# KM4CITY

www.km4city.org

## FROM DATA TO SERVICES FOR SENTIENT CITIES

### TRANSFORMING DATA IN VALUE FOR THE CITY

- providing integrated data services for: mobility, tourism, energy
- generating suggestions and engagement rules for social innovation
- enabling a wide range of commercial and business applications, monetizing data
- keeping city services and status under control via complete and flexible dashboard
- assessing and improving city resilience, safety and security
- assessing city usage at multiple levels
- enabling integrated city services into third party web portal for all
- accelerating and simplifying the implementation of business and service oriented Apps

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# INTRODUCTION

Km4City platform is a Smart City tools for implementing the city vision, monitoring the city evolution, diffusely providing new services for improving quality of life of city users, for the city economic grow; stimulating city users; since an attractive city is a "city that produces" in which user are happy and proud. The new generations of smart city services enable to aggregate heterogeneous data (static and real time data, open and private data), as derived and provided by city, city operators, IOT sensors, social media, and mobile applications with the city user behavior. They are capable to take advantages from multi domain data: mobility, energy, government, welfare, wellness, tourism and culture, environment, weather, education, governmental, etc. Despite to the huge amount of potential services and data accessible on the city; thus losing for the city the possibility of controlling the data flow evolution and value; and in part also the control, the view. On the contrary sentient cities should provide a data aggregation platform supporting data analytics and producing user suggestions and engagements on demand for implementing city strategies as well as requests of city operators/stakeholders.

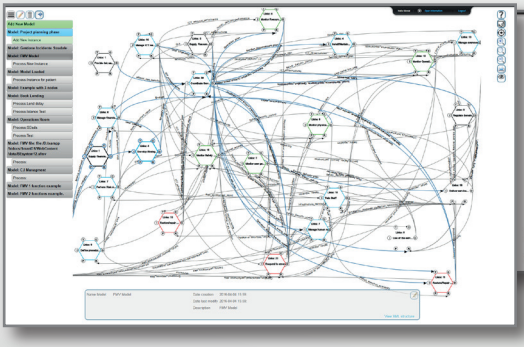
Most of the market open data aggregation tools, just based on ingesting and aggregating open data, are unsuitable for proving smarter and sentient services. Classical open data collection and indexing, browsing and visualization tools are unsatisfactory tools for producing value from data via services, and thus for enabling the construction of smart services and making them sustainable for city and service providers. Also solution that harmonize the services among the several operators are unsatisfactory for creating value from data, since data still remain non interoperable, and the development of new service and tools, too expensive for the operators.

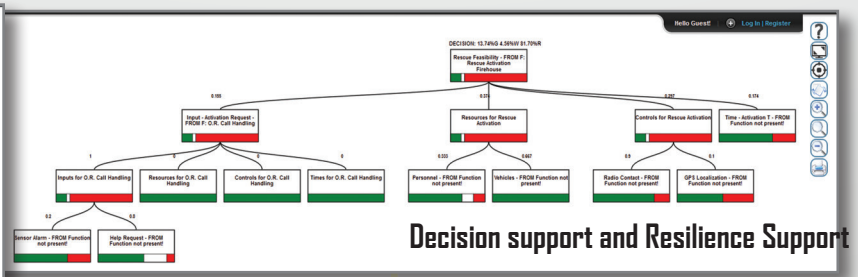
State of the art solutions for smart city have large problems for the (i) lack of data semantic interoperability and reconciliations among the hundreds of data sets, (ii) difficulties in managing real time data flow and putting them in connection with the rest of static data, (iii) lack of support for managing complexity of licensing mechanisms, (iv) lack of tools for social innovation producing strategic suggestions, user engagement, taking into account people and traffic low, origin destination analysis, user flow analysis, etc. (v) lack of easy to use tools for developing mobile and web Apps for the city services and events, (vi) lack of integrated solution for setting up flexible smart city control room dashboard and resilience assessment.

# CITY MONITORING AND MANAGEMENT GROUNDED ON DATA

Km4City Ecosystem is a platform to provide services, to stimulate citizens according to city strategies, and provides a smart decision support for assessing city resilience against natural and non-natural disasters. Km4City keeps under control city evolution, assesses and manages city infrastructures resilience, provides services to city stakeholders, accelerates commercial activities with simple developer tools, and provides smart services to the city users on the move. All these features and services are possible thanks to the Km4City unified data model and data hub, based on semantically aggregated data and services, on which new data and services can be easily added, and exploited for suggestions and stimulus to the citizens. Thus pushing the city users to virtuous behavior in the city: using the public transport, exploiting the external parking, taking the bike, walking, etc.

For the city, to become an urban platform, covering the role of data aggregator is a strategic step and decision that put the control in the hands of the city and not in those of the multinational commercial operators. Km4City models and simplify the production of semantically integrated data from different domains, providing tool to take advantage of inferential deductions, solutions for setting up Control Rooms and perform business intelligence, data analytics, decision support, risk analysis, user behavior analysis, suggestion and stimulus towards city users, etc.

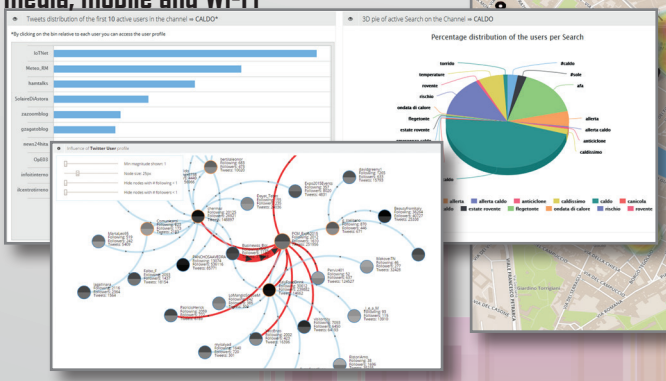


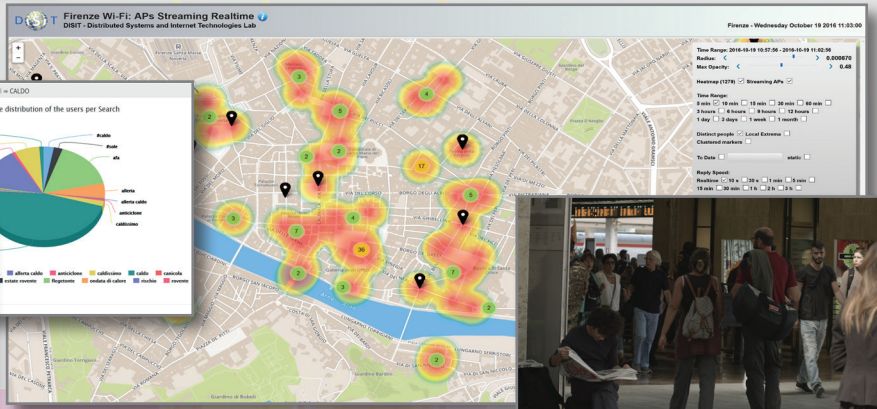


**Decision support and Resilience Support**

**Development Tools for Smart Services**

**Monitoring city users via social media, mobile and Wi-Fi**





Examples of services guided by the city strategy may be: decision support systems for risk prevention and resilience analysis, dashboard for city control room, etc. Services for city users: personal assistants for city users and operators, connected drive support for the city drivers and taxi, personalized suggestions to stimulate city users to move towards virtuous behaviors (reducing traffic, inter-modality, reducing time to park, exploiting interchange parking, increasing bike usage, increasing public transport usage, etc.); bonus system and virtual wallet for pushing and stimulating city users towards virtuous attitudes of for marketing, personal car sharing, promotion of commercial activities and districts, etc. These and many other strategic models can be activated with Km4City, since it understands the population and communicate with city users via mobile Apps, in one or more domains. The efficient delivering of these solutions strongly depend on computing of the user behavior, which enables the acceleration of commercials and art-craft activities, may push the tourists towards the second offers, thus increasing the city usage, reducing queues, improving the city visit and life experience.


**City User Behavior Computing and Analysis**

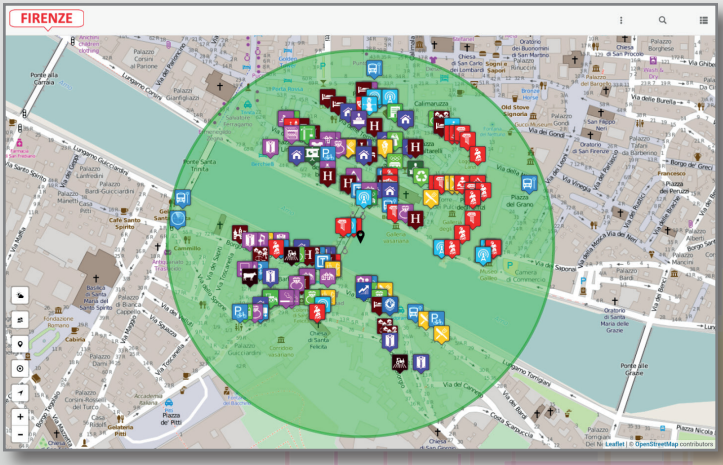
# AN OPEN SERVICE MOBILE APP: KM4CITY. WHAT. WHERE. . .

The production of open data is a duty of many cities. Apps derived from the city open data are hardly sustainable since are very expensive to be created and maintained if the data have to be singularly accessed. In general, the business of App is complex, the offer is high, most of the Apps are vertically focused on specific services and offered for free. Apps are nowadays a commodity: the city users expect to have them free of charge, and are thus a wide range of Apps by city operators of public and private transport, tickets services, parking, commercial mall, etc. On the contrary, specific Apps can only give a partial view of the city service, and thus are hard to be smart.

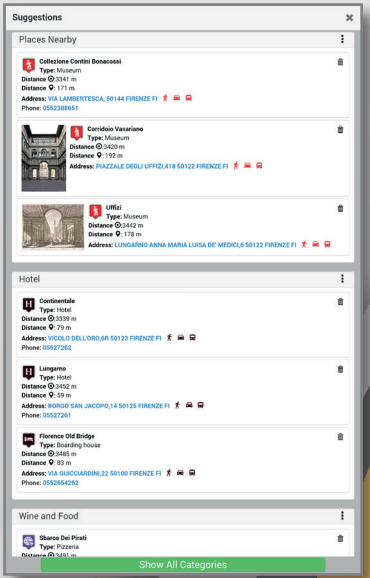
With Km4City, the city may provide access to aggregated data and services, so that a set of specific mobile and web Apps can be easily produced by city operators and firms at low cost.

The Km4City App and Development Tool allow to freely put in the hand of the city users and city operators a customized multilanguage and multipurpose App which can:

- provide access to multi-domain integrated data (mobility and transport, culture, events, parking, tourisms, health, safety, etc.), searching them by text, GPS, region, by navigation;
- provide suggestions for instilling virtuous behavior for the city according to their profile and city purpose, with the personal assistant and connected drive;
- provide support for navigation in the city, multimodal routing, point of interest routing;
- inform population about city hot issues and alarms from: civil protection, environmental aspects, weather forecasts, hot events, major communications, cycle paths, changes in the viability;
- collect comments and feedbacks about services to enrich their information and improve them, collecting humors from city users;
- measure service efficiency in the city, measuring Wi-Fi and Bluetooth iBeacon fields;
- tracking and learning city user behavior, providing origin destination matrixes.





