BIG DATA

Big Data in the Arts and Humanities

As digital technologies occupy a more central role in working and everyday human life, individual and social realities are increasingly constructed and communicated through digital objects, which are progressively replacing and representing physical objects. They are even shaping new forms of virtual reality. This growing digital transformation coupled with technological evolution and the development of computer computation is shaping a cyber society whose working mechanisms are grounded upon the production, deployment, and exploitation of big data. In the arts and humanities, however, the notion of big data is still in its embryonic stage, and only in the last few years, have arts and cultural organizations and institutions, artists, and humanists started to investigate, explore, and experiment with the deployment and exploitation of big data as well as understand the possible forms of collaborations based on it.

Big Data in the Arts and Humanities: Theory and Practice explores the meaning, properties, and applications of big data. This book examines the relevance of big data to the arts and humanities, digital humanities, and management of big data with and for the arts and humanities. It explores the reasons and opportunities for the arts and humanities to embrace the big data revolution. The book also delineates managerial implications to successfully shape a mutually beneficial partnership between the arts and humanities and the big data- and computational digital-based sciences.

Big data and arts and humanities can be likened to the rational and emotional aspects of the human mind. This book attempts to integrate these two aspects of human thought to advance decision-making and to enhance the expression of the best of human life.

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Big Data in the Arts and Humanities

Big Data in the Art and Humanities

Theory and Practice

Edited by
Giovanni Schiuma and Daniela Carluc

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In the IRP2 project, students were free to experiment and prototype, receiving much-needed support from the professional software developer. Later, their efforts were consolidated, refactored, and merged into the evolving project. Project leaders carefully evaluated the abilities of team members so that all the students worked on features appropriate for their available time and skill levels.

Some features in any software development project will be beyond the skills of most graduate students outside computer science. In these cases, it is more efficient to draw on the expertise of a software developer. The balance of professional and student-led work ultimately depends upon the project's requirements. With the IRP2 project, the balance was 80/20 student to professional software development and metadata identification in the first year; in the second year, the breakdown was 60/40.

Conclusion and Next Steps

The provenance challenges reflected in the Portal will be much more manageable with the full implementation of the prototype described earlier. Major gains in researcher access can be appropriately anticipated. However, overall major provenance issues remain in the management and exploitation of big data in archives, special collections in libraries, and in museums. The DCIC and the SPRI, along with other national and international research collaborators, intend to explore archival and museum provenance issues with the goal of integrating archival research data and user-contributed data, at scale, with cyberinfrastructure to generate new forms of analysis and engagement.

Specifically, the DCIC and SPRI will use Dras-tic (Digital Repository at Scale that Invites Computation) to improve collections software currently used to research, record and securely share big data, including provenance data. Dras-tic is an open-source community software project that evolved from a $10.5 M National Science Foundation grant involving the University of Maryland and was developed in collaboration with Archival Analytics Solutions, Ltd., a software development firm in the United Kingdom.

The ability to accurately determine the provenance of archival and museum collections is at the heart of the Dras-tic enterprise: its goal is to build out a horizontally scalable archival framework to serve the academic, museum, archival, library, and scientific management communities as a credible solution for big data management in the cultural heritage community.

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Chapter 14

Mobile Technology to Contribute Operatively to the Safeguard of Cultural Heritage

Fabrizio Terenzio Gizzi, Beniamino Murgante, Marilisa Biscione, Maria Danese, Maria Sileo, Maria Rosaria Potenza, and Nicola Masini

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Introduction

In recent times, several activities have been developed with the support of mass cooperation. This tendency, often adopted in public agencies and by local authorities, is based on an open government approach, as well as on a more participative method to government where citizen's ideas and activities have to be considered and collected in a sort of a continuous flow. Consequently, public involvement,

getting ideas, suggestions, or simply data/information production, is a daily activity fundamental in decision-making process. Obama's administration has given a great impetus to this approach, implementing such a policy and enlarging the possibility to capture public imagination by means of social networks, blogs, and all possible solutions for directly interacting with citizens.

