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DESIGN CULTURE(S)

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Data visualisation and knowledge sharing in participatory design to improve people liveability in urban places.

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Abstract | People living in urban areas are expected to highly increase in future. Society in urban context becomes more complex, and newer social, cultural and economic challenges occurs while decision-making processes become more difficult due to the increase of actors involved and plenty of information flowing by ICT networks and media. In such crowded environment, people can be very close to each other and, at the same time, might not know about urban issues due to different backgrounds or lack of knowledge. Looper demonstrates how an ICT and Urban Living Lab integrated approach can be enforced by environmental design methodologies that start from user needs and improve knowledge proximity and physical proximity. The Verona study case, described in the paper, shows how a collaborative usage of ICT allows a better comprehension of different points of view, enhancing a fertile co-design process avoiding the creation of "cultural bubbles" that hinder cultural proximity.

KEYWORDS | CO-DESIGN, KNOWLEDGE SHARING, DATA VISUALISATION, INTERACTION DESIGN, USER CENTERED DESIGN

1. New challenges in the design of urban spaces

Since the ratio of people living in urban areas is expected to increase from 55% in 2018 to 68% by 2050 (United Nations, 2018), it is becoming always more important to understand how to design - and transform - urban spaces to realise the most liveable urban environments for this increasingly population.

Due to this growth forecast, nowadays the design of urban spaces is characterised by different tasks that need to be faced. Following the SDGs from the United Nations it is possible to see how a main challenge - SDG 11 - is that of creating more sustainable and liveable cities, by also reducing their adverse environmental impact. This has to be done both with regard to the impact that a city has on global terms, and both with regard to the community level. SDG 11 target 11.3 says: "By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries" and its indicator says: "Proportion of cities with a direct participation structure of civil society in urban planning and management that operate regularly and democratically".

To reach this goal then it is necessary to apply participatory approaches - that have been used since the '70s but are only now becoming more widely diffused - that can help to trigger changes in the built environment. To have a successful participatory approach then there is the need of a wider involvement - or the creation, depending on the existing socio-cultural environment - of the bottom level, since changes with participatory methods are triggered with bottom-up approaches - as further shown by the Looper project described in this paper.

Our idea is to check how these challenges can be faced by using culture of proximity to approach environmental design to create more liveable urban places.

2. Culture of proximity for liveable urban places

To manage and deal with the abovementioned new design requests, there is the need to evolve an organic methodology based on the bottom level approach. The features needed to create this new environment are:

- urban phenomena knowledge, not only on a larger urban scale but mostly at a small local scale that allows a better knowledge of the neighbourhood. This knowledge of urban phenomena needs to be not only theoretical but more direct, practical and material;
- exchange and transfer of knowledge, to be combined with knowledge storage not to disperse what was done previously;
- avoidance of "cultural bubbles" to create a fertile ground for the exchange of knowledge between parties.

In our vision the cultural environment that is created by these features is a possible interpretation of culture of proximity. This concept of proximity can then be understood in two different ways, and both ways are complementary to define culture of proximity. Proximity can be:

- "proximity of space"
- "proximity of people"

Proximity of space is related to the knowledge of the local area in which someone lives. This proximity aspect is about the nearness of someone to the investigated area. Residents of the investigated area are then the main actors when *proximity of space* is triggered.

Proximity of people is about the ability to exchange knowledge between users of the same space - the closeness allows the reciprocal learning between people living and using same places. This proximity allows people to feel closer one another as they are working towards a common goal and they have a mutual understanding.

When both a *proximity of space* and a *proximity of people* is found, then it is possible to activate a functional - and functioning - culture of proximity.

An example of triggered culture of proximity are Urban Living Labs (ULLs) were residents, that have a more direct understanding of a certain urban place, can share their knowledge - by allowing a *space proximity*. In the same way, since different stakeholders are involved in ULLs, a wider knowledge sharing can take place within ULLs. This then allows a *proximity of people* since individuals with different backgrounds, and that use the project area for different needs, can gain deeper knowledge on the place and can share a different point of view from the resident's one.

Urban Living Labs are not the only expression of culture of proximity, they are more of an example of organised triggered culture of proximity. The contemporaneous existence of proximity of space and proximity of people can take place also in a more organic way, when people are willing to make a place more liveable even for a short period of time, or to allow others to take back their places - e.g. festivals, events. This need to retrieve public places to create a better urban reality based on physical and cultural proximity was partially expressed by Michael Sorkin (1992) that talked about proximity to encourage cultural creativity triggered by these fluid connections.

