Methodological Framework for LIVING LABS in European Cities

C3PLACES Project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 693443.

Methodological Framework for LIVING LABS in European Cities

Executive Summary

C³PLACES aims at developing the strategies and tools to increase the quality of public open spaces through Information and Communication Technologies **(**ICT) by influencing positively co-creation and social cohesion effects. The proposed methodology covers the coordinated implementation of the case studies - each one devoted to different *user groups* and different *types of public spaces* - enabling C³PLACES to reach a wide range of users and urban spaces typology. The case areas identified will give an overview of state-of-art in the interaction between *people - places* and *technology and* will serve as Living lab for exploiting new approaches. The Methodological Framework for LIVING LABs in European Cities sets the guidelines for application of **C³PLACES** framework in 4 national Living Labs and supports their coordination. The cases of Living Labs address communities' or government initiatives, stakeholders, existing and new ICT-based applications from local and global industrial companies. The data and information collected on selected public open spaces in Belgium, Italy, Lithuania and Portugal enables **C³PLACES** to analyze and compare expectations, behaviors and attitudes of different user groups. The proposed methodology is mainly concerned with assessing and monitoring the impacts and processes before, during, and after the implementation of cases where co-creation plays a vital role. The Methodological Framework consists of the Methodology for Exploring LIVING LABs, the Template of LIVING LAB Work Plan and the Template of LIVING LAB Report. Proposed frameworks enable uniform collection of data, generalization of gathered data in Living Lab studies and comparability of the results.

1. Aim of LIVING LABs

C³PLACES has as a primary objective to develop knowledge and know-how to design attractive, responsive and inclusive public spaces by integrating efficiently social value to ICT solutions. LIVING LABs focus on following objectives:

1. To better understand the impact of ICT on improving public spaces' enjoyment, quality and accessibility > *attractiveness of public space*;
2. To investigate **co-creation approach and multi stakeholder perspective,** to be implemented by **announcing call for international and local industrial companies to provide their products for public open spaces** that an international interdisciplinary team will investigate, also by establishing a local sustainable structure for co-creation with users > *inclusiveness of public space*;
3. To explore new dynamics of user's behavior and characteristics of public places from social, technological, and urban design perspectives by **implementing scientific research in different countries** focused on local context and needs of different social groups > *responsiveness of public space*.

Methodological framework provides the background for testing the working hypothesis of **C³PLACES**:

A. Participatory processes mediated and facilitated by ICT result in the design of public open spaces (POS) that are more appreciated and more frequently used by local inhabitants that may or may not have taken part in the participatory design process.
B. Introduction of cyber-aspects (IoT, augmented reality, etc. …) in POS increases the quality of experience (QoE) of these spaces and attracts users that have been underrepresented: teens, elderly, people with special needs, etc.

The proposed methodology is mainly concerned with assessing and monitoring impacts and processes before, during, and after the implementation of several case studies where co-creation plays a vital role. Apart from the innovative digital technologies that will be deployed in the POS, also innovative tools for assessment will be used.

2. Methodology for Exploring LIVING LABs

The methodological background for LIVING LABs is based on social indices calculation approach. Scientific literature (Handbook on Constructing Composite Indicators, 2005, Saisana et al., 2005, Huggins, 2003) defines a (complex) index as an instrument for qualitative or quantitative assessment of certain domain that is composed of individual sub-indicators and is used to compare various analyzed subjects. The index method is typically used to incorporate separate statistical values that

may be described using different scales and numeric characteristics into a certain measurement system.

The proposed **C³PLACES** methodology offers a framework to evaluate and compare the interaction between people-places-technology and identify cases that can be potentially transformed into effective co-creation ecosystems. For **C³PLACES** framework, Digital Co-creation Index (see Figure 1) was developed consisting of 3 Sub-Indexes: **Place Attractiveness Index, Digital Inclusiveness Index, Social Responsiveness Index.**

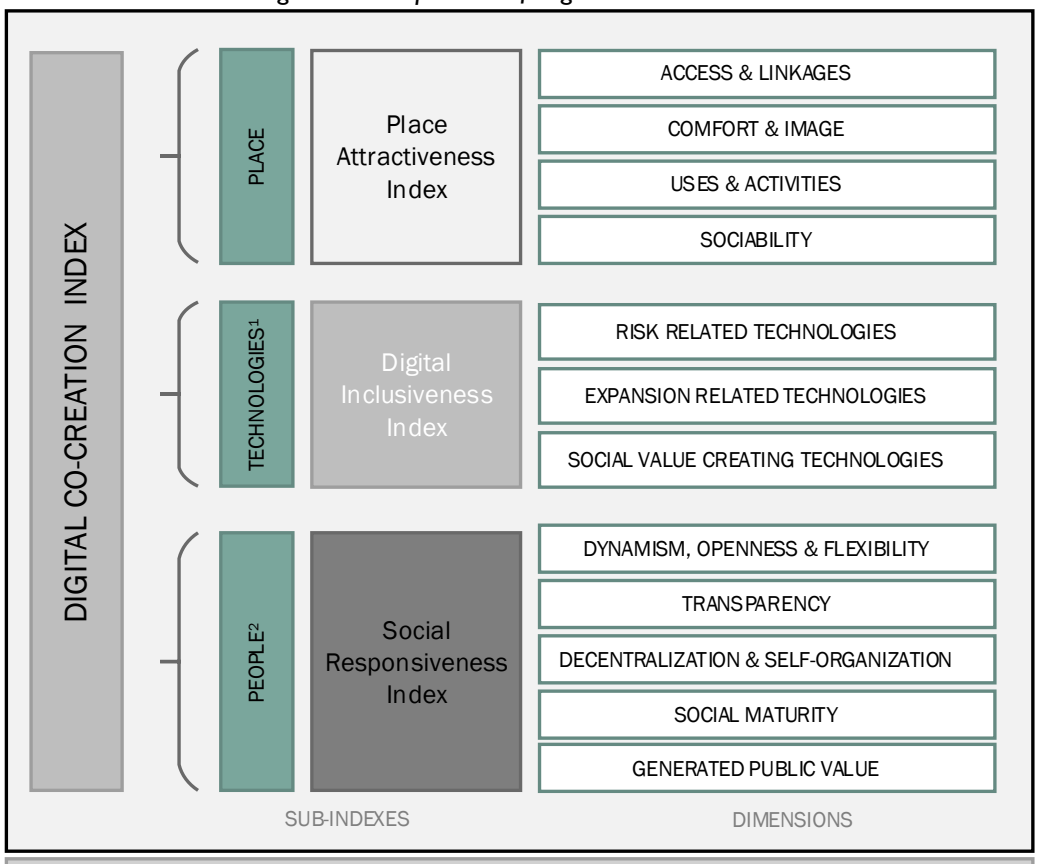
Place Attractiveness Index evaluates the attractiveness level of an observed public place through the qualities of places.