This new approach is often called Gov. 2.0. Open government without a 2.0 approach is still based on a direct action. "Providers" is a sort of Right to Information where the administration tries to inform people, but having interaction just with the main stakeholders. Gov. 2.0 is a more open approach, which "enables" citizens to have an important role in defining policies as well as in producing user-friendly, ubiquitous, and personalized services.

Social media and all 2.0 platforms are a key element in generating a direct contact with citizens. Extensions of 2.0 philosophy completely changed the relationship between citizens and administration. People directly subrogate services that public administration and private sectors consider uninteresting or unprofitable.

Web 2.0 tools, such as websites, blogs, WebGIS, and mobile applications for smartphone and tablet, represent a sort of transition from "one-way" to "two-way" information and interaction tools able to share ideas, compare opinions, and collect information (Conroy and Evans-Cowley, 2006; Murgante et al., 2011a).

This approach leads to "crowdsourcing" (Goodchild, 2009), where a lot of activities or decisions have been realized using a mass collaboration, or to "volunteered geographic information" (Goodchild, 2007), where distributed masses create, manage, and disseminate spatial data (Sui, 2008).

In the introduction to the book *Geocomputation and Urban Planning* (Murgante et al., 2009), the authors cited the famous paper by Franklin and Hane (1992), who, in 1992, quoted that 80% of all organizational information contain some references to geography.

After the publication of this book, a lot of discussions started on social networks and blogs on how was it possible that in 1992, 80% of information contained a spatial component. This book was published in 2009 and up to date; after only few years, the situation is completely changed: each mobile phone has a *Global Positioning System* and Google has transformed geographical information from a specialist interest to a mass phenomenon and probably 100% of data have a spatial relation.

In spatial information, the added value could be represented by "neogeography" (Turner, 2006; Hudson-Smith et al., 2009), where citizens produce data integrating maps with geo-tagged photos, videos, blogs, Wikipedia, etc. These actions directly derive from public administration in efficiency. One could say, "why do I pay taxes if citizens have to directly provide the services?" The reduction of funding, coupled with the increase in data availability, led governments to have huge

data sets without having the possibility to check their quality and to update them. Consequently, these data have become old before they are published. In the geographical sector, it is very frequent that local authorities do not share data with the other actors involved in the production of similar data. The first attempt to solve this problem has been Executive Order 12906 (1994), "Coordinating Geographic Data Acquisition and Access: The National Spatial Data Infrastructure," imposed on American agencies, organizations, and local authorities, which led to a huge resource optimization. In Europe, the Infrastructure for Spatial Information (INSPIRE) Directive did not achieve the same results because of European bureaucracy and because of a sort of inertia from European countries in applying European directives. The other problem of the INSPIRE Directive is articulation based on a lot of detailed annexes, which are not easy to apply, which discourages many institutions in its application.

Obviously, there was a large increase in data sharing with the introduction of spatial data infrastructures, but this development is much lower than the growth of data production due to voluntary actions. Probably, in the future, spatial data infrastructures will be developed by big organizations, while local authorities will tend mostly toward cloud platform using Google or OpenStreetMap as base map. The great advantage of these solutions is the possibility to integrate Google data, Spatial Data Infrastructure (SDI) services (i.e., Open Geospatial Consortium Standards Web Map Service, Web Feature Service, etc.), OpenStreetMap data, and so on, with all data produced by administrations or volunteers. Another strength is the possibility to mash up spatial data with all possible information available on Internet (e.g., pictures, videos, descriptions, etc.).

In the last few years, terms such as "smart city" and "big data" became a sort of imperative. Despite that the two terms seem not connected, big data are mainly produced by intensive volunteer actions of citizens and by the shared data of national agencies and local authorities. These two aspects are strongly related to smart city.

