Citizen involvement in local environmental governance: a methodology combining Human-Centred Design and Living Lab approaches

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Abstract: Nowadays, involving citizens into Local Environmental Governance (LEG) is becoming more and more important. In order to empower the role of citizen in this context, we propose an approach which relies on the establishment of a physical and intellectual space for shared understanding and collaboration between all stakeholders impacted by an environmental problematic (in our case odour emission). Based on the development of an Information Technology (IT) system allowing odour emission measurement as well as citizen feeling collect, a Living Lab (LL) approach, involving citizens, public authorities, industry and environmental Non-governmental organisations (NgoS) is being implemented. 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 the 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 technics that will be used in order to setup such a Living Lab. More precisely we focus here on the first step of this method: defining components which will support the management of a Living Lab relying on an IT system. This step consist mainly on the identification of the Living Lab stakeholders (citizen, industry, public authorities, NGos,…), including their characterisation, fears, expectations, involvement and engagement towards the Living Lab.
To do this, several approaches are combined:

- Use of technics coming from Human-Centred Design (HCD), in order to combine the need of the IT developments and the LL needs: Personas methodology and usability test user.
- Context analysis in order to draw the actual context in which the LL will take place and identify stakeholders.
- Stakeholder's characterisation and management, with a participative methodology (Network ScoreCard Suite - NSC Suite) for the analysis of stakeholders structuration based on a structurationist framework (Giddens 1984).
- Presenting the results thanks to the characterisation of the different stakeholders in the future LL and drawing a "Social Map": characteristics and value (services); relations versus influence; responsibility, engagement and prioritisation of the different elements identified in order to plan the LL implementation and ensure sustainability.

The approach is relying on an *Underlying task: Stakeholders involvement in order to build trust and common goal.* The article presents the theoretical context in which our study takes place as well as the global methodology.

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

1. Introduction

Actually, one of the main concerns in environmental governance is to be able to build real partnerships between public authorities, private industry and citizens. In this perspective, the importance of the citizens' involvement is becoming more and more pregnant. However, bringing all stakeholders in the process, achieving a common goal with each of them having their own interest, is not so obvious. Citizens are most of the time considered, in this governance process, as data producers than real contributors as public authorities and private industry are. 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, citizen's representatives and public authorities impacted by an environmental problematic (odour emission).
Based on the development of an Information Technology (IT) system allowing odour emission monitoring as well as citizen feeling collect, a Living Lab (LL) approach, involving citizen public authorities, industry and environmental Non-governmental organisations (NgoS) is being implemented.

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 next paragraphs of this article will alternatively focus in the theoretical base of these 2 approaches. At the same time, we will put forward the options and methods that have been retained and are applied in the OMNISCIENTIS project.
Finally, as a conclusion, perspectives of the present on-going project and associated research will be proposed.

2. 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; it must be evaluated in terms of impact and potential annoyance on people. In contrast to air pollutants or noise, odour monitoring limitation and regulation are a complex issue and non-homogenous concepts and approaches support the odour regulation in Europe. Industrials usually develop strategies to mitigate the olfactory impact of their production processes on the neighbours, in the framework of the existing regulations (use of masking products, adjustment of the production to cope with legal constraints). Though, citizens are up to now, "victims" appealing against odour nuisance. Sometimes they may be asked to contribute to solve the problem in "passive" observatories, allowing them to complain but, in the majority of cases, without getting feed-back. 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 OMNISCIENTIS (Environmental Information System and Odour Monitoring based on Citizen and Technology Innovative Sensors) project funded by the EU, is the integration of citizens as "community-based" observation providers, giving the odour perception and discomfort and getting feed-back 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 core is an information system allowing inhabitants to serve as human sensors, acting according to sociological patterns, which influence odour perception, discomfort and nuisance. It provides a dedicated tool to consider odour acceptability, based on a 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 geo-mobile application and obtained by e-nose and modelling. The global informatics system, included citizens' observations through the geo-mobile application and the plat-form where data are saved, is called "monitoring system".

Innovative in-situ sensors are improved to monitor ambient odour exposures. A specific odour dispersion model system is developed to obtain inter-related spatial odour exposure levels. This fast and innovative model system helps us to evaluate the performance of measures taken at the very moment odours are emitted and with respect to the way in which these occur. The Living Lab approach ensures stakeholder involvement, citizens' participation in decision-making and supports dissemination activities. The results are conveyed to stakeholders and general public.

2.2 Problematic and process description

Manque de méthodfes associées à l'approche LL => mobilisation des methods UCD dans le cadre du'ne approche socio-technique.

