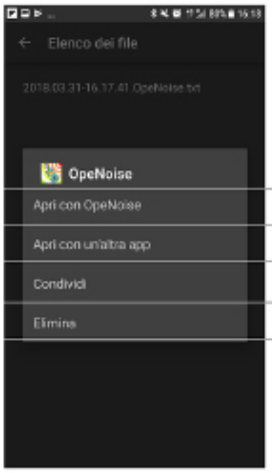
9

	List of documents
	Example of document with collected data

If you press the "Saved Data" option from the "Menu" button in the Home page you will see a text of .txt documents as in the above image.

The document name will be composed by the date (YYYY.MM.DD) and the time in which the measurement started (Hour.Minute.Second) plus the ".OpeNoise" text

10

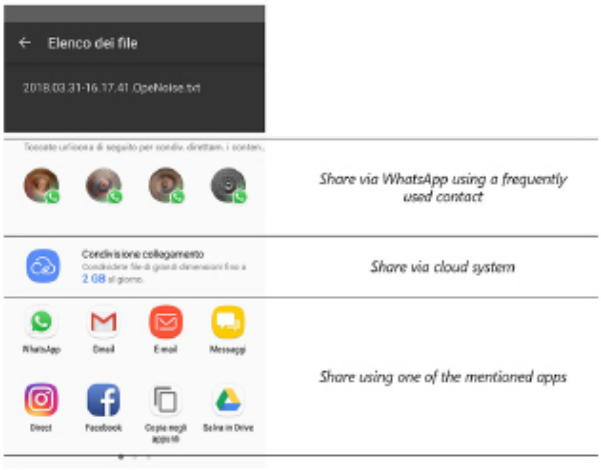


	Open with OpeNoise
	Open with another app
	Share
	Delete

Once you click on the file that you want to save, you will be asked if you want to: open it with OpeNoise; open it with another app; share it; delete it.

To save and export it you have to select the "Share" option.

11



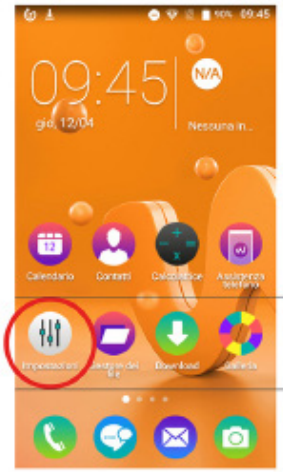
As you press the "Share" button this screen will pop up.

From here you can choose how to share the selected file. As you need to have the file saved on your laptop please select "Gmail" or "E-mail", this has to be selected depending on the e-mail account that you have on your smartphone.

After selecting your preferred e-mail you will see the usual screen of an e-mail. At this point you can send the file as attachement to the e-mail.

"SMARTPHONE SETTINGS" OPTION

13



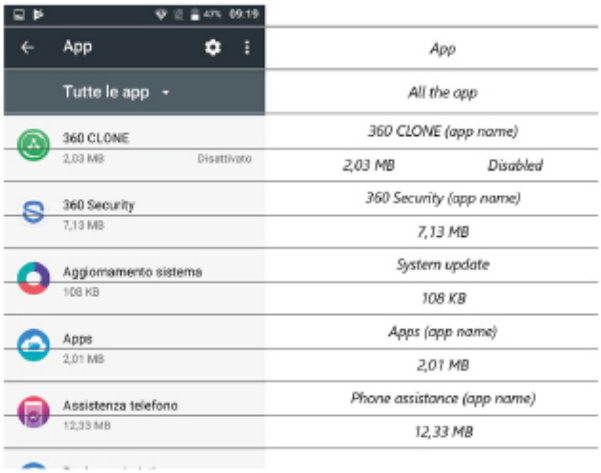
Smartphones have some predefined settings that needs to be changed in order to make the OpeNoise application work at its finest.

To change the smartphone, or tablet, settings you need to choose the "Settings" option (in the image abothe is the one in the red circle) from the main screen as you switch the smartphone, or tablet, on.

14

Impostazioni	*Settings*
Wireless e reti	*Wireless and networks*
Wi-Fi	*Wi-Fi*
Bluetooth	*Bluetooth*
Schede SIM	*SIM cards*
Utilizzo dati	*Data usage*
Altro	*Other*
Dispositivo	*Device*
Display	*Display*
Audio e notifiche	*Sound and notifications*
App	*App*
Archiviazione e USB	*Storage and USB*
Batteria	*Battery*
Memoria	*Memory*

15

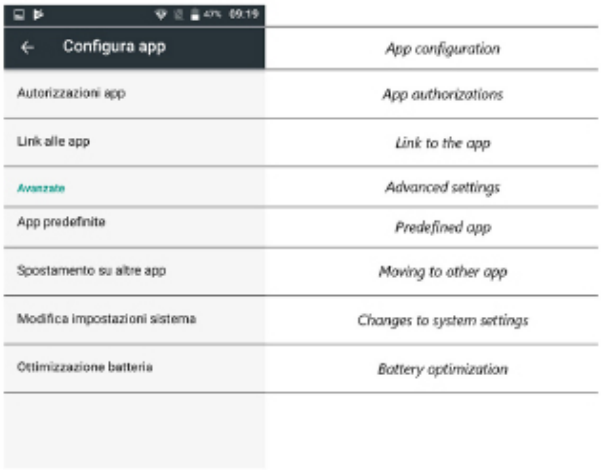


Once you open the "Settings" option it is possible to see there are multiple options. You will need to scroll down and choose "App" from the "Device" group of settings (previous page).

As you open the "App" settings you will see a list with all the apps which are on the device. Here you will need to open the settings of the "App" page.

To do so you have to click on the "Gear symbol" on the top right part of the screen (on the right looking at the "App" text).

16



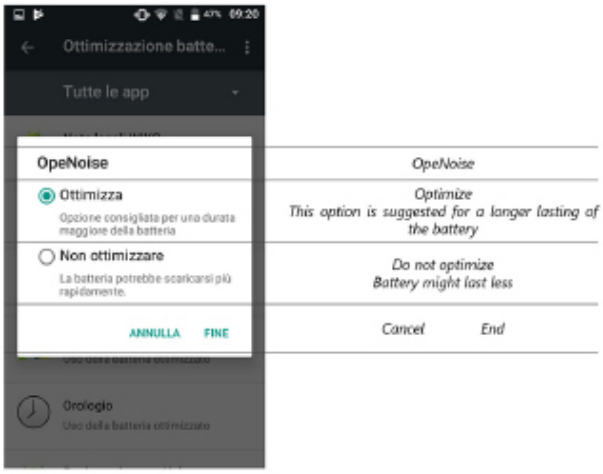
Clicking the "Gear symbol" will open the "App configuration" page.

