Evaluating the Impact of Smart City Initiatives
The Torino Living Lab Experience

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Abstract: Launched in January 2016 by the city of Turin, the Torino Living Lab initiative has been designed with the goal of fostering innovation and entrepreneurship and include the citizens in the Smart City innovation process. Aimed to private organizations and startups, the initiative identified the most promising Smart City technologies, systems, and applications, and gave them an opportunity to be tested in a real-life environment. This paper presents a formal methodology for impact assessment and measurement of success of the Torino Living Lab initiative. A procedure of ex-ante and ex-post measure is established upon review of research literature on Living Lab approaches. 16 performance indicators are selected and adapted to the characteristics of the initiative. Finally, some key takeaways resulting from the preliminary investigation are presented.

1 INTRODUCTION

In recent years, the growth of global population is fueling the debate on what a city can do to limit the risks and exploit the opportunities brought by increasing urbanization trends. In this complex context, the Smart City (SC) paradigm has been introduced as a multi-disciplinary and multi-objective concept with the goal of helping policy makers and public managers face the problems and chase the opportunities of the modern urban environment. The complexity of the SC concept makes it difficult to understand what are the actions that a city must undertake to become "smart". In broader terms, a city can be considered smart when "investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance" (Caragliu, Del Bo and Nijkamp, 2011). Quality of life, competitiveness and sustainability are the main pillars upon which a city must build its strategic SC plan. This has been the case of the city of Turin, Italy. In 2009, the municipality adopted the Turin Action Plan for Energy (TAPE), a plan aimed at reducing by 40% the city's CO2 emission by 2020. The TAPE was a comprehensive sustainability plan, which included interventions on multiple dimension of the city, including improving the energetic sustainability of public and private buildings, reducing emissions by public transportation, increasing local production of energy and optimizing the public lighting system (Città di Torino, 2009).

In 2011 the municipality of Turin decided to expand the reach of this strategic renovation initiative. The result was the creation of the Torino Smart City (TSC) foundation. The strategic vision of the TSC is to create a city that is sustainable, environmental-friendly and efficient; a city that improves the quality of life of its citizens and their participation by including them in the innovation process (Torino Smart City, n.d.). By working in close contact with the industry, start-up companies, public offices and citizens, the two main challenges of the TSC foundation has been facing over the years have been: how to include the citizens in the innovation processes of private companies, and how to reduce the bureaucratic burden that an innovative firm faces when collaborating with public administrations.

To tackle these challenges, in 2015, the TSC foundation started working on an initiative that aims to allow private companies and start-ups to interface their innovation processes directly with the citizens, and to facilitate the bureaucratic burden that these companies have to face. The result of this work has been the Torino Living Lab (TLL) initiative.

This initiative is a new and unexplored concept for the city of Turin and many others and the city had the need to develop a formal methodology for

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measurement and assessment of the success of the initiative and its impact on the neighborhood.

This paper describes the methodological approach taken by the city in order to evaluate the TLL initiative. First, an overview of the TLL initiative is given, then the methodology for the assessment of the initiative is presented and some preliminary results are showed and discussed while the TLL is still underway.

2 TORINO LIVING LAB

With the TLL initiative, the city of Turin wanted to identify the most promising technologies, systems, and applications, in accordance to the objective of the TSC strategic plan, and give them the opportunity to be tested in a real-life environment while encouraging the involvement of the final users in the innovation process, as it is the main objective of the Living Lab research approach (Schuurman et *al.,* 2012) (Niitamo et *al.*, 2006). The area chosen for the experimentations is the neighborhood called Campidoglio.

In January 2016, a public call (Città di Torino, 2016) is launched, defining the main objectives of the initiatives. The call defines the requirements that each proposal have to fulfill in order to be accepted into the initiative. A commission evaluates proposals based on following parameters:

- The proposals should not have a direct financial burden on the municipality;
- The objective of the proposals have to be coherent with the overall objectives of the TSC plan;
- The proposals have to be in some way synergic with other SC solutions implemented by the city;
- The proposals have to have an element of innovation, whether in the technology, the processes, or the services provided;
- The proposals have to be impactful on the citizens;
- The proposals have to be replicable and scalable to the whole urban environment;
- The proposal have to be accompanied by a preliminary business model in order to guarantee its economic sustainability;
- The proposal have to be technically feasible. With feasibility is intended the ability of the TSC office to provide the required facilitations for the start of the proposed project.

