Smart City Governance Strategies to Better Move Towards a Smart Urbanism

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Abstract. This paper intends to summarize the principal reached objectives of an ongoing project on smart cities governance called GHOST financed by MIUR (Italian Ministry of Education, Universities and Research), in order to provide an overview on how the smart governance analysis applied to smart urbanism has evolved in two particular case studies in Italy (Cagliari and Florence). Firstly, authors analyze the concept of 'Smart City Governance' (SCG), it is associated with a set of commonly accepted terminologies and not yet standardized even if nowadays academic attention to smart cities and their governance is growing rapidly. Secondly, this paper analyses the major aspects of smart city governance applied to case studies from: (i) the governance data acquisition approach with particular reference to tourism sector, and (ii) the adaptations of urban strategies (in general) and of these data acquisition in Florence and in Cagliari (in particular), due to the Km4city city dashboard, created and developed by the DISIT lab. The paper concludes by evaluating the emerged results of the case studies analysis, in order to find the necessary balance for urban synergies, and, consequently, to better move towards a smart urbanism.

Keywords: Smart cities · Smart governance · Km4city · Smart urbanism
Twitter analysis · Cagliari · Florence

1 Introduction

This paper offers a summary of the work conducted under the project Governing tHe smart city: a gOvernance-centred approach to SmarT urbanism (GHOST) of which the authors are still involved. A more complete description of the results will find a more

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comprehensive space in a monograph dedicated to the GHOST project. However, before describing this, the authors believe it is necessary to deepen the concept of Smart City Governance (SCG).

Despite the smart governance applied in the smart cities paradigm is recently introduced [1–3], the meaning of this concept was presented and discussed elsewhere far earlier, with reference to 'good governance' - the process of interactions and decision-making among the actors involved - or 'ways of governance' - the different relationships between state, market, and civil society [4, 5].

Particularly the last fifteen years have witnessed a major conceptual evolution that has interested the good-smart governance mechanisms in urban policies sector [1, 6–12]. Its conception has changed: from an element of political and administrative authority to an essential political tool in which governments are able to manage the different mechanisms of urban development, addressing social, environmental and economic issues through an integrated and planned, long-term strategic vision. Willke, the pioneer of smart governance term, underlines that the smart governance is 'an abbreviation for the ensemble of principles, factors and capacities that constitute a form of governance able to cope with the conditions and exigencies of the *today's* society' [2, p. 165].

Today, SCG is one of the prevailing sectors [13] compared to the different aspects that characterize the smart city (economy, environment, governance, living, mobility, people), because through a good and smart governance, the city becomes able to know, to understand and govern problems, through sophisticated information technologies (ICTs) and through optimal decoding and systemization of the 'data' that today are available. From this point of view, the smart governance concept is characterized by a coherent systemic and programmatic vision in which it is possible to know, understand and govern the city through a skilled orchestration of the linking between 'big data', (material and immaterial) infrastructure, people and physical spaces (such as neighborhoods, buildings, and places of relationship). Hans underlines that 'ideally, smart (democratic) governance paves the path for smart government, which helps instigate the evolution of a smart urban space. […] Smart governance, smart government, and smart city are literary vehicles for promoting the discourse about our future directions of human life on this planet' [14, p. x].

Thus, the smart governance concept has become synonymous with the ability to succeed in creating urban innovation, 'making the right policy choices and implementing these in an effective and efficient manner, within the existing administrative structures' [15, p. 3].

In order for the city to be truly attractive and sustainable, an evolution towards this model of smart governance is required, in which public administrators produce strategic, effective, credible and achievable decisions and at the same time, valorize efficiently their city, by systematizing the existing infrastructure, and declining in its context the most appropriate methodology to take example from best practices that have common tendencies and complementary capabilities with the city of reference [16]. In order to achieve these goals, public administrations caused a revolutionary transformation in urban service delivery in smart cities thanks to the implementation of ICTs [17]. Starting from these assumptions, this article begins by analysing the methodology that led to achieving the main goals of the ongoing project GHOST on

smart cities governance financed by MIUR (Italian Ministry of Education, Universities and Research). Then, the case studies (Cagliari and Florence in Italy) and the big data platform 'Km4city', created and developed by the DISIT lab (http://www.km4city.org/), are presented. Finally, results of the study are exposed with a particular focus on tourism sector, by providing an overview on how acquired data (through sensors, Wi-Fi, mobile application) can help urban policies and political actions in order to confirm or reshape them, as a result of in progress and *ex post* processes for a smart governance.