This paper will then focus on how to activate culture of proximity for designers that are willing to create more liveable urban places through participatory design.

3. Strategies to activate a culture of proximity

How is then possible to activate this culture of proximity inside a design process? To benefit of the culture of proximity what can be used are Urban Living Labs - as aforesaid - and

different tools for data storage, data visualisation and knowledge sharing. These two approaches are suggested to be used simultaneously to reach better results.

Like said before, Urban Living Labs are a fertile ground for both proximity of space and proximity of people. This can happen because ULLs are able to create a neutral terrain for people living close-by, where they are able to share their knowledge with other actors of the urban environment change, but they can also allow the exchange of knowledge between other stakeholders that might not be residents.

The involvement of cultural proximity in urban design then gives better results when the new shared knowledge basis - given by the presence of both residents and other actors - allows the mitigation of social, cultural, technical and economical differences. Once these differences are mitigated then the cultural proximity can be used to work towards a shared goal.

To create the necessary background for the growth of culture of proximity, also different ICT tools can be used. Indeed, to share knowledge - when it comes to urban environment changes - there is the need to have both visualisation tools, that can allow an immediate sharing of information, and storage tools, that can allow a longer-term sharing. ICT tools usage starts from a carefully designed data collection phase - that gives better results if it is centred on a participatory approach, that then allows the visualisation of the acquired knowledge - based on a combination of qualitative and quantitative data. The information gained with both the data collection and data visualisation, are then used to co-design and co-evaluate possible solutions to make urban places more liveable.

4. Culture of proximity's activation strategies as applied in the Verona case study within the Looper project

This concept of culture of proximity has been applied and tested in a European research project. The Looper project is co-founded under the JPI Urban Europe program and it focuses on three pilot cases: Manchester, Brussels and Verona. In this section, to better describe our concepts, the Verona case study is used and in particular the area of Verona Sud is considered in the framework of the project.

The area of Verona Sud (Figure 1) is mainly influenced by air quality and noise pollution issues, and there are multiple neighbourhood associations which have a conflictual relationship with public partnership and policymakers. This contrast is due to misunderstandings which are raising from lack of shared knowledge by both parties.

Hereinafter a real-life application of the culture of proximity concept to Urban Living Labs and to different tools is described.

Figure 1. Verona location with reference to the Venice and Milan, and a zoom-in of the Verona Sud area that is divided from the city centre by the Verona former freight yard

4.1 Urban Living Lab

Within the Verona ULL the actors where linked by both a proximity of space - i.e. residents - and by a proximity of people - i.e. between residents and public administration, NGOs, commutes and other final users. Verona ULL's actors were: citizens and citizens' associations as bottom level stakeholders; Verona City Council as public administration and local governance stakeholder; Legambiente - an NGO actively working on environmental issues - with the role of stakeholder and of support to organisers; Università Iuav di Venezia in the role of researchers and organisers.

Having all these different actors working together was challenging in the beginning, because there were many different points of view at the same table, but once all stakeholders understood the benefits they could gain, the meetings started to be more constructive. The knowledge sharing given by culture of proximity was the one thing that triggered the willingness of actors to actively participate at meetings, because they understood they could be empowered by what was happening during the meetings.

Different activities were done during each ULL meeting, and to support culture of proximity within these activities different tools were used. Activities faced topics of data collection, data visualisation and analysis and design of possible solutions to improve the urban environment liveability. The tools that supported the ULL activities allowed a levelling of knowledge between different actors.

4.2 Data driven design of support tools

The tools used within Looper ULL differed based on the activity they supported. They can be divided into three main groups: data collection tools, data visualisation dashboard and co-design tools.

Data collection hardware tools were low-cost and official body sensors to collect quantitative data about pollutants, and these quantitative data were integrated with a web

app to collect qualitative data about the perception of urban spaces. This app has been very helpful to better understand the knowledge of residents, allowing to link objective data to the knowledge shared by people. This stage was essential to the process because it was possible to support with quantitative data the space proximity knowledge. Indeed, at the same time it was possible to link space proximity and proximity of people because some misunderstandings about pollutants were repressed.