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

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

The first approach aims to reduce technical constraints to citizen involvement. And the second one aims to give meaning to participation.

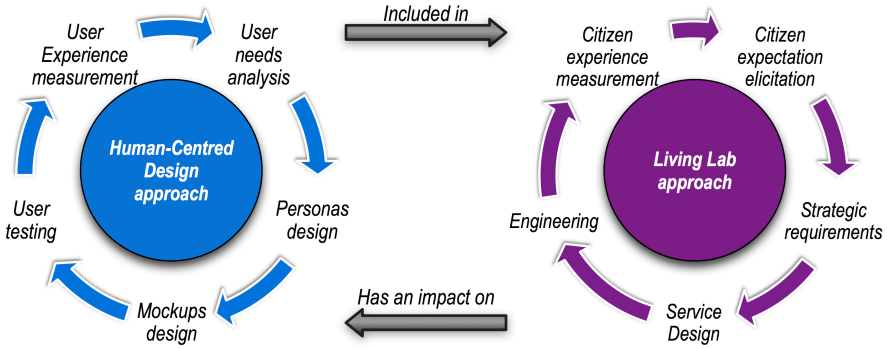

Figure 1: Participation strategies for citizen involvement.

In the following parts, we describe the both approaches and present how they are included in the OMNISCIENTIS project, in order to allow 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, and usability knowledge and techniques. This approach enhances effectiveness and efficiency. It improves well-being, user satisfaction, accessibility and sustainability. Finally, it counteracts 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, and the future use of the product, users are likely to have.

We have adopted a Human-Centred Design approach for the OMNISCIENTIS project in applying 5 main following ergonomics methods that will be described below:

1. User needs analysis
2. Personas design
3. Mock-ups design
4. User testing
5. User Experience measurement

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

3.1 User needs analysis

Citizen's 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 requirements elicitation and can help to identify issues which need to be tackled. The general idea is that each participant can act to stimulate ideas of the other participants, and that, thanks to discussion process; the collective view which is build is greater than the sum of the individual parts.
During this phase, we have collected a set of needs that helped to establish the specification for the development of the monitoring system. For example, citizens expressed the need to receive information on the watchmen network, or on odour emission 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 researches and was popularized by (Cooper 1999).

Personas are created as tools to represent needs, desires, skills and environment of one or more classes 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.

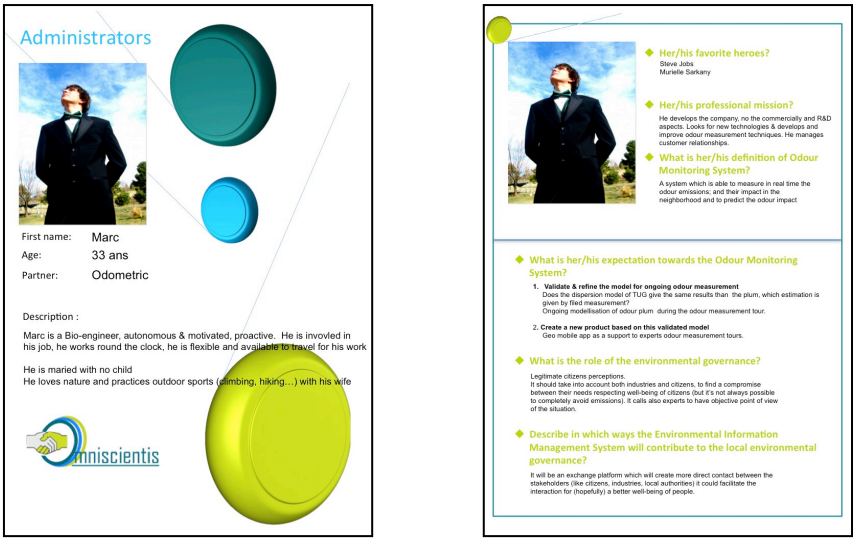

Figure 2: A sample of persona designed for the need of the OMNISCIENTIS project (front and back).