Digital Inclusiveness Index explains technological readiness of the place for enabling co-creation and measures preconditions for the inclusiveness of public places.

Social Responsiveness Index refers to the co-creative maturity of actors (stakeholders and community members) in responding to the social challenges and in generating the public value.

Each component related to the dimension reflects from grouping of different indicators, as presented in Tables 1,2 and 3.

Figure 1. Composition of Digital Co-Creation Index



[1,2] Sub-Indexes created based on selected dimensions of Collective Intelligence of Networked Communities Potential Index and adapted for particularities of Digital Co-Creation. Published in Skarzauskiene et al. *Social Technologies and Collective Intelligence*, 2015, www.collective-intelligence.lt/get.php?f.99

Tables 1, 2 and 3 present components of sub-Indexes and methodology of their data collection and evaluation.

Research groups for each Living Lab study may select either qualitative, quantitative data collection methods or a combination of them based on their aims and capabilities. The assessment methodology is provided in Chapter 3.

The Annexes, the Work Plan (Annex 1) and the Report of LIVING LAB (Annex 2), provide guidelines for the research team to implement the case study.

Table 1. Dimensions of Place Attractiveness Index

Criteria	Criteria describing questions	Evaluation guidelines
Access and linkages		
Level of readability	Can you see the space from a distance? Is the interior visible from the outside? Is there a good connection between the space and the adjacent buildings? Or is it surrounded by blank walls? Do occupants of adjacent buildings use the space?	HIGH (if all responses are positive) MEDIUM (if some responses are positive, the rest – negative or vice versa) LOW (if all responses are negative)
Level of convenience for movement	Can people easily walk to the place? For example, do they have to dart between moving cars to get to the place? Do sidewalks lead to and from the adjacent areas? Does the space function for people with special needs?	
Level of accessibility	Do the roads and paths through the space take people where they actually want to go? Can people use a variety of transportation options – bus train, car, bicycle, etc. – to reach the place? Are transit stops conveniently located next to destinations such as libraries, post offices, park entrances, etc.?	
Criteria	Criteria describing questions	Evaluation guidelines
Comfort and image		
Level of captivation	Does the place make a good first impression? Are people taking pictures? Are there many photo opportunities available?	HIGH (if all responses are positive) MEDIUM (if some responses are positive, the rest – negative or vice versa) LOW (if all responses are negative)
Level of comfort and cleanness	Are there enough places to sit? Are seats conveniently located? Do people have is a choice of places to sit, either in the sun or shade? Are spaces clean and free of litter? Who is responsible for maintenance? What do they do? When?	

Level of safety	Does the area feel safe? Is there a security presence? If so, what do these people do? When are they on duty? Do vehicles dominate pedestrian use of the space, or prevent them from easily getting to the space?	
Criteria	Criteria describing questions	Evaluation guidelines
Uses and activities		
Level of vitality	Are people using the space or is it empty? Is it used by people of different ages? Are people in groups? Which parts of the space are used, and which are not (ratio of used/not used space)?	HIGH (if all responses are positive) MEDIUM (if some responses are positive, the rest – negative or vice versa) LOW (if all responses are negative)
Variety of activities	How many different types of activities are occurring – people walking, eating, playing baseball, chess, relaxing, reading? Are there choices of things to do?	
Criteria	Criteria describing questions	Evaluation guidelines
Sociability		
Level of welcoming	Is this a place where someone would choose to meet his or her friends? Are others meeting friends here or running into them? Do people use the place regularly and by choice? Do people bring their friends and relatives to see the place or do they point to one of its features with pride? Do people tend to pick up litter when they see it?	HIGH (if all responses are positive) MEDIUM (if some responses are positive, the rest – negative or vice versa) LOW (if all responses are negative)
Level of interactivity	Are people in groups? Are they talking with one another? Are people smiling? Do people make eye contact with each other?	
Level of diversity	Do people seem to know each other by face or by name? Is there mix by gender? Does the mix of ages and ethnic groups reflect the community at large?	

Table 2. Dimensions of Digital Inclusiveness Index

Criteria	Criteria describing questions	Evaluation guidelines
Risk related technologies		
Security and privacy assurance technologies	Existence of mechanisms for providing secure and legal online and offline activities; Existence of mechanisms for providing the protection of personal data; Existence of mechanisms of message control; Existence of mechanisms for offering anonymity of the ideas.	HIGH (if all responses are positive) MEDIUM (if some responses are positive, the rest – negative or vice versa) LOW (if all responses are negative)
Criteria	Criteria describing questions	Evaluation guidelines
Expansion related technologies		
External and internal networking/ collaboration technologies	Existence of synchronous and asynchronous modes of communication e.g. chat tools, open forums, social platforms, etc. Provided access and integrated service to all devices (handhold, PCs etc.)	HIGH (if all responses are positive) MEDIUM (if some responses are positive, the rest – negative or vice versa) LOW (if all responses are negative)
Criteria	Criteria describing questions	Evaluation guidelines
Social value creating technologies		
Data aggregation & data access technologies	Existence of mechanism to collect data; Existence of mechanism to evaluate and analyze the performance; Existence of mechanism to share and re-use data.	HIGH (if all responses are positive) MEDIUM (if some responses are positive, the rest – negative or vice versa) LOW (if all responses are negative)
Sharing/ creating knowledge technologies	Existence of mechanism to add value to content; Existence of mechanism to generate feedback; Existence of technological solutions for knowledge visualization and organization; Existence of mechanism for idea classification; Existence of mechanism for mass argumentation; Existence of mechanism to create interests' groups.	
Decision-making technologies	Existence of mechanism for collective brainstorming; Existence of mechanism to vote/rank idea/solution; Existence of mechanism to make decision or conclusions.	

