Supporting Living Lab with Life Cycle and Tools for Smart City Environments

Paolo Nesi, Michela Paolucci
Distributed Systems and Internet Technology Lab, DISIT Lab, University of Florence
{Paolo.nesi, michela.paolucci}@unifi.it, http://www.disit.org, https://www.km4city.org , http://www.snap4city.org

***Abstract*—Smart Cities are becoming proactive environments in which municipalities are engaging stakeholders in contributing and participating to the life of the smart city and to the development and updating of the smart solutions in the infrastructure. To this end, the methodologies and tools for Smart City Living Lab start up, management and life cycling are becoming relevant. In this document, the solution developed for Snap4City project is described. Snap4City has been developed on the basis of Km4City tools for supporting Living Lab in response to the competitive call of Select4Cities European commission project directed by three major cities in Europe: Helsinki, Antwerp and Copenhagen. The proposed Snap4City solution includes a IOT/IOE development model, a life cycle and a set of tools for data collection, data sharing, processes and analytics development, collection and management, and sharing. The paper also reports the experience of using these tools.**

Keywords— Smart City, Living Lab, Open Data, Collaborative Systems, Co-Creation Activities

I. INTRODUCTION

Smart cities are complex ecosystems in which many distinct aspects coexist, and many kinds of actors interact, such as public administration, citizens, SMEs, stakeholders, research organizations, universities. The main developing areas for a Smart City identified by the IEEE regards: economy, mobility, environment, people, living, governance. In this context, Smart City applications need to support multiple paradigms as data driven, stream and batch processing, to promote new working paradigms to enhance the collaboration among all the actors involved. One of the most diffused ways to apply this paradigm is set up a Living Lab (LL) as a place/methodology to cope with the city evolution in terms of services and city users' needs and capabilities. Living Labs are instruments where develop and implement technology to accelerate innovations cities [1]. Many studies have been made on Living Labs, for example two different approaches have been identified that can be adopted to realize them: top down and bottom up. The first approach provides technologically deterministic ideas, such as the use of: smart control room, dashboards, centralized architecture to manage the city, ICT-based overview of the activities of the citizens and it is realized in collaboration with stakeholders and companies. The bottom-up approach is a more experimental view point, it is taking place in the last years and it is centered on the idea that the innovation comes from the citizens (e.g., guerrilla bike), so that the main feature is the interaction among the final users [1], [2]. A Living Lab is also seen as a starting point to collaborate and generate models to create Smart Cities [3], as a way to develop collaborative systems capable to engage the community (students, lecturers, computer scientists, electronics engineers, politician, tourists, etc.) [4]. Living Labs are also an instrument to go toward an open innovation business model in which play a fundamental role, aspects such as: co-creation activities, sustainability, multi-disciplinarity, collaborative networked development approach, self-organizing, collaboration of various stakeholders, etc. [5]. Useful activities to promote the collaboration among the different actors involved in a Living Lab, can be: i) organization of events involving the citizens; ii) improvement of co-creation activities, or hackathon to produce new useful services [6]. Over the course of time, Living Labs evolved and moved from the older Three Helix (TH) model to the Quadruple Helix (QH) model. The TH proposes that the three major parties in innovation are industry (wealth generation), universities (novelty production) and public control (government), while the QH poses the attention on the users, identifying them as the *fourth helix*. The QH classifies the different kind of users as capable to transform the classic innovation actions into user-centric processes: i) enabler (financier and provider of the infrastructure); ii) decision maker (city guidelines, R&I programs supporting user innovation activities); iii) supporter (who promotes the users actions and activities); iv) utilizer (who uses the services produced); Developer; Marketer; Quality controller, [7], [8]. The Living Labs are obviously connected with the concept of Open Innovation, they exploit the possibility of bringing together people with different skills, experiences, roles, expertise, motivations, etc. and many kind of organizations (universities, public administrations, SMEs, stakeholders, industries, etc.) to collaborate and realize useful service considering territorial aspect, sustainability, policies adopted by the cities, [6]. In the Living Lab it is possible to test some technologies and new paradigms to foster the innovation, to shape the applications and services being developed for their citizens, at both micro- and macro-levels. In the living Lab users are not treated only as objects in the innovation process or as mere customers but also as early stage contributors and innovators [9], [5]. In Europe Living Labs are taking place in the Smart Cities and are increasingly adopted as a new paradigm to accelerate innovation actions: the European Network of Living Lab (EUoLL) is a valid reference to be considered to realize a successful LL model. EUoLL recognizes almost 400 Living Labs in the EUoLL present in its network [10].