Moving on with the process, the visualisation dashboard was an interactive web map were all data previously collected were freely accessible to allow an exchange of knowledge between all actors of the process, and not only a sharing of knowledge between people with a proximity of space. This tool showed not only data collected with official body sensors, but also data collected with participatory sensing. This data visualisation was the first real moment of confrontation were proximity of space and proximity of people gathered together to benefit of the culture of proximity concept.

Then, for co-design, both online and offline tools were used. For what it concerns a culture of proximity point of view, the online part is of more interest. The used online co-design tool was developed by a third party, and it allowed to link the proposed solutions with a particular location within the project area. This online tool allowed both a share and a storage of knowledge. The knowledge sharing was intrinsically possible due to the online characteristic of the tool, this meant that anyone could propose their idea even if they could not attend the offline meetings. The tool also worked as storage of knowledge, because it was possible to upload the solutions proposed during ULL meetings. This possibility to store, and not only share, is a focal point for culture of proximity because it allows to reach new participants.

5. Data driven tools for co-design

5.1 Looper data driven tools design strategy

For the design of the Looper platform, a multidisciplinary team was formed involving architects, digital technologies experts and design experts (all partners of the Looper project). Particularly, technical developers worked alongside with visual/data interaction designers who also held specific technical skills that helped in avoiding one of the typical problems in this kind of scenario that is the delegitimization of the role of designers in the development of ICT tools. This issue is clearly investigated by Gasson (1999); during the implementation of IT tools, which are “purely technical” tools, the technical developer does not take designer's contribution into consideration, neither in terms of defining the data model nor of interaction design.

Gasson (1999) argues that, in many cases, the User Centred Design (UCD) approach can be adopted in a more formal than substantial way; in the case of Looper, UCD was applied from

the very beginning in the conceptual modelling phase of the platform by using a special survey aimed at knowing what data and knowledge were needed for the three ULLs.

Following the first step of user research, a UI mock-up was designed and developed (Figure 2). The first prototype was then presented to participants of ULLs to get feedback about it, and it was then implemented following the suggestions collected from this second round of user experience observation. This participatory UCD was done following the typical Living Lab approach of design, test and implementation inside the real environment.

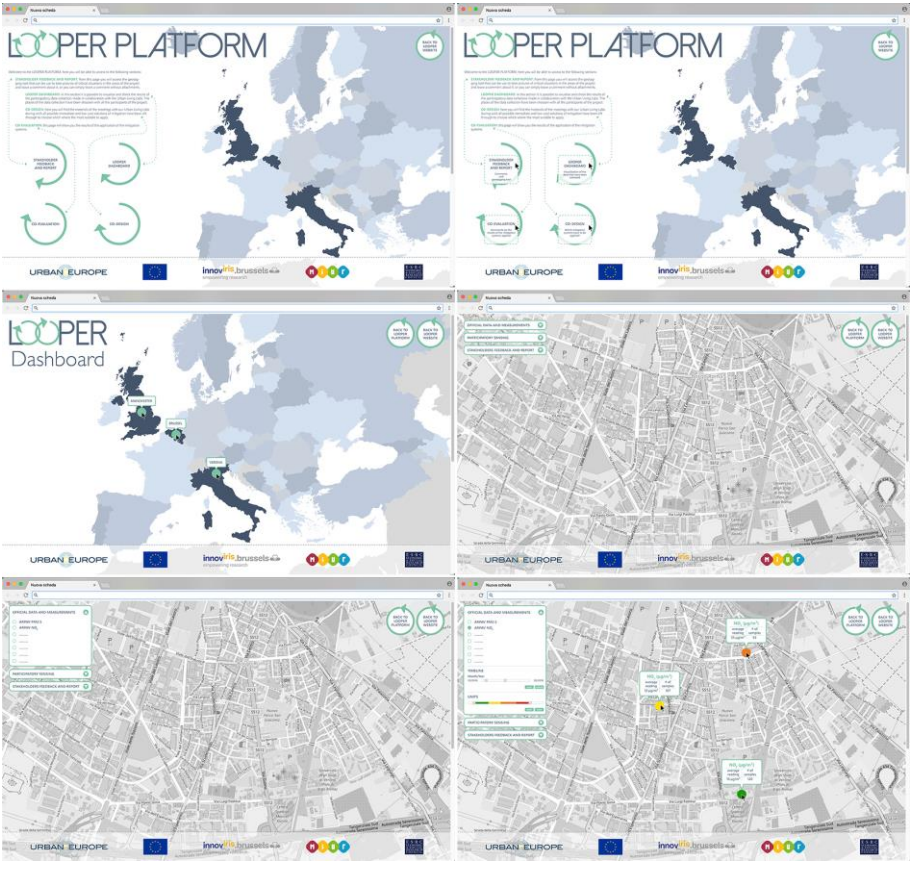

Figure 2. Looper platform mock-up. Here the initial design of the UI is shown

The issues that can arise in trying to obtain an optimal proximity of people within ULLs are manifold; some of them are related to the use of technological tools and digital interfaces by very different users with very uneven digital skills while others are more related to the