2 Methodology and Objectives of GHOST Project

In the context of the smart cities paradigm, it is now known that the city is a complex, non-linear system in constant evolution [18]. In the city there are not only objective elements (physical structures, infrastructures, connections, physical elements that overlapping, characterize the material city), and subjective elements (perceptions, feelings about places, etc.), both interconnected, but also people that produce continuous data [19, 20].

The management of this complexity necessarily connects the political, economic, social, environmental, urban and technological dimensions. This latter increasingly shapes current urbanism and forces governments to implement new and innovative forms of governance, in which it is possible to provide for (i) dynamic data monitoring (perceptions data and movement data); (ii) data capturing in real time; (iii) data comparison with other static data; and, especially, (iv) translation of raw data into useful information for the decision-making processes.

In addition, multi-source big data, real-time processing for complex data, sensors and so on, are changing the city-users' behaviors, and consequently, the way to know and govern the cities.

Starting from these assumptions, the main goal of the GHOST project is to evaluate the SCG, by analyzing different perceptions, points of view, behaviors to enhance the institutional base of smart city initiatives, with particular focus on tourism sector. The idea of analyzing the SCG through the tourism sector is because tourism considers all sectors mentioned above of smart city paradigm. In addition, tourists can see the city in an unbiased way and because they are an active sensor for responding to general city services. Tourism helps to define shared strategies for sustainable and competitive development of the city, through the measurement of the main phenomena related to the tourism sector and through the participation of all actors involved in the city. Furthermore, as Bellini and Pasquinelli suggested, 'tourism penetrates and increasingly influences policy decisions in all fields of city development: land use, site development, building regulations, infrastructures, innovation, environmental quality, social inclusion, entrepreneurship, urban governance to include tourism perspectives in the models implemented to face urban issues and challenges. Tourism may support cities in building their reputation, in promoting their relational capital in the global arena, and in proposing and supporting a quality model of urban development' [21].

These urban evaluations on tourism sector are possible thanks to the significant and innovative example of a big data platform, called 'Km4city', developed in Florence by

the University of Florence DISIT lab, in collaboration with local public administrations and covering the whole Tuscany region with data.

'Km4city' has been a big data active platform in the Florentine context since 2013, initially as a data aggregator and ontology; and since 2016 as dashboard systems grounded on data. Km4City has been further developed in the Sii-Mobility MIUR national Smart City project started in the 2016 (on mobility and transport), and it has been adopted and improved by REPLICATE SCC1 H2020 (for energy and IOT), RESOLUTE H2020 (for risk and resilience aspects) and, finally, by GHOST project (for tourism and urban policies aspects). Although Km4city analyzes urban performance in different ways, its state of the art features allows further development and implementation.

In particular, for the GHOST project, the main aspects analysed in relation to tourism sector and in relation to case studies (Cagliari and Florence) are the distribution of tourists with specific attention to the use of services such as:

1. public transport (land, air and naval);
2. receptivity (accommodation, hotels, b&b, catering, and other forms of hospitality),
3. health services (presence of first aid points, medical service, pharmacies),
4. points of historical - cultural interest - POIs (museums, places of worship, architectural heritage, natural assets, identity goods, etc.)
5. commercial points of interests where are sold local products.

The analysis of the different flows and types of tourists, classified according to their temporal and spatial distribution, combined with the census of all the activities and attractiveness present in the territory (POIs) contributed to the definition of customizable tourist itineraries in relation to the time schedule at disposition of user.

Through the web and mobile system, the tourist-user can:

- know which places of interest are classified by type within a specified radius on a map;
- know where the urban mobility stops are located and the timetables of the vehicles (currently the bus stops of Public Transport Company of Cagliari, called CTM – *Consorzio Trasporti Mobilità* – and Florence, called ATAF – *Azienda Trasporti Area Fiorentina* –, show the expected time of arrival of a vehicle on a public line at each stop);
- check which main cultural events are held in the metropolitan area;
- have alerting services (weather, urban road conditions, etc.).