The main technical issues regarding smart city solutions are related to manage data, consequently they have to solve problems, such as: data access, aggregation, reasoning, access and delivering services via Smart City APIs [11]. The final aim is serving city users in a smarter and more efficient manner, stimulating their participation to the city strategies and collaborating with all the actors involved. Therefore, collected and produced data are used to facilitate the creation of smart and effective services exploiting city data and information. Specific end-users' smart services should be developed and managed by enterprises and city operators, rather than by the municipality. On the other hand, the municipality has to provide a flexible data access and services. This means to make effective and efficient the data access with their semantics, the service delivering, the access to define and control dashboards, and the interoperability with any other smart control systems active in the city (e.g., mobility, energy, telecommunication, fire brigade, security, etc.). In the world, municipalities/cities and public administrations are publishing huge amount of open data. These data can be coarsely aggregated for integration by using solutions such as CKAN [12], OpenDataSoft [13], ArcGIS and OpenData [14]. In most cases, these solutions for open data are suitable for collecting open data files and make their indexing on the basis of corresponding descriptive metadata. Open data, in those cases, can be uploaded by providing files in different formats: CSV, XLS, XML, SHP, etc. In some cases, they provide access to effective datasets, by using some data integration and visualization tools which provide the possibility of creating graphic charts, such as distributions or pies, on the basis of the values contained in the dataset. In the extreme case, they also provide access to datasets as Linked Data (LD), Linked Open Data (LOD), coding data information in terms of RDF triples [15], [16]. Very rarely, they can provide data from some RDF store endpoints to make SPARQL queries on the data exploiting some ontology and other entities [17], rather than working only on metadata. The access to RDF stores for data browsing can be performed by using visual browsers as in [18]. In the case of directly accessible LOD, we are in presence of the so called 5 stars' open data [15]. On the other hand, in most cases the integrated LOD are not supported by multi-domain ontologies. We could state that 6 stars data would also provide a data access and SPARQL queries exploiting a semantic ontology for the integrated data model and data inference [19]. Real-time data are provided by city operators through some APIs as Web Services or REST calls. The APIs for providing data to the data aggregator of the city may be compliant with multiple standards (such as DATEX II for mobility, intelligent transport system [20]) for public services, parking; IETF [21], ETSI [22] or OneM2M [23] for Internet of Things (IOT), Green Button Connect [24] for energy data collection. However, some of the peripheral data kinds collected are not supported by any standard, thus custom solutions are adopted, such as the status of hospitals' emergency units (triage), the status of earthquakes in the regional area, etc. The effective deploy of smart services for city users is very frequently viable only by exploiting the semantic integration of data as: open data, private data and real time data coming from administrations and different city operators. This implies specific processes of reconciliation and the adoption of unifying data models and ontologies as in Km4City multi-ontology [25]. The semantic aggregation of data coming from several domains is unfeasible without a common ontology, since data are produced by different institutions/companies, by using: different formats and aims, different references to geographical elements, and different standards for naming and identification adopted in different moments [26]. Thus, datasets are rarely semantically interoperable each other since have been produced in different time, by different systems, by different people, etc. In addition, they may present different licensing models: some of them can be open, while other may be private of some city operator that would not be interested to lose the ownership by releasing them into an unregulated environment, or could simply provide some restrictions (e.g., no commercial); see for example the data of car sharing companies that are typically private of the company. For open data, as well as for private data, several different licensing models can be adopted [26], [27] enabling or preventing some business models, or simply their usage [28]. Therefore, well aggregated and re-conciliated data for the identification of services and locations (open and private) can be exploited by reasoning algorithms for enabling sophisticated service delivering. For example, by providing suggestions and hints on rout planning, inter-modality routing, parking, hospital finding in the case of emergence, finding specific point of interests, setting predictions (for parking and traffic) and detecting anomalies for early warning.