From here you have to click on the "Battery optimization" button. Doing this you will be able to enter the page which allows you to configurate at its best the OpeNoise app.

17

In the "Battery optimization" page you have to click on the "OpeNoise" button, this will allow you to change the battery setting of the app.

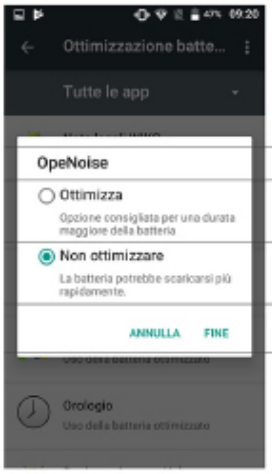
18



This screen will open. As you can see in the image above the battery optimization option is switched on as defautl option.

You MUST change this setting to avoid possible stopping in the recording by the app.

19

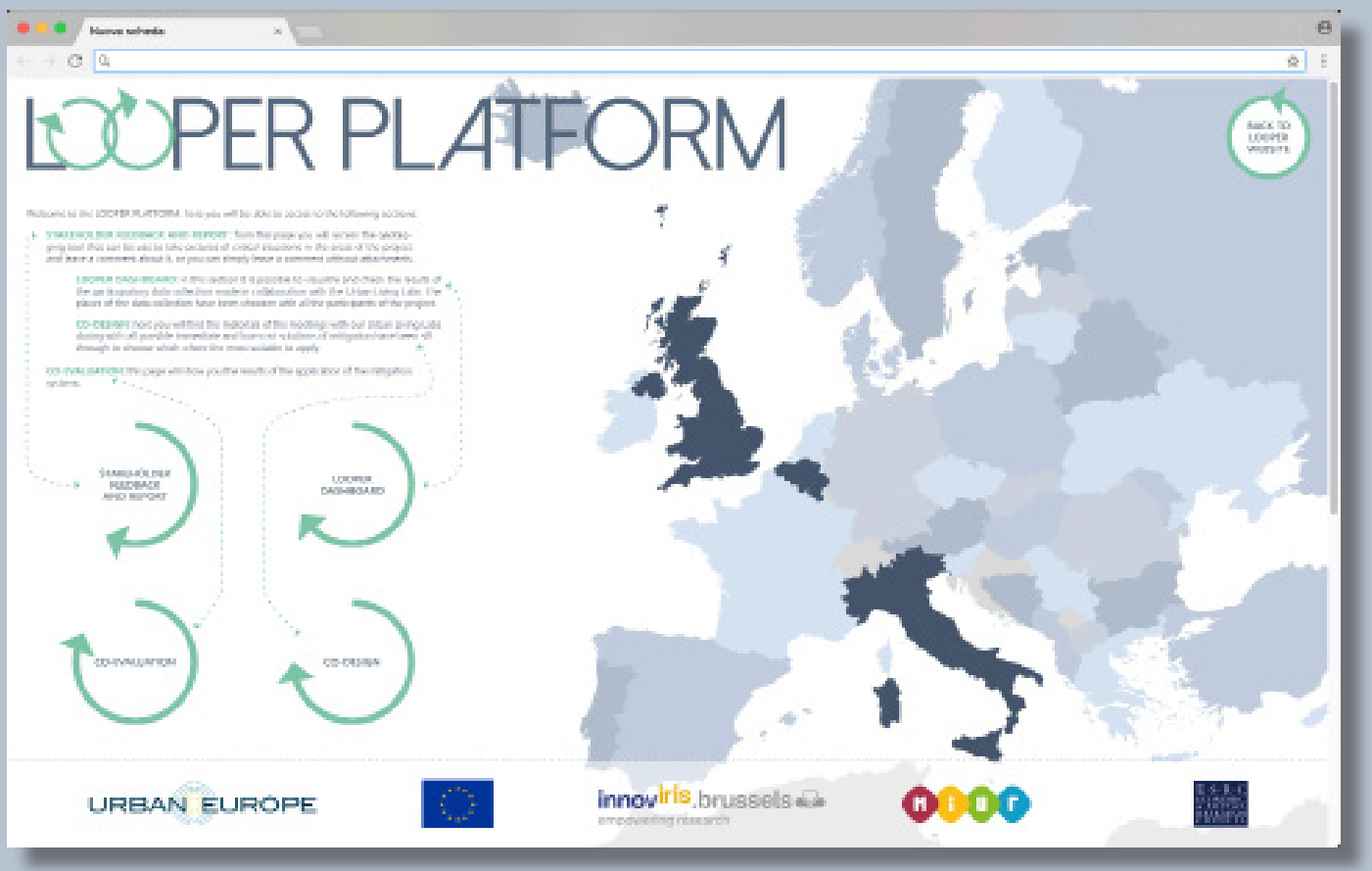


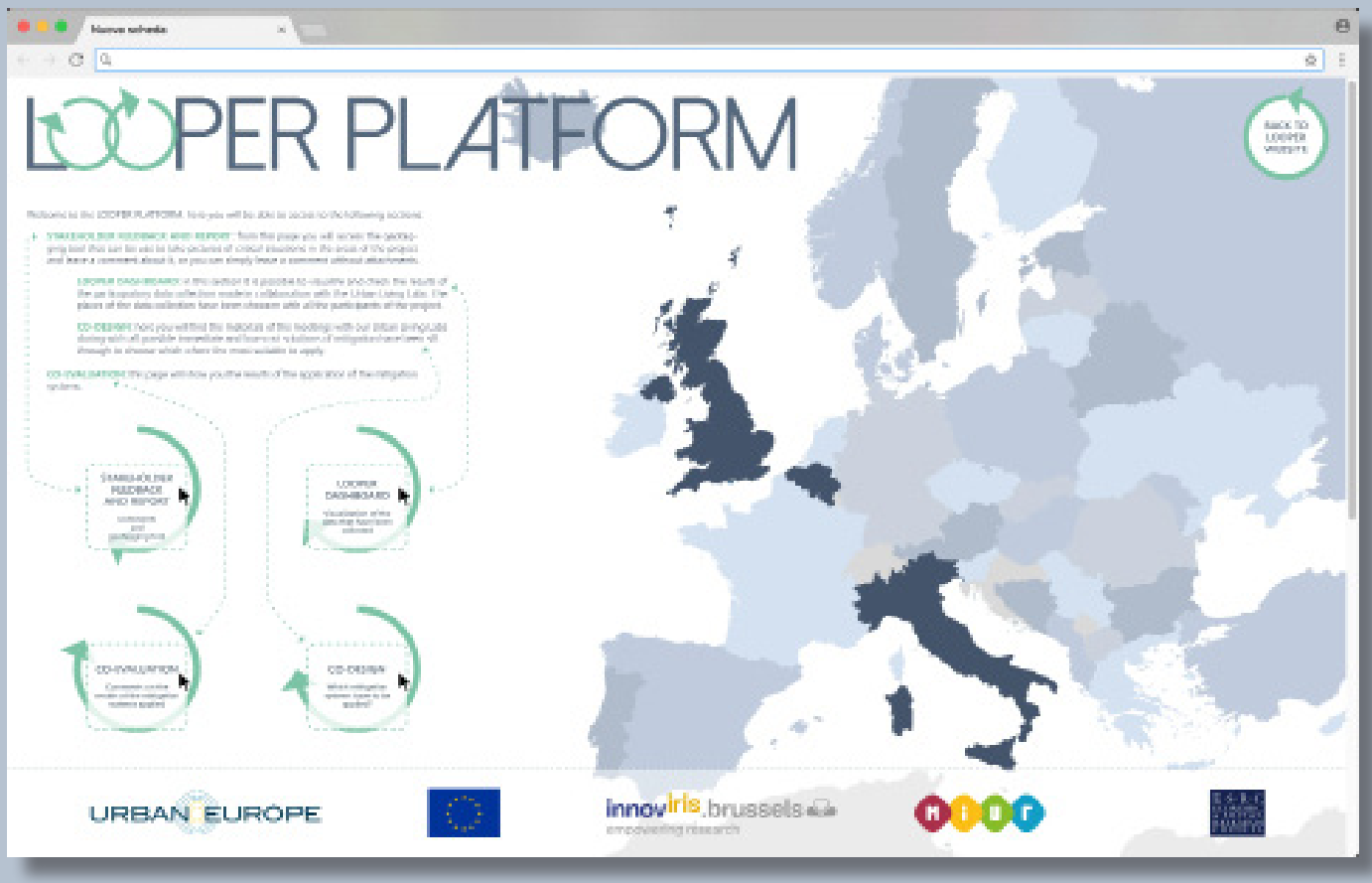
OpeNoise	
Optimize *This option is suggested for a longer lasting of the battery*	
Do not optimize *Battery might last less*	
Cancel	*End*

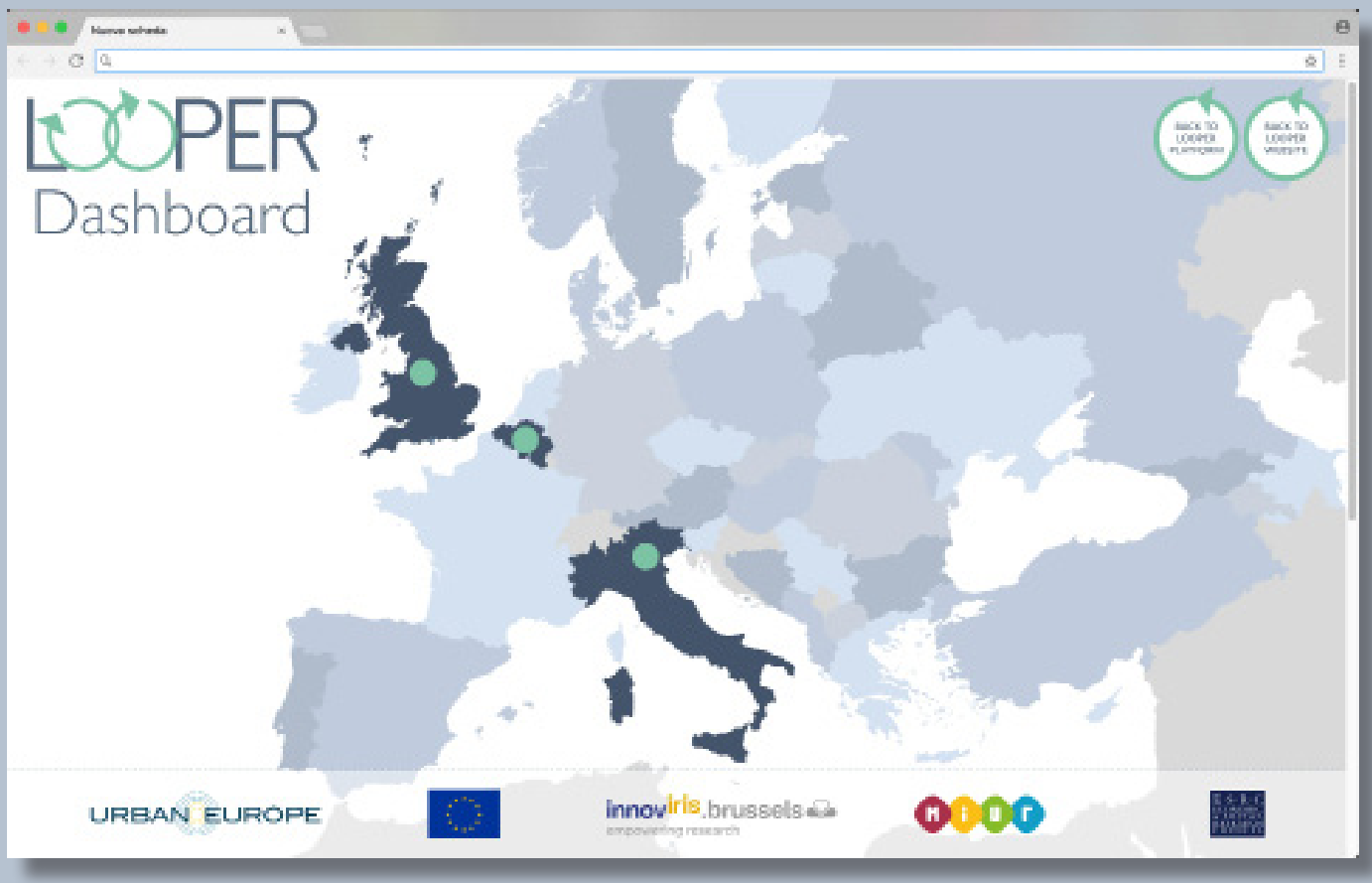
To change the option you have to click on the "Do not optimize" button. Once you have done this you must click on the "End" button to save the new setting.

After clicking on the "End" button you can close the "Setting" page of the device and you can start using the OpeNoise app.