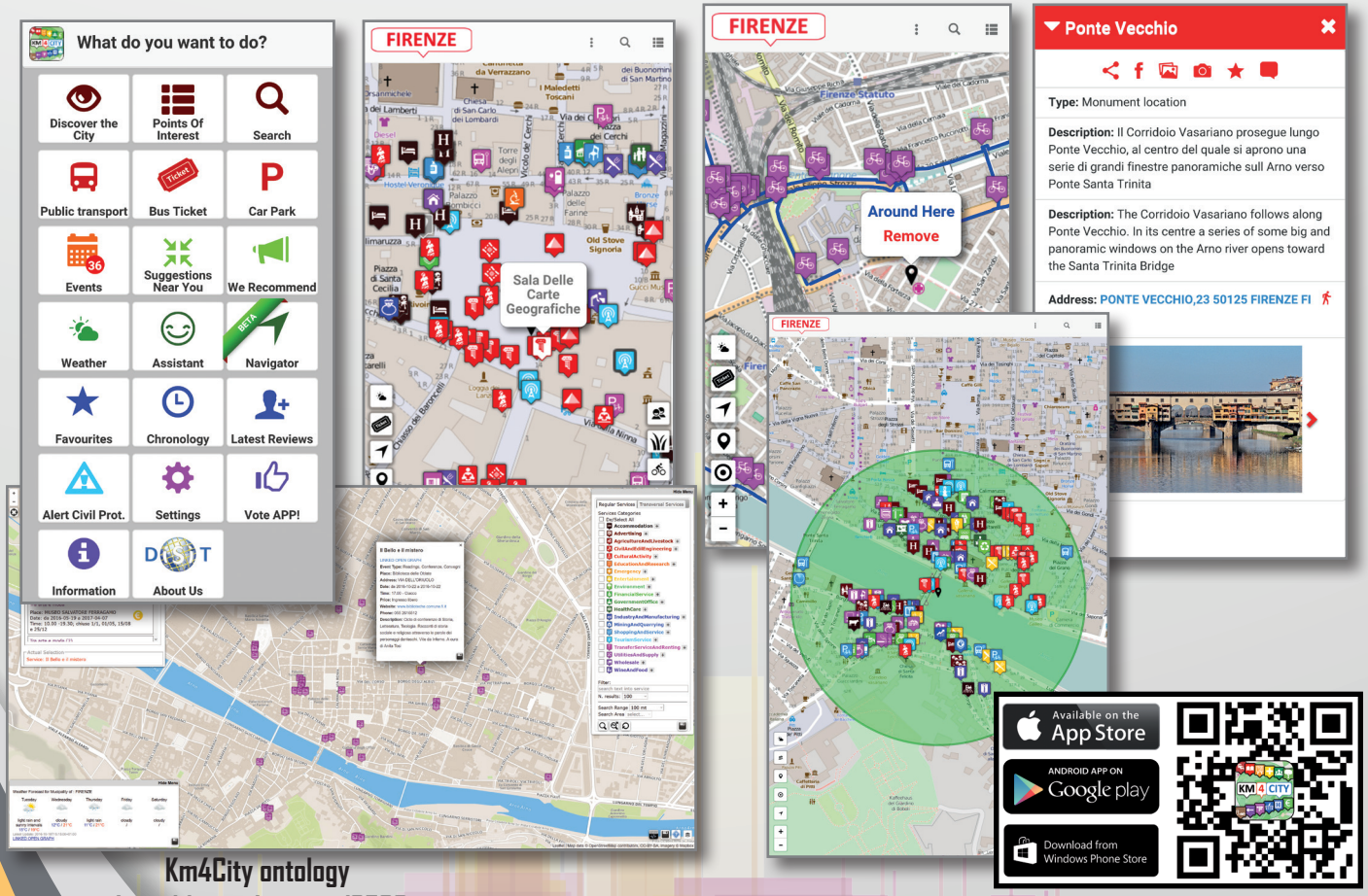



**SereviceMap: Web and Mobile Development Tool**

*http://servicemap.km4city.org*

The Km4City App is grounded on the open Km4City model and on corresponding Smart City API from which the whole knowledge base of the city can be searched and accessed. City Point of Interests and Services are classified in 20 categories and 512 subcategories.

Multi domain features of Km4City are related to mobility, parking, cycle paths, bus tickets, restaurants, accommodations, bathrooms, water, free Wi-Fi, paths, parks, digital locations, delays on bus lines, pharmacies, alerts of civil protection, ATMs, Internet of Things sensors, smart waste, smart lights, charging stations, etc. Data and services can become from transport and mobility, tourism, cultural heritage, energy, health, financial, commerce, sport, environment, weather, entertainment, sport, etc. The App provides access to Points of Interests, locations, paths and routing, areas, documents, video, audio, images, etc.

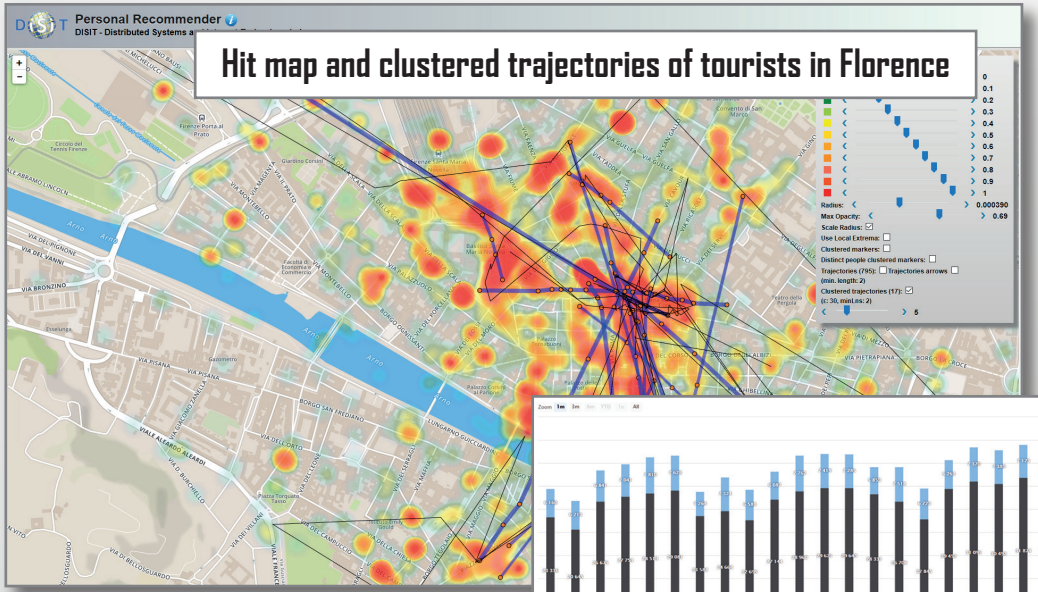


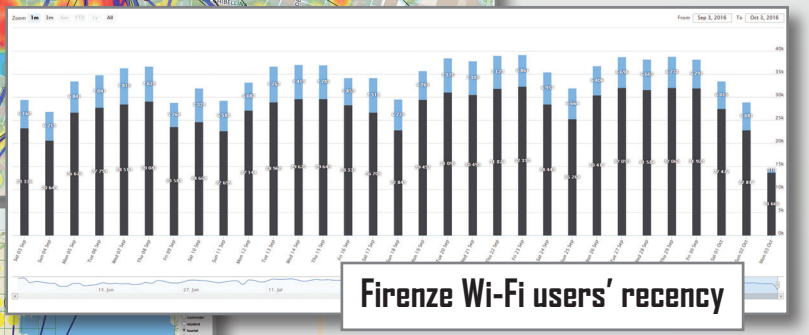

Km4City ontology

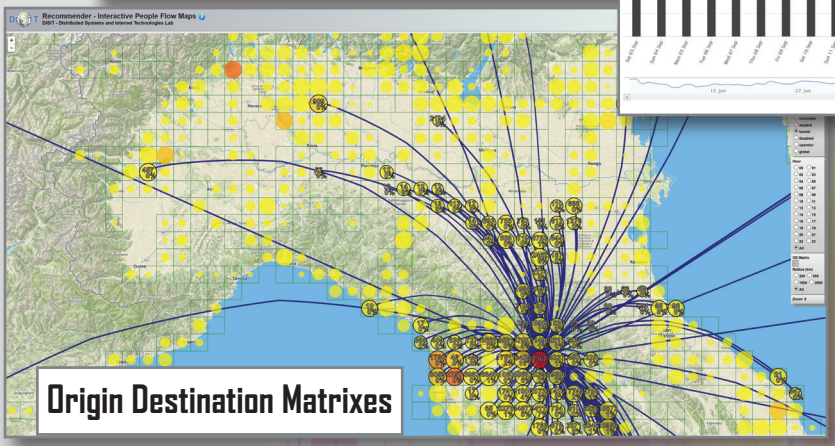
*http://www.disit.org/6506*

Km4City Mobile App is a sensor and front end desk for the city in the hands of the city users. All data are collected in a completely anonymous manner, while they inform and maps collective behavior of city users. The Open Km4City Mobile App exploits the Km4City Smart City API. Km4City Mobile App provides suggestions based on the user profile selected (citizen, commuter, tourist, student, and all) and on past anonymous action; measures the power of Wi-Fi and iBeacon.

The user can deactivate suggestions totally or selecting categories. These are classified as suggestions of: events, weather forecast, mobility and transportation, interesting issue to be done, utilities, accommodations, restaurants, twitter informative channels, etc. The Km4City suggestion engine is at the disposal of the city and of city operators. It learns from the city users, and thus avoid to press them with multiple identical suggestion and respect their preferences when suggestions are banned.



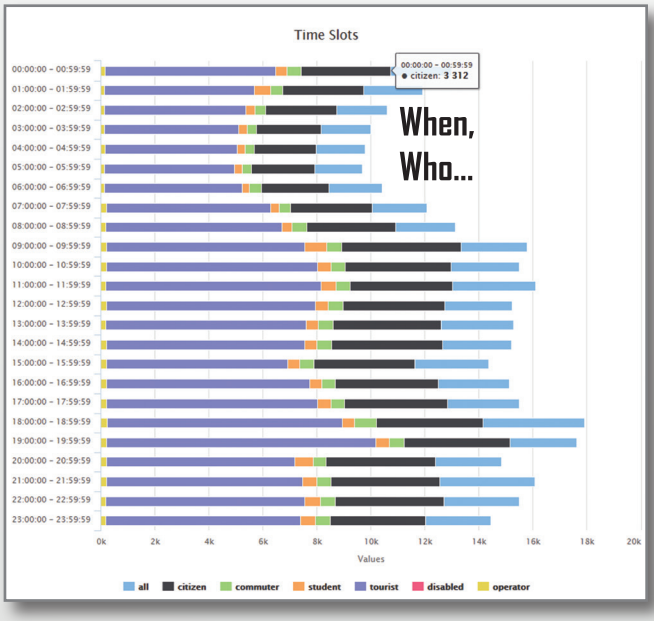

Available on the App Store

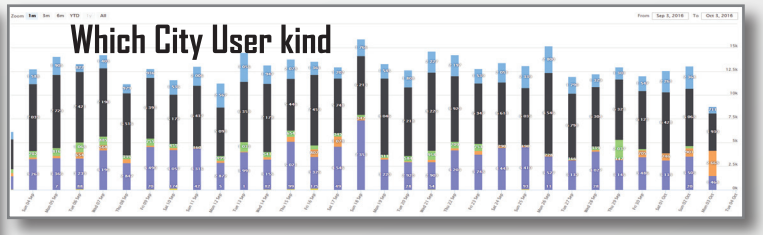
ANDROID APP ON Google play

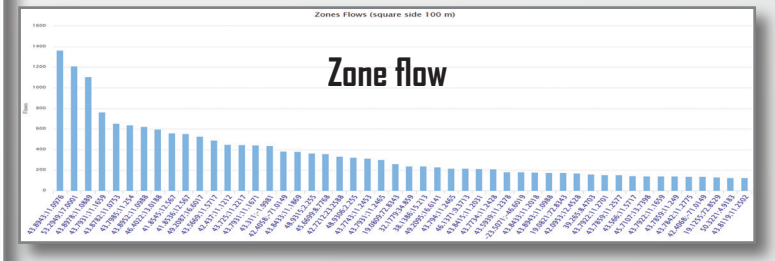
Download from Windows Phone Store

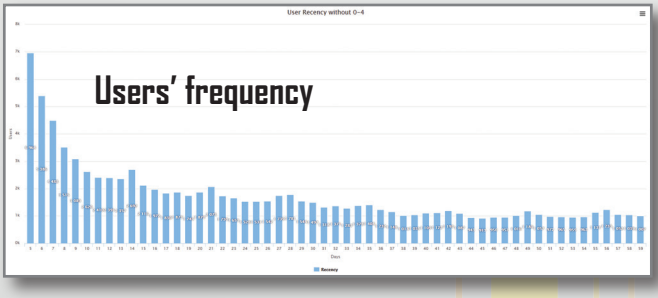
http://www.disit.org/app

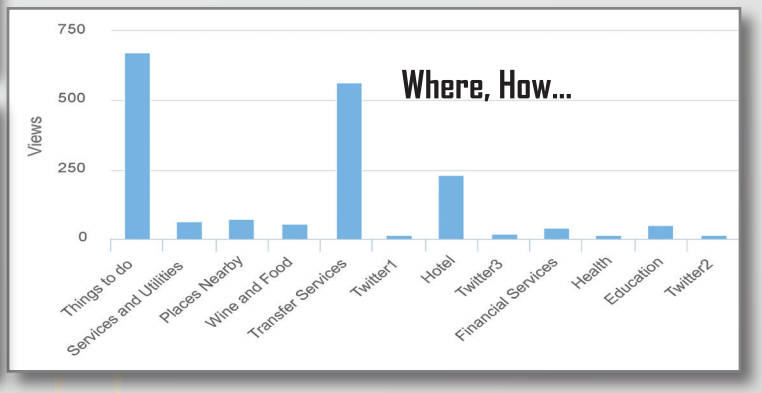
Km4City mobile App accumulate collective user profiles which can be exploited by the city for tuning services, extract what, when, which, where, and how the city users are using and/or appreciating services. It allows to produce and analyze Origin Destination matrices, for city operators, for mobility, tourism and transport in general.
Exploiting Smart City API, other Mobile App can be realized by City Operators, and commercial operators. Enabling a wide range of commercial and business applications.



