Citizen Involvement in Local Environmental Governance: A Methodology Combining Human-Centred Design and Living lab Approaches

Sandrine Reiter, Guillaume Gronier and Philippe Valoggia
Public Research Centre Henri Tudor, Luxembourg
sandrine.reiter@tudor.lu
guillaume.gronier@tudor.lu
philippe.valoggia@tudor.lu

Abstract: Nowadays, involving citizens in Local Environmental Governance (LEG) is becoming increasingly important. In order to empower the role of citizen in this context, we propose an approach that relies on the establishment of a physical and intellectual space for shared understanding and collaboration between all stakeholders impacted by an environmental problem (in our case odour emission). Based on the development of an Information Technology (IT) system allowing odour emission measurement as well as the collection of citizen feedback, a Living Lab (LL) approach is being implemented that involves citizens, public authorities, industry and environmental non-governmental organisations (NGOs). According to the definition of the European commission, Living Labs are "open innovation environments in real-life settings, in which user-driven innovation is fully integrated within the co-creation process of new services, products and societal infrastructures". Based on this definition and considering, in our case, citizens as one of the end-users of the IT system, we argue that such an approach will empower their role in local environmental governance. This article presents the method and techniques that will be used in order to set up such a Living Lab. More precisely, we focus here on the first step of this method: defining the components that will support the management of a Living Lab relying on an IT system. This step consists in the identification of the Living Lab stakeholders (citizen, industry, public authorities, NGOs, etc.), including their characteristics, fears, expectations, involvement and engagement regarding the Living Lab. To do this, 2 main approaches are being combined: A Living Lab approach that aims to involve citizens in local Environmental Governance (LEG) design. Use of Human-Centred Design (HCD), to combine IT developments and LL needs, for example Personas methodology and usability test. A Living Lab relies mainly on stakeholders' involvement in order to build trust and establish a common goal. In this sense, sociologists' approaches ((Akrich et al. 2006);) bring valuable information on how to mobilise different actors in order to innovate (Actor Network Theory). However, in the innovation process, these approaches are only considering human actors and do not take into account any technological aspects. However, if Living Labs are relying on human actors' interactions it should also take into account their interactions with the IT system it is based on. In this case, Human-Centred Design (HCD) being an approach that aims to make IT systems usable and useful by focusing on the users, their needs and requirements, is to be considered as complementary to the sociologists approaches. This article, based on the work performed in the FP7 European project OMNISCIENTIS, presents the theoretical context in which this study takes place as well as the overall methodology.

Keywords: citizens' involvement, living lab, environmental governance, human-centred design

1 Introduction

Currently, one of the main concerns in environmental governance is to be able to build real partnerships between public authorities, private industry and citizens. From this perspective, citizens' involvement is becoming increasingly important. However, it is not always clear how to bring all stakeholders into the process and achieve a common goal, with each of them having their own interests. Most of the time in this governance process, citizens are considered to be data producers rather than real contributors such as public authorities and private industry. In order to really involve citizens in local governance, they should be given the opportunity to become more active than passive.

This article is based on the work performed in the FP7 European project OMNISCIENTIS ((Ledent et al. 2013), (OMNISCIENTIS 2014)). In this project, we propose an approach which relies on the establishment of a physical and intellectual space which drives the management of interaction between industry, citizens' representatives and public authorities impacted by an environmental problem (odour emission).

Based on the development of an Information Technology (IT) system allowing odour emission measurement as well as the collection of citizen feedback, a Living Lab (LL) approach is being implemented that involves citizens, public authorities, industry and environmental non-governmental organisations (NGOs).

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We will first present the context in which the project takes place as well as the process that drives our research. This process is divided into 2 main components: Human-centred design and Living Lab approach, which interact within each other. As a consequence, the following paragraphs will focus on the theoretical base of these 2 approaches. At the same time, we will put forward the options and methods that have been retained and applied to the OMNISCIENTIS project.

Finally, we will conclude by presenting the perspectives of the ongoing project and associated research.