The TSC office, on its side, would help facilitating bureaucratic matters with other public offices, such as creating a fast line to secure permits and authorizations and waiving all the fees and taxes involved in the use of public spaces. It would also facilitate communications between the proposing firms and other private entities that may be necessary to start the experimentations, such as utilities or transportation. The TSC office would also guarantee exposure of each initiatives by using all available communication channels, such as institutional websites and social networking, local newsletters and poster campaigns, flyers and other advertising material in public offices. Finally, the TSC office would put considerable efforts to mediate and engage the neighborhood into the experimentation process. Each proposal would have the possibility to organize meetings with the population to present their solution, and the TSC office itself organizes several events to present the TLL initiative.

37 proposals were received. Each technology or service proposed was evaluated by the parameters discussed previously. Only the proposals that met all seven criteria were included in the initiative, bringing the number of projects down to 32. Starting from July 2016 the initiative entered operations, and will be concluded by December 2017.

3 METHODOLOGY

Schuurman et *al.* (2012) and Shamsi (2008) describe the process required in order to set-up a LL, and identify five main steps:

- Contextualization: exploration of the technology or service under investigation and its implications;
- Selection: identification of potential users or users' groups;
- Concretization: initial measurement of the selected users on a series of metrics in order to understand their characteristics, behaviors, and perceptions. This has to be performed as a pre-measurement;
- Implementation: kickoff of the operations of the LL;
- Feedbacks: final measurement of the selected users on the same metrics used in the Concretization phase. This has to be performed as a post-measurement at the end of the research.

The development of the TLL initiative followed a similar structure. First, the TSC office identified the neighborhood Campidoglio and its population as the final users of the initiative. After that, the call was announced and proposals selected.

The methodology for the "Concretization", "Implementation" and "Feedbacks" phases were left to single players, meaning that the TSC office and the

city of Turin would not enforce a standardized methodology for the implementation and evaluation of the solutions. However, the TSC office needed to develop its own methodology for evaluating the initiative as a whole and for assessing its impact on the population. To this end, the TSC office decided to measure the citizen's characteristics, behaviors, and perceptions before the implementation of the initiative, with an ex-ante measurement campaign. Note that these same metrics will be used for same ex-post measurement, after the TLL initiative will be concluded, in order to assess any changes produced by the initiative and to collect feedbacks.

Furthermore, the TSC office wanted to gather feedbacks and impressions from the providers of the tested solutions. A similar methodology of ex-ante and ex-post measurement was developed to understand the expectations and the objectives of the firms at the beginning of the initiative and whether they were able to meet them.

3.1 Impact Measurement on the Population

The approach chosen for the identification of the required set of indicators started by a review of the literature regarding the evaluation and ranking of SCs. These works, in fact, present comprehensive sets of metrics and indicators, employed by the authors to evaluate the "smartness" level of a city. These sets of indicators can therefore be used as a baseline for the evaluation of the TLL initiative's impacts. To this end, the work of four authors have been reviewed: Giffinger and Pichler-Milanović (2007), Cohen (2014), Lazaroiu and Roscia (2012), and Lombardi et *al.* (2012).

After the selection of the sources, the first step in drafting the set of indicators is to discard all the macro-economic indicators presented by the authors. That is because the limited temporal and geographical nature of the initiative implies a negligible impact on indicators such as the city's GDP, the employment's level or the immigration's level, making these metrics not relevant in the assessment of the TLL initiative. After these considerations, it can also be noticed that the authors presented their indicators mostly following the structure presented by Giffinger and Pichler-Milanović (2007) that identifies 6 main factors in the "smartness" of a city:

- Smart economy;
- Smart people;
- Smart governance;
- Smart mobility;
- Smart environment;
- Smart living.

The four sets of indicators, already modified by discarding the indicators for macro-economic factors, have been joined together, with duplicates eliminated. This resulted in a list of 42 indicators. The last step has been to confront each of these indicators with the 32 selected projects in the TLL initiative. Table 1 shows the classification of the 32 initiatives, following the SC structure proposed by Giffinger and Pichler-Milanović (2007).

Table 1: classification of the projects in the TLL initiative.

Domain	Number of projects
Economy	3
People	2
Governance	5
Mobility	5
Environment	8
Living	9

This final step allowed eliminating all those indicators that, while had the potential to impact, were not influenced by any of the projects in TLL, bringing the list down to 32 indicators.

However, this list presented some criticalities, such as the disconnection between the indicators and the goal of the investigation. While these indicators are meant to represent a quantitative measure or statistics, the goal of the investigation is, in fact, to analyze the characteristics, habits, and behaviors of the citizens exposed to the TLL initiative. With this objective in mind, the 32 indicators selected from the literature have been modified and reworded in a way that could capture the impressions and opinions of the citizens on those issues, and assign to those opinions a quantitative value that could be then used to evaluate the impacts of the various projects in the TLL initiative. The final shortlist of 16 indicators is presented in Table 2.