specific content, sometimes very technical, that the ULL must deal with. These issues can be summarized as follows:

- Language differences in actors with more technical profile and non-technical ones, belonging to different contexts or ordinary citizens;
- Usability and understanding of rich-content information and possible excessive cognitive load;
- Differences between datasets collected by different ULLs, and the complexity of defining a data model that allows to manage them in an integrated way;
- Previous mistrust between involved actors.

Differences in cultural backgrounds are strictly related to the proximity of people aspect. In Looper, actor's cultural inhomogeneity in some ULLs was an underlying design condition and it has imposed the development of a multilingual platform as well as a special data structure capable to manage contents in four different languages. However, in most cases, verbal language is not the only key point; indeed, also for the graphic language and maps visualization a special approach is needed to improve proximity of people. In map visualization symbols are frequently used, while styles' meaning is explained with a legend; when users have very different cultural backgrounds, this can be an issue and a limitation of graphic effectiveness. Therefore, minimizing the use of symbols whose meaning is not immediate is mostly recommended.

The problem of the too high cognitive load generated by graphic visualizations is known and well described by Mazza (2017) who argues that to achieve "good communication goals in HCI we aim to lower cognitive load on an interactor because this better support information memorization". Using map visualization, the too high cognitive load can be a more severe issue since there is often a tendency to overlap several information layers to obtain a more comprehensive synoptic view about different aspects or to highlight their mutual correlation.

The three study cases give us a scenario with a wide variability of themes data to be collected for monitoring tasks. The indeterminacy and variability of the data to be managed by the Looper platform forced to design a "flexible" data model that would allow to access different types of georeferenced data in different ways. The risks highlighted by Gasson (1999) relating to the technical approach in the development of Information Systems, have been mitigated by the strategic choice to subordinate the technical development to the content design and the definition of multi-actor data collection methods creating an effective "peer cooperation" between IT team and design team by involving a designer with specific technical skills. As Curtis et al. (1988) said while arguing about the "expert designer", the cohesion of the team can be greatly improved if the designer holds special IT skills because this allow him to proficiently and effectively interact with the technical developer.

The last identified main issue concerns frequent situations of distrust or contrast between actors that hinder fruitful cooperation. As well described by Mayr et al. (2019), issues about

“trust” in data usage is mainly related to provider credibility and its good relationship with the final user. However, also transparency is a key factor, and it is related to the possibility to access original data from which a processed information is obtained. This means that the willingness of actors to positively accept some provided data is related both to the acceptance of the source and to the way data were processed.

5.2 A user-centered data model

Bertin (1977) has clearly shown that information has a multi-layered structure. Basically, the main layers are two: entities and relationships - concept also known in database theory. This means that to design new IT tools, information designers must work very closely with technical developers. Cases such as Looper demonstrate a key point: the database structure modelling phase belongs to the content design, rather than the container design; this means that it is a task that designers must carry out, rather than the technical developers, as happens in most cases.

As already mentioned, the User Centered Design approach in developing the data model in Looper specifically aims at improving proximity of people. The first method used for this purpose was called “Problem Framing” and focused at designing the data structure needed to store and process the data coming from the multitemporal monitoring campaigns carried out by ULLs. As shown in Figure 3, the Problem Framing is fuelled by the results of a preliminary phase aimed at finding the issues on which the ULL wants to work.