2 The OMNISCIENTIS context

2.1 The OMNISCIENTIS project

Odour is recognized as a strong or even severe nuisance. Be it emitted by industry, landfill or livestock breeding, odour is listed as the second source of complaints by the Environmental Agency ADEME in France and the Environmental Policy in Wallonia (Belgium). Odour cannot be monitored or regulated like a pollutant: its perception is linked to a human sense and it must be evaluated in terms of impact and potential to annoy. In contrast to air pollutants or noise, odour monitoring and regulation is a complex issue and odour regulation in Europe is supported by non-homogenous concepts and approaches. Industrial companies usually develop strategies to mitigate the olfactory impact of their production processes on their neighbours, within existing regulations (use of masking products, adjustment of production to cope with legal constraints). Until now, however, citizens have been considered “victims” appealing against odour nuisance. Sometimes they may be asked to contribute to solving the problem in “passive” observatories, allowing them to complain but, in the majority of cases, without getting feedback in return. Their input is seldom used to validate the results of models or measuring devices such as e-noses (Ledent et al. 2013).

In this context, the challenge of the EU-funded OMNISCIENTIS (Environmental Information System and Odour Monitoring based on Citizen and Technology Innovative Sensors) project is the integration of citizens as “community-based” observation providers, sharing their odour perception and level of discomfort, and getting feedback in real time from a learning monitoring system. The level of annoyance depends on how odours are emitted and in what intensity, their dispersion under ambient atmospheric conditions and finally on citizens’ exposure and perception. The Environmental Information System and Odour Monitoring developed in the project OMNISCIENTIS brings together state of the art technologies and open communication capabilities in order to mitigate odour annoyance. The project allows for citizen feedback, deepens knowledge on odour measurement and management and aims to support harmonised legislation at EU level. Moreover, the project results can provide savings to industries. The primary focus is an information system that will allow residents to serve as human sensors, acting according to sociological patterns, to share their perceptions of the discomfort and nuisance caused by odour. It will provide a dedicated tool to consider odour acceptability using community-based opinion. Due to the subjective nature of odour perception, odour monitoring and fast modelling is used to assist and adjust the information citizens provide via a geo-mobile application and obtained by e-nose and modelling. The whole information system, including the geo-mobile application that gathers citizen observations and the platform where the data are stored, is called the “monitoring system”.

Innovative in-situ sensors will be optimised to monitor exposure to ambient odours. A specific odour dispersion model system has been developed to obtain inter-related spatial odour exposure levels. This fast and innovative system will help us to evaluate the performance of measures taken at the very moment that odours are emitted and with respect to the way in which these occur. The Living Lab approach ensures stakeholders involvement and citizens’ participation in decision-making, while also supporting dissemination activities. The results will be conveyed to stakeholders and the general public.

2.2 Process description

The OMNISCIENTIS project aims to involve citizens by combining two participation strategies:

- A Human-Centred Design approach to involve citizen in monitoring system design, including the geo-mobile application and the web platform named OdoMis;
- A Living Lab approach to involve citizens in local Environmental Governance (LEG) design.

The first approach aims to reduce technical constraints to citizens’ involvement, while the second aims to give meaning to participation.

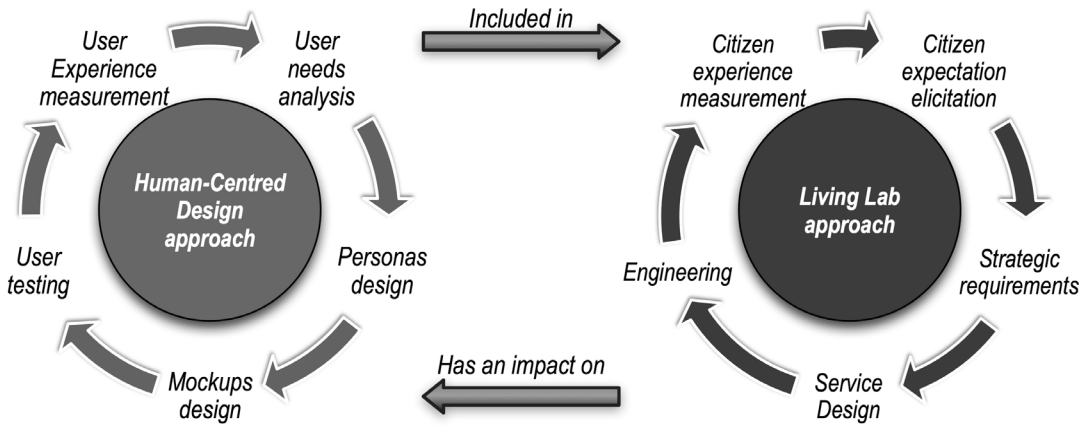

Figure 1: Participation strategies for citizen involvement

In the following sections, we will describe both approaches and explain how they are used in the OMNISCIENTIS project in order to allow for better citizens involvement.