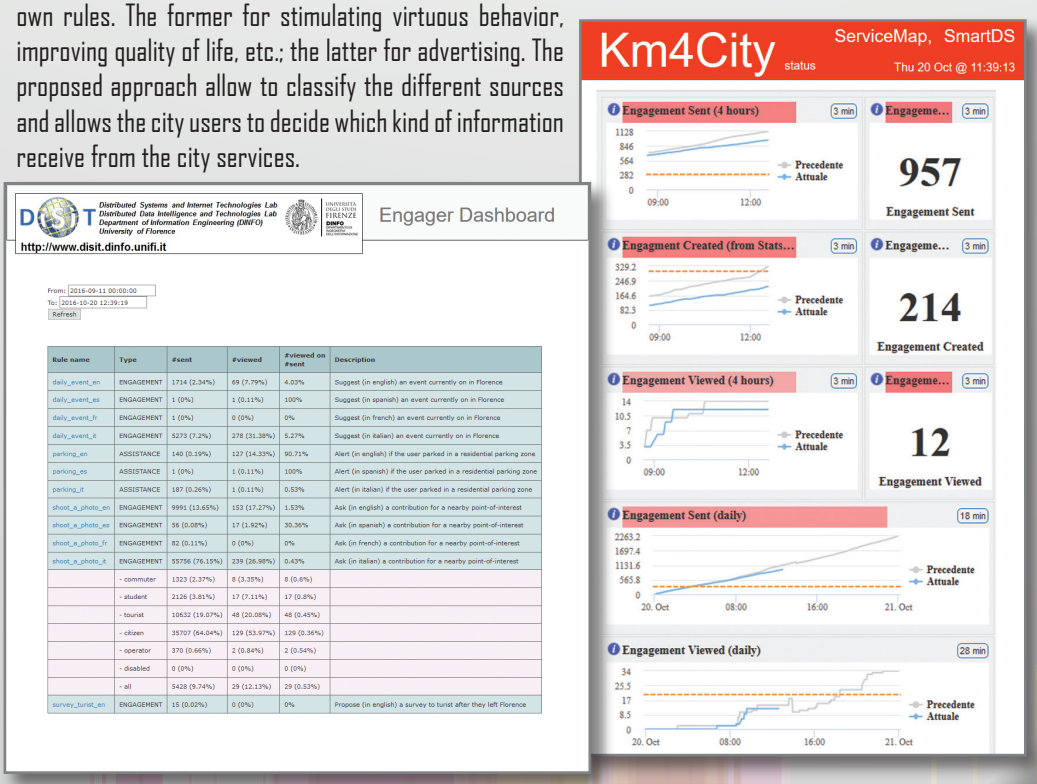




In Tuscany, Italy, more than 140,000 services are provided from Firenze, Pisa, Prato, Pistoia, Arezzo, Empoli cities.
With a particular focus to the Metropolitan Area of Firenze, and data coming from the Tuscany Region, LAMMA, observatory transportation and traffic manager MIIC, City of Florence for a total of more than 180 data sets. A web application on these data can be accessed via **http://www.km4city.org/webapp/**, and for developers **http://servicemap.km4city.org**

# USER ENGAGEMENT AND PERSONAL ASSISTANCE

In order to stimulate the city user toward virtuous behavior specific suggestions and stimulus can be provided. The aggregated data service can be used to provide the right information at the right moment and place with the satisfaction of the city user. On the other hand, the city strategies can be devoted to reduce the pollution, increasing the exploitation of public transport, distribute the cars in a more uniform manner, using bikes instead of car, using car pool, obtain higher quality garbage collection, apply some dynamic ticketing on ZTL, parking, and public transport. Almost all these goals could be obtained only by convincing city users to adopt better behaviors, toward a virtuoso behavior, in some cases also providing some bonus stimulating virtuoso behavior.

The production of stimulus and suggestions can be distributed to each specific user, by learning it typically behavior and providing assistance in the right moment and places, just when the critical habitudes are registered and occur for the health of the city, that mean in a sentient manner. Km4City Engager provides support for (i) exploiting mobile Apps with personal assistance enforced, as well as for (ii) enforcing the assistance in third party App and contexts. The same tool can be used for distributing bonus and just advices for improving the city life. Typically, the municipality as well as the city operators may be interested in defining their own rules. The former for stimulating virtuous behavior, improving quality of life, etc.; the latter for advertising. The proposed approach allow to classify the different sources and allows the city users to decide which kind of information receive from the city services.




| Rule name | Type | #sent | #viewed | #viewed on #sent | Description |
|---|---|---|---|---|---|
| daily_event_en | ENGAGEMENT | 1714 (2.34%) | 69 (7.79%) | 4.03% | Suggest (in english) an event currently on in Florence |
| daily_event_es | ENGAGEMENT | 1 (0%) | 1 (0.11%) | 100% | Suggest (in spanish) an event currently on in Florence |
| daily_event_fr | ENGAGEMENT | 1 (0%) | 0 (0%) | 0% | Suggest (in french) an event currently on in Florence |
| daily_event_it | ENGAGEMENT | 5273 (7.2%) | 278 (31.38%) | 5.27% | Suggest (in italian) an event currently on in Florence |
| parking_en | ASSISTANCE | 140 (0.19%) | 127 (14.33%) | 90.71% | Alert (in english) if the user parked in a residential parking zone |
| parking_es | ASSISTANCE | 1 (0%) | 1 (0.11%) | 100% | Alert (in spanish) if the user parked in a residential parking zone |
| parking_it | ASSISTANCE | 187 (0.26%) | 1 (0.11%) | 0.53% | Alert (in italian) if the user parked in a residential parking zone |
| shoot_a_photo_en | ENGAGEMENT | 9991 (13.65%) | 153 (17.27%) | 1.53% | Ask (in english) a contribution for a nearby point-of-interest |
| shoot_a_photo_es | ENGAGEMENT | 56 (0.08%) | 17 (1.92%) | 30.36% | Ask (in spanish) a contribution for a nearby point-of-interest |
| shoot_a_photo_fr | ENGAGEMENT | 82 (0.11%) | 0 (0%) | 0% | Ask (in french) a contribution for a nearby point-of-interest |
| shoot_a_photo_it | ENGAGEMENT | 55756 (76.15%) | 239 (26.98%) | 0.43% | Ask (in italian) a contribution for a nearby point-of-interest |
| | - commuter | 1323 (2.37%) | 8 (3.35%) | 8 (0.6%) | |
| | - student | 2126 (3.81%) | 17 (7.11%) | 17 (0.8%) | |
| | - tourist | 10632 (19.07%) | 48 (20.08%) | 48 (0.45%) | |
| | - citizen | 35707 (64.04%) | 129 (53.97%) | 129 (0.36%) | |
| | - operator | 370 (0.66%) | 2 (0.84%) | 2 (0.54%) | |
| | - disabled | 0 (0%) | 0 (0%) | 0 (0%) | |
| | - all | 5428 (9.74%) | 29 (12.13%) | 29 (0.53%) | |
| survey_turist_en | ENGAGEMENT | 15 (0.02%) | 0 (0%) | 0% | Propose (in english) a survey to turist after they left Florence |

# SMARTDS: SMART DECISION SUP PORT SYSTEMS

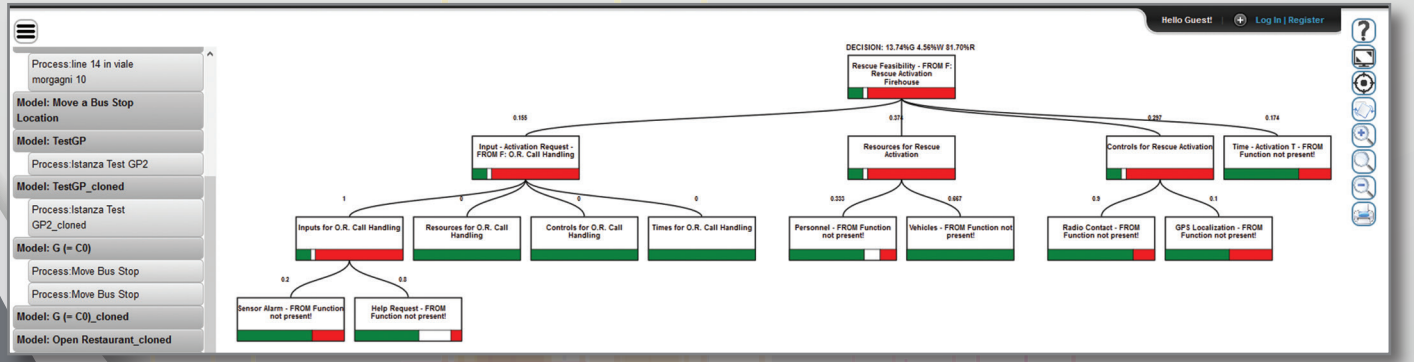
Smart City frameworks address new challenges to improve efficiency and sustainability of services for citizens, providing additional features and allowing the city environment to adaptively configure according to collected data/information and foreseen trend. To this aim, Decision Support Systems, DSS, have recently been acquiring increasing importance. The adoption of such as solution is quite new as described in RESOLUTE H2020, SteepProject FP7 and REPLICATE H2020, all projects of the European Commission.

A smart city produces a huge amount of data (open data, real time data, questionnaires, stakeholders opinions assessment, collaborative platforms, service reports, city operators data, user behaviors, social media, city users apps, etc.) The city decision makers are frequently queried to decide about: mobility and transportation changes, city shape and routing, dates for public works, changing strategies for lighting streets, opening commercial activities in a given area, performing welfare actions and services, etc. Most of these decisions need to be grounded on consultations, data assessment from services. In most cases, the oral update of these facts is the only help for the decision makers, that frequently have to make the decision with partial data.

**SmartDS** **http://smartds.km4city.org**, is a Smart Decision Support System for Smart City, based on the evolution of the Analytical Hierarchical Process model (which support System Thinking model), which has been integrated with the Italian Flag 3-values logic representation.

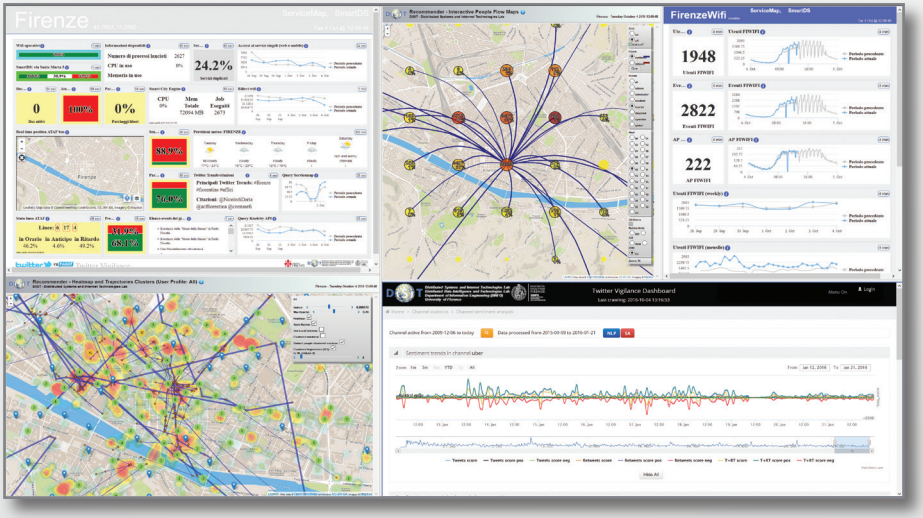
**SmartDS** is a web tool that allows to: (i) collaboratively develop decision models among decision makers of the city, applying the same model in multiple locations and contexts, allowing multiple users to share, clone and modify models and different instances of a same model; (ii) integrating social and data processes by accessing and querying external repositories, to gather Smart City related data assisting decision makers, through the use of properly defined functions and thresholds; (iii) directly update the assessment of the decision model according to the updated data and to communicate them to decision makers and making visible on a widget of the Km4City Dashboard.

The adoption of shared decision support tool allows minimizing the discretionarily of the decision, making the model shared with other decision makers, and making the decision also grounded on updated data coming, thus reducing the disputes since the assessment model has been collaboratively built.

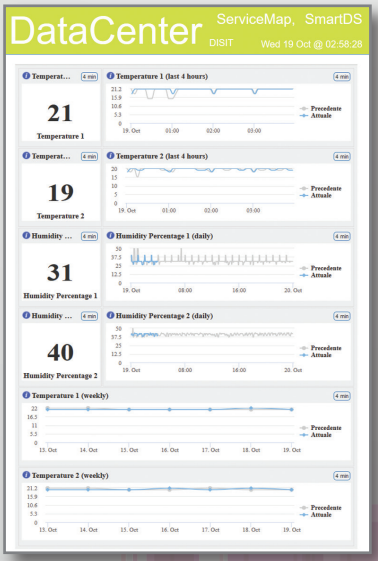


# SMART CITY CONTROL ROOM: DASHBOARD SYSTEMS

Smart Cities need to keep under control high level city indicators on cockpit/dashboards in the Control Room for city monitoring and decision support. In effect, small cities may have a single room, while large cities may have a large smart city control room as well as several specific control rooms for the critical infrastructures that may be managed by different city operators: mobility, energy, water, environment, civil protection, fire brigade, police, etc.