Once the sector (tourism) applied to case studies (Cagliari and Florence in Italy), and the big data platform are identified, the authors describe the results obtained relating to citizens and tourist behaviors such as mobility and exploitation. Finally, authors questioned the type and availability of data for monitoring and mapping tourist behaviors that can help understand the needs of the city and plan services and actions of governance. However, before describing it due to the big data platform Km4City, authors illustrate the case studies of Florence and Cagliari.

2.1 Case Studies: Florence and Cagliari

Cagliari and Florence are good case studies because both (i) are regional capitals, (ii) are the most important cities economically, administratively and culturally in their regions, and (iii) are important tourist centers (Fig. 1). In particular, Cagliari, located at the southern shore of the island and with 154,224 inhabitants, is the core of the metropolitan city of Cagliari (constituted by 17 municipalities). It hosts the most important port and airport of the region in terms of traffic and size. For that reasons, Cagliari has easy connections with the other European countries, and it is also more accessible also thanks to a cruise ships port right in its historical center. In addition, researchers affirm that municipalities in Sardinian coastal areas, as Cagliari, attract more tourists than the inner areas of the Island [22, 23].

Florence, located in the northeast of Tuscany and with 382,743 inhabitants, has a very particular position: it is surrounded by hills and mountains to the north, south and east, while in the west part there is a plain in which contiguous cities are developed. Also Florence is the core of the of the metropolitan city of Florence (constituted by 42 municipalities). It hosts an important airport and it is on the main national railway lines, so as to be easily accessible nationally and internationally. Florence plays a decisive role in the regional economy, especially for service activities, including, first of all, tourism, thanks to its artistic and monumental heritage.

Within the Italian context, the tourism of Cagliari and Florence focuses on the attractiveness of natural features, of historical monuments and of different points of interests of both Italian cities.

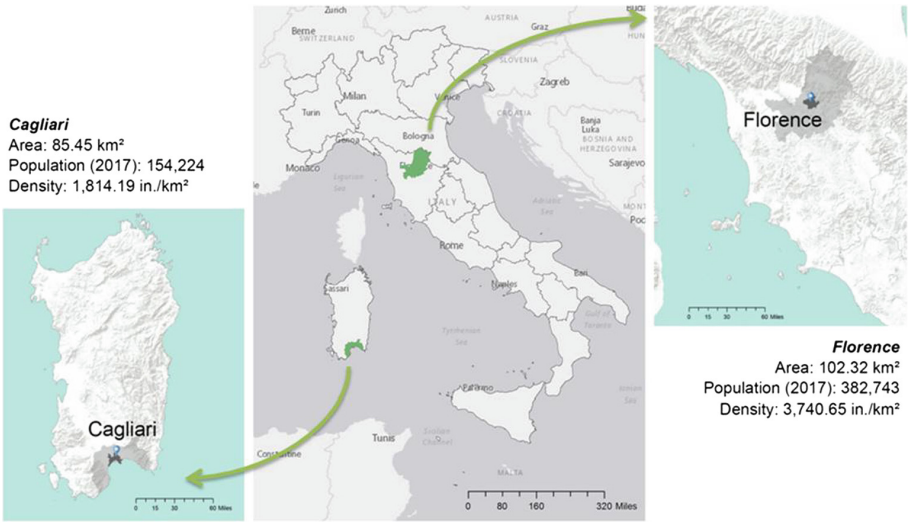

Fig. 1. Florence and Cagliari

3 Km4city: From Data to Services

All the smart city solutions must cope with big data volume, variety, and veracity [24]. Open data as static data are not the main source of information in the city. Most of the big data problems connected to smart city platforms are related to real time data (both public and private) such as: public transport/vehicle and human mobility in city, events, IoT, etc. Smart city architecture should be capable of taking advantage of the huge amount of data coming from several domains, at different speed for exploiting and analysing them, for computing integrated and multi-domain information, making predictions, detecting anomalies for early warning and for producing suggestions and recommendations to city users and operators.