3 Human-centred design approach

According to the norm (ISO 9241-210 2010), Human-Centred Design (HCD) is an approach to interactive system development that aims to make systems usable and useful by focusing on the users, their needs and requirements, and by applying human factors, usability knowledge and usability techniques. This approach enhances effectiveness and efficiency of the developed system. It improves user well-being and satisfaction, as well as accessibility and sustainability. Finally, it counteracts any possible adverse effects of use on human health, safety and performance. A Human-Centred Design lifecycle, involving users in design and development, provides a valuable source of knowledge about the context of use, the tasks users are likely to carry out, and the future use of the product.

We have adopted a Human-Centred Design approach for the OMNISCIENTIS project in applying 5 ergonomic methods, which will be described below:

- User needs analysis
- Personas design
- Mock-ups design
- User testing
- User Experience measurement

This approach has been applied in order to monitor the IT system, including the geo-mobile application and the web platform OdoMis.

3.1 User needs analysis

Citizens' needs were collected using focus group methodology. A focus group brings together a cross-section of stakeholders, or users, in a discussion group format (Maguire 2001). This method is useful for elicitation of requirements and can help to identify issues that need to be tackled. The general idea is that each participant can act to stimulate the ideas of the other participants, and that, thanks to the discussion process the collective view which is built is greater than the sum of the individual parts.

During this phase, we have collected a set of needs that helped to establish the specifications for the development of the monitoring system. For example, citizens expressed the need to receive information on the watchmen network, or on odour emissions from the polluting industry.

3.2 Personas

In theatre, a persona (meaning "mask" in Latin) refers to a role played by an actor. In Human-Centred Design, a persona is a detailed representation of an example user (Rind 2007). Personas are fictional characters, based on actual data that depict target user populations. They are fictitious, specific and concrete representations of

target users (Pruitt & Adlin 2006). The persona method relies on previous research and was popularized by (Cooper 1999).

Personas are created as tools to represent needs, desires, skills and environment of one or more groups of real users (Turner & Turner 2011). According to (Pruitt & Adlin 2006), they are "figurative models rather than abstract models, that is, they are constructed to resemble real users, even down to photos, background information, and personal history". In the OMNISCIENTIS project, we designed several personas representing the project stakeholders including the citizens. We used the classical methodology, proposed by (Cooper 1999), in order to define our personas.