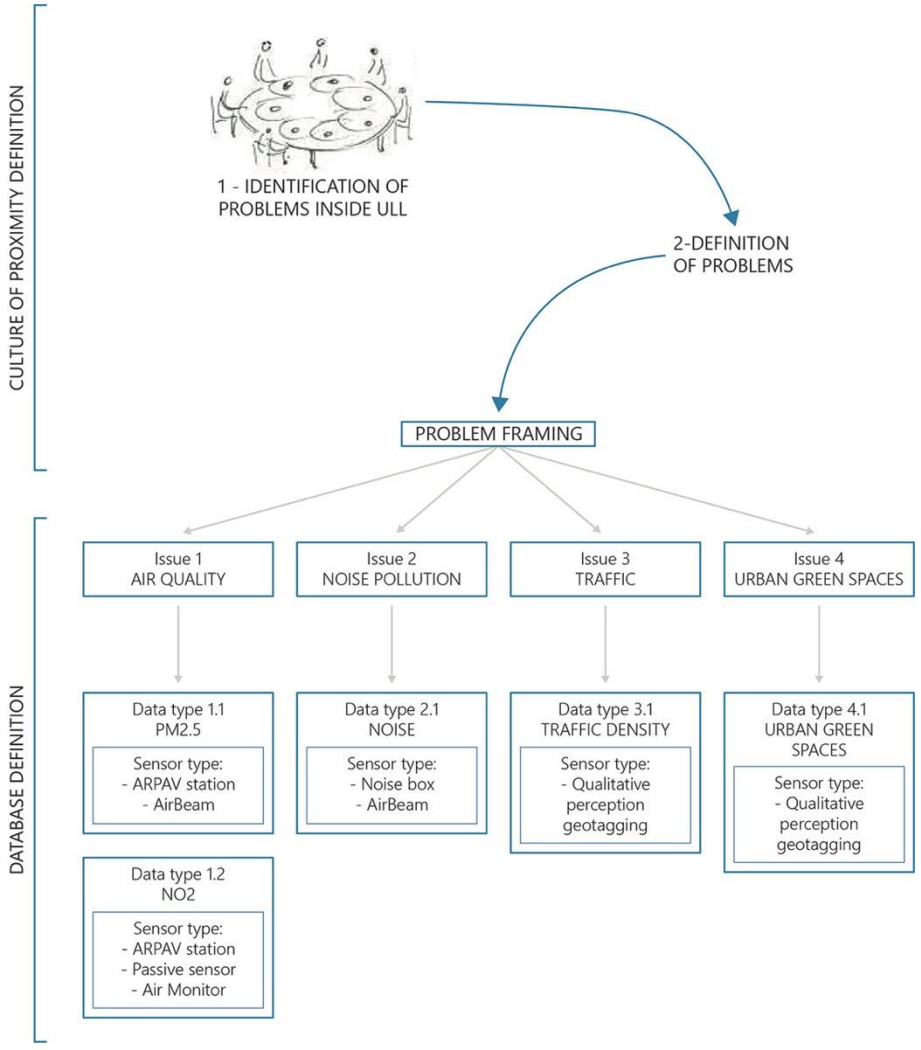

Figure 3. Data model of the Verona case study. Here data to be uploaded in the database are defined to allow a common framework for the three study cases.

A two-layer - issues/data-type - data structure came from the results of a special survey aimed at finding needs of each ULL. The semantic relationship between the two layers is the capability of each data-type to support decision process about one or more issues. More in depth, the data model structure is further divided into other entities: from data-type to raw-data, sensor-type, campaigns, sensors and, as regards geolocation, measuring-spots (for point geolocation) and grids (for distributed geolocation).

5.3 Data visualisation tools

Designing the Looper platform, as result of the problem framing, some choices have been made regarding the data model definition, however, other choices made are more related to visualization and interaction concerning map layers structure, data processing, interactive tools and maps symbology.

In terms of map layers structure, the choices were basically two: the separation of all data into simple layers by type of measured phenomenon (only one type of information for each map layer) and the layers grouping by source. The separation of different sources helps to perceive the difference in data accuracy implicitly related to the collecting methods, and it allows to simplify the symbology as much as possible so to reduce the cognitive effort endured by the user (cf. Ware, 2004).

The choice not to process and integrate datasets, providing simple and direct - uninterpreted - layers is intentionally aimed at increasing credibility of the source and trust in the end user-provider relationship (cf. Mayr et al., 2019). It also eases to apply quantitative symbols according to Rensink's "carriers'" definition: "visual property that conveys quantitative information" (Rensink, 2018), which maximizes the effectiveness of visual communication of measured phenomena.