Batty et al. (2012) identify seven points on which attention should be focused, analyzing key problems of cities, using information and communication technologies:

1. A new understanding of urban problems;
2. Effective and feasible ways to coordinate urban technologies;
3. Models and methods to use urban data across spatial and temporal scales;
4. Developing new technologies for communication and dissemination;
5. New forms of urban governance and organization;
6. Defining critical problems about cities, transport, and energy; and
7. Risk, uncertainty, and hazard in the smart city.

Murgante and Borruso (2015) defined the three main pillars of a smart city: connections, open data, and sensors, specifying that the third indicator has to be intended not only in terms of technology but also in terms of citizens able to actively participate in a bottom–up way in city activities and data production.

Murgante and Borruso (2013) defined a set of indicators able to identify the smartness level in cities:

1. Adoption of OpenData (Belisario et al. 2011) and Open Geospatial Consortium Standard;
2. Free wifi;
3. Projects implementation of augmented reality for tourism;
4. Crowdfunding initiatives;
5. Decisions taken by crowdsourcing;
6. Implementation of INSPIRE Directive; and
7. Quantity of public services achievable through apps.

Garau and Ilardi (2014) highlighted the importance of mobile technologies in managing and improving cultural heritage tourism. Murgante et al. (2011b) described a volunteered approach adopted in mapping all tourist services and related information. This mapping activity has been integrated with a neogeography approach linking all data with other information already existing on the web, such as movies, pictures, Wikipedia, historical documentation, etc., producing a sort of local miniportal for tourism development.

Considering the "citizens science" these two experiences can be located at the bottom part of the Haklay (2011) ladder, where crowdsourcing is the lowest level. The highest level is a sort of collaborative science, where citizens can have the responsibility in defining problems and in finding possible solutions. The application described in this paper (SaveHer App), developed in the framework of Pro_Cult project (Gizzi et al., 2015; Masini et al., 2016) can be located at the upper part of the Haklay ladder because citizens can support agencies and local authorities in cultural heritage safeguarding.

State of the Art

In recent years, many apps for cultural heritage promotion, disclosure, and enjoyment have been published. The content of apps embraces from the little known to well-known cultural heritage, with utilities such as localization, reporting points of interest, and associated digital assets. Among the most recent, we can mention Pompeii Sites, Cooltura TAG CLOUD, Beato Angelico, Cultural Heritage Administration, Smart Underground, Kulturarv, The Civil War Today, UNESCO World Heritage, Patrimonio Mondiale Ticino-Svizzera, Florence heritage, and Appasseggio.*

The tourist can make use of several App guides in order to recognize and discover cultural heritage through the photos taken by the visitors and provide insights or comments suggesting sightseeing tours (see also Kenteris et al., 2006, 2009; Panda et al., 2012). From this point of view, some of the most popular apps are as follows:

- GetCOO (https://www.getcoo.com/, last accessed 2 February 2016), which recognizes major works of art and monuments of the world through their photos;
- ViviMondo (https://itunes.apple.com/it/app/vivimondo/id518122303?mt=8, last accessed 2 February 2016), which allows the user to explore his/her surroundings and to get information about the distance from important monuments.

In this case, detailed descriptions gleaned from Wikipedia, and the chance to see the environments through augmented reality are added. Other apps with the purpose of tourism multimedia content provide geolocation information to reach the preferred location (Discover Cape South, Calabria Grecanica).†

The civic involvement encouraged by apps is also useful for emergency management of cultural heritage. With this respect, we cite the ERS Emergency Response Services and the Library Floods apps. The first one outlines the critical stages of a disaster response such as stabilizing the environment and assessing the damage. It provides practical salvage tips for photographs, books and documents, paintings, electronic records, textiles, furniture, ceramics/stone/metal, organic materials, and natural history specimens. The second one, created by the US National Library of Medicine, provides information on how to recover collections after a flood emergency in libraries.