Table 3. Dimensions of Social Responsiveness Index

Criteria	Criteria describing questions	Evaluation guidelines
Dynamism, openness and flexibility		
Degree of interaction and engagement	Existence of external links; Existence of opportunities to disseminate knowledge (the content generated by the community); Realization of game-based approach; Adaption for different age groups'.	HIGH, MEDIUM, LOW The researcher evaluates whether knowledge dissemination mechanisms exist from the user point of view. Assessment of whether elements encouraging competition are present. Assessment of whether a clear identification of different age groups and clear communication mechanism designed for specific age groups are present.
Degree of adequate supply of critical mass ("swarm effect")	Number of people in the target communities; Total visits; Unique visitors; Repeat visitors (number or proportion of visitors who have visited the place more than once (ever, or over some period of time); Total participation in site polls and surveys (number of respondents/voters).	HIGH, MEDIUM, LOW Estimations are done on the basis of an average number in general activity: "HIGH" over 50 members/visits "MEDIUM"– from 10 to 50 and "LOW" where members are absent or visits only occasional.
Degree of diversity in the source of ideas	Percentage of females in the community; Percentage of different nationalities and age groups; Number of contributions and or contributors.	HIGH, MEDIUM, LOW The researcher subjectively estimates diversity of visitor's gender, nationality and age based on the acquired data. The diversity is low when the acquired data show that the majority of the visitors involves only individuals of a limited age group, including exceptionally only one gender and one language, and comprises a limited geographical area (e.g., one city). High diversity means balance in gender, use of several languages, inclusions of different geographical areas)
Criteria	Criteria describing questions	Evaluation guidelines
Transparency		
Degree of development of transparent structure and culture	Is it clear how to get engaged? Are procedures of decision making clear? Are functions and responsibilities of co-creation actors clear?	HIGH (if all responses are positive) MEDIUM (if some responses are positive, the rest – negative or vice versa) LOW (if all responses are negative)

Degree of independence	Existence of privacy policy and anonymity possibilities; Equal rights for participants	HIGH (if all responses are positive) MEDIUM (if some responses are positive, the rest – negative or vice versa) LOW (if all responses are negative)
Criteria	Criteria describing questions	Evaluation guidelines
Decentralization and self-organization		
Degree of decentralization and self-organization	Existence of common community norms and regulations; Existence of common community "mental models"; Development of shared vocabulary and other infrastructure.	HIGH (if all responses are positive) MEDIUM (if some responses are positive, the rest – negative or vice versa) LOW (if all responses are negative)
Criteria	Criteria describing questions	Evaluation guidelines
Social maturity		
Maturity of social impact	Degree of civic engagement; Degree of sustainability; Maturity of monitoring (identification) social matters; Degree of diversity in cooperating partners and financing; Feedback from government; Interaction with stakeholders (how many stakeholders are involved?); The extent to which the work connects to local communities; The ability to attract investment from a range of non-DCA sources	Qualitative description: indicators to be developed HIGH, MEDIUM, LOW
Maturity of social motivation	Level of motivation to deal with societal challenges; Level of social sensitivity of Community` members; Adequacy of task to community members motivation; Balance between communities and individual objectives	
Maturity of social orientation	Adequacy to socio-cultural context (local, national, global); Degree of development of improvements and learning processes within the community; Degree of social responsibility	

Criteria	Criteria describing questions	Evaluation guidelines
Generated public value		
Efficiency of problem-solving	Are any ideas/ suggestions provided to the public institutions, governmental entities and authorities? Do any services or products influencing public opinion developed? Is the reputation of the public place formed? Is awareness about social issue increased?	HIGH (if all responses are positive) MEDIUM (if some responses are positive, the rest – negative or vice versa) LOW (if all responses are negative)
New qualities in form of ideas, structured opinions, competencies, etc.	Total number of messages posted (all forms of messaging including forums, blog comments, video comments, etc.); Number of new ideas, decisions, prototypes, activities, innovations, structured opinions; Aggregated position (idea improved after comments) Diversity of created knowledge/products	Qualitative description: indicators to be developed HIGH, MEDIUM, LOW

3. Assessment methodology

The Assessment is a crucial aspect of the Project's implementation, as it provides the context for its impacts to be measurable and should offer the operational tools to describe and compare the different test sites, as well as the same site before and after the strategy implementation. It will establish whether the pre-defined goals have been achieved (or to what extent).

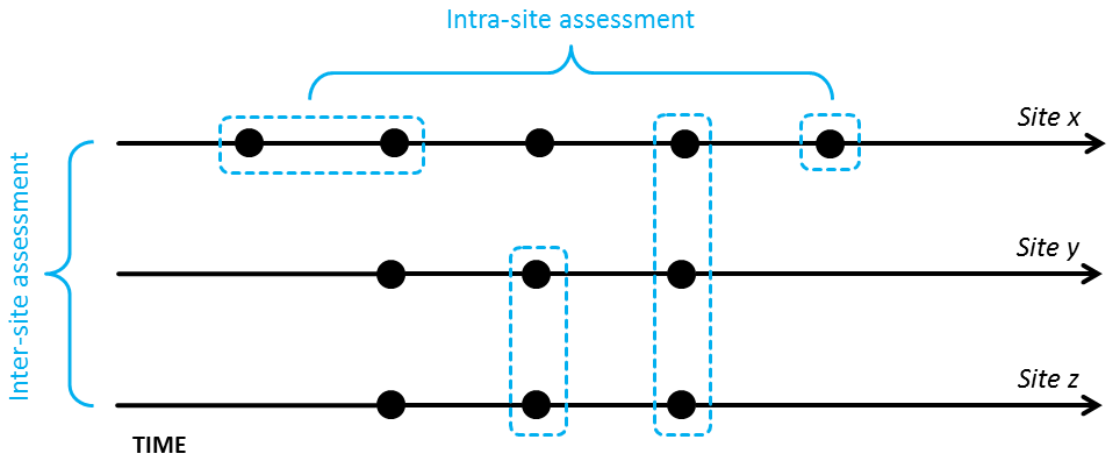
For example, the assessment methodology for **Place Attractiveness Index** established within **C3Places** applies to the users' **Quality of Experience (QoE)** (Möller & Raake, 2014), for which **four main dimensions** are identified for a place (Project for Public Spaces, 2009): uses and activities; comfort and image; access and linkages; sociability. For each of these dimensions, **indicators and corresponding data gathering** methods are identified by the Project as proxy of QoE or 'performance' of the site in general. In order to fulfil to overall Project's goals, it is necessary to define indicators where the contribution of the ICT realm to the QoE and/or performance improvement is clearly identifiable (Barth, et al., 2017).

The assessment of the sites will be **twofold**:

***Intra*-site assessment** – this provides **temporal variability**; the same site is assessed at different moments in time, as a difference between an *ante*- and *post operam* condition (e.g., after the implementation of an improvement) or as a time series for multiple checkpoints (e.g., as an ongoing monitoring for a continuous intervention)

***Inter*-site assessment** – this provides **spatial variability**; having fixed a given moment, different sites are benchmarked on multiple indicators against each other at the same time.