In order to create an efficient Living Lab, the following key principles have to be taken into account: i) Value (create value for users and customers as a key aspect for business success: involve SMEs, mitigate the competition, open new markets); ii) Influence (users seen as active, competent partners and domain experts, concretize new services coming from the citizens ideas); iii) Sustainability (e.g. choose right materials, implementing user-friendly approaches, considering the social and economic impact of the innovation), iv) Openess (open collaboration between people with different expertise and backgrounds. Different perspectives could lead to a successful innovation process), v) Realism (the innovation actions are carried out in the real-life, realistic and natural settings, this to increase understanding on how innovation can bring advantages valid in the real market) [8]. Another fundamental aspect is also connected to territorial needs, this is the reason why sometimes it is stated about the Urban Living Labs, that "*are environments in which innovation is spatialized, i.e., it is generated within a specific spatial environment. These are environments in which the openness of innovation manages to transcend the organizational infrastructures that are traditionally operating in the city and to invent new institutional figures for, or ways of, dialoguing between citizens and institutions*" [29], [30], [31].

In the context of Smart City, also supported by Living Labs, a set of key features for an infrastructure capable to manage all the complex aspects described above, have been identified. A Smart City Living Lab infrastructure have to be: i) able to activate practice-based knowledge production in collective and private environments (e.g., taking into account both Private and Open Data and contexts); ii) able to learn internally but also externally, by experimenting with other cities that share the same problems; iii) aware of new civic engagement models being experimented all over the world; iv) aware of the growing demand for new citizenship models; v) capable of directing investments toward opportunity creation (i.e., experiments) rather than pre-developed solutions, [32]; vi) stimulating the participation of all stakeholders in the activities of data collection and process/solution production.

Those types of infrastructures manage a massive set of data (Big Data context) that can be shared, processed, used to generate new knowledge; moreover, are capable to ingest both Open and Personal/Private Data (e.g. the user's profiles and actions done in the city). All the processes realized by this kind of infrastructures imply the necessity to pose attention on a relevant aspect: the treatment of the privacy rights on data (especially the sensitive ones), underlined also by the General Data Protection Regulation (GDPR), [33], [34], [35], [36].

In this paper we propose the Snap4City solution as a Smart City infrastructure, responding to the key features/requirements above described, and enabling the Living Lab paradigm especially in the acquisition of City Data and developing smart city solutions. The paper is structured as follows. In section II, the Snap4City Life Cycle and Architecture are described. Section III presents Datagate as collaborative tool to upload Open Data in the Snap4City Knowledge Base. Section IV contains the description of the Process Loader as a tool to publish, share and launch data Extraction/Transforming/Load processes. In Section V, the Results obtained in terms of Data acquisition, thanks to the collaborative work done, are reported. Section VI describes the conclusions and the future work.

II. ARCHITECTURE

Smart Cities need to set up a flexible Living Lab to cope with the city evolution in terms of services, city users' needs and capabilities. To this end, the Snap4City solution provides a set of tools and a flexible method and solution to quickly create a large range of smart city applications exploiting heterogeneous data and stakeholder services also enabled by Internet of Thing (IoT)/Internet of Everting (IoE) technologies and Big Data analytic. The Snap4City solution and all the innovation activities carried out for its development, have been realized involving different kind of Organizations (Universities, SME and Large Industries, Public Administrations) and users (City Operators, Resource Operators, Inhouse companies, Tech providers, Category Associations, Corporations, Research groups, Strat-ups, Early Adopters, large industries, advertisers, City users, Community builders, etc.), thus reflecting the features, described in Quadruple Helix (QH), [7], to facilitate the Living Lab approach in a Smart City, Fig. 1. The innovative aspects of the solution proposed are related to semantic computing of entities for discovering and search information, resources management, parallel and distributed computing and cloud management, applications based on microservices and external services, dashboard and development tool kits, etc. The proposed solution is flexible enough to support extensions at distinct levels of granularity: data, analytics, tools and applications.