3.3 Mock-ups design

Mock-ups are used by designers mainly to collect feedbacks 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 project, mock-ups are built in an ergonomics perspective, integrating ergonomics 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. The evaluation consists in setting up system trials where representative users are asked to perform a series of tasks with it. The aim is to gather information about the citizens' performance with 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 are implementing for the next version of 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 the user experience of the citizens towards the monitoring system, especially the geo-mobile application, we have used the AttrakDiff survey (Hassenzahl, M., Diefenbach & Göritz 2010). The first results showed that the geo-mobile application was generally well perceived 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, which are responsible for understanding capacities offered by emerging technology (Thomke & Von Hippel 2002). A way to meet this challenge is to bring users directly in the innovation process. Since a few years, a specific user-driven innovation approach, named Living Labs, emerged as one of the solution. We have decided to adopt this Living Lab approach, to ensure the development and implementation of Local Environmental Governance (LEG). This part begins by specifying Living Lab theoretical foundation, 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 including users, from the beginning, in the innovation process. One approach, based on user's involvement principle, and which can be used in order to overcome this problematic, 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-creator** in the innovation process. And because users are considered as a source of innovation, they should be confronted, during the innovation process, with prototypes or demonstrators of future products or services (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.

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 missing or inadequate institution whereby innovation process could take place. The last failure is path dependency, i.e. the tendency of actor to stay with the existing paradigm of innovation. Living Lab is a physical and intellectual space where innovation's stakeholders can create and validate "in a collaborative multi-contextual empirical real-world environments" (Eriksson et al. 2005). Living Lab introduces a new way to innovate by creating an adequate institution where stakeholders could interact in order to develop 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 to set up and manage LL development is based on two theoretical foundations. The first one is Actor-Network Theory ((Akrich et al. 2006); (Law & Hassard 1999)). Actor-Network Theory (ANT) leads us to consider innovation as a socio-technical network development. Managing innovation supposes to manage socio-technical network development. To do so, we have to pay attention to the development of a "common matter" and to user's *enrolment*. The second theoretical foundation of our approach is given by (Pettigrew 1987). Innovation is seen as a "continuous process in context". This statement supposes to pay attention to both the context where innovation takes place and its development process. Context refers to "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 infrastructures". To achieve it, we adopt a Living Lab approach that involved different stakeholders. Living Lab Management supposes to be aware of the context where it takes place in order to monitoring sense-making and power

strategies. We have designed a managerial tool that aimed at tackling those practical issues and at supporting LEG development.

4.2 Management of the Living Lab

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

- Find an interest to LEG
- Define a governance purpose, i.e. define a "common matter"
- Find a way to sustain LEG.

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

Before introducing these steps, the context where the LEG development takes place has to be specified, thanks to a context analysis approach.

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

4.2.1 Citizen expectation elicitation

The first step consists in individual expectation elicitation. Each stakeholder should expect something specific regarding issue (i.e. Odour Annoyance) or context. It's important to help them to explicit its expectation because 1) this elicitation should help them to give meaning regarding their involvement in the Living Lab; 2) it is easier to exchange it with other stakeholder in order to foster transparency and trust between them; 3) the common matter is based on these individual expectations. In some case, stakeholders encounter difficulties to define their expectations. In such a case, it is possible to use creativity technics regarding LEG topic (i.e. Odour Annoyance) and functionalities filed of the technological component (i.e. Monitoring System).

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

ID stakeholder 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, on the 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 their reaction is likely to be 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 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 LL success (High, med, low)

Table 1: ID stakeholders card components

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 is implemented thanks to the definition of the **Strategic requirements,** which represent the goal of the LEG. This goal definition is based on expected outcomes, and for each of these outcomes, a list a requirements is defined.

In the proposed approach, goal, outcomes and requirements are define in a **Strategic Map,** which aims to describe the main components of the LEG. Components described in this strategic map, represent "global" requirements. At this stage, nothing is proposed on the way goals and outcomes will be reached. This means that this first step is not enough detailed 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 of the strategic map, the definition of services.

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 as to be taken into account, in order to give an overview of the what can reasonably been accepted or not. A dedicated actor, representing this technical side, has then to be involved in the process as 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 feedbacks will be collected through an **Experience Measurement** approach. This measure could push towards a new design stage, or even modify stakeholder's 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 citizen as real actor in a Local Environmental Governance. In this project, we propose to combine two participation strategies: A Human-Centred Design approach and a Living Lab approach. These two approaches and their interaction have been presented in this article. We are currently in the citizen expectation elicitation phase working on the definition of the stakeholders ID card moving slowly to the as well as the strategic map identification. Further work will be performed in the coming months in order to first capitalized on the work performed in the first phases and further define the methodologies to be used the next steps (i.e. Service Design, Engineering and Experience Measurement).

Adopting the proposed combine approach, citizens become real actors in the Local environmental governance. The use of Human-centred design technic to reduce technical constraints that could prevent them to get 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 works and studies are still needed, on a more long term bases, in order to improve the process and to ensure its sustainability.
Especially, tools to monitor, to trigger and to support the LEG management will be needed.
Future developments 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 value (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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