Figure 2. Inter-site and intra-site assessment methodology



For the purpose of this framework we will differentiate between **(1) perceptual assessment items**, and **(2) parametrical assessment items**.

The items of the former group are those where individuals and/or groups (the differentiated target population of each syudy) are actively providing a feedback (i.e., the project is gathering individual responses) and people are assessing something (e.g., QoE dimensions). Such data are collected through questionnaires, web surveys, focus groups with local experts, spontaneous likes, sharing and promoting, etc. The feedback can be provoked in a more classical approach motivating people to participate by lowering participation threshold using ICT.

The items of the latter group, on the other hand, refer to elements that are being 'measured'. Such items might include environmental/physical indicators (e.g., sound levels, light parameters, air quality indicators, presence of people, duration of stay), but also online activity metrics related to the test sites (i.e., analysis of the 'social buzz' through data mining). It should be noted that the parametrical assessment items' group might include elements that are still related to 'subjective' information about the appreciation of a place, but such appreciation is derived/computed indirectly/passively. This could be the case, for example, of parameters related to crowd movements, behavioural observations, density of people in a place, or else (going online) number likes/retweets and so on…

Ideally, at the end of the project, the C3Places framework could be able to provide predictive models for the perceptual qualities, starting from the measurable items. For instance: a predictive model of the perceived QoE, based on online activity metrics and environmental indicators.

Perceptual assessment items

This kind of data is provided by humans, about their **individual responses to the environment and/or experience**. Gathering such data has privacy and confidentiality implications, as humans are source of information, therefore ethical approval will need to be sought from the appropriate committees and institutions in the different countries of the Project. An important influencing factor of the QoE is the **context** of the perceptual assessment. Different levels of context can be identified from a very local individual level towards a societal level (Mantovani, 1996): interaction context (e.g. interaction with artefacts such as devices, applications), situational context (e.g. environment), and socio-cultural context (e.g. society). Although context is an essential component to assess and model, it is often formulated very vaguely or used as a container concept for various intangible aspects of factors influencing product use (Geerts, 2010). Given the widely varying context in POS, taking into account the context of the user will be crucial for perceptual assessment items.

Within the framework of C3Places, perceptual assessment items can be seen under multiple lenses, and can possibly be layered correspondingly. One way of seeing such data is **according to the context where the corresponding experience occurs**. Three main types of experience are identified (Figure 3):

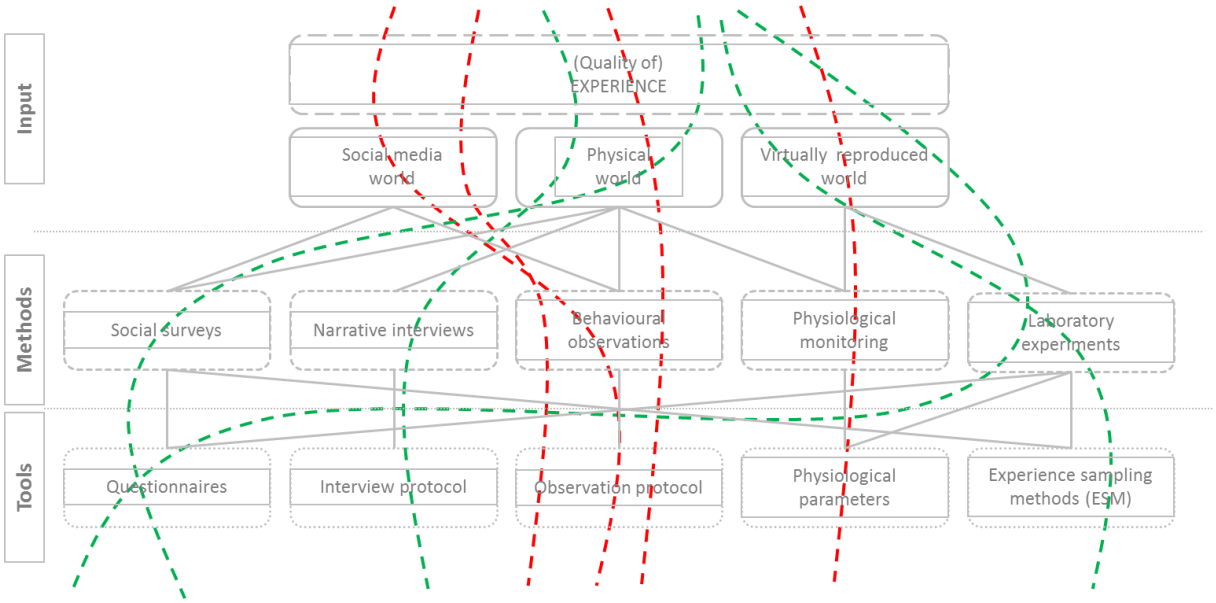
Physical (real) world – this means that data are gathered on site (or off-site in particular circumstances). This approach offers the most ecologically valid option, but limited control of environmental conditions. Therefore, insights might be useful only for the specific situation and could not be generalised (i.e., difficult to establish causal connections). Why only ecological? Is not our interest to understand the features of the place and how people use (or not) them – if such features meet their needs and preferences? In this way causal connections can be established…

Virtually reproduced world – this offers the opportunity for high control of environmental conditions and potential to isolate the effect of single factors, but there might be a lack of ecological validity (i.e., users do not react as they would in the real world).

Social media world – this provides better insights into social and cultural meanings related to the investigated place, level of attention, social 'buzz' and alike.

Another way of looking at the data is the **level of participation and/or awareness of users** during the data collection process. In this vein, data could be collected either in a participatory or non-participatory process (Figure 3).

Figure 1. *Considering the methods proposed before, the figure shows possible* ***participatory*** *(**in green**) and* ***non-participatory*** *(**in red**) paths for data collection.*



Participatory process – in this case users are approached (either in a physical, virtual or social world) and recruited for the data collection. Informed consent is sought from participants (re: Ethical approval) and they are informed about the background and goals of the proposed site's assessments. This approach usually provides more robust and structured information but presents the inconvenient of potentially introducing the "experimenter bias"; i.e., by asking explicitly, the experimenter drives the attention of the user to something (s)he might not have necessarily reflected thoroughly of, and problems could arise (e.g., preconceptions, personal beliefs, etc.).

Non-participatory process – this is the typical case of covert behavioural observations, which could take place either in a physical world, or even on social media platforms. Users are not aware they are being studied and their behaviours assessed. This approach typically rules out the experimenter bias and can grasp individual responses at a spontaneous/unconscious level, but it is usually hard to control for possible confounding factors during data collection.