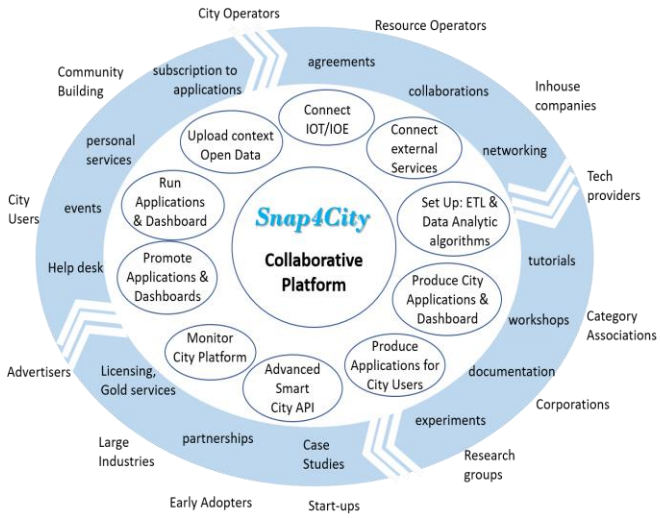

Fig. 1. Snap4City Life Cycle.

One of the first activities for creating a Living Lab in a city is the process of setting up the technical infrastructure which in turn is grounded on many valuable enabling tools. They must support the city in: the modeling of data; the upload of context data and open data; the connection of IoT/IoE sources and external services; the creation of Extract Transform and Load (ETL) processes and data analytics algorithms, to arrive at producing smart city dashboards and at starting the production of Snap4City Applications based on Microservices. All these phases must be accompanied and supported by the availability of a set of development tools, easy to use, accessible and open. To this aim, the Snap4City solution has been designed to create a collaborative environment in which different kinds of stakeholders can mutually collaborate. At the same time in which the setup is created, the collaboration among stakeholders can start by creating: agreements, collaborations, networking, producing tutorials, workshops, hackathon, etc. Fig. 1, so at to arrive at involving the stakeholder around case studies, and finally to sign contracts of partnership, licensing, etc. Thus, the delivering of specific solutions to city users, operators, etc., is becoming possible. This process must be driven by the municipality and, on the other hand, the municipality needs support for technical aspects if it is not very large and technological oriented. Typically, the single companies even if participated by the city or the city operators, do not have the view and the mission to put in common a so large multi-domain multiservice framework and environment.

From the technological point of view, the above process can be released using a set of tools, to provide a support for collaboration and sharing at distinct levels. We propose the Snap4City architecture (see Fig. 2) as capable to solve all the problems described above and which consists in:

- A layer to **ingest all the different kind of data coming from a smart city** that can be classified in: Open Data, Personal Data, IoT and IoE, Social Media, static and real time. The set of data regard many distinct categories such as: transport systems, Mobility, Car park; Public Services, Security, Museums; Sensors, Cameras, IoT, IoE; events; Environment, Water, Energy; Shops, Services, operators;

Social Media, Wi-Fi, Networks, etc. The flow of data coming from the city data can be: static, slow, real time.