A survey was the natural choice for conducting this kind of investigation and assess the values of the indicators presented in Table 2. The survey submitted both on line (through the aid of local associations) and face-to-face during neighborhood meetings, is structured as follows. The first question set gathers the demographic profile of the respondents (age, gender, profession). Then, a question is asked on whether the interviewees are generally aware of the TLL initiative and, if yes, which of the 32 projects, if any, they know. Finally, 15 questions are asked to understand and measure the perception, behaviors, and habits of the citizens on the set of indicators given in Table 2. These perceptions are quantified with a 1 to 5 point Likert scale, with 1 representing a strong

disagreement or a minimum, and 5 representing a strong agreement or a maximum.

Table 2: list of indicators used for the assessment of the impacts of the TLL initiative.

Domain	Indicator
Economy	Components of domestic material consumption
People	Civic engagement activities
Governance	Usage and perception of applications based on open data
	Usage and perception of institutional digital services
Mobility	Frequency of use and perception on bikes and/or bike-sharing
	Frequency of use and perception on car-sharing and/or car-pooling
	Frequency of use and perception on public transportation
	Assessment on the extensiveness of efforts to increase the use of cleaner transport
Environment	Perception on the total residential energy consumption
	Perception on particulate matter emission and air quality
	Individual effort in protecting nature and the environment
	Assessment on the extent to which citizens may participate in environmental decision making
	Assessment on the engagement in environmental and sustainability-oriented activities
Living	Perception on public safety
	Participation to cultural initiatives and events
	Use of public and green spaces

As already stated, this measurement needs to be performed twice in order to gather an ex-ante and an ex-post measurement, which will allow determining the impact of the initiative. The first survey, representing the ex-ante measurement, has been submitted to the population between the period of May and July 2016, right before the start of the projects, and received 71 responses. The ex-post measure will be done at the end of the TLL initiative, approximately December 2017 and January 2018. To guarantee consistency between the two investigations, the 71 respondents gave their contact information and agreed to be contacted again to participate in the ex-post measurement.

3.2 Measure of Impacts on the Firms

The TSC office had also the need to assess the success on the TLL initiative from the point of view of the technology and service providers and have a clearer picture on the expectations and objectives of the firms when starting the tests on their projects, and whether these objectives were reached by the end of the initiative. A similar methodology of ex-ante and ex-post investigations was developed. The investigation tool chosen has been semi structured interviews with each firm, where three questions were asked:

- What are your objectives in participating in the TLL initiative?
- How do you plan to evaluate your participation in the TLL initiative?
- Do you have a set of indicators, either qualitative or quantitative that you plan to measure?

The 32 interviews, with a duration between 15 and 30 minutes have been recorded and some takeaways can be extracted. At the end of the initiative a second set of interview will be performed to ascertain whether the objectives were reached and how did they evaluate their participation in the TLL initiative.

4 RESULTS AND DISCUSSIONS

As discussed earlier, the methodology for assessing the impacts of the TLL initiative requires two sets of measures. Nevertheless, it is possible to gather some interesting insights by the preliminary analysis of the ex-ante measurement.

4.1 Survey

The demographic distribution of the survey's respondents, by gender, age and profession is presented in Table 3.

Table 3: demographic mark-up of the survey's respondents.

Gender		
Female	32	45%
Male	39	55%
Age		
Less than 18	0	0%
18 - 25	7	10%
26 - 35	12	17%
36 - 45	19	27%
46 - 55	11	15%
56 - 65	11	15%
More than 65	11	15%
Profession		
Employee	24	34%
Self-employed/entrepreneur	8	11%
Student	7	10%
Retired	11	34%
Other/unemployed	21	30%

The analysis of the ex-ante survey gives an initial picture on the characteristics, habits, and behaviours of the citizens of the neighbourhood Campidoglio. For each question, the degree of agreement was computed as the percentage of positive votes (4 or 5) over the total and these results are reported relative to the measure indicators presented in Table 2:

Economy: the buying choices are dictated first by the quality of the product (77%), then by the cost (55%) and lastly by the place of origin (44%).

People: the citizens are not typically engaged into civic activities (15%).

Governance: most of the digital services and applications used by citizens are related to transportation and mobility (42%) and civic activities (48%), but in general the frequency of use is quite low (14%). The usage of these applications is, however, extremely passive, and lacks user engagement as a content co-generator. Considerations about the usefulness of these services and ease of use is also low (respectively 24% and 28%).