Parametrical assessment items

Parametrical assessment items will mostly refer to environmental indicators in the physical world or particular activity indicators in the social media world. Environmental indicators will need to be monitored during the experimental period in the test sites of the project to better inform the assessment procedure and potentially look for associations with the perceptual assessment items. Such indicators should also relate to the above four dimensions identified to describe QoE in public space. While the Project might have an opportunistic/mobile approach to environmental monitoring on site in some occasions (e.g., for calibration/validation purposes), it is assumed that most of the

monitoring will be performed through a network of fixed nodes to be deployed in the different test sites. As a general concept, nodes will continuously measure indicators' levels, with a temporal resolution which varies according to the environmental indicator of interest. The sensors' network should be connected to the internet. During the observation period(s), data will be sent over the internet to the server infrastructure located at one of the Project's partners. Data will likely be subsequently further processed through an agent-based approach and stored in a warehouse database. Figure 4 presents the overall architecture of the proposed sensors' network (Dauwe, Van Renterghem, Botteldooren, & Dhoedt, 2012) (Domínguez, et al., 2014).

Figure 2. *General overview of a proposed environmental monitoring sensor network architecture*

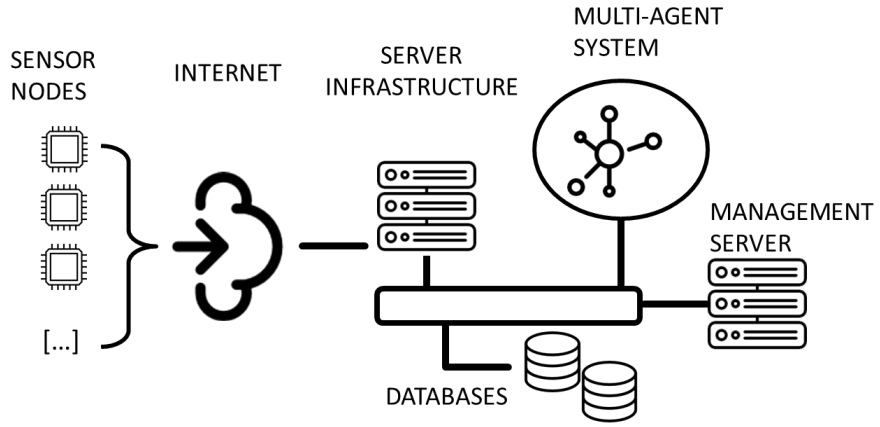


Table 4 proposes a tentative list of environmental indicators that might be monitored during the project and the potential degree of relationship with each of the 4 dimensions used to assess the experience of the public space.

Table 4. *Possible indicators for assessment with suitability for assessing the 4 dimensions determining the QoE of a public place.*

Environmental indicators	Uses and activities	Comfort and image	Access and linkages	Sociability
Equivalent sound levels	++	+		++
Temperature and humidity	++		+	
Daily precipitation data	++	+		
Particulate matter data	++	+		
[…]				

4. Supporting technology and tools for assessment

This section proposes examples of methods/tools for data collection where the ICT/technology component is predominant and provides a brief description of software/hardware requirements to support the process.

Detecting vocal activity

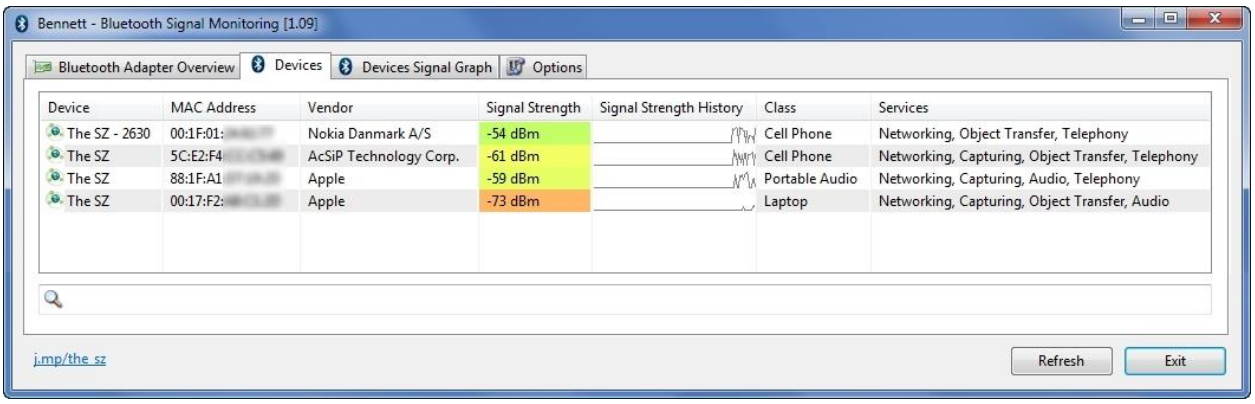
Fixed sound sensing nodes can detect human vocal activity as a proxy of presence of people and their social interactions (Aumond, et al., 2017). High mechanical noise levels (traffic) might interfere with detection of presence of voices. Yet the appropriateness of the place for social interaction is also reflected by this and hence the technique may be sufficiently robust.

Tracing presence and route of Bluetooth devices

Today, many people carry devices that are interconnected through wireless technology. Bluetooth is often kept active to connect for example a phone to a wireless headset or wearable (e.g. smart watch). Any Bluetooth enabled sensor node can detect the MAC address of any discoverable devices that comes into the Bluetooth range (depending on the class, this range goes up to 100 meters). The signal strength can be used to estimate the distance to the sensor node. This technique has been applied to detect the movement of traffic and crowds (Semanjski & Gautama, 2016). Connected sensor nodes can trace for example where people enter and leave a public space and how long they remain inside. The number of people carrying a detectable device may only be a few percent but as the total observation time can be long, the amount of data collected can be sufficient for statistical

significance. The same reasoning can be applied to users' mobile devices that act as a mobile hotspot using tethering. Recent versions of mobile device operation systems make detectability via Bluetooth more difficult, yet the technique could be extended to Wi-Fi detection or even detection of 3G/4G activity using dedicated EM monitoring.

Figure 3. *Example of a tool for Bluetooth device monitoring*



Analyzing social realm

Social media data might be mined to extract semantic information about perceptions and moods of users of the public space (Aiello, Schifanella, Quercia, & Aletta, 2016). This could be done either using APIs for a number of social media platforms or by making specific textometric analysis on specific web *fora*, online community groups, online news, etc. (Gasco, Asensio, & De Arcas, 2017).