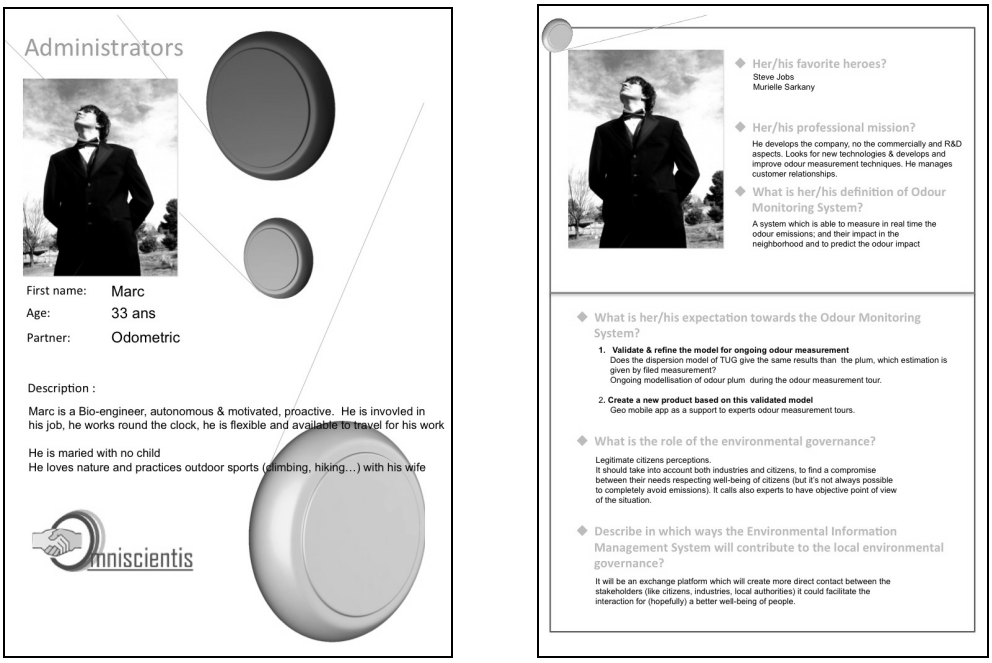

Figure 2: A Persona designed for the OMNISCIENTIS project (front and back)

3.3 Mock-ups

Mock-ups are used by designers mainly to collect feedback from users on design ideas at an early stage in the design lifecycle. Mock-ups are early prototypes made of cardboard or otherwise low-fidelity materials. The user, helped by the designer, may test the mock-up and thus provide valuable feedback about functionality, usability and understanding of the basic design idea.

In OMNISCIENTIS, mock-ups were built from an ergonomic perspective, integrating ergonomic criteria in order to improve the quality of the human-computer interface (Scapin & Bastien 1997).

3.4 User testing

User testing is one of the most revealing methods of human-centred design. System trials are set up and representative users are then asked to perform a series of tasks. The aim is to gather information about the citizens' use of the system, their comments as they operate it, their post-test reactions and the evaluator's observations. The benefit of this method is that the system is tested under conditions close to those that will exist when it is used "for real'' (Maguire 2001).

10 representative citizens were asked to use the geo-mobile application in order to detect the main usability problems. A set of ergonomic recommendations was proposed and will be implemented in the next version of the geo-mobile application.

3.5 User experience measurement

According to (Hassenzahl & Tractinsky 2006), User Experience (UX) is "a consequence of a user's internal state (predispositions, expectations, needs, motivation, mood, etc.), the characteristics of the designed system (e.g.

complexity, purpose, usability, functionality, etc.) and the context (or the environment) within which the interaction occurs (e.g. organisational/social setting, meaningfulness of the activity, voluntariness of use, etc.)".

In order to gather information on the citizens' user experience with the monitoring system, especially the geo-mobile application, we used the AttrakDiff survey (Hassenzahl, M., Diefenbach & Göritz 2010). The first set of results showed that the geo-mobile application was generally well received by citizens.

4 Living lab approach

One of the basic problems in product development is that user/customer needs have to be understood by developers, who are responsible for understanding the options offered by emerging technology (Thomke & Von Hippel 2002). One way to meet this challenge is to bring users directly into the innovation process. Several years ago, a specific user-driven innovation approach known as Living Labs emerged as one of the solutions. We have decided to adopt this Living Lab approach to ensure the development and implementation of Local Environmental Governance (LEG). This section begins by describing the theoretical foundations of the Living Lab, and continues by explaining our strategy to ensure its application to LEG.

4.1 Theoretical foundations

As stated by (Von Hippel 1988), users are more often the source of innovation than the manufacturers themselves. As a consequence, innovations would be more efficient if users were involved in the innovation process from the beginning. One approach, based on user's involvement principle, and which can be used in order to overcome this problem, is known as Living Lab (LL).

Living Labs are "open innovation environments in real-life settings, in which user-driven innovation is fully integrated within the co-creation process of new services, products and societal infrastructures" (EU Commission 2008). Two main characteristics are put forward in LL.

First of all, **end-users** are identified as real **co-creators** in the innovation process. And because users are considered as a source of innovation, they should be presented with prototypes or demonstrators of future products or services during the innovation process (Schuurman & De Marez 2012).

Secondly, the innovation process should take place in a real-world context. Indeed, as stated by (Eriksson et al. 2005), Living Labs are experimental platforms where end-users can be studied in their **everyday** context.