At the level of Smart City, the municipality and decision makers need to kept under control city operators and their service level agreements with the city, **public transport quality, energy on public services, mobility of people, Wi-Fi quality of service, tourism flows, welfare, parking, cultural services, governmental services, environment, pollution, water supply, weather, waste, economic indicators, social media, taxi, bike and car sharing, etc.** (see **http://www.disit.org/6935**). The monitoring has to be personalized for the assessor and main, for the technical and brigade, etc, and may be for city users

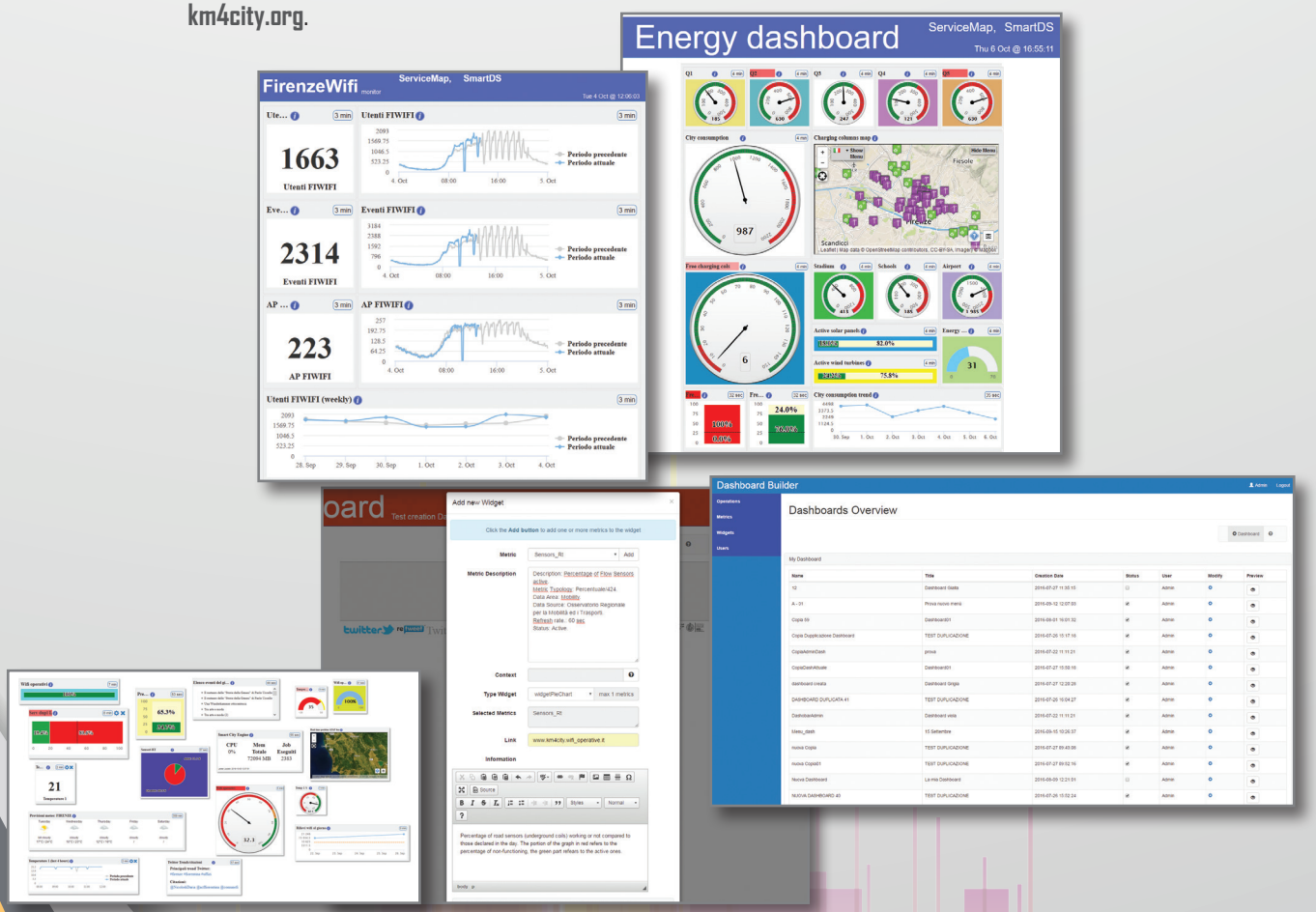



It is very difficult to manually monitoring thousands of indicators in the city, to check if they are working and changing in the correct manner, and which are the value of the corresponding key indicators, their historical values, etc. For example, the number of active busses, the mean delay on bus stops, the number of free taxi over time, the energy consumption on the recharge stations, etc. Most of the dashboard tools for data rendering are unsuitable since are only focused on presenting graphs according to some database, disregarding the complexity of multiservices, service level agreement, historical collection of data, and by the fact that data may be obtained by taking data from same place or receiving them in some manner (push and pull), and disregarding the fact that the control room panel are typically placed on the from wall and they have to update automatically according to each specific measured value.

The Dashboard Builder tool is capable to produce multiple dashboards accessing at static and real time data from some data store and services. The tool allows multiple users to build multiple dashboards by visually producing dashboards by using several different kinds of widgets (number, percentage, gauge, speedometer, graph, graph time trend compare, embedding web pages, weather forecast, pie, decision support, etc.). In most of them, it is possible to set up a threshold above which an email / alarm is sent; a link to use them as buttons, an info pop up for presenting descriptions and credits, etc. Widgets are updated automatically and singularly on the dashboard according to the parameter set: the countdown is visible on the upper right corner of each widget. This feature makes the produced Dashboards very suitable to be rendered on Control Room panels.

The Dashboard Builder may also control service level agreements on data and service providers, manage tickets for opening and managing maintenance, send messages/alerts on the basis of events; create public and private dashboards for administrators as well as for public promotion and evidence.

The example on a Florence dashboard is accessible on **http://www.km4city.org** or **http://dashboard.km4city.org**.



# CRITICAL INFRASTRUCTURE: RESILIENCE ANALYSIS

City infrastructures are resilient when they provide the ability to sustain required services and operations in both expected and unexpected conditions. This means that they need to provide some capability of continuously adapting the operational capabilities to persecute system intention/purpose, the quality of life for its city users.

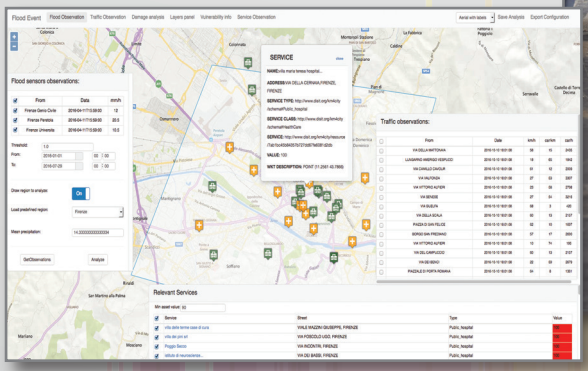
A city may present a number of interdependent sub-systems. Effects of unexpected critical events triggered by climate changes or manmade behavior can be propagated in the city with unpredictable dynamics and damages. Understanding city resilience is becoming more and more important: transport, water, communication, hospital, energy, cultural, etc., are even more connected and depending each other. A failure in one of those sub-systems may affect the system as whole.

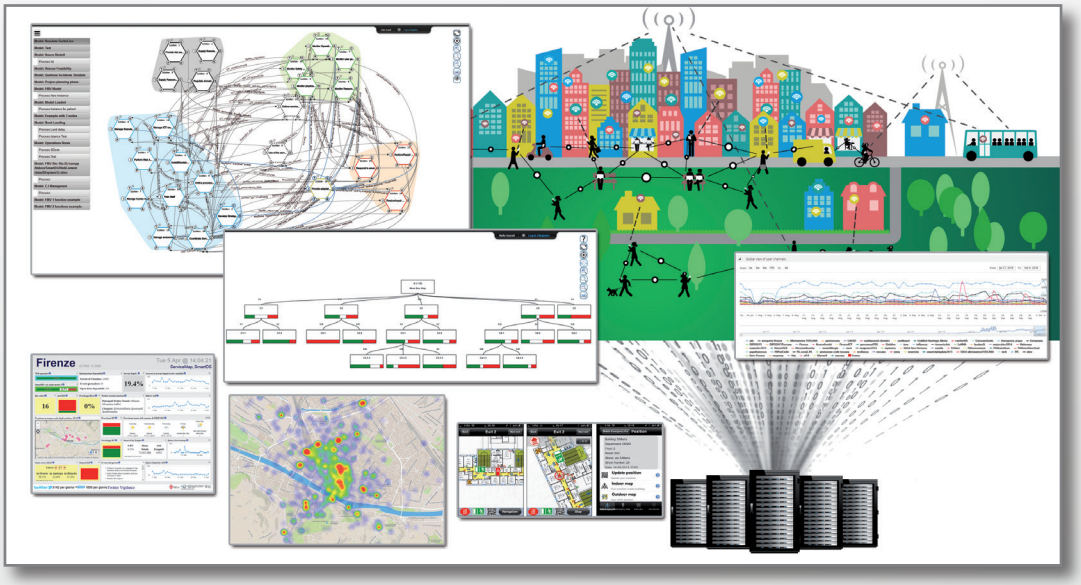
Resilience analysis and assessment aim to tackle the challenges of the uncertainty and interdependency expanding and integrating the current Risk Management approach, usually based on known threats.

The aim of a Resilience Decision Support, **http://ResilienceDS.km4city.org**, is to support decisions at strategic, tactic and operational levels to assess and develop sustained adaptability capacity: to be effective during the preparation, plan, absorption, recovering and adapting phases.

The main core of the ResilienceDS tool is based and extend the Functional Resonance Analysis Method (FRAM). ResilienceDS is a visual tool for system resilience modelling and risk focuses on modeling and analyzing system interdependencies, their dynamics, relationships and complexity; taking into account of the effective available resources in real time. Within this context, a system functionality/process can transform its state on the basis of actions performed by human, technological devices or natural. Thus the city model with respect to causes and affects can be modeled and followed in real time, for Smart City Control Room and decision makers.

ResilienceDS visual tool takes into account the non-linear nature of city performance, as opposed to building cause-effect sequences of events over time. It is based on the principle that accidents in complex sociotechnical systems are produced by unexpected combinations (resonance) of "normal performance" variability. Hence the visual tool supports resilience assessment by providing an understanding and steering option towards controlling (damping) sources of variability.




Functions, selection, coupling and the identification of their potential sources of variability can be investigated through Smart City Big Data Analytics of Km4City or other data assets as well as through the classical stakeholder workshops and focus groups with Decision Makers, Critical Infrastructure managers, First Responders, Civil Protection, Citizen association, etc. The making decision processes can be modelled by using SmartDS which in turn compose uncertainties combining stakeholders experiences and when possible exploiting real data from Km4City.

The results of such analysis is represented with a ResilienceDS tool including FRAM visual tool that consents advanced modelling (e.g., nested functions) and graph oriented formalizations in view of evidence driven resilience assessment, monitoring and simulation.

In Km4City, the integrated resilience analysis tools allow to produce and validate models for resilience and decision making in case of emergency and hazardous cases of critical infrastructures by composing different data: open data, real time data, surveys, stakeholders opinion assessments, collaborative platforms, service reports, data from city operators, and analysis of user behaviors, city apps, social media, etc. ResilienceDS allows city managers to tackling classical decisions under critical conditions, to be prepared and to absorb and react to them at the best. The approach has been improved in the context of RESOLUTE H2020 project.

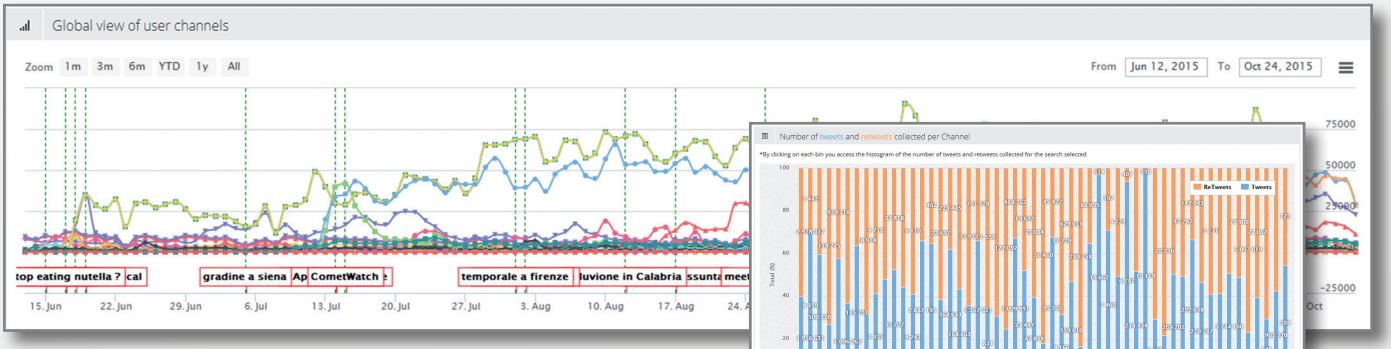
# TWITTER VIGILANCE: SOCIAL MEDIA ANALYSIS

Social Media channels are sources of information for: assessing moods of city users on services and environment, for predicting audience at large events, for communicating with the city users, etc. Among the several social media platforms Twitter is probably one of the most reactive in terms of velocity by which the information is flooding in it. Twitter has been successfully used for prediction and measuring events in the cities. Together with the measures performed by the mobiles it completes the view about the occurrences and city users in the territory.