Pop-up questionnaire (Experience Sampling Methods)

The Way CyberParks TOOL is being developed within the COST Action CyberParks mainly by Deusto (Spain) and is a result of strong international cooperation of ICTs developers, urban designers/landscape architects and social/behavioural scientists. The TOOL aims at providing support for fieldwork on the interactions between people and the public urban spaces making use of the potential opened up by mobile technologies.

The TOOL CyberParks consists of a smartphone application (app) and a web service. It is developed towards increasing data and insights on how people use public spaces by tracking the users' activities outdoors - collecting paths and time, and by allowing researchers to pose questions to users when asserted Points of Interest (PI) are reached. Both enable the gathering of meaningful data about the use and context opinions. For researchers the web service monitors the tracked paths in real time allowing to visualize people's routes, filtered by gender, age, occupation, or reason for visiting the space, and to analyse the responses of users, regarding suggestions and complains. Besides these

functionalities, the TOOL also provides users with contextual information on PIs through augmented reality, to send suggestions or complains (via text, videos), or to answer the posed questions. The app is used in different countries world-wide including several European countries, South American countries, and India. The area of study can be limited to a specific public area or it can be an extended region (has been tried in Flanders). Motivating citizens to participate remains an important challenge.

When using rating scales in questionnaires, the various response styles of the users have to be taken into account. Extreme response styles of individuals may affect the conclusions. Even cross-cultural differences in the rating scale can be witnessed as well as discrepancies of the rating distributions with national consumer statistics and self-reported actual behaviour (Van Herk, Poortinga, & Verhallen, 2004). This emphasizes the importance of data pre-processing before the actual analysis.

Apps for reporting / citizen's science

The advent of citizen's science has led to a wide variety of tools for measuring or observing the environment and reporting all kinds of disturbing elements (poor roads, neglected infrastructure, etc.) (e.g., (Maisonneuve, Stevens, & Ochab, 2010) (D'Hondt, Stevens, & Jacobs, 2013) (Guillaume, et al., 2016)). For scientific research, the *ad hoc* character of the report or complaint poses an important challenge. Often it is observed that few people complain/observe and repeat their complaints/observations several times (Unsworth, Forte, & Dilworth, 2014). Social reporting is also a feature of the WAY CyberParks…

Counters for explicit feedback

Various explicit feedback mechanisms are implemented as buttons that allow users to express their opinion. Social networks, forums, blogs often use likes / dislikes, up-votes/down-votes (or any other pre-defined mood, like in the case of Facebook) to get loads of data community feedback on the effect their content quickly. A counter for each evaluation option is often used as aggregated statistic to draw conclusions.

Typical examples in the physical world the number of elegit participants may become a significant fraction evaluation systems consisting of total likes/dislikes. Hence a device on site may be preferred. Such a device could easily be developed with five or less buttons, which assess the users' satisfaction with a service or infrastructure. An example is the evaluation of the cleanliness of bathrooms in airports.

These kinds of systems are characterized by their ease of use, simplicity, and quick usage. Users have to spend almost no time on people's memory about an experience is not reliable. Moreover, people that did not visit the POS under study may participate in the evaluation process, and if the platform cognitive burden is open to very limited. As a result, these systems have a high participation rate.

As the information embedded in the simplistic like/dislike response does not give any clue for the detection of the underlying reasons for liking or not liking the POS. A combination with careful sensing of the environment and other opportunistic data obtained from any of the techniques discussed in this section could result in useful data analytics.

Figure 4. *Example evaluation system at the airport of Brisbane*

Embedded self-assessment of use

The intervention in the case studies will often be interactive in some way. They could simply react to human activities, promote new uses of the public space or augment the experience of the physical space. It is straight forward for these technologies to collect basic statistics on their use.

Furthermore, at a smaller scale of observation and with specialized hardware, such as the Microsoft Kinect, specific body movements can be detected; for instance: jumping, waving, hand movements, body position, head orientation, etc. (De Pessemier, Martens, & Joseph, 2017). The accuracy of the detection is influenced by environmental factors such as illumination, background, and the distance between user and camera.

Figure 5. *The Kinect hardware equipped with 2 cameras to track user movements*

Virtual reality for scenarios' simulation

Simulated or reproduced environments (typically in an indoor laboratory) allow for control of the stimuli presented to individuals and might take advantage of Immersive Virtual Reality technologies for the elevated level of realism they can provide. VR technologies make it possible to explore the relationships between causes and effects, which may contribute to theory development. However, because of limited ecological validity, results obtained through such techniques ought to be validated on site (Maffei, Masullo, Aletta, & Di Gabriele, 2013) (Echevarria Sanchez, Van Renterghem, Sun, De Coensel, & Botteldooreen, 2017).

5. CO-CREATION: monitoring the process

Participatory design is not a new concept and first experiences in this direction date as back as the 1970's (Bødker & Pekkola, 2010). However, the approach went from being applied mainly in an organizational context and/or working environment, to having a much broader scope, making use of technologies and other means for users' participation also in non-work settings, like urban design and planning (Livari, Isomäki, & Pekkola, 2010). The Project acknowledges that Co-creation requires significant stakeholder involvement, as well as planning and a structured methodology (Skaržauskienė, Tamošiunaitė, & Žalėnienė, 2013). Within this framework we propose the following steps.

Main phases in the co-creation process

Definition of the problem and context – at this stage, the objective of the design interventions will be identified. This will not include "design solutions" but rather, the reasons for implementing a 'change' and potentially an overall strategy to achieve it.

Pre-assessment – this stage will be developed within the design teams and coordinated by the WP Leader. It will include an assessment of the 'openness' of the design teams with respect to users' engagement and participatory design in each test site.

Sampling – considerations about who to involve (i.e., finding the right participants is the key to successful co-creation). At this stage it will be necessary to identify target users, and involve a combination of primary *persona* types to get different perspectives into the process. Literature seems to suggest 10-15 participants per session.

Session's planning – co-creation sessions will need to be highly structured. At this stage, a detailed script, specific milestones, and sessions' goals will be defined by the session's coordinator. Each session will also have a 'facilitator' to manage the group dynamics and to make the most of everyone involved.