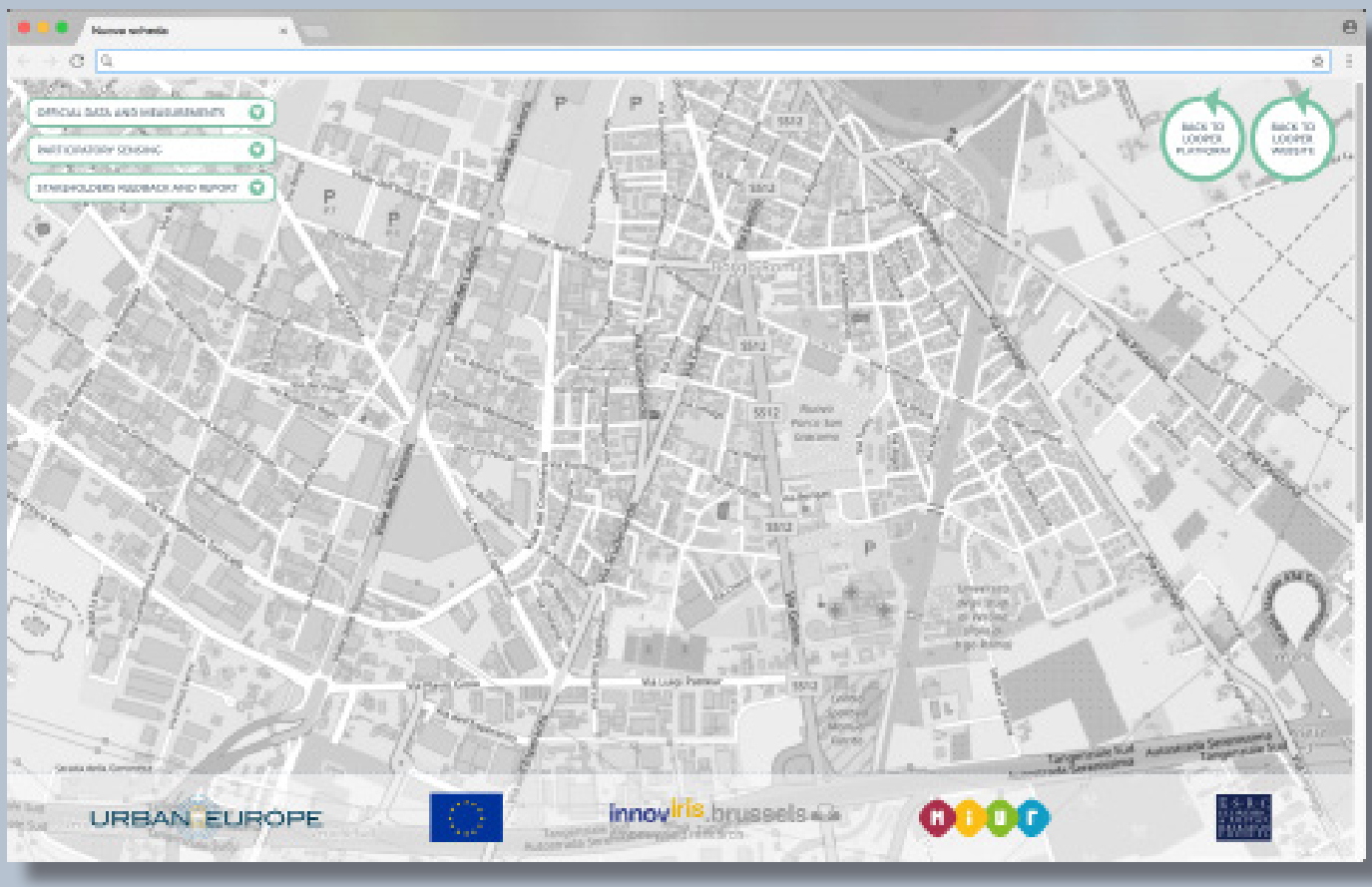
ANNEX 6
INITIAL VISUALISATION
DASHBOARD DESIGN PROPOSAL

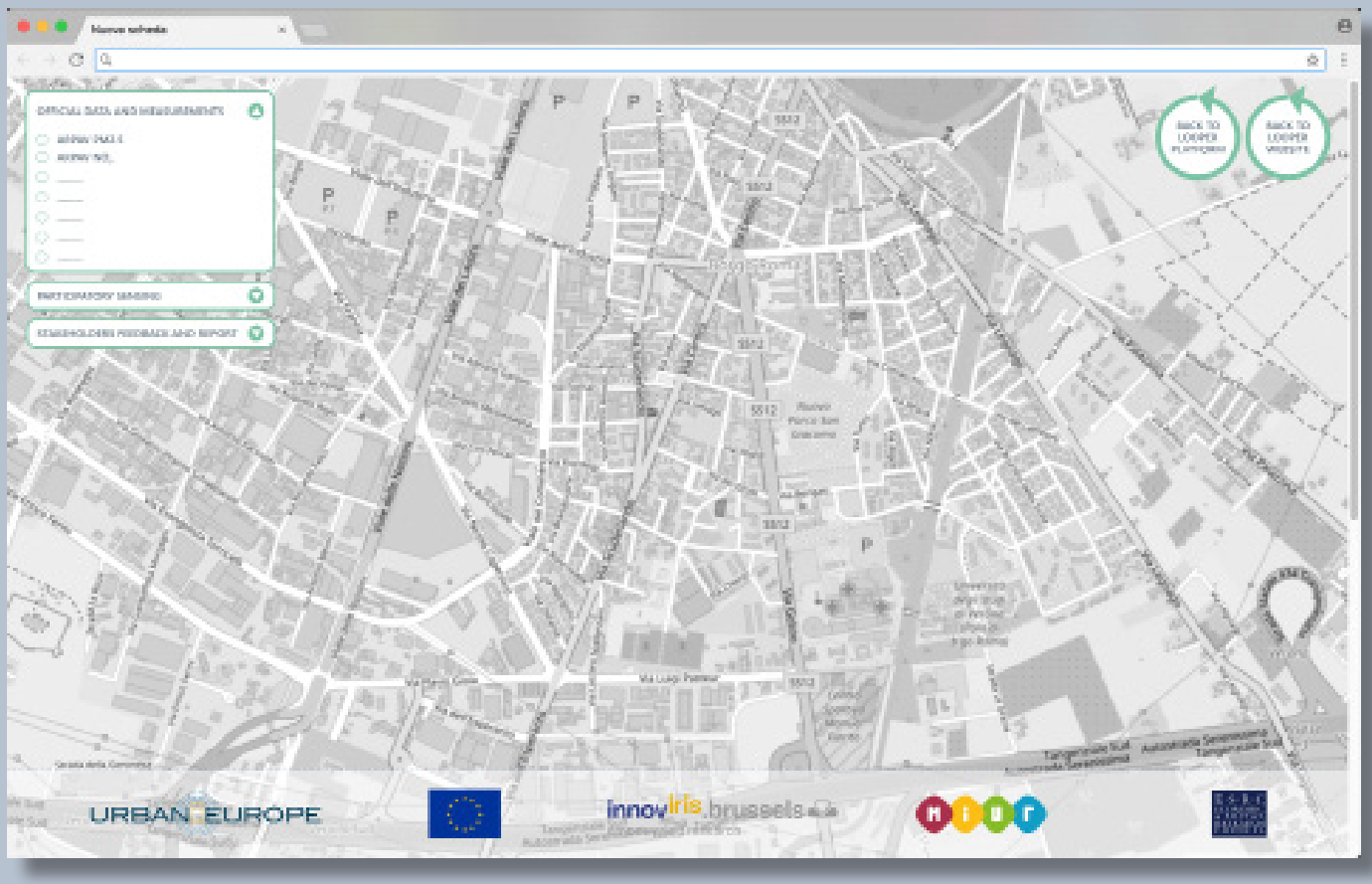


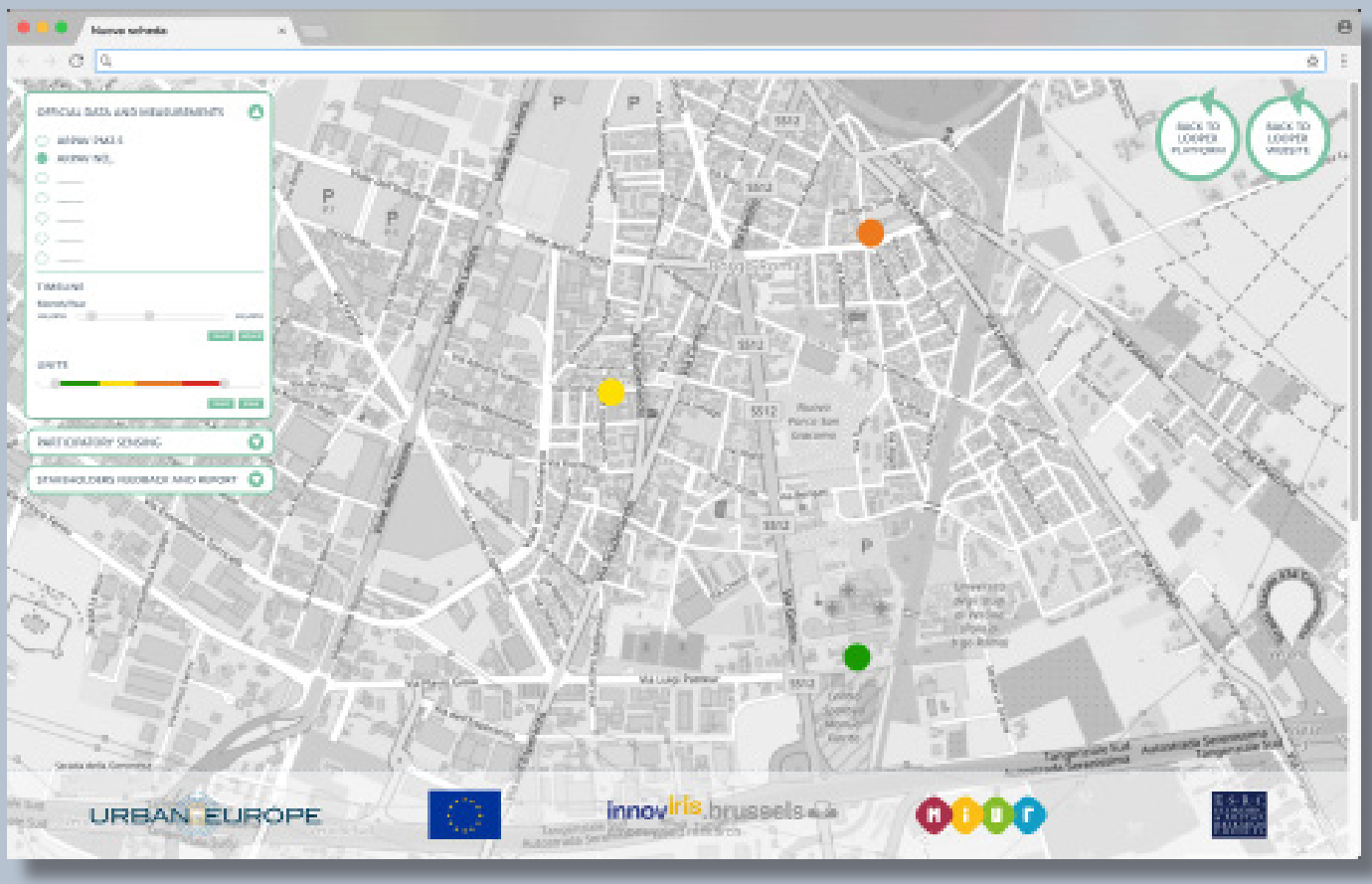

LOOPER PLATFORM
URBAN EUROPE
innoviris.brussels

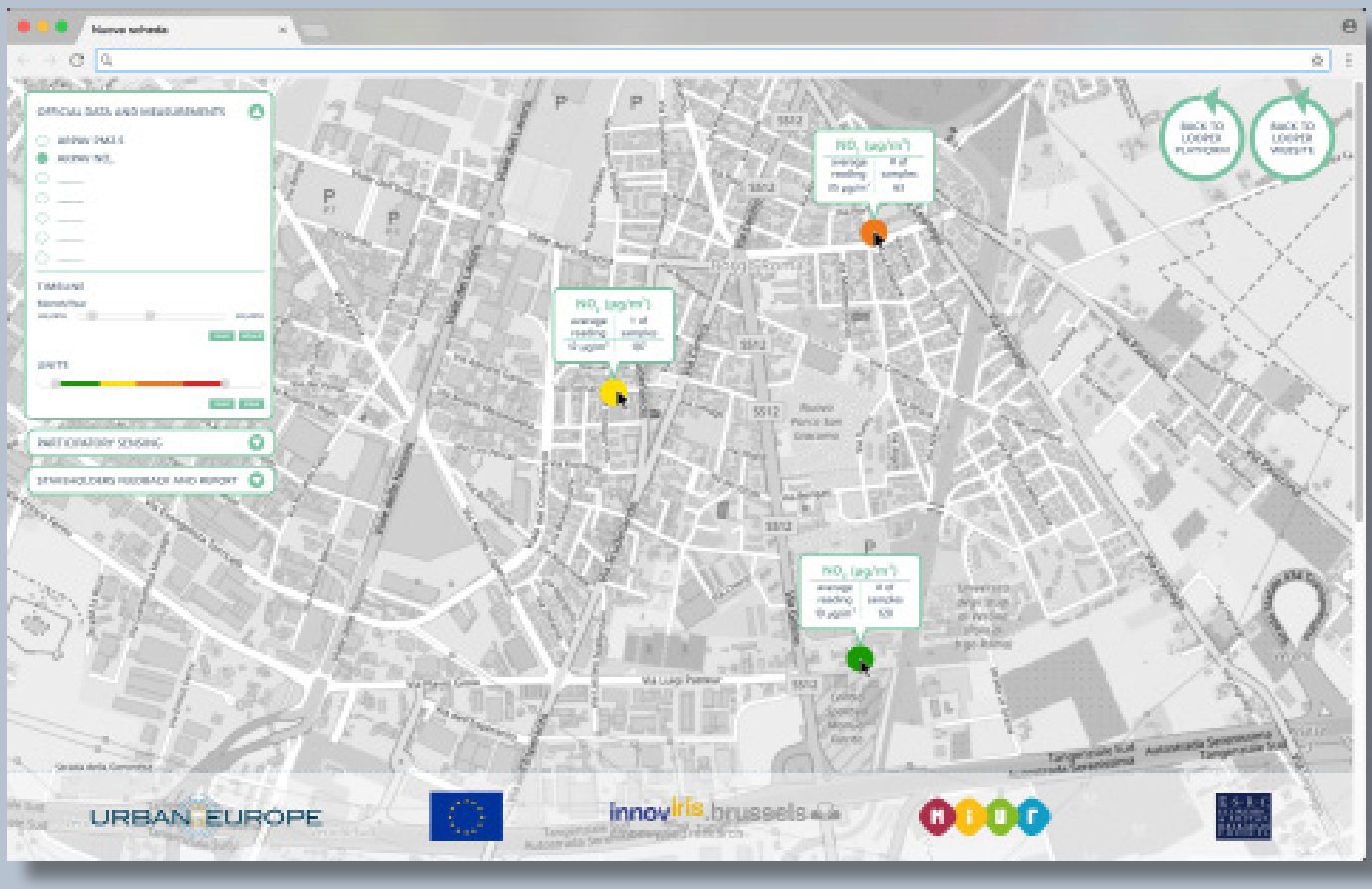

LOOPER
Dashboard
URBAN EUROPE
innoviris.brussels


LOOPER
Dashboard
MANCHESTER
BRISTOL
VERONA
URBAN EUROPE
innoviris.brussels
empowering research


URBAN EUROPE
innoviris.brussels


URBAN EUROPE
innoviris brussels


URBAN EUROPE
innoviris brussels


URBAN EUROPE
innoviris brussels

ANNEX 7
MANUAL FOR DATABASE UPLOAD

1. RULES AND SCHEMA FOR DATA COLLECTION AND DATA RECORDING

Some terms used in the next paragraphs and used in the LOOPER database derive from the "Common Framework for Data Collection" of D.2.1.

As said in 2.1 of D2.1, the diagram in Figure 1 explains the problem framing "logical model" shows the hierarchy of the connections between each urban problem to each single data to be collected.

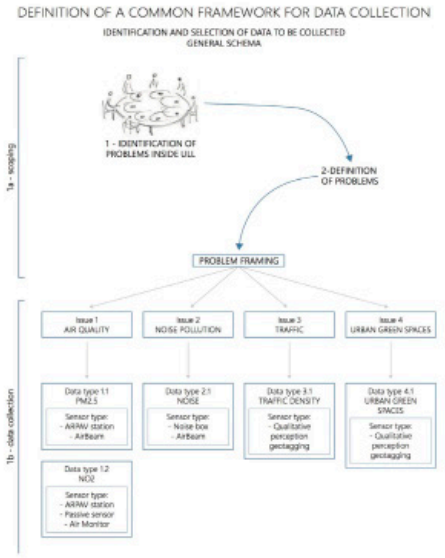


Figure 1: example of Common Framework for Verona Data Collection from D2.1

5

2. STATIONARY DATA

Here it will be explained more in detail how to name and organize the data that have been collect and needs to be inserted in the database. It is important to understand which is the logic behind the different tables of data that have been implemented in the database.