As regards to interaction, according to Kirsh (2004), the goal is to "reduce the complexity of choice" in the perception of how to explore data and better understand map content. Furthermore, to reduce the usability gap between more and less digital skilled users, map based interaction has been limited to the two basic actions: "click to get info" and "drag to pan", leaving out other typical functions such as "drag to select", "drag to zoom-in" etc.

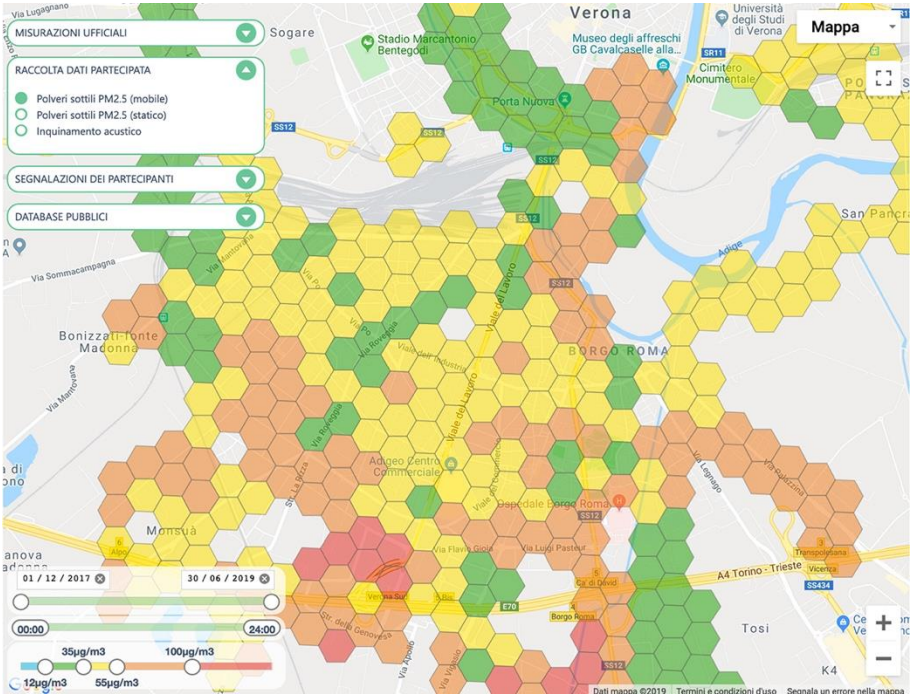

Figure 4. Example of visualisation of data collected with a participatory sensing tool that works with a continuous in movement method. Each hexagonal cell shows one value that is the average of all data collected within the area defined by the cell, and in the timeframe defined by the scrollers on bottom left.

In some cases it was necessary to make some data pre-processing because of visual and technical ineffectiveness of displaying raw datasets; this is the case of all distributed monitoring campaigns resulting in millions of point data that had to be interpolated upon a fishnet layer (Figure 4) and styled using the colour carrier (Rensink, 2018). In this particular case, a special tool has been developed in order to enable users to customize styles in real time - mitigating the perception of viewing already interpreted data.

5.4 Co-design tools

Like the display section of the Looper web platform, the co-design section is also designed as an asynchronous multi-actor remote repository, that is a dynamic and implementable storage system of useful digital resources that can support ULLs decision processes.

Even if hosted on the same platform, the two sections have been deliberately kept independent; no data available in the co-design section is dynamically linked to any other stored in the monitoring section, precisely to enhance interpretation of live data during ULL

activities carried out in a participated way leading to the development of solutions through direct interaction of the actors.

Technically, the online co-design tool, developed by Urbanista, was developed using a WordPress plug-in (Figure 5). This tool was chosen due to the possibility of adapting styles according to the main website, its easy integration and user-friendly mode with few steps needed to insert a new idea.

Figure 5. Example of the online co-design page that firstly shows a map with the proposed ideas localised in the project area, and by scrolling down shows a grid with the ideas and their description.

The proposed solution or ideas can be easily uploaded by filling few fields of the format as per the following Figure 6. Out of the seven fields only four are mandatory - 1. Category, 2. Title, 3. Description and 4. Name or nickname - while the others are optional. The category field is a drop-down menu from which to choose a category, this allows to later evaluate the proposed solutions easily as they can be grouped. The title and description fields instead are free fields and have no minimum or maximum number of characters.

The structure of this online co-design tool also allows a storage of the solutions proposed during the offline meetings, as it is possible to mark them by using a nickname that refers to the meeting date.