In this sense, the KM4City Architecture and the semantic model on which the architecture is based the KM4Cioty multi-ontology [24], has been developed to collect, aggregate and manage these different kind of data (Fig. 2) in order to provide a set of services, such as: Dashboards [25], smart decision support systems [26], useful in having an idea of the 'status' of a smart city; web and mobile applications [27]; Twitter Vigilance [28]; statistics and prevision analysis, suggestions and recommendations for citizens (Smartening Tools), etc. KM4City Architecture is focused on the Tuscany region, especially on Florence, and it is also expanding to the Cagliari context, thanks to methodological and empirical advances in the GHOST project and thanks to an agreement with the public administration of Cagliari.

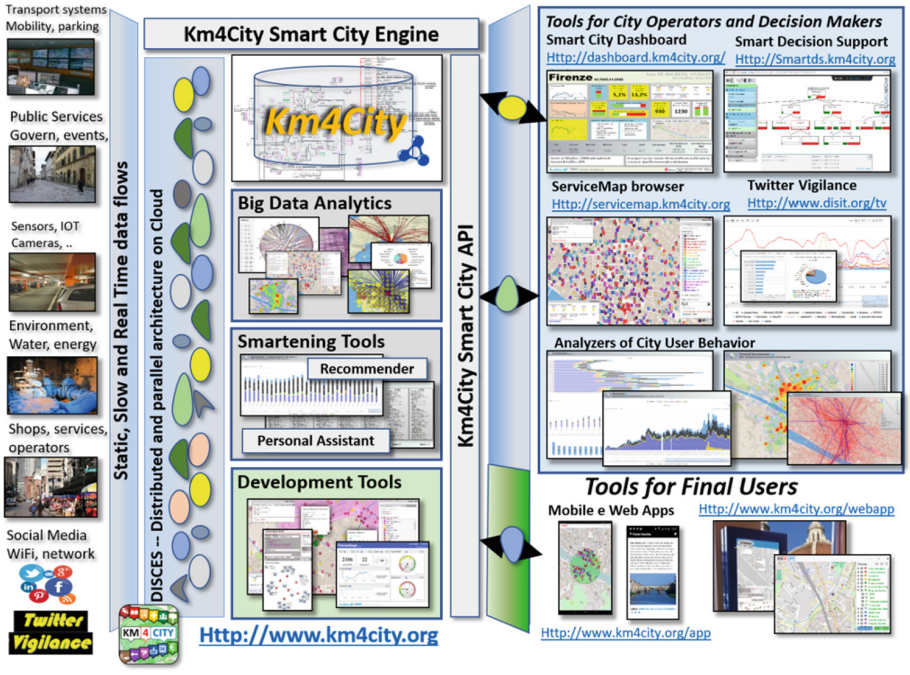

Fig. 2. KM4City Architecture

Once the data is collected, the back office performs several processes to improve data quality (Extract-Transform and Load processes or ETL processes based on Pentaho Kettle tools, [29]), reconciling data and converting static data into triples for the RDF store of the Knowledge Base [24] implemented by using a Virtuoso triple store and storing the dynamic data in a NoSQL database [30, 31]. The processes for data collection can be scheduled according to several different policies to cope with Open Data (to verify if they change sporadically), quasi real time data (changing a few times a day) to real time data (changing every few seconds, such as the position of a Bus, or the position of the City Users) and considering all the permission accesses connected to each different piece of information managed in the KM4City Knowledge Base. Some results in terms of numbers of users, kind of data and datasets managed are synthesized in Table 1.

Table 1. Some of the Km4City datasets and users managed, starting from 2011.