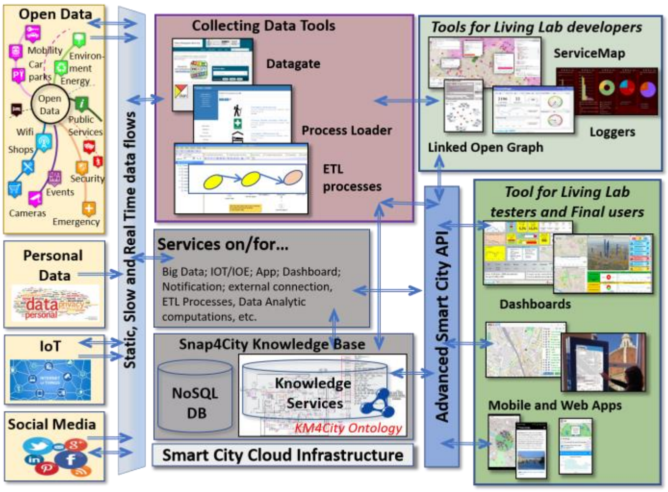

Fig. 2. Snap4City Architecture.

- **Collecting Data tools.** These tools are both for developers (ETL processes) and for users with no technical skills, and were developed precisely to exploit the possibility of bringing together people with different skills, experiences, roles, expertise, motivations, etc. and many kinds of organizations such as universities, public administrations, SMEs, stakeholders, industries, etc.
  - **ETL processes**, for developers and based on the Pentaho Kettle Tool, [38]. The Extract Transform and Load (ETL) processes can be personalized to manage many different kinds of data: open and personal, static and real time or periodic, geo-localized. The ETLs consider that data can come from: any kind of sources and providers, IoT/IoE or Sensor Networks, city users' devices, social media, open street map and in different protocols and formats. Their final aim is transform data so that it conforms to km4city multi-ontology and load them in the Sna4City Knowledge Base (in the form of RDF Store for e the static data, and in an HBase - NoSQL- store for the real time data, [39]).
  - **ProcessLoader** and Scheduler has been developed to manage processes to be executed in specific scheduling applications (for example ETL processes analyzing real time or periodic data which need to be launched every day/Hour/minute, as well as Data Analytics processes in R Studio, Java, Python, etc.).
  - **Datagate**: is a web-based open source management system for the storage, distribution, qualification, reconciliation and aggregation of Open Data. It is an extension of the very diffused Open Data platform CKAN (Comprehensive Knowledge Archive Network), [12].
- **Services for**:
  - **executing data analytics and computations** that can exploit data to provide advanced smart services one demand, early warning, both periodically and in real time modality.
  - **creating applications** that can be: data driven and/or periodic, based on Micro Services. These Services can be applications running on the platform itself (for example by using NodeRED or Pentaho [40], [38]), such as Dashboards and Mobile or Web applications.
- **Data storage layer,** collecting data in a **Knowledge Base (KB) connected to the Km4City Multi-Ontology** and making data indexing to prepare services on the data themselves, such as: data retrieval with the capability of inference and reasoning, search and retrieval, etc. [25]. While the real time Data are collected in a NoSQL database (HBase, [39]).
- **Advanced Smart City API,** capable to provide access to Snap4City data and services. The APIs can be exploited by web and mobile applications, as well as by many tools and cities, [11], [41].
- A set of **Tools for all the Living Lab Actors**, useful to test the effectiveness utility of the Snap4City solution in different contexts:
  - **Tools for Living Lab developers,** such as the web applications *Service Map* and *Linked Open Graph* for navigating on data results considering both the geographical metadata and the semantics aspects [42].
  - **Tools for Living Lab testers and final users** (community builders, city users, advertisers, Category Associations, etc. Fig. 1) showing and via dashboards and in turn make easy the production of specific dashboards for decision makers, city operators, etc. [41], [42]

In the following paragraphs, *Datagate* and *ProcessLoader*, as tools relevant to enable the Living Lab activities in a Smart City, will be described.