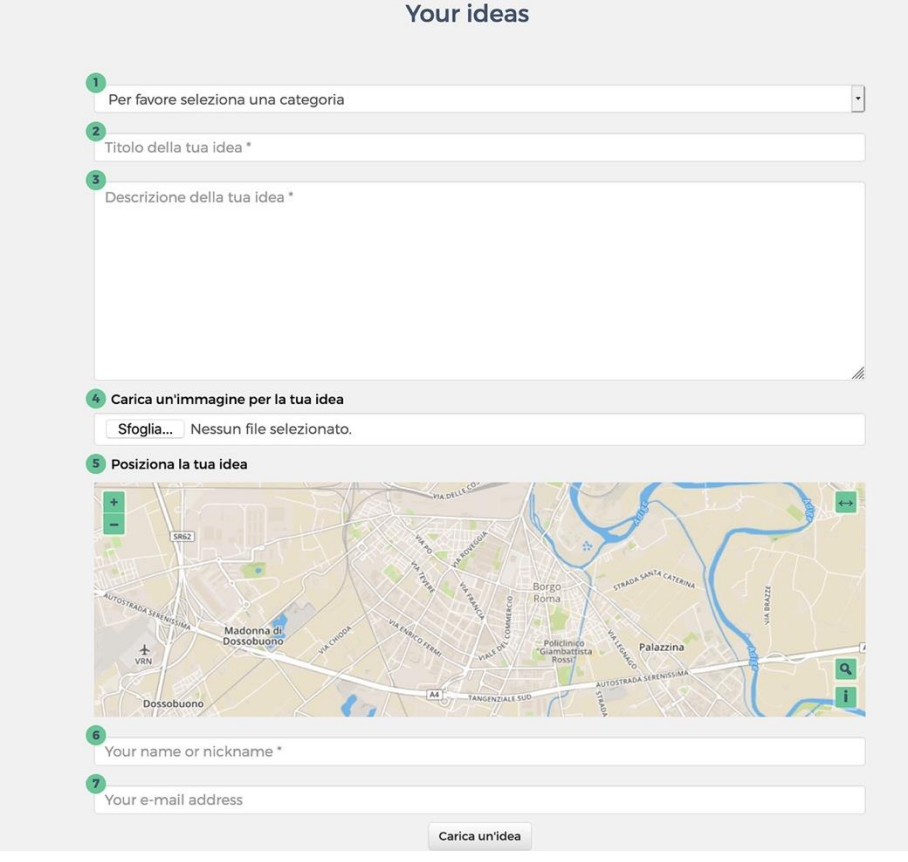

Figure 6. Ideas upload format. From the map, users can add the location for the proposed solution.

6. Conclusion

Within this framework, ICT and interactive tools need to be designed and inspired not to support activity of collaboration between people further away - and to create a global network, but need to be designed to support a culture of proximity that is focused towards the improvement of people's liveability in urban places.

Within the Looper project it was possible to have an evaluation of the platform from a co-creation process point of view (Figure 7), since the aim of the platform itself was that of enhancing participation even for users who could not come to offline meetings.

ICT tools are then of mixed use due to the proximity concept, meaning that they are feasible both in their online version and in their collective usage during offline meetings.

HAS BEEN THE PLATFORM USED BY ORGANISERS?	
Comments	*Organisers mostly used the platform as it helped to organise and keep a focus during the workshops done with stakeholders. The platform was also used within internal meetings to always have control of what was happening during the project* *This happened both during the first and second loop*
N° of data layers	*13 (first loop)* *15 (second loop)*
HAS BEEN THE DASHBOARD USED BY USERS?	
Comments (by organisers)	*Users used the dashboard both during the first and the second loop*
N° of accesses	*1607 (2018)* *714 (2019)* *23 (2020)*
Its usage during living labs sessions?	*The dashboard was mostly used during living lab session of the first loop*
USABILITY	
Comments by (organisers)	*Users asked the implementation of the scrollers (timeline) for a more detailed visualisation of the AirBeam data in different periods, they also found interesting the acoustic zoning layer once added*
User feedbacks	*They found the dashboard feasible and user-friendly for their needs*
DOES THE DASHBOARD TRIGGERED LEARNING PROCESSES?	
information ('know-what')	*Participants learned the importance of the participatory data collection as they could see how many data they could collect all together* *This happened both during the first and second loop*
networks ('know-who')	*No. The dashboard did not allow direct interaction in-between different stakeholders since it is a visualisation tool.* *This happened both during the first and second loop*
skills / resources ('know-how')	*Participants learned how to read collected data in a clearer way* *This happened both during the first and second loop*
norms / goals ('know-why')	*Based on the shown results, participants better understood why official sensor are not positioned too close to each other.* *This happened both during the first and second loop*