Kind of data	Category	Numbers
Static dataset	Road graph (Tuscany region)	• 132.923 Roads • 389.711 Road elements • 318.160 Nodes • 1.508.207 Street numbers
	Road graph (Sardinia)	• 113495 Roads • 1556061 Road elements • 1556061 Nodes • 392446 Street numbers
	City services (Tuscany and Sardinia)	• Classified in 20 different taxonomy categories and more than 500 sub categories (related to the km4City ontology)
	Public transport operators (Tuscany)	• 21.280 Bus stops • 1081 bus line
	Public transport operator (Cagliari)	• 947 Bus stops • 1 bus line
Dynamic/Real time data	Public transport operators (Tuscany)	• Real time bus lines: 144 updates per day
	Mobility (Tuscany)	• Car park status: 210 sensors; 76 updates per day per sensor • Traffic status: 796 sensors; 288 updates per day per sensor
	Weather (Lamma in Tuscany)	• Weather predictions: 285 cities monitored, 2 updates per day for each city
	Healt (Tuscany)	• Hospital triage status: 12 First Aids, 96 updates per day per hospital
	Social media (Twitter)	• From 600,000 to 4.5 M Tweets per day
	Smart benches (Florence)	• 1 smart bench: 1 update every 5 min (288 per day)

(*continued*)

Table 1. (*continued*)

Kind of data	Category	Numbers
	Charging stations (Florence)	• 177 charging stations: 1 update of the dataset every 15 min (96 updates a day for each station)
	Smart waste (Florence)	• 15 waste sensors in florence: 1 update of the dataset every 30 min (48 updates a day for each sensor)
	Weather sensor (Florence)	• 1 sensor in Florence: 1 update of the dataset every 15 min (96 updates a day for each station)
	Bike rack (Pisa and Siena)	• 39 racks: 1 update per dataset every 15 min (96 updates a day for each rack)
Mobile app	Number of users	• More than 2600 users
		• Measures made: 50,000 per day

KM4City is an Architecture and Knowledge model than can be applied in many different contexts, this is the reason why the experience done in Florence will be applied and expanded also in Cagliari.

4 Results

Governance must be considered as a dynamic process that involves people, technology and data. The experience developed in Cagliari and Florence is presented in this paper as a summary with the purpose of (i) identifying the more relevant strategic guidelines and rules that orient urban planning processes; (ii) identifying an application field (smart tourism) (iii) creating a replicable model for other smart communities and other governance contexts; (iv) making an assessment toolkit available in order to build a long-term vision of smart urbanism pathways; (v) providing accurate information so as to evaluate the decision-making processes and, if necessary, reorient and refocus them.

The great advantage of having a big data platform, such as km4city, firstly consists in the possibility of dynamic data monitors (both perceptions data and movement data) and to capture it in real time, in order to immediately increase the level of awareness of the multiple phenomena that are occurring in a specific territorial contest and have a shared perception of these. Secondly, data must compare it with other static data, so as to obtain reliable predictive models capable of making row data, useful for the decision procedures, that is the decisive goal of the entire process. Each of the phases of this cycle involves different competences and roles, but everyone contributes to the realization of a shared strategy.

In the two case studies, for example, in addition to the data from the web and from mobile apps mentioned above, another data source was also used, that is, the social network Twitter.com that is 'one of the most effective in propagating information in real time, and the propagation effectiveness of a post (i.e., tweet) is related to the number of times the tweet has been reTweeted' [32, p. 1]. The characteristics of this type of communication (the limit of the text in 140 characters, the frequent

destructuring of the text that is well suited to the ability and to the possibility to include a direct mention of a user, that can be done by using the '@' prefix such as '@user-nickname' or a topic, which can be done by using the '#' prefix such as '#keyword') allow the diffusion of information in a simple way, by making this source indispensable, especially in contexts in which the capacity of communicating information is fundamental for advertising, promoting alerts of civil protection, etc. [32].

The Twitter Vigilance platform (http://www.disit.org/tv/) has been designed and realized by the DISIT Lab as a multipurpose comprehensive tool providing different tasks and metrics suitable for Twitter search API and streams, their monitoring and analysis, for research purpose [33].

'The data acquisition approach is based on the concept of Twitter Vigilance Channel, consisting in a set of simple and complex search queries which can be defined by a registered user by combining keywords, hashtags, user's IDs, citations, etc., in a structured logical syntax, according to the search syntax of Twitter. Collected tweets are made accessible to the back-office processes, which implement statistical analysis, natural language processing (NLP) and sentiment analysis' [32, p. 9].