Twitter Vigilance, TV (**http://www.disit.org/tv**) is a multi-user tool for Twitter analysis in real time and offline. The Twitter Vigilance ensures the collection of 98% of tweets/retweets referred to events by providing the yield and precision. Twitter Vigilance is capable to monitor and analyze slow and explosive events on Twitter with same efficiency and precision. A fast or explosive event occurs with several hundred thousands of tweets per day/per hour. Slow events can occur with very few tweets per day or week or their absence.

Twitter Vigilance provides adaptive algorithms to allow effectively cope with slow events that become explosive without losses, acquiring all tweets and retweets. Twitter Vigilance Real Time (http://www.disit.org/rttv ) is used for monitoring events in real time and provide Twitter flow data also computing Sentiment orientation in real time.

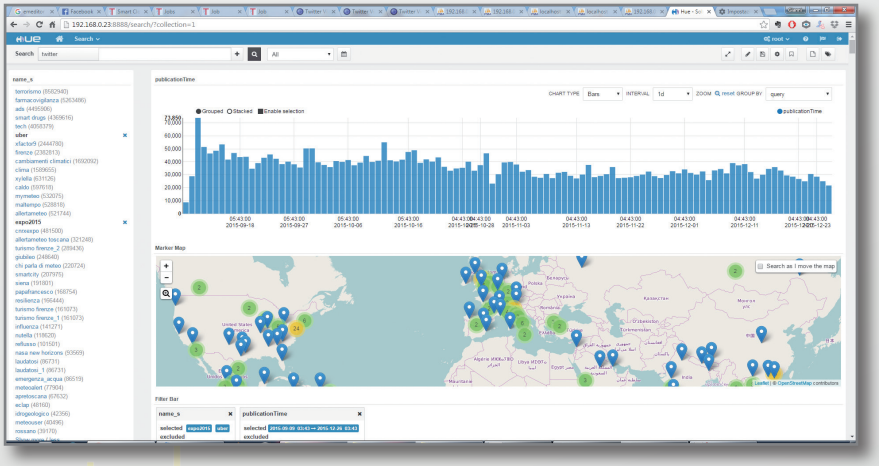
In Florence and Tuscany, Twitter Vigilance is adopted by LAMMA for monitoring weather aspects, by Sii-Mobility for assessing mobility and transport services, and by other agencies.

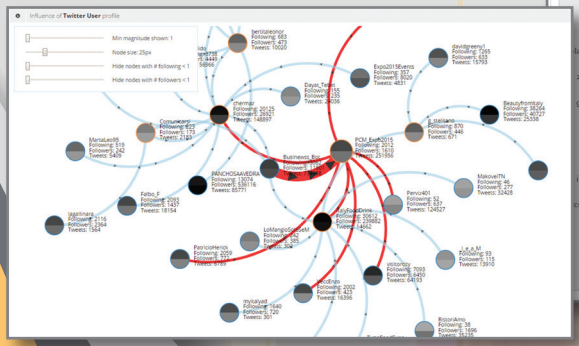


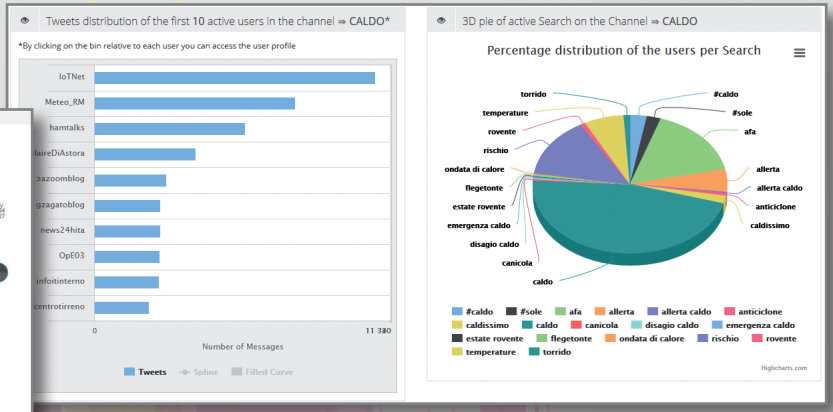

**Twitter Vigilance** daily and real time tool can be used to:

- participatory analysis and stimulus;
- discover and evaluate new trends;
- discover and stimulate influencer;
- early detection of events;
- predictive audience assessment;
- assessments of acceptance;
- marketing and communication;
- informing city users;
- assessing appreciation of decisions;
- sentiment analysis;
- risk and security assessment.

Twitter Vigilance assessment and evaluations can be exploited in the SmartDS and monitored on Dashboard; and put results at disposal of decision makers in real time.



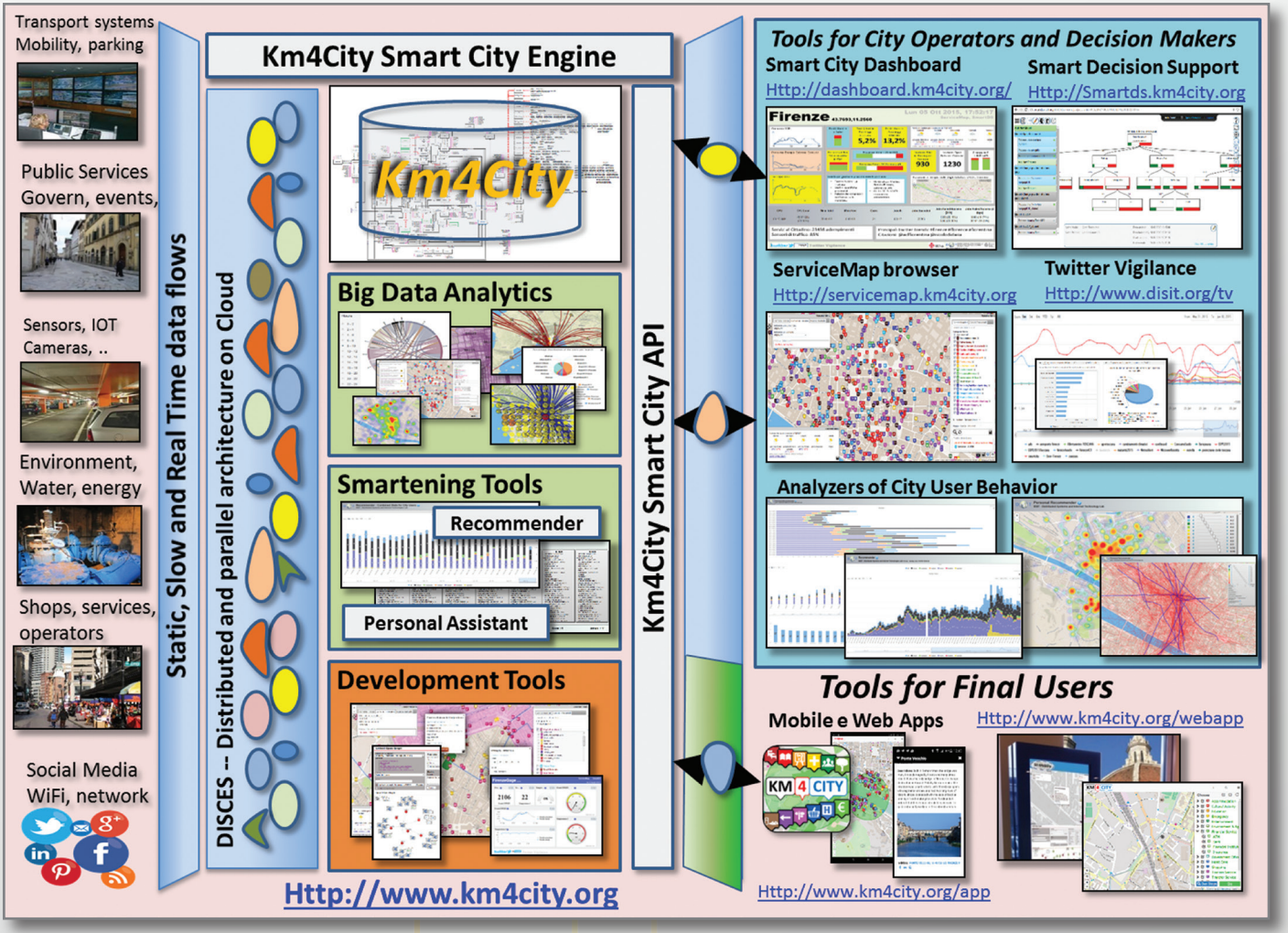




# Km4City ECOSYSTEM OVERVIEW

The **Km4City Smart City Engine** performs the:

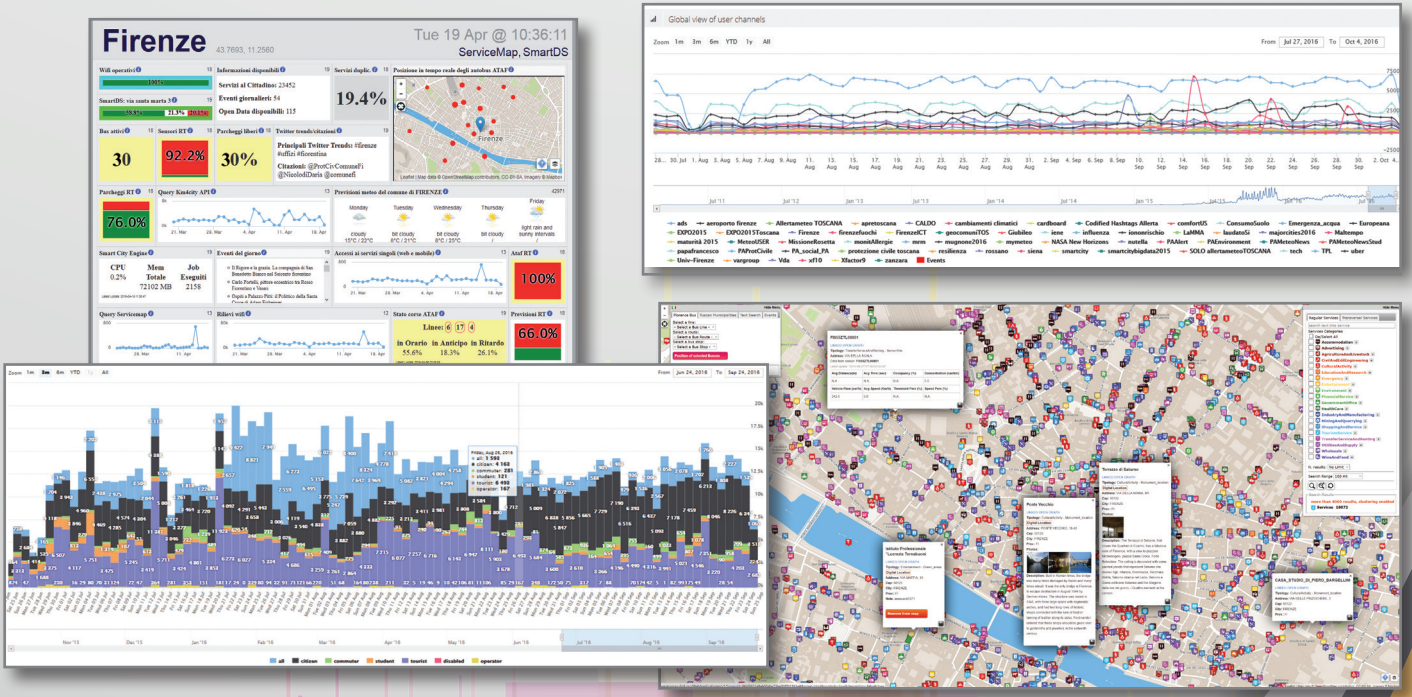
- **data gathering and harvesting**. Data can be open and private, static and real time, with some licensing conditions, from city operators and directly from sensors, IOT. Most of them are geo-located and ingested as files in different formats, such as: CSV, XLS, KMZ, JSON, XML, HTML, MySQL, ZIP, LSMA, SHP, etc., from protocol or service: WS, REST, ODBC, RDF, LD, LOD, via RDF Store end points, and social media crawlers, etc. From any data kind, Km4City extracts and aggregate information and knowledge to be used for supporting city strategies and city user quality of life. The data gathering and harvesting processes are totally automated by the DISCES distributed scheduler. The whole data gathering process is managed by the Data Ingestion Manger (DIM) and by the RDF Indexing Manager (RIM). The DIM and RIM also manage data ingestion and licensing, also versioning of the Km4City knowledge store.
- **data aggregation and reconciliation towards Km4City Smart City Ontology**. The data aggregation for semantic interoperability is performed towards the Km4City ontological model (free of license and distributed). It takes into account relations among the several concepts of the city elements, and enables the systematic inference and reasoning on smart city knowledge taking into account several domains, plus spatial and temporal aspects.
- **big data management**. The huge amount of data coming from different sources, different formats, different velocity, licensing and version is managed by Km4City by using a noSQL databases and distributed parallel architecture. The data computing processes are managed and executed by DISCES distributed scheduler and/or as Hadoop MapReduce algorithms, depending on the Smart City size and complexity. The data analytic perform daily and/or real time elaborations such as: risk assessment, people flow, origin destination matrix, decision support update, natural language processing and sentiment analysis on social media, dashboarding.
- **smartening tools**. The huge amount of integrated data descrbing the context and territory, the analysis of city user behavior and of the traffic, the precise activities of the users allow to provide them suggestion, recommendations, and stimulus according to the city strategies. Km4City allows exploiting data analytics for smart city by producing personalized: recommendations, user personal assistance, routing, multimodal routing.
- **Km4City Smart City API** provide services on data access and smart city computing. The Smart City APIs are a service bus by which the Km4City Ecosystem tools exchange data and results. As described in the first part of this document, Km4City provides suggestion and personalized service on demand for any kind of smart city applications: mobile and web app, vehicular kit, totem and advanced applications, etc. Km4City Data API provide a multilayer model to access at data and services, from simple REST CALL to more complex SPARQL queries. Smart City API are supported by the ServiceMap development tool, by which the programmer can visually perform search and query on Km4City and from this obtaining excerpts of Code to be used in their mobile applications. Thus shortening the development time.