First, it must be clear since the beginning which kind of data are to be collected. This because the type of data that needs to be collected also influences the sensors that have to be used.

The following sections will show:

- File name: how to name the files of the data collected
- Measuring spot: how to fill the table with the measuring spots that have been chosen for the co-monitoring
- Data type: how to list all data that will be collected
- Sensor type: how to name and organize the type of sensors that will be used
- Sensor: how to list all the sensors that will be used
- Campaign: how to organize data from the co-monitoring campaign

File name here has been inserted as a first section, but please note that it is the result of the data collected and uploaded in the tables of the database.

The "Measuring spot" and "Campaign" table are linked to each other because in the "Campaign" table a data from the "Measuring spot" table is required. Both these tables are not linked to the "Data type", "Sensor type" and "Sensor" tables.

To the contrary "Data type", "Sensor type" and "Sensor" are strictly connected one to the other and have to follow the order shown in Figure 2 to be filled:

1. Data type needs to be collected. This will result in the creation of the "Data type" table and the "datatype_id";
2. "Sensor type" table has to be created and "datatype_id" has to be used to fill in the table about sensor type. This table will create "sensortype_id".
3. The "sensortype_id" will be used to complete the sensor table which will result in the creation of a "sensor_id".

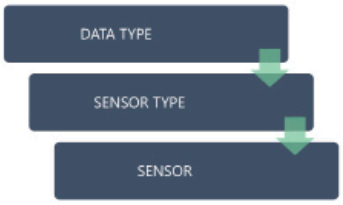


Figure 2: stationary data collection schema

2.1.File name

The file with the data of each different measure must be named with a specific code name. It must be used the following schema:

"spot_id"_"sensortype_id"_"sensor_id"_"start_date"-"end_date"

Example:

VER006_NO2-ARPAV-STATION_1VER_16february2018-23april2018

In the following paragraphs are described all the parameters and the information that have to be collected during monitoring campaign.

2.2."Measuring spot" table

It must be created a table that list all the "measuring spots" of the ULL. A "measuring spot" (see Figure 3) is a specific place where the measurements are carried out. They are spots inside the city that have been identified as sensible places for a specific issue.

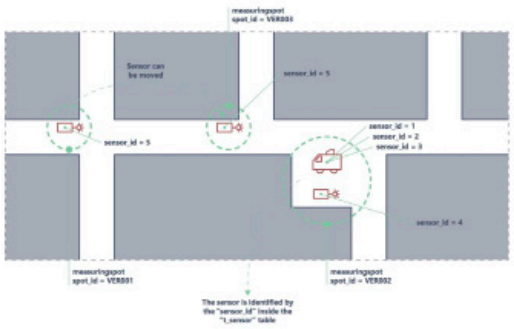


Figure 3: example of "spot_id" and "sensor_id"

The table must have 5 columns filled with the following data:

- "geo_lat" and "geo_lon":
  They indicates the geographical position of the spot.
  These data are collected with the World Geodetic System 84 (WGS 84) using coordinates in decimal degrees (i.e. Google Maps).