The main Twitter-based metrics (i.e., the total number of tweets and/or retweets associated with a Twitter user or presenting a certain hashtag) can be used to predict and estimate the number of people in some location, to predict the audience of scheduled television programmes or big events or even to perform risk analysis Crisci et al. [34].

'In the specific, the following information and metrics can be retrieved: number of tweets and retweets; user citations (to detect potential influencers, pushers, emerging citations, etc.); hashtags (to understand which are the most used, emerging, evolving, etc.); keywords tagged with their part-of-speech (that is, their grammatical function), in terms of nouns, verbs, and adjectives; sentiment analysis; relationships among users; etc' [32, p. 6].

For Florence and Cagliari, special channels have configured based on a selection of keywords (Figs. 3 and 4). In the specific case of tourism, the examination of tweets allows to understand, for example, through metrics such as Tweet score and retweet score, what tourists are looking for, where they go, what they do and how they move and, through sentiment analysis, it is possible to interpret their liking (what tourists liked and what they did not like).

It is more difficult to correlate this data with other datasets on tourist presences or in relation to events of particular interest, and consequently to elaborate predictive models, due to a lack of suitable data. In particular, the data on tourist presences are published in an aggregated manner and not chronologically aligned with the period examined and no data are known regarding the number of daily accesses to single museum structures or to points of major interest.

The analysis of recurrent keywords and relative metrics allowed to identify some behaviors of tourists who visit the two cities. The keywords related to sites of cultural interest (in Florence) or naturalistic one (in Cagliari) or to specific events (see 'pitti-immagine' fashion week) produced interesting results. The correlation between keywords identified as relevant and others related to means of transport has shown which are, in the two case studies, the means of the LPT (Local Public Transport) preferred to reach the destinations.

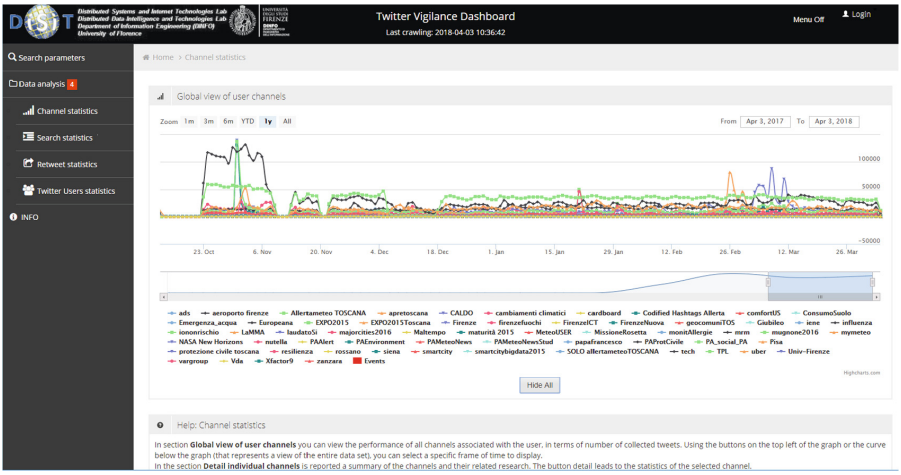

Fig. 3. Twitter vigilance front-end graphic user interface, showing trends volume based metrics calculated for Firenze channel during the last year.