III. DATAGATE

Datagate (https://datagate.snap4city.org/ , Fig. 3) has been designed with the aim to offer a collaborative environment enabling the data providers to archive, manage, share datasets. It primarily manages static (or periodic) data. Moreover, it allows the data providers to upload their content, with the following features and advantages, which go behind the simple i) data storage on the portal: ii) data enrichment and geo-localization (with the city street graph or directly with Open Street Map); iii) data aggregation, with all the other data contained in the Datagate portal and with those archived in the Snap4City Knowledge Base, thanks to the semantic aggregation made through the KM4City multi-ontology; iv) data sharing (with the IPR license chosen); v) data visualization using different tools (Service Map, Dashboards, web and Mobile Apps, etc., Fig. 2), Fig. 3. These advantages can be attained in an automatic or semi-automatic modality and are described here after.

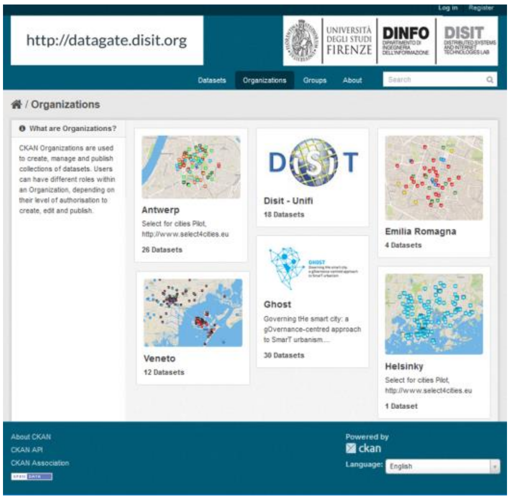

Fig. 3. Datagate: Organizations.

Data storage and sharing. These features are directly derived from the CKAN standard Open Data portal. Each data provider can be registered on the web portal and upload its datasets. A set of instruments to visualize the data are offered by CKAN (views, statistics on downloads, etc.), [12]. It is what can be viewed in Fig. 3: a set of datasets have been uploaded by their providers and then published on the web and visible to all the public Datagate users.

Data enrichment and geo-localization. This, and the following features have been added by the *'DataEnhancer'* plugin developed in the Snap4City context. If a dataset is uploaded following the specific template, the '*DataEnhancer'* features will be available on it, in addition to all default services offered by CKAN. The template is written in the form of a csv file and provides a set of fields (both mandatory and optional) to be filled to have the most possible advantages: i) mandatory fields: data name, geometry following the Well-known text (WKT) geometric objects: points (`POINT`), lines (`LINESTRING`) and areas (`POLYGON`) or address (city, street, civic number, etc.); ii) optional fields (description, web page, phone number, links, e-mail, etc.). Some fields are automatically enriched by Datagate (e.g. it can automatically calculate: postal code from address, latitude and longitude from address with civic number, moreover it reports incorrectly formed fields such as: e-mail, web portals, links, etc.), Fig. 4.

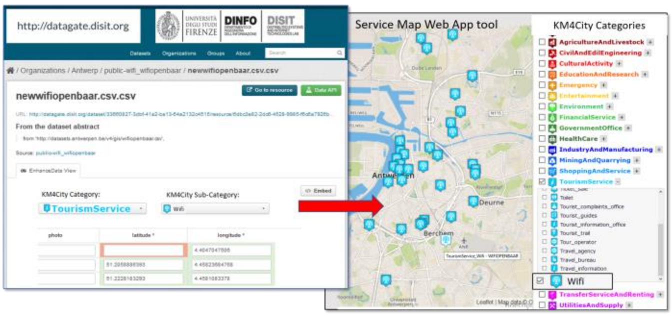

Fig. 4. Datatagate: autocompletion and error reporting. From Datagate to ServiceMap.