- "name":
  It is the name of the measuring spot.
  You should use here a name that easily indicates the position inside the city. You can use a free text inside here.
  N.B. This text will be visualized in the Platform.
- "spot_id":
  It is a unique code for the identification inside the database of the measuring spot.
  It must be unique and has to follow the rule:
  - the first three letters indicate the City (VER for Verona, MAN for Manchester and BRU for Brussels);
  - then a three-digit number.
- "note":
  It is a free field if you want to add notes.

The table schema is the following:

geo_lat	geo_lon	name	spot_id	note
45.40843	10.98517	Chiesa San Giovanni Battista	VER001	
45.41976	10.96926	Chiesa Santa Maria Assunta	VER002	
45.42076	10.97793	Fiera via Scopoli	VER003	
.....	.....	.....	.....	

Table 1: "Measuring spot" table schema

2.3. "Data type" table

The Data Type table lists all kind of "Data type" that are used in the data collection process of each Looper Living Lab.

Referring to the problem framing schemas of D.2.1 (paragraph 2.2), for each issues (a specific problem that will be analyzed in the Living Lab of a city) we are going to collect some data: a "Data type" is a measure of an indicator that is related with the specific issue. For example some "Data type" can be: concentration of PM2.5, concentration of NO2, use of public spaces, urban noise, ...

The table must have 5 columns filled with the following data:

- "datatype_id":
  It is a unique code for the identification inside the database of the type of data.
  It must be a single word with no spaces, there can be dots (i.e. PM2.5) but no other symbols.
- "datatype":
  It is an extended version of the datatype_id which should help participants to understand the type of data. I.e. the datatype field of a pollutant will be its name instead of its formula.
  N.B. The text in the "datatype" field will be visualized in the platform.
- "measunit":
  This field must be filled with the measuring unit of the data type.
- "issue":
  The issue column refers to the issues listed in Figure 1: example of Common Framework for Verona Data Collection from D2.1
- "note":
  It is a free field if you want to add notes.

This is the schema of the "Data Type" table:

datatype_id	datatype	measunit	issue	note
NO2	Nitrogen dioxide (NO2)	ug/m3	Air pollution	
NH3	Ammonia (NH3)	ug/m3	Air pollution	
CO	Carbon Monoxide (CO)	mg/m3	Air pollution	
NOISE	Noise	dB(A)	Noise pollution	
PM2.5	Particulate Matter 2.5	ug/m3	Air pollution	
GREENSPACES	Urban green spaces	qualitative	Urban green spaces	
MOBILITY	Streets and mobility	qualitative	Traffic	
ENVIRONMENT	Quality of the urban environment	qualitative	Urban green spaces and Traffic	

datatype_id	datatype	measunit	issue	note
ELEMENTS	Urban elements	qualitative	Urban green spaces and Traffic	

Table 2: "Data type" table schema

2.4."Sensor type" table

The Sensor Type table lists all kind of "Sensors" that are used in the Data collection process of each Looper Living Lab.

Referring to the problem framing schemas of D.2.1 (paragraph 2.2), for each Data we are using some instruments to measure it. In some cases we use also different instruments to measure the same "datatype_id". Each different kind of instrument represent a "Sensor Type". For example the "datatype_id" PM2.5 can be measured with two different "Sensor Types": a portable sensor or with a stationary official measuring station, etc.

The table must have 3 columns filled with the following data:

- "sensortype_id":
  It is a unique code for the identification inside the database of the type of data.
  This code can have more words but with no spaces, the words must be divided by an hyphen.
  The first word of the "sensortype_id" must be the "datatype_id"
- "type":
  It indicates the name of the kind of sensor that is used.
  N.B. The text in the "type" field will be visualized in the platform.
- "datatype_id":
  It is the same code used in the 2.3 "Data type" table.

This is the schema of the "Sensor Type" table:

sensortype_id	type	datatype_id
CO-ARPAV-STATION	CO rilevazioni ARPAV	CO
NO2-ARPAV-STATION	NO2 rilevazioni ARPAV	NO2
NH3-ARPAV-STATION	NH3 rilevazioni ARPAV	NH3
PM-ARPAV-STATION	PM2.5 rilevazioni ARPAV	PM2.5
NO2-PASSIVE-SENSOR	NO2 radiello	NO2
NO2-AIR-MONITOR	NO2 air monitor	NO2
PM-AIRBEAM	PM2.5 airbeam	PM2.5
NOISE-BOX	Noise box	NOISE
GREENSPACES-CROWDMAPPING	Crowdmapping	GREENSPACES
MOBILITY-CROWDMAPPING	Crowdmapping	MOBILITY
ENVIRONMENT-CROWDMAPPING	Crowdmapping	ENVIRONMENT
ELEMENTS-CROWDMAPPING	Crowdmapping	ELEMENTS

Table 3: "Sensor type" table schema

2.5."Sensor" table

The sensor table is a list of all sensors (instruments, devices etc..) that you use to make measurements. You can have more sensors for each "Sensor Type".

The table must have 6 columns filled with the following data:

- "sensor_id":
  It is a unique code for the identification inside the database of the sensor.
  It must be unique and has to follow the rule:
  - first a one-digit number:
  - then the first three letters of the City (VER for Verona, MAN for Manchester and BRU for Brussels);

  NB: Table can be integrated at any time, but the "sensor_id" name MUST remain the same
- "name":
  It shows the name that have been given to the sensor. A number can be added if there are more sensors of the same kind.
- "stationary":
  It indicates if the sensor is stationary or not.
  NB: the "t" stands for "true", while the "f" stands for "false"
- "owner_id":
  It indicates who is the owner of the sensor (i.e. national agency, living lab, etc.)
- "sensortype_id":
  It is the same code used in the 2.4 "Sensor type" table
- "note":
  It is a free field if you want to add notes.