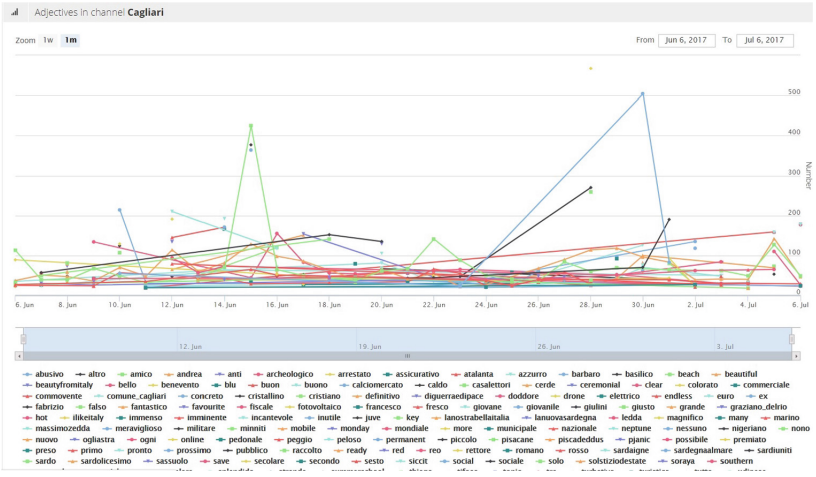

Fig. 4. Twitter vigilance front-end graphic user interface, showing trends volume based metrics calculated for Cagliari channel during one month last year.

The analysis of the volume of the same keyword in Italian and English helps to provide information on the relationship between Italian and foreign visitors (Figs. 5 and 6). The analysis of the RT/TW rate was then focused on the places of interest, since it is believed that this index is explanatory of the emotional level that certain places are able to arouse, for which, subsequently, a sentiment analysis will be applied in a way to appreciate the liking or disapproval of the city user (Figs. 7 and 8).

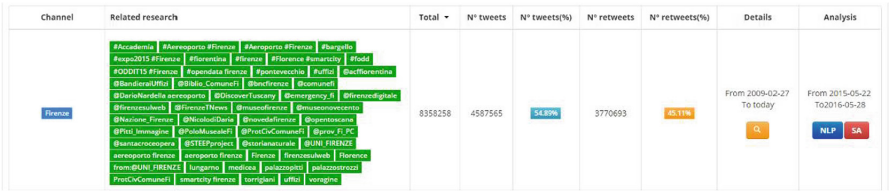

Fig. 5. Details on Firenze channel.

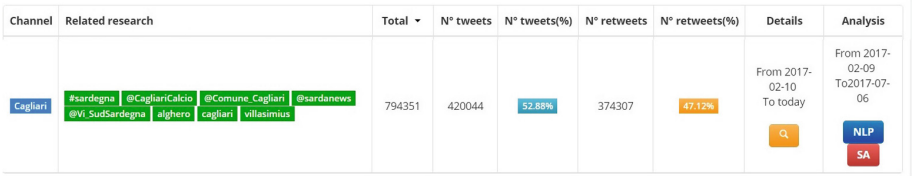

Fig. 6. Details on Cagliari channel.

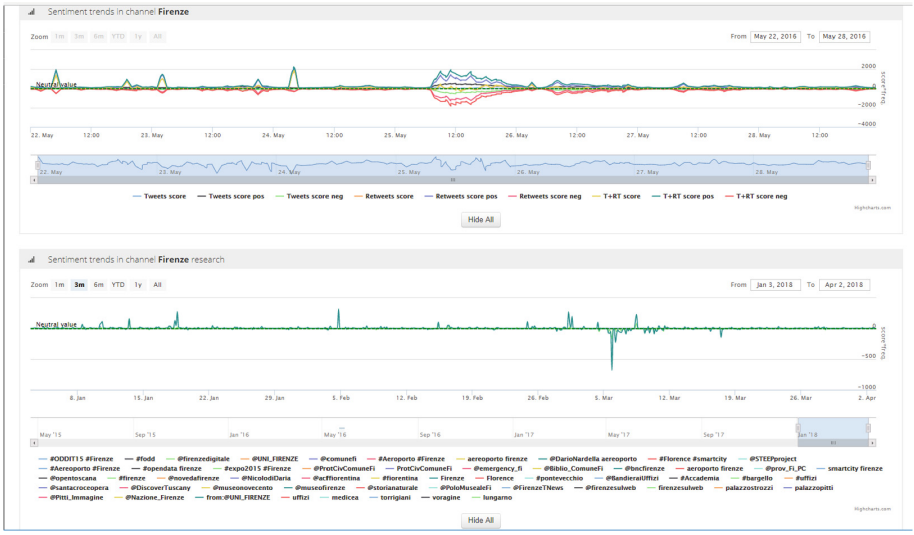

Fig. 7. Sentiment trends in Firenze channel

In this paper, authors considered useful to provide only an extreme summary of the analyzes produced, because the aim is to show how this approach can be used at different levels, by municipalities within smart-city initiatives, by regional governments, in order to create the general context in which smart city initiatives take place or by research systems, to place their knowledge in the direction of innovation. In the latter case, a formal evaluation system will be central to the pursuit of a strategy no longer based on individual projects implemented in those areas where indicators have