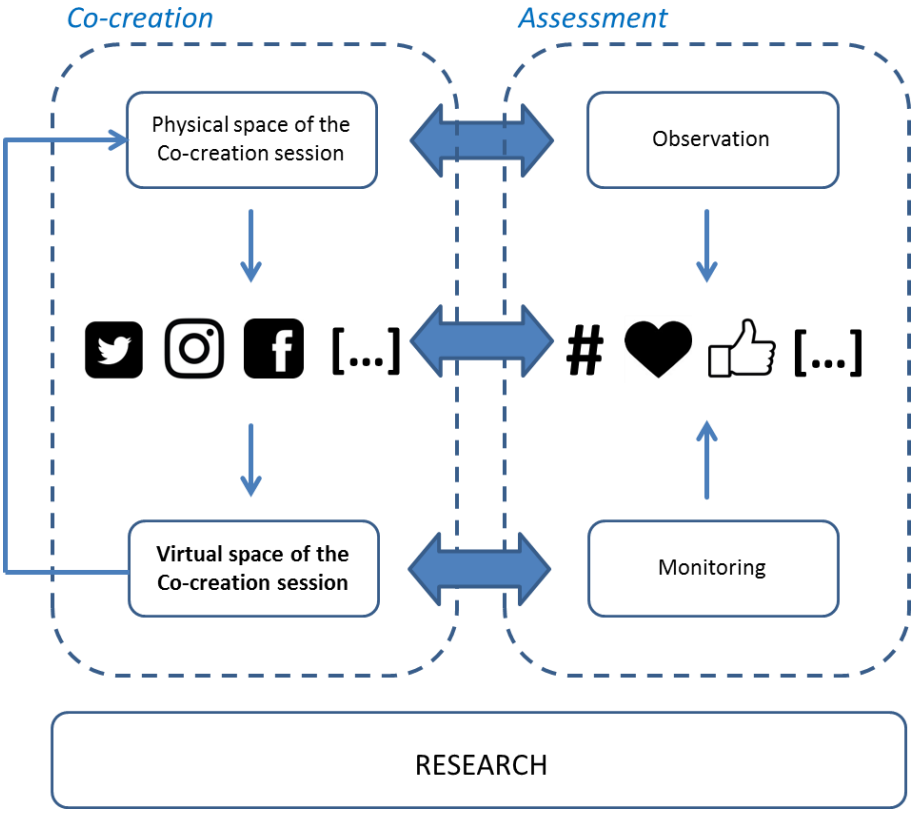
Follow-up – The WP leader will be responsible for informing the sessions' participants about how the outcomes of the co-creation process have been implemented at each stage in the different test sites. It is indeed crucial for the Project to take action and show participants that their insights are valued and used.

Monitoring the co-creation process itself

In addition to investigating the impact of the co-created interventions and designs described above, the various steps in the process of co-creation should also be monitored.

It is worth noticing that the **Project aims to go beyond the sole implementation of** a (set of) **co-creation** session(s). Therefore, C3Places will provide additional ICT tools, to support co-creation processes for POS, as well as make **use of ICTs to monitor and evaluate the different steps of the process**.

Figure 6. *Overall scheme to show how to monitor the co-creation process both in the physical and virtual world*



The (physical) participants of a co-creation session for POS should define themselves their own virtual space. This would include deciding what *fora*, platforms, communities or alike the sessions should use online to develop/enhance the co-creation process. As soon as the virtual space is defined, it will be possible (from the research side) to select appropriate methods and tools/indicators to monitor the evolution of the session and how the virtual space affects the physical one, in the process of co-creating. This should be in accordance with the assessment framework defined in Section 1.

Ideally, there should also be some 'control' sessions where the virtual space and ICT solutions in general are not implemented so to have some cases for comparisons.

ANNEX 1. Template of LIVING LAB Work Plan

WORK PLAN FOR LIVING LAB IN ……..……..…

1. Scope of the LIVING LAB

Description of the area of LIVING LAB. Sketch physical characteristics, usability and other features of the public space selected for your Living Lab. Describe any cultural, societal, technological and regulatory backgrounds that influence or could influence your case study.

Objectives of the LIVING LAB. Elaborate the general aim of the Living Lab with specific objectives in the tables provided below. Keep in mind, that The LIVING LABs approach aims at exploring dynamics of user's behavior and characteristics of public space from social, technological, and urban design perspectives.

What & why?	
Who?	
The Context	
How?	

Objectives:

1	
2	
3	

Description of actors related to the case study. Describe actors (public place users, owners, investors etc.) including partner organizations that contribute to execution of the research. Specify if the case study targets at some specific group (e.g. youth, elderly using the public place etc.).

Research group. Identify the leader and members of the research group (name and surname, affiliation, position and tasks in case study).

2. Methodology for exploring the LIVING LABs.

In the template below, outline the data sources and qualitative and/or quantitative collection methods for each dimension of digital co-creation index.

PLACE ATTRACTIVENESS Index		
Dimension	**Method(s)**	**Comments**
Uses and activities		
Comfort and image		
Access and linkages		
Sociability		
DIGITAL INCLUSIVENESS INDEX		
Dimension	**Method(s)**	**Comments**
Risk related technologies		

Expansion related technologies		
Social value creating technologies		
SOCIAL RESPONSIVENESS INDEX		
Dimension	**Method(s)**	**Comments**
Dynamism, openness and flexibility		
Transparency		
Decentralization and self-organization		
Social maturity		
Generated public value		

3. Research plan and timetable.

Outline of the main activities and their timetable below.

No.	Activity	Time of completion	Responsible researcher	Comments
1				
2				
3				
4				
5				
6	Submission of the report			

ANNEX 2. Template of LIVING LAB Report

REPORT FOR LIVING LAB IN ……...……...….

The report of the Living Lab consists of three parts. Part 1 describes the scope of the Living Lab (retrieved form the Work Plan), Part 2 – presents the results of the Living Lab, and Part 3 – conclusions and recommendations.

1. SCOPE OF CASE STUDY

Description of the area of Living Lab	
Objectives of the Living Lab	
Description of the actors related to the Living Lab	
Research group	
Reflection on the co-creation need and approach that your Living Lab demonstrates	
Research steps and timeframe	

2. RESULTS OF CASE STUDY

The table below provides a template for the results of the Living Lab based on the dimensions of Place Attractiveness Index.

Dimension	Criteria	Evaluation results	Methods applied for data collection and comments
Access and linkages	Level of readability		
	Level of convenience for movement		
	Level of accessibility		
Comfort and image	Level of attractiveness		
	Level of comfort and cleanness		
	Level of safety		
Uses and activities	Level of vitality		
	Variety of activities		
Sociability	Level of welcoming		
	Level of interactivity		
	Level of diversity		

The table below provides a template for the results of the Living Lab based on the dimensions of Digital Inclusiveness Index.