This is the schema to follow:

sensor_id	name	stationary	owner_id	sensortype_id	note
1VER	ARPAV Mobile Station 01 NO2	t	ARPAV	NO2-ARPAV-STATION	
2VER	ARPAV Mobile Station 01 NH3	t	ARPAV	NH3-ARPAV-STATION	
3VER	ARPAV Mobile Station 01 CO	t	ARPAV	CO-ARPAV-STATION	
4VER	ARPAV Mobile Station 01 PM	t	ARPAV	PM-ARPAV-STATION	
5VER	ARPAV Mobile Station 02 NO2	t	ARPAV	NO2-ARPAV-STATION	
6VER	ARPAV Mobile Station 02 NH3	t	ARPAV	NH3-ARPAV-STATION	
7VER	ARPAV Mobile Station 02 CO	t	ARPAV	CO-ARPAV-STATION	
8VER	ARPAV Mobile Station 02 PM	t	ARPAV	PM-ARPAV-STATION	

sensor_id	name	stationary	owner_id	sensortype_id	note
9VER	NO2 Air Monitor 01	t	ULLVR	NO2-AIR-MONITOR	
10VER	PM AirBeam 01	f	ULLVR	PM-AIRBEAM	
11VER	PM AirBeam 02	f	ULLVR	PM-AIRBEAM	
12VER	Noise box 01	t	ULLVR	NOISE-BOX	
13VER	Noise box 02	t	ULLVR	NOISE-BOX	
14VER	Noise box 03	t	ULLVR	NOISE-BOX	
15VER	Noise box 04	t	ULLVR	NOISE-BOX	
16VER	Noise box 05	t	ULLVR	NOISE-BOX	
17VER	Noise box 06	t	ULLVR	NOISE-BOX	
18VER	Crowdmapping web app	f	ULLVR	GREENSPACES-CROWDMAPPING	
19VER	Crowdmapping web app	f	ULLVR	MOBILITY-CROWDMAPPING	
20VER	Crowdmapping web app	f	ULLVR	ENVIRONMENT-CROWDMAPPING	
21VER	Crowdmapping web app	f	ULLVR	ELEMENTS-CROWDMAPPING	
.....	.....	.....	.....	.....	
100VER	NO2 radiello 01	t	ULLVR	NO2-PASSIVE-SENSOR	
.....	.....	.....	.....	.....	

Table 4: "Sensor" table schema

2.6."Campaign" table

The Campaign table lists all the monitoring "campaigns" that have been done in each Looper Living Labs. A "campaign" is each single measurement activity.

The table must have 7 columns filled with the following data:

- "campaign_id":
  It is a unique code that will be automatically generated by the database
- "start_date" and "end_date":
  They indicates the starting date and the ending date of the co-monitoring campaign.
  These data are collected using the YYYY-MM-DD schema.
- "spot_id":
  It is the same code used in the 2.2 "Measuring spot" table
- "sensor_id":
  It is the same code used in the 2.5 "Sensor" table
- "camp_type":
  Only with the following labels can be used:
  - Official data and measurements
  - Participatory sensing
  - Stakeholders reports
- "file_name":
  It is the same code used in the 2.1

This is the schema to follow:

campaign_id	start_date	end_date	spot_id	sensor_id	camp_type	file_name
	2018-02-16	2018-04-23	VER006	1VER	Official data and measurements	VER006_NO2-ARPAV-STATION_1VER_16february2018-23april2018
	2018-02-16	2018-04-23	VER006	2VER	Official data and measurements	VER006_NH3-ARPAV-STATION_2VER_16february2018-23april2018
	2018-02-16	2018-04-23	VER006	3VER	Official data and measurements	VER006_CO-ARPAV-STATION_3VER_16february2018-23april2018
	2018-02-26	2019-03-09	VER013	12VER	Participatory sensing	VER013_NOISE-BOX_13VER_26february2018-09march2018
	2018-01-31	2018-02-21	VER003	12VER	Participatory sensing	VER003_NOISE-BOX_13VER_31january2018-21february2018

campaign_id	start_date	end_date	spot_id	sensor_id	camp_type	file_name
	2018-02-26	2018-03-09	VER014	13VER	Participatory sensing	VER014_NOISE-BOX_12VER_26february2018-09march2018
	----	----	----	----	----	

Table 5: "Campaign" table schema

3. UPLOADING DATA ON ONEDRIVE

Once the data are collected you will be required to upload it on the OneDrive LOOPER Team Shared Folder following the steps described in the next sections.

There will be only one table per type (measuring spot, data type, sensor type, sensor, campaign), this means you MUST upload data on the tables that will be found in:

LOOPER Team Shared > WP2_Data collection and visualization > Monitoring data collection > Tables

To facilitate the first upload, already known data from the Verona LLL have been uploaded and can be used as blueprints.

3.1.Tables Upload

To upload data in the tables please follow the instruction from 2. STATIONARY DATA of this document.

In the following sub sections it will be explained how to make modifications to the tables.

3.1.1.Tables changes

Please notice that you MUST NOT change any data, you can only add rows from the tables.

This is extremely important and has to be kept in mind, otherwise there can be problems with the database.

If you need to delete a row from a table on the folder, you have to fill the row in red (Figure 4). To delete a row you DO NOT HAVE to delete the information in the row, you ONLY HAVE to turn it red. In addition you also have to select the text and apply the strikethrough formatting to it (shortcut for Windows: CTRL+5; shortcut for Mac: CMD+SHIFT+X).

5VER	ARPAV mobile station 02 NO2	t	ARPAV	NO2-ARPAV-STATION	
6VER	ARPAV mobile station 02 NH3	t	ARPAV	NH3-ARPAV-STATION	
7VER	ARPAV mobile station 02 CO	t	ARPAV	CO-ARPAV-STATION	

Figure 4: example of deleted row

In the same way, if you want add a row you to add it after the last filled row, you have to fill it with the data required and in the end you also have to fill the row in green to declare that it is a new set of data (Figure 5).

21VER	Crowdmapping web app	f	ULLVR	ELEMENTS-CROWDMAPPING	
22VER	ARPAV mobile station 01 NO	t	ARPAV	NO-ARPAV-STATION	
23VER	ARPAV mobile station 01 NOX	t	ARPAV	NOX-ARPAV-STATION	
24VER	ARPAV mobile station 02 NO	t	ARPAV	NO-ARPAV-STATION	
25VER	ARPAV mobile station 02 NOX	t	ARPAV	NOX-ARPAV-STATION	

Figure 5: example of added row

Nota Bene: a set of linked data used in a deleted row cannot be used again (i.e. the sensor_id "6VER" from Figure 4 once has been deleted cannot be used anymore).

3.2.File Upload

After filling all the tables you will be able to compose the file name for your data. After you are able to gain the file name the first thing to do is to rename the linked document (.txt, .xls or .xlsx) so that it gains an univocal reference and it is ready to be uploaded.

After naming the file, in the Monitoring data collection folder (LOOPER Team Shared > WP2_Data collection and visualization > Monitoring data collection), you will find other three sub-folders, besides the "Table" folder, where the file can be uploaded.

As can be seen from the folders name, data will be collected and stored separately for each city. The three folders are:

- WP5_data BRU;
- WP6_data VER;
- WP7_data MAN;

and in each of them all data collected in a LLL must be uploaded. No other subfolders have to be created as file names already give information about the type of pollutant, the campaign period and the sensor that have been used.

Once data have been uploaded to the folder they MUST NOT BE CHANGED as they will be uploaded to the database.

Nota Bene: The prefix (001, 002, etc.) that can be seen for files in the folder WP6_data VER is an automatically generated prefix which will be added once files are uploaded to the database. You MUST NOT add it by yourselves.