There are also apps for cultural heritage aimed at mobile learning (Dowling and Whalen, 2014) or applications that combine augmented reality and three-dimensional modeling techniques such as Jumieges 3D, MuseoSanGi, Art Glass,

* Appstore/Android market: https://play.google.com/store/apps/details?id=com.duva.pompeiartem.en,https://itunes.apple.com/it/app/cooltura-tag-cloud/id1034307226?mt=8,https://itunes.apple.com/it/app/fra-angelico-inside-painting/id982481167?ls=1&mt=8, https://play.google.com/store/apps/developer?id=Cultural+Heritage+Administration, https://play.google.com/store/apps/details?id=com.sinappsys.smartunderground, https://play.google.com/store/apps/details?id=dk.codeunited.kulturarv, http://www.heritagemontgomery.org/montgomery-county/civil-war-app, https://itunes.apple.com/it/app/unesco-world-heritage/id412183802?mt=8, http://www.webatelier.net/mobile-app-for-two-world-heritage-sites-in-ticino-switzerland-is-available-on-the-app-store, http://app.comune.fi.it/app/a0005.html, http://www.creative-heritage.eu/internaz_and_localization.html, http://www.webatelier.net/mobile-app-for-two-world-heritage-sites-in-ticino-switzerland-is-available-on-the-app-store.

† https://play.google.com/store/apps/details?id=com.map2app.CapoSudCalabriagrecanica

Liguria Heritage, CittàIdeale, and CittàIdeale AR* (Bonacini, 2014; Giloth and Tanant, 2014; Verykokou et al., 2014).

Also, the technologies typically used for diagnostic purposes (Masini and Soldovieri, 2017) such as x-ray fluorescence, infrared thermography, or reflectance transformation imaging (RTI) can make use of specific apps (Touch Van Gogh, Second Canvas, RTI Mobile App†).

High-quality content and sophisticated investigation technique make the users (not experts but attentive, curious, and demanding) confident with the cultural heritage. Artifact is instead a new app designed for diagnostic imaging presented at the Scientific Symposium of the International Council on Monuments and Sites (ICOMOS) (Vanoni et al., 2015).

The iTPC Carabinieri‡ app is an application developed by the Cultural Heritage Protection Unit of the Italian Police in collaboration with the Italian Ministry of Cultural Heritage and Activities and Tourism that targets the protection of cultural heritage. It helps citizens to fight theft and damage to cultural heritage and to support the activities of the police in search of works of art unlawfully removed.

From this overview, it emerges that SaveHer is an app that offers new dialogue perspective with the institutions responsible for the conservation of heritage properties: therefore, the user becomes a promoter and actor of the protection through the use of mobile technologies.

SaveHer Features

In order to make the application cross-platform and scalable to different operating systems, SaveHer was planned using the Cordova Phonegap by Apache Software Foundation by means of which it was possible to develop applications running on Apple iOS, Google Android, Microsoft Windows Phone 7/8, and RIM Blackberry.

The first release of the app was performed on PlayStore Google on February 2015 after having carried out several tests among different users and mobile devices both to bring to light technical problems and to improve the app graphical user interface (available in the Italian language at present).

As a matter of fact, it is well known that technological barriers can prevent the use of mobile devices with their content by users (Verkasalo et al., 2010).

* https://itunes.apple.com/it/app/jumieges-3d/id556799877?mt=8,http://t4all.it/portfolio-articoli/museo-civico-sangi/, http://www.liguriaheritage.it/heritage/it/home.do

† http://heritageinmotion.eu/project/touch-van-gogh-app-for-tablet/, www.secondcanvas.net https://itunes.apple.com/it/app/rti-mobile/id878658913?mt=8

‡ https://play.google.com/store/apps/details?id=it.reply.leonardo.mobile&hl=it, https://itunes.apple.com/it/app/itpc-carabinieri/id858588594?mt=8

Figure 14.1 Workflow of SaveHer app.