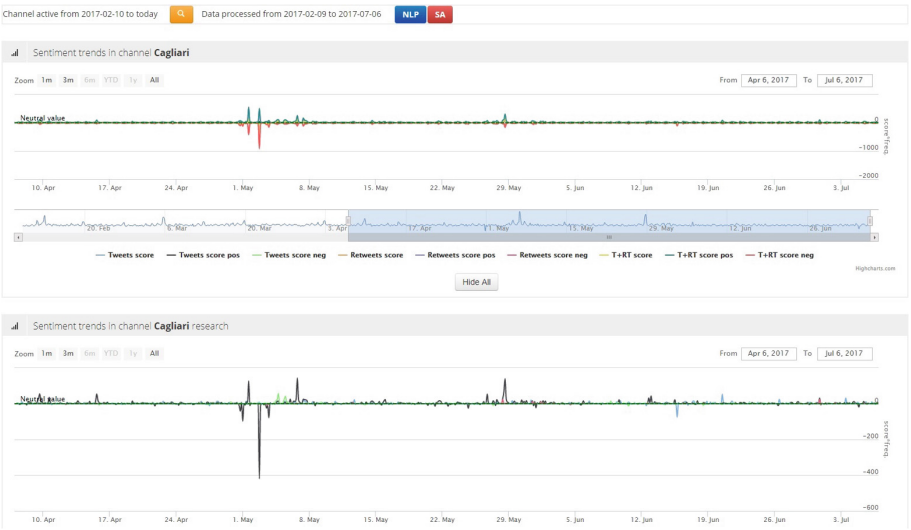

Fig. 8. Sentiment trends in Cagliari channel

shown deficits, but it is focused and effective in being able to create an 'observatory' for smart urbanism monitoring and the produced results.

5 Discussion and Conclusions

This paper retraces in brief some aspects developed under the GHOST project with Km4City. This Dashboard is now running for the Municipality of Florence, Cagliari and collects data from the whole area of the Florence and Sardinia regions.

In a complex urban system, as the smart cities are, a good governance can be considered as the process of interactions and decision-making among the actors involved and that considers the different relationships between state, market, and civil society.

At the base of this dynamic process must be placed the need of actors to know the city on which they have to operate and as a result the availability of cognitive frameworks useful for decision making is essential, in order to cope with the conditions and exigencies of the today's society.

According to these premises, a monitoring system for smart city governance should consist of analysing of conditions such as (1) transport impact; (2) quality of life of city users; (3) Active conservation of cultural heritage; (4) active conservation of the environmental heritage; (5) identification of active protection of city sights; (6) decreasing/optimizing the use of natural resources, especially water; (7) reduction and optimization of energy consumption; (8) waste management and so on.

In the case studies here presented, the use of Km4City Dashboard for the Municipality of Florence and Cagliari allowed to enhance the institutional base of smart city initiatives, analyzing different perceptions, points of view, behaviors with

particular focus on tourism sector, as tourists have been considered an active sensor for responding to general city services.

The main advantages obtained with the use of Dashboards in the City of Florence are related to: (i) increase of the collaboration between the various entities involved in the different phases of data management municipality, metropolitan area and developers (University of Florence, Disit); (ii) increase in standardization for making data available (both for Open and Private data); (iii) production of a multiplicity of easy to use dashboards, to be seen by different actors: Mayor of the city in the city control room, citizens in public panels, developers, etc.; (iv) capability to see problems in a real time modality and solve them as soon as possible (basing on the different kind of problem): advising the data providers if the data is missing, making provisions based on different events monitored in the dashboards, etc.

Currently we are replicating the km4city platform in the city of Cagliari. The experience made in Florence has allowed to understand that the nodal issues to be faced concern the availability of strong technical infrastructure and data (static, dynamic and possibly open) and above all public administration involvement and awareness.

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