A Living Lab approach gives relevant responses to what (Ballon et al. 2005) have identified as the three Innovation System Failures. The first failure is related to insufficient interaction between stakeholders. The second is a missing or inadequate institution where the innovation process could take place. The last failure is path dependency, i.e. the tendency of the actor to stay within the existing paradigm of innovation. A Living Lab is a physical and intellectual space where an innovation's stakeholders can create and validate "in a collaborative multi-contextual empirical real-world environment" (Eriksson et al. 2005). A Living Lab introduces a new way of innovating by creating an institution where stakeholders can interact in order to develop an innovation.

According to (Bergvall-kåreborn et al. 2009) special attention should be paid to methods and tools allowing the involvement of stakeholders in the Living Lab activities. Moreover, (Fahy & Leon 2007) put forward that the success of a LL is based on several development phases, from which the strategic one is the establishment of the partnership.

Our approach towards setting up and managing the LL development is based on two theoretical foundations. The first is Actor-Network Theory ((Akrich et al. 2006); (Law & Hassard 1999)). Actor-Network Theory (ANT) leads us to consider innovation as socio-technical network development. Managing innovation implies managing socio-technical network development. To do so, we have to pay attention to the development of a "common goal" and to users' *enrolment*. The second theoretical foundation of our approach is given by (Pettigrew 1987). Innovation is seen as a "continuous process in context". This statement assumes that attention is paid to both the context where the innovation takes place and its development process. Context

refers to the "antecedent condition of change [or innovation], the internal structure, cultural and political context" (p.650). According to (Pichault 2013), process depends on sense-making and political strategies.

Local Environmental Governance (LEG) appears as a "societal infrastructure". To achieve this, we have adopted a Living Lab approach that involves different stakeholders. Living Lab Management entails being aware of the context in which it takes place in order to monitor sense-making and power strategies. We have designed a managerial tool that aims to tackle these practical issues and to support the LEG development.

4.2 Management of the living lab

In the OMNISCIENTIS Project, a Living Lab is used to ensure the development of Local Environmental Governance. This LEG refers to "collectivity steering, coordination and control mechanisms" (Scholte 2002) regarding odour emission issues. Based on an Odour Monitoring System, this governance implies the participation of citizens, industrial companies and public authorities. These stakeholders have to together define governance principles regarding odour annoyance. The challenge of the OMNISCIENTIS Living Lab lies in stakeholder's ability to:

- Take an interest in the LEG
- Define a governance purpose, i.e. define a "common goal"
- Find a way to sustain the LEG.

The management of the LL aims to help stakeholders to achieve these objectives. To this end, we have adopted a managerial tool dedicated to bringing different stakeholders together in a common innovation process (Dumont et al. 2011). This tool is structured into five steps.

Before introducing these steps, the context where the LEG development takes place must be defined using a context analysis approach.

This context analysis should provide primary information on 1) stakeholders to involve; 2) state of sense-making and political process. Our analysis was based-on the Alternative Model for Local Innovation developed by (Moulaert & Rodriguez 2005).

4.2.1 Elicitation of citizen expectations

The first step consists in elicitation of citizens' individual expectations. Each stakeholder should already have a specific expectation regarding the issue (i.e. odour annoyance) or context. It's important to help them to make this expectation explicit because 1) this elicitation should help them to see meaning in their involvement in the Living Lab; 2) it will be easier to share it with other stakeholders in order to foster transparency and trust between them; 3) the common goal will be based on these individual expectations. In some case, stakeholders encounter difficulties in defining their expectations. In such cases, it is possible to use creative techniques relevant to the LEG topic (i.e. Odour Annoyance) and the functionalities of the technological component (i.e. Monitoring System).

Based on our expertise in Human-Centred Design, we propose adopting the same approach in order to enrich our earlier work on Personas. This work will lead us to characterise each stakeholder previously identified in the context analysis phase, though what we call the "stakeholder ID card" ((Varvasovszky & Brugha 2000) and (Jepsen & Eskerod 2009)). ID card characteristics are presented in Table 1.

4.2.2 Strategic requirements

After having identified stakeholders and their respective expectations, the LL definition should be focused on the identification of their common interests that will drive the future of the LEG. This should be implemented through the definition of the **Strategic requirements,** which represent the common goal of the LEG. This goal definition is based on expected outcomes, and for each of these outcomes, a list of requirements is defined.