Dimension	Criteria	Evaluation results	Methods applied for data collection and comments
Risk related technologies	Security and privacy assurance technologies		

Expansion related technologies	External and internal networking/ collaboration technologies		
Social value creating technologies	Data aggregation & data access technologies		
	Sharing/ creating knowledge technologies		
	Decision-making technologies		

The table below provides a template for the results of the Living Lab based on the dimensions of Social Responsiveness Index

Dimension	Criteria	Evaluation results	Methods applied for data collection and comments
Dynamism, openness and flexibility	Degree of interaction and engagement		
	Degree of adequate supply of critical mass ("swarm effect")		
	Degree of diversity in the source of ideas		
Transparency	Degree of development of transparent structure and culture		
	Degree of independence		
Decentralization and self-organization	Degree of decentralization and self-organization		
Social maturity	Maturity of social impact		
	Maturity of social motivation		

	Maturity of social orientation		
Generated public value	Efficiency of problem-solving		
	New qualities in form of ideas, structured opinions, competencies, etc.		

3. CONCLUSIONS & RECOMMENDATIONS

References

Aiello, L. M., Schifanella, R., Quercia, D., & Aletta, F. (2016). Chatty Maps: Constructing sound maps of urban areas from social media data. *Royal Society Open Science, 3*, 150690. doi:10.1098/rsos.150690

Aletta, F., Lepore, F., Kostara-Konstantinou, E., Kang, J., & Astolfi, A. (2016). An experimental study on the influence of soundscapes on people's behaviour in an open public space. *Applied Sciences, 6*(10), 276.

Aumond, P., Can, A., De Coensel, B., Botteldooren, D., Ribeiro, C., & Lavandier, C. (2017). Modeling Soundscape Pleasantness Using perceptual Assessments and Acoustic Measurements Along Paths in Urban Context. *Acta Acustica united with Acustica, 103*(3), 430-443.

Barth, J., Fietkiewicz, K. J., J, G., Hartmann, S., Ihan, A., Mainka, A., . . . Stock, W. G. (2017). Informational Urbanism. A Conceptual Framework of Smart Cities. *Proceedings of the 50th Hawaii International Conference on System Sciences.* Waikoloa Village.

Bødker, S., & Pekkola, S. (2010). Introduction the debate section: A short review to the past and present of participatory design. *Scandinavian Journal of Information Systems, 22*(1), 4.

Dauwe, S., Van Renterghem, T., Botteldooren, D., & Dhoedt, B. (2012). Multiagent-Based Data Fusion in Environmental Monitoring Networks. *International Journal of Distributed Sensor Networks, 8*(6). doi:https://doi.org/10.1155/2012/324935

De Pessemier, T., Martens, L., & Joseph, W. (2017). Intuitive Human-Device Interaction for Video Control and feedback. *IEEE International Symposium on Broadband Multimedia Systems and Broadcasting (BMSB).*

D'Hondt, E., Stevens, M., & Jacobs, A. (2013). Participatory noise mapping works! An evaluation of participatory sensing as an alternative to standard techniques for environmental monitoring. *Pervasive and Mobile Computing, 9*, 681-694.

Domínguez, F., Dauwe, S., The Cuong, N., Cariolaro, D., Touhafi, A., Dhoedt, B., . . . Steenhaut, K. (2014). Towards an Environmental Measurement Cloud: Delivering Pollution Awareness to the Public. *International Journal of Distributed Sensor Networks, 2014*. doi:http://dx.doi.org/10.1155/2014/541360

Easteal, M., Bannister, S., Kang, J., Aletta, F., Lavia, L., & Witchel, H. (2014). Urban Sound Planning in Brighton and Hove. *Proceedings of the Forum Acusticum 2014 Conference.* Krakow.

Echevarria Sanchez, G. M., Van Renterghem, T., Sun, K., De Coensel, B., & Botteldooreen, D. (2017). Using Virtual Reality for assessing the role of noise in the audio-visual design of an urban public space. *Landscape and Urban Planning, 167*, 98-107. doi:https://doi.org/10.1016/j.landurbplan.2017.05.018

Gasco, L., Asensio, C., & De Arcas, G. (2017). Towards the assessment of community response to noise through social media. *Proceedings of the Internoise 2017 Conference.* Hong Kong.

Geerts, D. (2010). Linking an integrated framework with appropriate methods for measuring QoE. *Second International Workshop on Quality of Multimedia Experience (QoMEX)*, (pp. 158-163).

Guillaume, G., Can, A., Petit, G., Fortin, N., Palominos, S., Gauvreau, B., . . . Picaut, J. (2016). Noise mapping based on participative measurements. *Noise Mapping, 3*(1), 140-156.

Livari, J., Isomäki, H., & Pekkola, S. (2010). The user - the great unknown of systems developments: reasons, forms, challenges, experiences and intellectual contributions of user involvement. *Information Systems Journal, 20*(2), 109-117.

Maffei, L., Masullo, M., Aletta, F., & Di Gabriele, M. (2013). The influence of visual characteristics of barriers on railway noise perception. *Science of the Total Environment, 445-446*, 41-47.

Maisonneuve, N., Stevens, M., & Ochab, B. (2010). Participatory noise pollution monitoring using mobile phones. *Information Polity, 15*, 51-71.

Mantovani, G. (1996). Social context in HCI: A new framework for mental models, cooperation, and communication. *Cognitive Science, 20*(2), 237-269.

Möller, S., & Raake, A. (2014). *Quality of Experience - Advanced Concepts, Applications and Methods.* Cham: Springer.

Park, B. J., Tsunetsugu, Y., Kasetani, T., Hirano, H., Kagawa, T., Sato, M., & Miyazaki, Y. (2007). Physiological Effects of Shinrin-yoku (Taking in the Atmosphere of the Forest)—Using Salivary Cortisol and Cerebral Activity as Indicators—. *Journal of Physiological Anthropology, 26*(2), 123-128.

Project for Public Spaces. (2009, December 30). *What Makes a Successful Place?* Retrieved from Project for Public Spaces: https://www.pps.org/reference/grplacefeat/

Semanjski, I., & Gautama, S. (2016). Sensing Human Activity for Smart Cities' Mobility Management. In *Smart Cities Technology*. InTech.

Skaržauskienė, A., Tamošiunaitė, R., & Žalėnienė, I. (2013). Defining social technologies: evaluation of social collaboration tools and technologies. *Electronic Journal of Information Systems Evaluation, 16*(3), 232-241.

Unsworth, K., Forte, A., & Dilworth, R. (2014). Urban Informatics: The Role of Citizen Participation in Policy Making. *Journal of Urban Technology, 21*(4), 1-5.

Van Herk, H., Poortinga, Y. H., & Verhallen, T. M. (2004). Response styles in rating scales: Evidence of method bias in data from six EU countries. *Journal of Cross-Cultural Psychology, 35*(3), 346-360.