Mobility: from the survey's results, the preferred mean of transportation is public transportation (49%) followed by car (24%), bike (23%) and, lastly, alternative means of transportation such as bike or care-sharing (20%). Necessity is the main factor in the choice of transportation (68%), followed by speed, travel distance (63%), and cost (49%). The environmental impact of the vehicle is considered as less important (45%).

Environment: the citizens do not consider themselves particularly informed regarding the level of air pollution (14%) and their energy consumption (34%). Meanwhile they consider themselves relatively informed on the correct practices to reduce their energy and environmental impact (42% and 45% respectively). They are also practicing and encouraging environmental friendly and sustainable behaviors (66% and 58% respectively), and they try to preserve the public green spaces (54%). On the other hand, there is a lack of participation in civic activities aimed to environmental protection (15%).

Living: the citizens of Campidoglio feel themselves relatively safe in their neighborhood (42%). The usage of public spaces is also relatively high (46%). Engagement in cultural and social activities is, again, scarce (20% for both).

In general, it can be noticed a lack of engagement of the citizens in civic activities and initiatives, regardless of the topic. The use of digital services and applications is also considerably low. The awareness on environmental matters is mixed. While citizens feel informed on the behaviors to take to be more environmental friendly, they do not feel informed on the actual level of pollution.

4.2 Interviews

The first question of the interview asked about the objective of the project and the participation to the TLL initiative. While each firm had its own objective, it is possible to draw some similarities. Between the 32 firms, 4 are participating to the TLL primarily to test the technical feasibility of their solution. The primary goal will be to gather valuable insights from the final users in an early stage of development. Other 4 firms are presenting a relatively mature service or technology and are using the participation in the TLL initiative as a way to test on a limited scale the economic sustainability of the proposed business model. Furthermore, 15 firms are presenting a solution that is already at a commercial phase of deployment and their participation's goal is creating demand for the product or tested service, while gathering user's feedbacks and opinions for some possible changes or modifications. The remaining 10 projects present multiple objectives and different maturity, which makes it difficult to include them in a single category. Out of these projects, 5 neither have or plan to have a commercial market application and are more focused on knowledge sharing, dissemination, or plan to achieve academic recognition.

Finally, the interviews also gave insights on the planned final users of the projects. The first consideration that can be done is that most of the projects tested have multiple final users, whether the citizens, other businesses or the public administration. The public administration, find itself with the double role of enabler of the TLL and of the final users of, specifically, 16 projects. Furthermore, 15 projects have the citizens as their primary target market, and 21 have other businesses.

5 CONCLUSIONS

One of the challenges that the public administration has to face in designing a complex and wide-breath initiative, such as the TLL, is the development of a control mechanism able to capture the impact of the initiative on the citizens and to assess its success. From a the point of view of the literature on the LL research approach, the most appropriate way to develop a LL measurement process is to collect the user's impressions, habits, and behaviors before the start of the initiative, in the so-called Concretization

phase, and then compare them with those collected after the end of the testing, in the Feedback phase (Schuurman et *al.* 2012) (Shamsi, 2008). The first step in the application of this methodology has been the identification of a set of indicators able to capture the citizen's habits, behaviors, and impressions. This process started from a review on the literature regarding the methodologies for the ranking of SCs. The comprehensive sets of indicators presented in these works have been used as a starting point in designing a set of indicators able to capture the impacts of the SC innovations tested in the TLL initiative. However, these sets of indicators required several further modifications:

- Elimination of macro-economic indicators (GDP, employment, etc.);
- Harmonization of the four selected sets into a single shortlist;
- Eliminations of all the indicators of dimensions not impacted by any project participating in the initiative;
- Modifications of more quantitative indicators to capture the qualitative nature of the citizen's opinions.

The result of these steps was a final shortlist of 16 indicators. This bottom-up approach for identification of the assessment indicators can be applied with minimal effort by public administrations in the context of a LL initiative aimed to test innovative SC solutions.

Between May and July 2016, the first ex-ante investigation has been completed through submission of a survey to a sample of 71 citizens. While these results are still incomplete and the ex-post measure will be necessary to understand the entity of the impacts of the initiative, it is still possible to gather some interesting preliminary insights. The results show a severe lack of engagement of the population in civic activities and most of the interviewed population reports a minimal use of digital services offered by the city. Moreover, while there is a general awareness on environmental issues, the population reports a lack of information on the level of pollution.

Finally, semi-structured interviews with the organizations participating into the initiative showed a heterogeneity in both the maturity of the projects and on the user targets, from the citizens, to other businesses, to the public administration.

The next step in the research will be the ex-post investigation, by the end of the initiative. This will allow to assess the impacts that TLL had on the habits and opinions of the population, and to evaluate the success of the initiative from the point of view of the organizations involved.

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