Data aggregation and visualization. Once the datasets are uploaded in the Datagate Portal, their responsible can connect the data to the KM4City multi-ontology by selecting one of the categories and subcategories present in the ontology and accessible from Datagate thanks to the possibility of selecting 'KM4City Categories' and the 'KM4City Sub-Categories' from a drop-down menu, Fig. 4. Click the publish on Snap4City button and upload the data also in the Snap4City Knowledge Base. In this way the data will be visible

IV. PROCESS LOADER

Algorithm/Process Loader is a web application, developed for allowing the creation and management of processes to be executed in specific scheduling applications with a user interface that receives input data in the form of compressed files that are analyzed, archived and finally transmitted to the desired scheduler. The main application's activities are focused on uploading many compressed zip archives containing files and directories required to create and execute a process on an external scheduling application through a series of API requests sent to the application. The processes cab be realized by developers coming from different context and smart cities and realized using different kind of technologies (ETL processes, R, Dashboards, nodeRED, R, etc.).

The user interface provides the following services:

- Ingestion of processes (in the form of compressed files) by authorized users. Each process is analyzed, archived and finally transmitted to the desired scheduler and properly launched.
- Process Execution: once the authorized users have uploaded their processes, they can launch and execute them, thanks to the presence of a scheduler, Fig. 5. The Process Loader users have only to insert some mandatory metadata such as the frequency with which a process has to be launched and other parameters that can depend on each process features (e.g. the web server from which the data are taken, the smart city related to the data, etc.). For example, an ETL process that links to an Open Data portal providing busses' timetables in a certain city, updated once a month. The user can create an ETL capable of collecting data and transform them as he or she sees fit (for example, to insert them in the Knowledge Base of Snap4city in order to take advantage of all the services offered by this solution). Then he/she can upload the ETL process in the process Loader, set the ETL to run periodically (e.g. once a month). In this way he/she can always have (for example on one of the services offered by Snap4City such as ServiceMap) the updated data as results without having to do any further work.
- Archiving and indexing of all the processes, that can be shared and easily retrieved, downloaded, re-used (basing on the license associated to each of them), ranked. All the metadata related to the processes are indexed via Apache Solr [44]. Each process publisher can make public its processes so that they can be shared. A web page (Fig. 6) offers the list of the public processes and an easy form to

search the ETLs basing on the metadata associated to them.

Fig. 5. Process Loader: processes running in the scheduler.

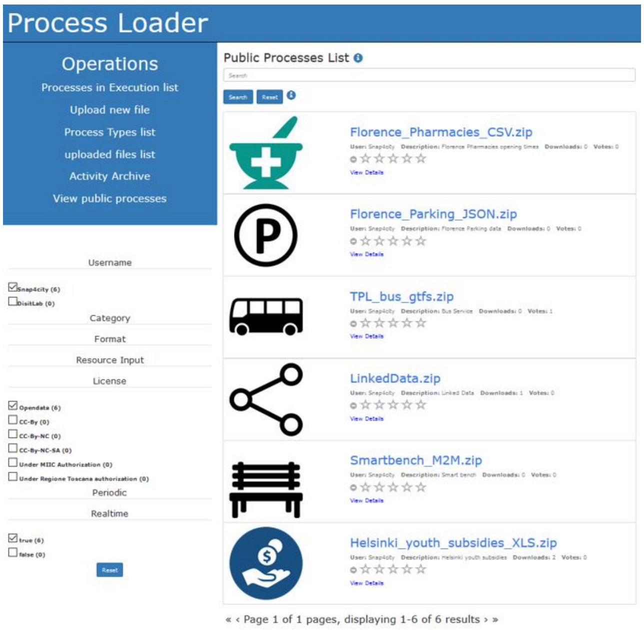

Fig. 6. Process Loader faceted search.

V. EXPERIMENTAL RESULTS

In the following tables, the main data related to the DataGate and ProcessLoader activities in terms of results obtained and services offered to the citizens are reported. These results can be navigated thanks to the ServiceMap on using all the other Snap4city tools both for Final users and for developers descripted in Section II.