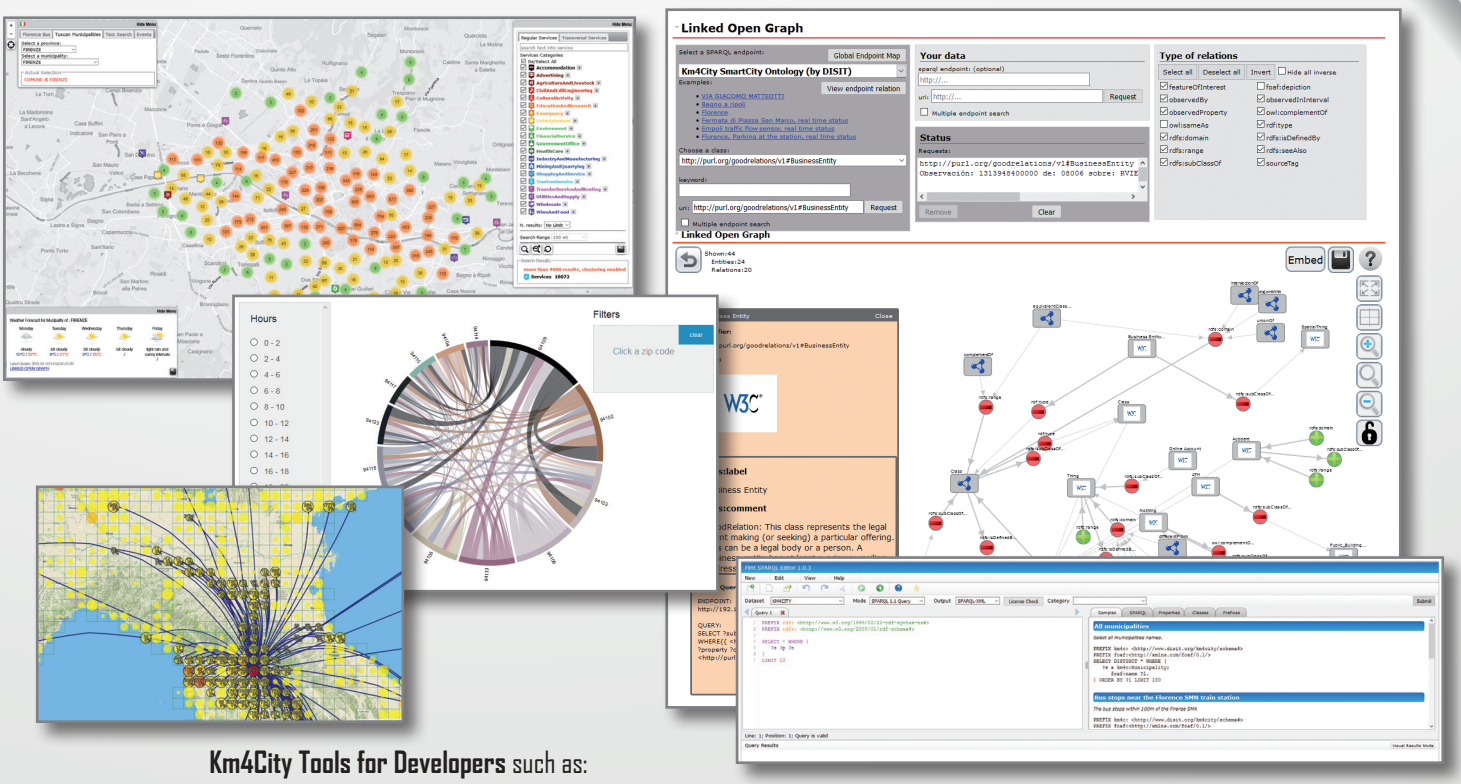

Transport systems
Mobility, parking
Public Services
Govern, events,
Sensors, IOT
Cameras, ..
Environment,
Water, energy
Shops, services,
operators
Social Media
WiFi, network
Static, Slow and Real Time data flows
DISCES -- Distributed and parallel architecture on Cloud
Km4City Smart City Engine
Km4City
Big Data Analytics
Smartening Tools
Recommender
Personal Assistant
Development Tools
Km4City Smart City API
Tools for City Operators and Decision Makers
Smart City Dashboard
Http://dashboard.km4city.org/
Smart Decision Support
Http://Smartds.km4city.org
ServiceMap browser
Http://servicemap.km4city.org
Twitter Vigilance
Http://www.disit.org/tv
Analyzers of City User Behavior
Tools for Final Users
Mobile e Web Apps
Http://www.km4city.org/webapp
Http://www.km4city.org/app
Http://www.km4city.org


FIRENZE
Lungarno Degli Archibusieri

**Tools for City Operators and Decision Makers** such as:

- **Dashboard builder and the set of Dashboards** which can be visually produced by city operators by rendering aggregated data per domain, per district, per event, per goal, etc.
- **Smart Decisions Support, Smart DS**, which is a System Thinking based tool for collaborative development of decision support models which can exploit data from the Smart City, as well as data coming from consultations, social media, experts, etc.
- **Twitter Vigilance**, which is a tool for social media monitoring specifically tuned for analyzing Tweets about the city services by means of natural language processing to assess the appreciations/ sentiment and user relationships. The operator can set up monitoring channels for listening city users on transport system, energy, governmental services, etc.
- **Service Map Browser**. A tool for browsing services and data contained into the Km4City Smart City data. It allows performed text and geo queries, visualizing services located on the map according to their related information.
- **Collective User Behavior Analyzer**. A tool for browsing the descriptive features about collective profiles for city users to understand: what, where, how, when, why, the city users the use and live the city. The tool computes hit maps (the most interested parts of the city for the user category), preferred trajectories and paths in the city, origin destination matrices for pedestrian and vehicles. To know these details for city users as commuters, citizens, tourist, operators and students, allows to tune city services and assess appreciations.






**Km4City Tools for Developers** such as:

- **Service Map** (**http://servicemap.km4city.org**). TThis tool is described in more details in the following. It allows visually searching and browsing data into the Km4City model, and once performed a visual search the corresponding query/code is sent via email to the developer: for training and shortening the time to develop web and mobile Apps exploiting **Km4City Smart City API**.
- **Linked Open Graph** (**http://log.disit.org**) is a tool for browsing the Km4City knowledge base as well many other RDF models, as RDF Store Linked Data. The tool allows visually browsing and making queries on the model. During the browsing the user creates and expands a graph among entity relationships in the city models and data. Any graph can be saved and shared among other colleagues.
- **SPARQL RDF End Point and licensing verifier** is a tool to perform and setup SPARQL queries on the Km4City RDF Store. The same tool allows to verify if a given query and corresponding results can be exploited for a given application according to the licenses corresponding to the data (**http://log.disit.org/sparql_query_frontend/**). This tool is very relevant since some of the private data are typically provided with no-commercial clause.
- **Origin Destination tools** (**http://www.disit.org/6694**, **http://www.km4city.org/odmatrix-people-flow.png**). A set of tools and algorithms to collect data and analyses traffic flow and collective user behavior for producing Origin Destination matrixes (for different user profiles and at different time slots). They can be useful for routing algorithms, tourism assessment, city service assessment and tuning, etc.

# Km4City ontology and model

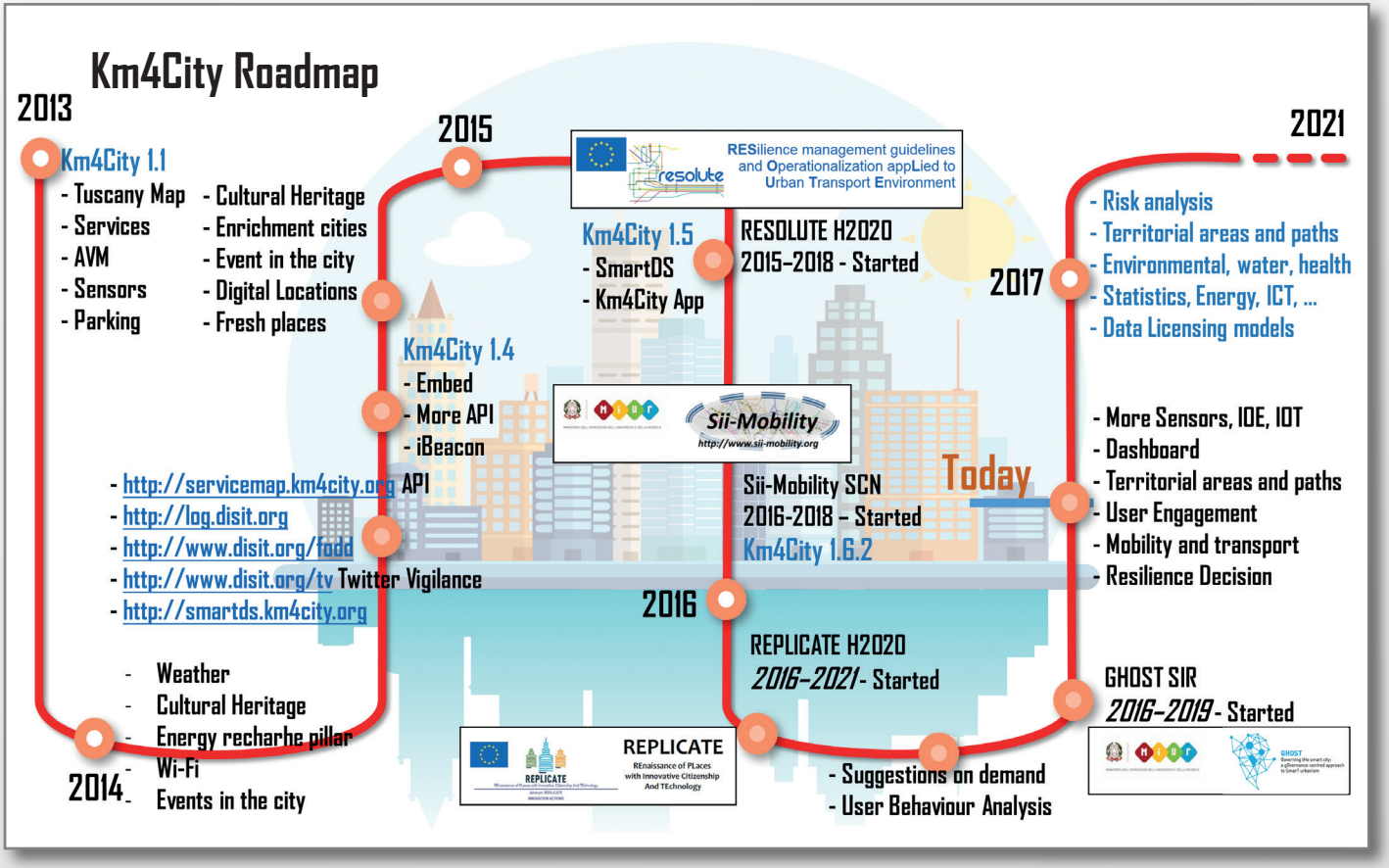
Km4City is a knowledge model for Smart City solutions and services. It semantically integrates any data coming from different operators. In the process of data aggregation it allows to establish all needed relationships among elements, thus making a general data set semantically interoperable at model level (e.g., associating the street names with toponimous coding, resolving ambiguities in names, removing errors in data, completing missing data, etc.). Km4City multi-domain ontological model is

- **open, well documented and accessible free of charge**, aggregating open and private data, static and real time data, social media, sensors, etc.;
- **modeling services and relationships in the city** as: accommodation, advertising, agriculture, engineering, cultural, education, research, emergency, entertainment, environment, financial, governmental, health, industry, manufacturing, mining, shopping, tourist, transfer and mobility, utility, wine and food, etc. for more than 500 different specific categories, in agreement with chamber of commerce and cultural model;
- **representing localized and relationships among**: services, areas (e.g., districts, LTZ, parking, green area), paths (e.g., cycle, tramline, busses, touristic paths), weather forecasts, events, Wi-Fi access points, sensors (e.g., traffic, environment), IOT services and tool, recharge stations, parking, public transport, etc.;
- **covering**: street and geographical aspects, point of interests and services, public local transport, environmental and traffic sensors, temporal aspects of data, data licensing, real time events, etc.