Figure 7. Platform evaluation for the Verona ULL

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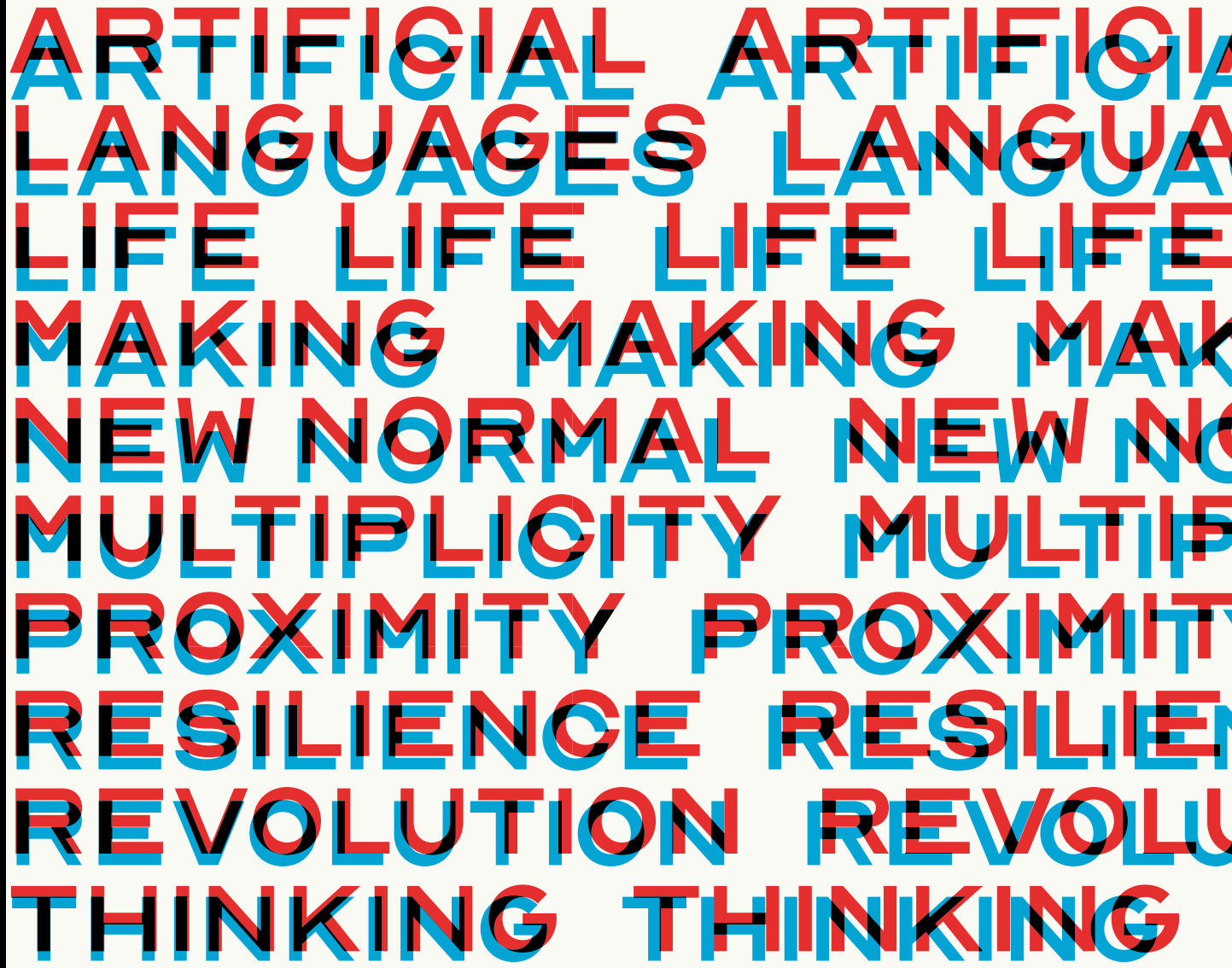
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