DataGate	
Organizations	10
Data providers	31
Datasets number	167
Smart cities (medium and small)	Total number: more than 20 • Italy: ○ Medium: Florence, Venice, Bologna, Cagliari ○ Small: Sassari, Pisa, Lucca, Arezzo, Livorno, Pistoia, Siena, Prato, Grosseto, Massa-Carrara, Nuoro, Oristano, Sud Sardegna, etc. • Europe: Helsinki and Antwerp (medium)
ServiceMap Web Portals	• Tuscany: http://snap4city.km4city.org/ServiceMap/ • Italy (all other regions, without Tuscany) http://www.disit.org/smosm/ • Europe (mainly Helsinki and Antwerp): http://antwerp.km4city.org/ServiceMap/
Triples produced	Total: 84412 (62836 in Italy, 21576 in Europe: Helsinki and Antwerp)
Arguments treated	• cultural activities (e.g. libraries, churches, museums, theaters, monuments, etc.), hospitals, Wi-Fi, entertainments (e.g. beaches, cinemas, gymnasium), accommodations (e.g. B&B, hotels), limited traffic zones, cycling paths, etc.
Services/ point of interest in terms of PIN visible in the service map tool	• Florence: 365 • Italy: (total number: 5169) ○ Emilia Romagna: 367 ○ Veneto: 769 ○ Sardegna: 4033 • Europe (total number: 1749) ○ Antwerp: 1547 ○ Helsinki: 202

Table 1. Datagate numbers.

ProcessLoader:	
Processes uploaded	32
Processes published and shared	47
Processes running	10
Users	2

Table 2. ProcessLoader numbers.

Note that the numbers reported are only related to the data obtained thank to the tool presented. The Snap4City Knowledge base contains a huge amount of data that are considerably increasing in number and in terms of kind of users, different smart cities, organizations involved, thanks to the collaborative tool described.

VI. CONCLUSIONS

Methodologies and tools for Smart City Living Lab start up, management and life cycling are becoming relevant. In this document, the solution developed for Snap4City project has been described. Snap4City has been developed on the basis of Km4City ontology and tools with the aim of adding solution for supporting Living Lab in response to the competitive call of Select4Cities European commission project directed by three major cities in Europe: Helsinki, Antwerp and Copenhagen.

The proposed Snap4City solution included: (i) development model suitable for IOT/IOE applications; (ii) life cycle presented in Figure 1; (ii) a set of tools for data collection, data sharing, processes and analytics development, collection and management, and sharing as presented in this paper as DataGate and ProcessLoader. The paper also reported the experience of using these tools. As a conclusion, in order to create an efficient Living Lab, in the following table a summary of the relations among the key principles described in [10] and the Snap4City services and tool are presented.

Key principles for a Living Lab	**Snap4City solution**
Value	The data managed, and the services available in the Snap4City solution, come from many different providers: municipalities, SMEs, research centers, etc. enabling the connection among users and stakeholders considering the business aspects as playing a fundamental role for the solution success.
Influence	Many of the services proposed put the users as key actors to: give suggestions, upload data in the system, share data and opinions, etc. Moreover thanks to the Datagate and to the Process Loader tools, it is possible to: i) see the activities realized in other city; ii) to apply a set of a results in a city a starting point to realize the same services in other smart cities (e.g. use data coming from a city as a proof of concept in another one); iii) take inspiration from has already be done, to concretize new services directly coming from the citizens ideas.
Sustainability	Snap4City has been produced as an Open Architecture (also open source) that is applied in some Italian (e.g., Tuscany, Sardinia, Veneto, Emilia Romagna) and European Region and smart cities (e.g., Helsinki, Antwerp, Copenhagen). It can be reused without additional costs in every smart city context, thanks to its versatility and openess.
Openness	Thanks to several types of services offered, the work done on the Snap4City solution has involved, and continues to involve, many people with different skills and who play a different role in society enabling the interaction among different perspectives and needs.
Realism	All the data managed, and the services offered (previsions, dashboards, etc.) are made in a real context and are directly used by citizens, stakeholders, public administrations. This increase the possibility to study both innovations or advantages than cab be useful in the real market.

Tab. 1. Key principles for a Living Lab & Snap4City solution.

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