**The Florence and Tuscany case, accessible from http://servicemap.km4city.org and "Firenze what where, ..." mobile App on all platforms**. The identification of the most relevant data sets was performed to activate the data aggregation process by integrating information for the city users about services and mobility/transport. Geographic data have been integrated from Mobility Integration Information Center of the Tuscany Region, many open data from Florence Municipality, sensors, weather forecast from LAMMA agency, several information about commercial activities from the web, and social media. The data which are present on Km4City for Florence and Tuscany are covering the whole Tuscany region with all districts and denser data on Florence Metropolitan Area for a total of more than 120 million of elements.

The Km4City model and ontology has a certain and founded roadmap to evolve with the support of a number of projects investing on its technology, such as:

- Sii-Mobility is providing a regional level environment for inter-modality and advanced services on mobility and transport, licensing;
- RESOLUTE DRS14 H2020: on risk and resilience analysis and tools, people and traffic flows, etc.;
- REPLICATE SCC1 H2020: on integrating sensors, IOT, energy aspects, lighting, smart benches, etc.;
- GHOST SIR MIUR: Governing the smart city: a governance-centred approach to smart urbanism.




## Tuscany and Florence case (October 2016)

**Static elements**: Road Graph (Tuscany region) as 132,923 Roads, 389,711 Road Elements, 318,160 Road Nodes, 1,508,207 Street Civic Numbers; 110,374 Services (20 main categories, 512 subcategories); 16 Public Trasport Operators (Busses, Tram, Ships, Railway), 41,281 Bus stops and 1,081 bus lines (of the whole Tuscany); 210 Parking areas in Tuscany; 796 Traffic Sensors in many cities; about 2,000 IoT sensors; information on elements that are located on GPS points, paths, areas, etc.;

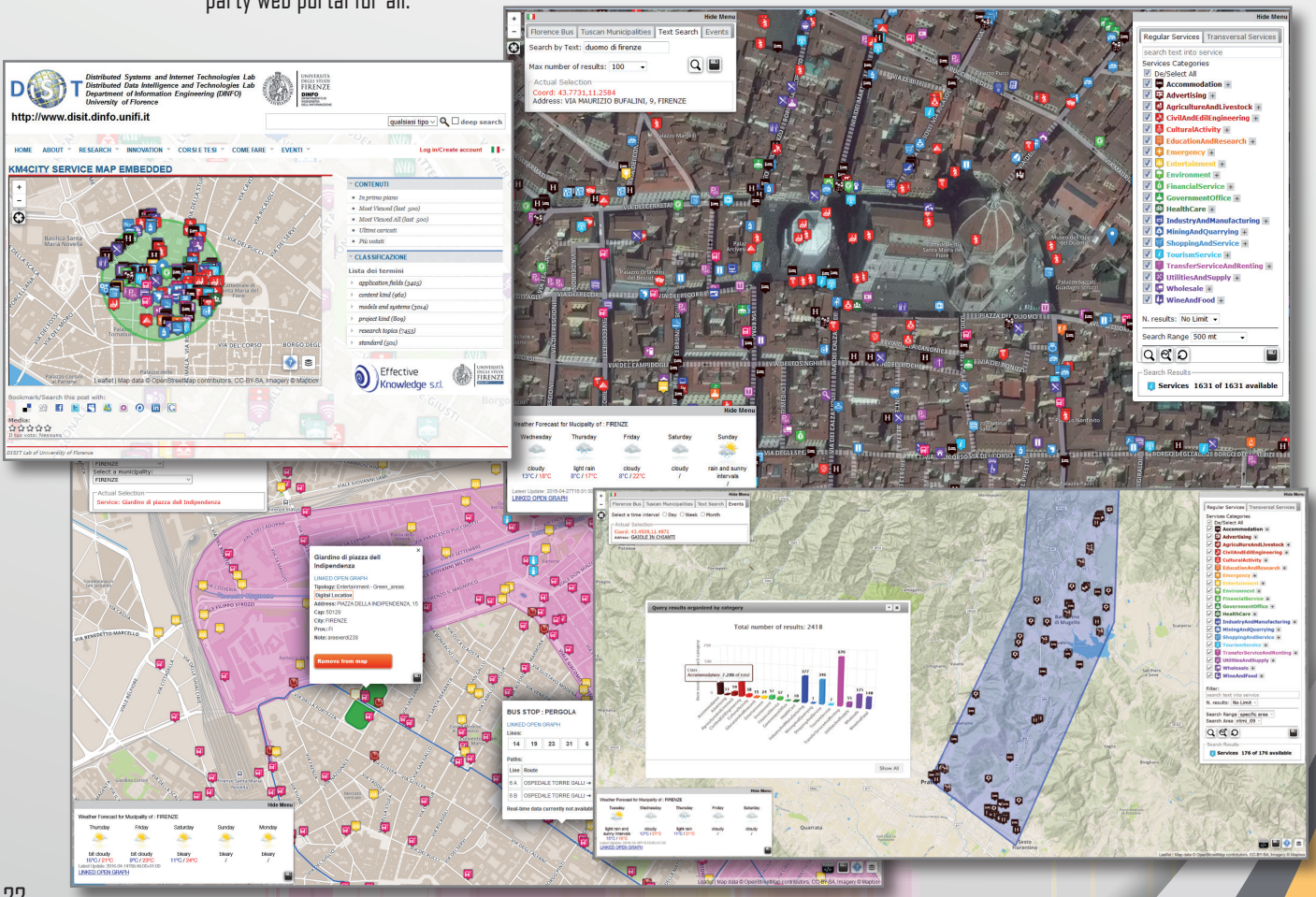
**Dynamic/real time**
- bus lines: 144 updates/day per line
- Parking status: 72 updates/day per sensor
- Traffic sensors: 288 updates/day per sensor
- Weather: 2 updates/day for 285 areas
- Events: about 60 new events/day
- Wi-Fi: 350,000 measures per day
- mobile app: 50,000 meaasures per day
- more than 35,000 distinct user per day
- from 500,000 to 1,2 million Tweets per day

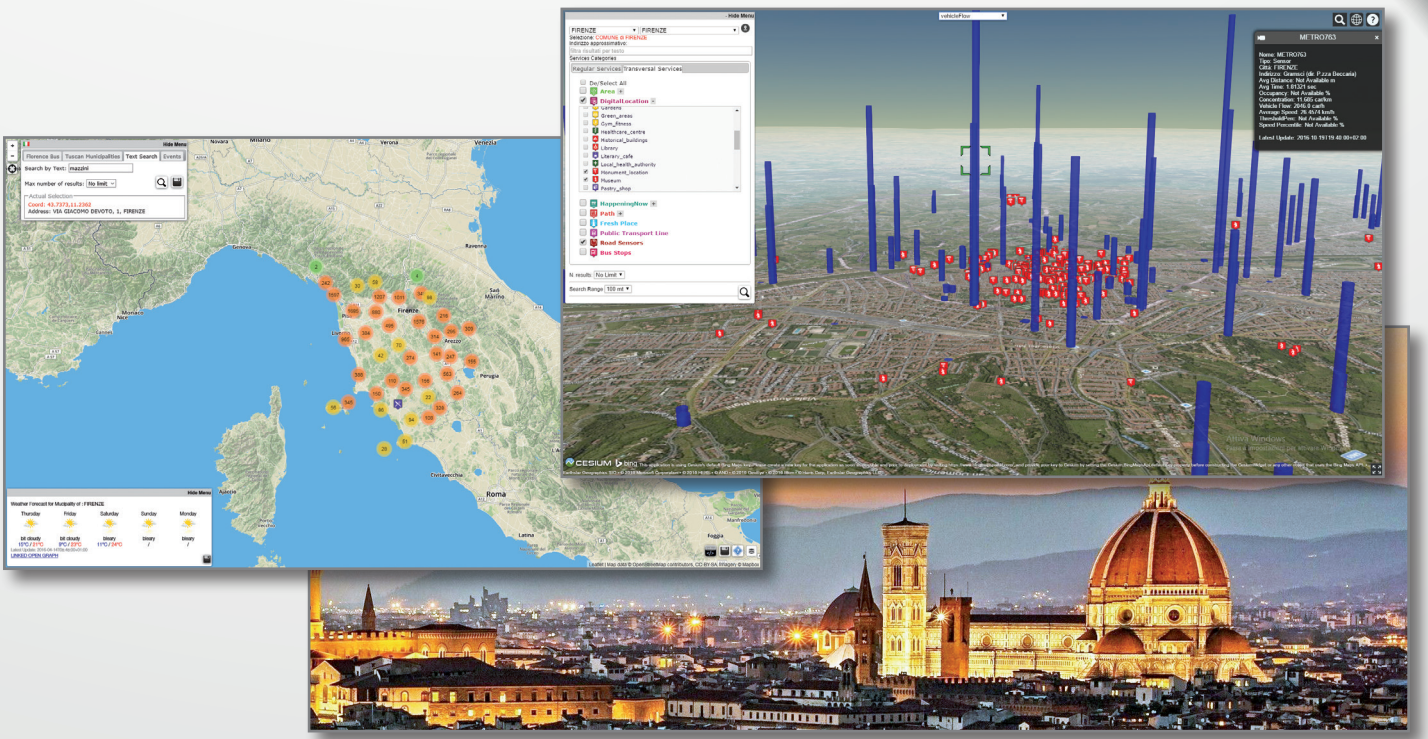
# SERVICE MAP: THE MAIN TOOL FOR DEVELOPERS

Aggregated data into Km4City can be geographically browsed and queried by using ServiceMap tool **http://servicemap.km4city.org**. SeriviceMap is a fully open source solution for public administration at city, district and regional levels.

ServiceMap is the main **development tool for Km4City EcoSystem**, since it allows:

- visually producing queries and calls to Km4City Smart City API that can be past for developing mobile and web applications for shortening the development time, receiving by email this information and training. Saved visual queries can be invoked by a QueryID from web and mobile applications; and can be changed in structure from the ServiceMap, thus making the query as a dynamic aspect of your application;
- visually producing queries/scenarios that can be embedded iframe into third party web pages. Once invoked actualizes the query at the current values. Thus enabling the integration of city services into third party web portal for all.





ServiceMap allows to:

- **perform full text queries** on street names, service name, description, areas, categories, lines and polylines, etc.;
- **perform queries to get geo-located services closer to a given point (proximity query)**, with and without filtering;
- **work on simple and complex geographical areas**: region, districts, metropolitan area, municipality, restricted traffic zone, etc., and allows to query for collecting services with and without filtering and/or clustering;
- **show**: areas and surfaces (e.g., RTZ, parching area, green, districts), lines and polylines for paths (e.g., bus lines, cycle lines, bus lines, train lines), events information, bus lines courses and delays with respect to single bus-stops, sensors data, etc.
- **monitor real time data**: events, bus lines, sensors, traffic flows, weather forecast, etc.

Advanced services allows to:

- access at statistical data services coming from open data of the municipality and collected from the Dashboard;
- report from real time data collected. For example the data results on bus line reports about deadlines, parking status, sensors, traffic flows, etc.

ServiceMap is Open and grounded on Km4City ontology and Smart City API. Any additional module to satisfy new needs can be easily developed and added. Modules and functionalities can be typically made accessible as new functions for the Km4City Smart City API.