In the proposed approach, the goal, outcomes and requirements are outlined in a **Strategic Map,** which aims to describe the main components of the LEG. Components described in this strategic map represent "overall" requirements. At this stage, nothing is defined regarding the way goals and outcomes will be achieved. This means that this first step is not detailed enough to monitor the future LEG activities during the Engineering

step. In order to be able to perform this future monitoring, the next step is dedicated to, for each entry in the strategic map, the definition of services.

Table 1: Stakeholder ID card components

Stakeholder ID card component	Definition
Characteristic	What sort of person or organisation are they?
Impact on current situation	What impact do they currently have on the situation/project? Are they interested in it?
Main interests/Area of interest	What are their main interests or motivations (in changing the current situation)?
Interests, fears, expectations	How are they likely to react to the Living Lab approach?
Relation to LL (Stakeholders allegiance) http://www.mmu.ac.uk/bit/docs/Stakeholder-analysis-toolkit-v2.pdf	What is the most likely position they will adopt towards the Living Lab?
Potential impact/risk if not involved	How important or serious might the consequences be for the Living Lab (low, med high, critical)?
Strategy: Recommendations, management involvement strategy	How would they be involved in the LL?
Priority	Importance of the stakeholder in the success of the LL (high, med, low)

4.2.3 Service design

In order to operationalize the Strategic Map, stakeholders have to identify and define services that will serve their common interests. During this phase, the technological point of view has to be taken into account, in order to have an overview of what can reasonably be accepted or not. A dedicated actor representing this technical side, has then to be involved in the process with any other stakeholders. If not, the risk is that services that are not technically feasible will be identified but not developed, which will, at the end, reduce individual enrolment.

The next step in the LL process is the **Engineering** stage. Stakeholders are encouraged to try the identified and previously developed services. Their feedback will be collected through an **Experience Measurement** approach. This measure could lead towards a new design stage, or even modify stakeholders' expectations. Once again, we will rely on our experience in Human-Centred Design in order to use the same methodologies as proposed in the user experience measurement phase.

5 Conclusions and perspectives

In this article, we propose an approach experimented within the FP7 project OMNISCIENTIS which aims at involving citizens as real actors in a Local Environmental Governance. In this project, we propose the combination of two participation strategies: a Living Lab approach and Human-Centred Design approach. A Living Lab relies mainly on stakeholders' involvement in order to build trust and establish a common goal. In this sense, sociologists' approaches ((Akrich et al. 2006);) bring valuable information on how to mobilise different actors in order to innovate (Actor Network Theory). However, in the innovation process, these approaches are only considering human actors and do not take into account any technological aspects. However, if Living Labs are relying on human actors' interactions it should also take into account their interactions with the IT system it is based on.

In this case, Human-Centred Design (HCD) being an approach that aims to make IT systems usable and useful by focusing on the users, their needs and requirements, is to be considered as complementary to the sociologists approaches.

We are currently in the phase of eliciting citizen expectations and working on the definition of the stakeholder ID card while moving slowly towards the creation of the strategic map. Further work will be performed in the

coming months in order to build on the work performed in the first phases and further define the methodologies to be used in the next steps (i.e. Service Design, Engineering and Experience Measurement).

By adopting the proposed combined approach, citizens as well as the IT system can become real actors in the Local Environmental Governance. The use of Human-Centred Design techniques will reduce technical constraints that could prevent them from getting involved in the process. The Living Lab approach gives them the opportunity to be identified as one of the stakeholders, and then to take into account their own interests as well as to give meaning to their involvement in the process.

We are currently only at the beginning of the study, which aims at building the Living Lab and its base principles. Further work and studies are still needed, on a more long term basis, in order to improve the process and to ensure its sustainability.

In particular, tools to monitor, to trigger and to support the LEG management will be needed.

Future development will then be dedicated to the presentation of the results. Our intention is to use the concept of "Social Map" in order to present the characterisation of the different stakeholders in the future LL: characteristics and values (services); relations versus influence; responsibility, engagement and prioritisation of the different elements identified in order to plan the LL implementation and ensure its monitoring and sustainability.

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