## Sii--Mobility (http://www.sii-mobility.org)


- Advanced mobility and transport services
- Connected drive and participatory actions
- Experimentation and validation in Tuscany
- Integration with present central station and subsystems

DISIT Lab, University of Florence, is the technical-scientific coordinator

**Partners**: ECM; Swarco Mizar; Inventi In20; Geoin; QuestilT; Softec; T.I.M.E.; Liberologico; MIDRA (autostrade, motorola); ATAF; Tiemme; CTT Nord; BUSITALIA; A.T.A.M.; Effective Knowledge; eWings; Argos Engineering; Elfi; Calami & Agresti; Project; Negentis.

MINISTERO DELL' ISTRUZIONE, DELL'UNIVERSITÀ E DELLA RICERCA

## Resolute (http://www.resolute-eu.org)

- **Develop European Resilience Management Guidelines (ERMG)**
  - Develop a conceptual framework for creating/ maintaining Urban Transport Systems
- Enhance resilience through improved support of human decision making processes, particularly by training professionals and civil users on the ERMG and the RESOLUTE system
- **Operationalize and validate the ERMG by implementing the RESOLUTE Collaborative Resilience Assessment and Management Support Systems (CRAMSS) for Urban Transport Systems** addressing Road and Urban Rail Infrastructures
  - **Pilots in Florence and Athens**
- Adoption of the ERMG at EU and Associated

Horizon 2020
European Union Funding
for Research & Innovation
Grant Agreement n°653460

University of Florence, DISIT lab DINFO (Project coordinator)

**Partners**: DISIA and DST of UNIFI; Thales; Attiko Metro; Comune di Firenze; Centre for Research and Technology Hellas; Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V.; Humanist; Swarco Mizar; Associação para o Desenvolvimento da Investigação no Instituto Superior de Gestão; Consorzio Milano Ricerche.

## Replicate (http://replicate-project.eu/)

- To demonstrate Smart City technologies in energy, transport and ICT in districts in:
  - San Sebastian, Florence and Bristol,
  - follower cities of Essen, Nilufer and Lausanne
- Cities are the customer: considering local specificities
- Solutions must be replicable, interoperable and scalable.
  - Integrated Infrastructure: deployment of ICT architecture, from internet of things to applications
  - Low energy districts
  - Urban mobility: sustainable and smart urban services

Horizon 2020
Europen Union Funding
for Research & Innovation
Grant Agreement n°691735

**Partners**: (Coordinator) Fomento De San Sebastian; Ayuntamiento De San Sebastian; Comune Di Florence; Bristol Council; Stadt Essen; Nilufer Belediyesi; Ville De Lausanne; Ikusi Angel Iglesias; Endesa Energía, S.A.; Eurohelp Consulting, S.L.; Iluminacion Inteligente Luix, S.L.; Fundacion Tecnalia Research & Innovation; Euskaltel, S.A.; Compañía Del Tranvía De San Sebastián; Cnr Italy; Enel Distribuzione, Spa; Mathema, Srl; Spes Consulting; Telecom Italia, Spa; **Unifi Dinfo. Disit**, Dief; Thales Italia, Spa; Zabala Innovation Consulting; Technomar; University Of Bristol; University Of Oxford; Bristol Is Open, Ltd; Zeetta Networks; Knowle West Media Centre; Toshiba Research Europe, Ltd; Route Monkey, Ltd; Esoterix Systmes, Ltd; Nec Laboratories Europe, Ltd; Commonwheels Car Club; University Of The West Of England; Esade Business School; Sistelec Soluciones De Telecomunicacion, S.L.

## Ghost SIR (http://sites.unica.it/ghost/)

Governing tHe smart city: a gOvernance-centred approach to SmarT urbanism:

- To offer a comprehensive framework for measuring and reassessing urban smart development and related rankings;
- Critical assessment of smart city ranking index existence;
- Definition of an enabling technology supporting the action plans for strengthening multi-level place-based governance, applied in the tourism context;
- Definition of strategies for good smart governance, with the purpose of providing recommendations to start or implement an institutional and development process leading towards smart city governance

GHOST
Governing tHe smart city:
a gOvernance-centred approach
to SmarT urbanism

**Partners**: (Coordinator) University of Cagliari DICAAR and DMI, University of Sassari DADU, University of Florence **DINFO.DISIT** and SAGAS, University of Torino ESOMAS.

MINISTERO DELL' ISTRUZIONE, DELL'UNIVERSITÀ E DELLA RICERCA

# ADOPTING Km4City SOLUTION

Most of the smart cities actions are based on targeting specific vertical applications, with closed technologies, high costs and low interoperability. This makes impossible, their extension and integration unless substantial funding for adaptation. This approach is no longer viable and neither sustainable. Public administrations need urban platforms interoperable solutions capable to manage complexity in the smart city services and corresponding sustainability issues. This is highlighted by the fact that proposed services are scalable and moving to city level become inadequate. They need sustainable solutions based on open standard, open source, interoperability, scalability and flexibility, that may provide a number of services on the city in scalable and customized manner.

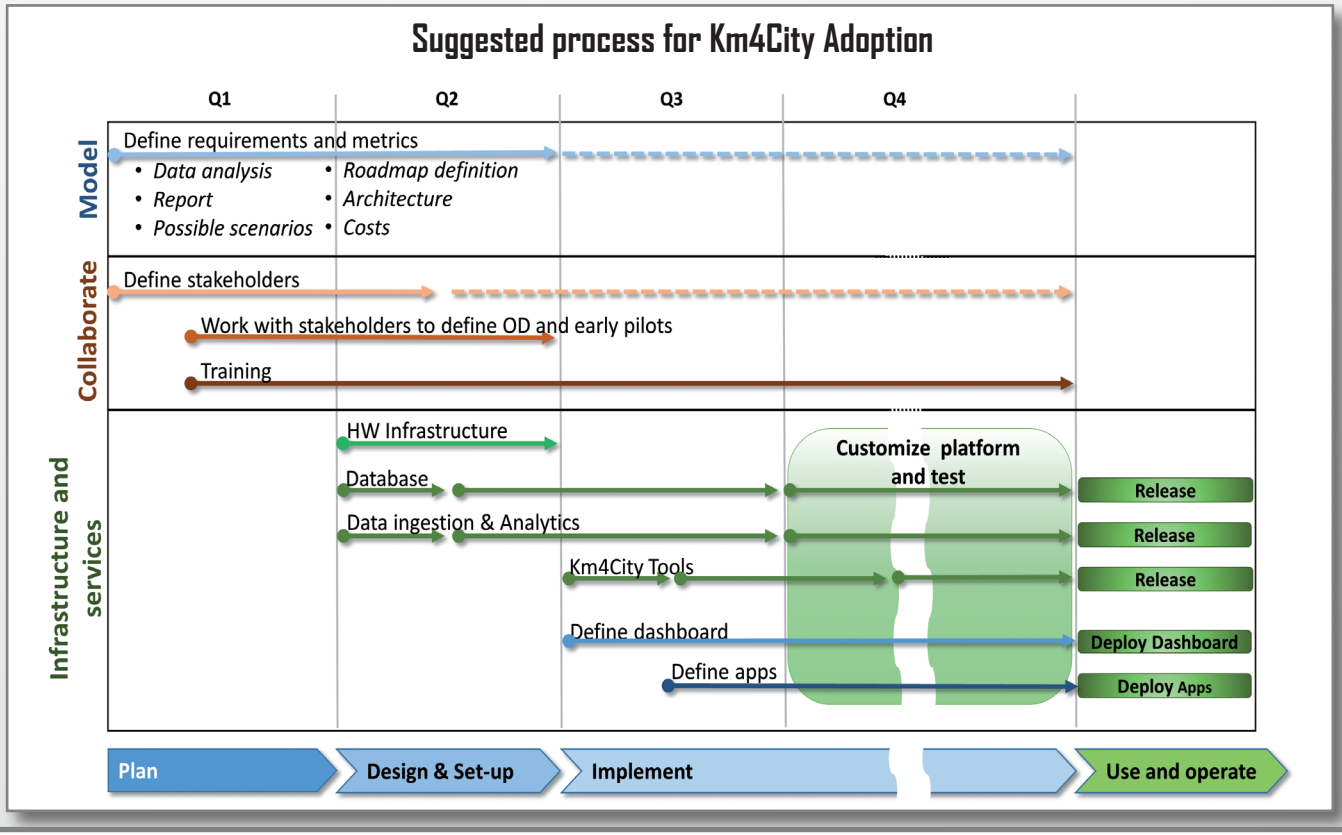
The adoption of Km4City can be easily started passing from your objective to a concrete plan which can be realized in few months and not years. Km4City is an Open Source solutions well- tuned and tested in several conditions, where each single tool can be adopted to be included in any kind of context since they are fully interoperable and open, with their API and standard interfaces and tools.

Km4City can be adopted installing some of the solutions on your cloud on premise (just taking them from open source portal, for instance) as well as asking to us to have all of them or just a port of them instantiated on your premise or finally you as Km4City as a Service basis on some cloud under high availability and fault tolerance. In the latter case, the deploy and arrangement of the infrastructural aspects are shortened.

The following schema summarizes an example of planning for the set-up of a generic solution based on Km4City to be customized to satisfy specific objectives. The roadmap is divided in three main processes:

1. Stakeholders identification and interaction for collaboration;
2. Study of the context and model definition, requirements analysis, data and metrics analysis; collaboration with the identified stakeholders to share ideas and experiences, scenarios and use cases definition;
3. Km4City infrastructure and services customization and deploy (simplified or absent in the case of Km4City as a Service).

The action is dived in four phases: 1) planning, 2) design and set-up, 3) solution implementation by customization and tuning, and finally 4) use in the real context. The solutions that request a smaller number of tools may be faster to be deployed and finalized.




In order to reach the objectives, a smart city action needs to involve different actors for activating an effective process of modernization for: managers and local government leaders; public of private service operators (water, energy, gas, communications, transport, waste, education, etc.); end-users, citizens and representatives of local businesses; investors, banks, venture capital; technology providers.
The training activity is focused on coaching the city staff that will use the solution in the public administration, and for city operators in general.
In the first phase of the adoption, it will be necessary to analyze the available data and to identify the additional information could/should be integrated to expand the solution to enable additional and smart use cases and scenarios.
From the interaction of these activities, a **report** is defined with the details of **possible scenarios and use cases** that the solution must meet, a **detailed roadmap** of activities and time schedule, the **definition of the architecture** and a detailed costs planning for the implementation of the solution. Indicatively the duration of this first phase of analysis will be of about 3 months. During the action it will be possible to update the analysis document to add further details and refine. After the first phase, the development phase will start with the set up and tuning of the defined solution for the city (the infrastructure configuration if on premise) and the start of the phase of customization of the Km4City tools and solutions. These activities will include the setup of tools to acquire and process data that have to be ingested in a unified model. A first release of the solution will be deployed out after about 6-8 months from the project start. Subsequent activities are focused in the optimization and customization of the solution and validation activities to arrive at the production of the final version for the city

# SHORTCUTS TO KM4CITY TOOLS AND SUPPORT

**Km4City**: http://www.km4city.org **for**

**Public administrators and Decision Maker tools:**

- Dashboards and Dashboard builder: http://dashboard.km4city.org
- City Resilience Assessment: http://resilienceds.km4city.org/
- Smart decision support system: http://smartds.km4city.org
- Twitter Vigilance: http://www.disit.org/tv
- Real Time Twitter Vigilance: http://www.disit.org/rttv
- ServiceMap Browser: http://servicemap.km4city.org
- Collective User Behavior Analyzer
- Traffic Flow Analyzer: http://www.disit.org/6694

**Final Users tools:**

- Km4City mobile applications: see on stores
- Km4City web application: http://www.km4city.org/webapp

**Developers tools:**

- ServiceMap developer tool: http://servicemap.km4city.org
- Ontology Documentation: http://www.disit.org/km4city
- Smart City API on Data and Services: http://www.disit.org/6597
- LOG LOD Km4City Relationships Browser: http://log.disit.org
- Km4City SPARQL query tool: http://log.disit.org/sparql_query_frontend/

**Projects and trials:**

- **Sii-Mobility SCN MIUR** for inter-modality and advanced services on mobility and transport, licensing: http://www.sii-mobility.org
- **RESOLUTE DRS14 H2020**: risk and resilience analysis and tools, people and traffic flows, etc.; http://www.resolute-eu.org
- **REPLICATE SCC1 H2020**: on integrating sensors, IOT, energy aspects, lighting, smart benches, etc.: http://replicate-project.eu/
- **GHOST SIR MIUR**: Governing the smart city: a governance-centred approach to smart urbanism.
- Other smaller projects.

**Back Office tools:**

- Data Ingestion Manager, DIM: http://www.disit.org/6732
- Distributed Smart City Engine Scheduler, DISCES: http://www.disit.org/6515
- RDF Indexer Manager, RIM: http://www.disit.org/6708
- Open Source DISIT Tools: https://github.com/disit

# YOUR NOTES

Available on the App Store

ANDROID APP ON Google play

Download from Windows Phone Store

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