SaveHer works through eight main steps hierarchically arranged (Figure 14.1):

1. The citizen/user identifies the monument damaged or affected by problems.
2. The user starts SaveHer and performs the login through the App interface or using Facebook or LinkedIn social network login details (Figure 14.2a and b).
3. The user takes from one to three pictures of the considered monument, putting the attention to what he/she wants to be reported. The photos will be geotagged, including information about the latitude and longitude of the site (Figure 14.2c).
4. The user is asked to answer a simple questionnaire that consists of 10 questions aimed at identifying in a more detailed way the observed problems, such as vandalism, damage after extreme weather events, the effects of an earthquake or landslide, and so on (this phase is optional) (Table 14.1).

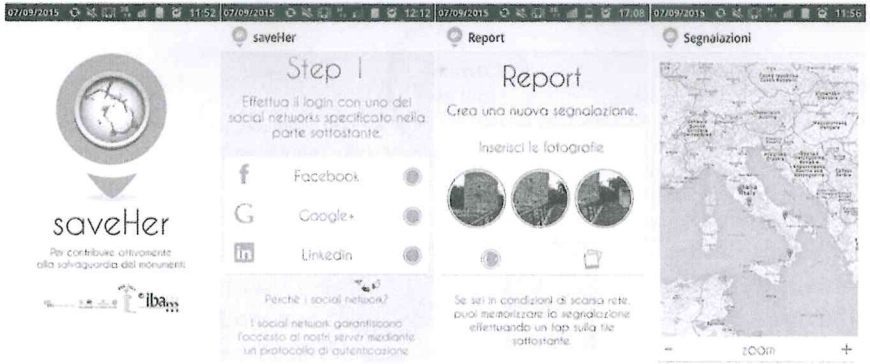

Figure 14.2 Screenshots of the four main steps of the use of SaveHer: the start of app (a); the login phase using the social networks Facebook, Google+, or Linkedin (b); the step for taking the photos of the affected monument so as to make a report (c); the georeferenced data sent by the user are reported on the map (d).

5. All the data, including the georeferenced photos and the replies to the questionnaire, are sent to the remote cloud server and recorded in a database.
6. The website administrator will check the bearing, quality, and reliability of the information recorded on the database.
7. The data (with the user credits) will be published both on the dedicated web page (http://www.appsaveheritage.com/) and app: a map will show the location of the monument, the photos will explain the problems detected, and the replies to the questionnaire (if compiled) will add further information on the affected heritage (Figures 14.2d and 14.3).
8. The data will be sent to the institutions (e.g., municipality, monuments, and fine arts office) in charge of safeguarding the affected monument through an ad hoc e-mail form arranged in the administrator website page. In this way, the institution will be able to plan proper countermeasures to mitigate the risk affecting the heritage.

According to what was previously described, the user can draw up a questionnaire to better identify the problems affecting the monument. The survey is made up of 10 demands embracing both the type and cause/object of the damage affecting the heritage (monument or works of arts located inside it), starting from literature and the authors' personal experiences and skills (e.g., Marchetti et al., 2006; UNI 11182, 2006; Gizzi, 2008; Canuti et al., 2009; Papa and Di Pasquale, 2011; Gizzi et al., 2012, 2016).

Analyzing the questionnaire, it emerges that the first three demands refer to the damage brought about by natural events such as earthquakes, landslides, extreme weather events, and carelessness on heritage. We refer to collapses and cracks in the walls, floors, and roofs. Demands 4 and 5 deal with the damage caused by

Table 14.1 Questionnaire That Users of SaveHer Can Fill in to Identify Carefully the Nature of the Problems Affecting Heritage

Demand	*Type of Damage*	*Cause of the Damage/ Object of Damage*
1	✓ Collapses (walls, floors, roofs, etc.)	• Earthquake • Landslide • Carelessness • Weather event • Other • Unknown
2	✓ Cracks or deformations (walls, pillars, floors, etc.)	• Earthquake • Landslide • Carelessness • Weather event • Other • Unknown
3	✓ Disconnected roof	• Earthquake • Landslide • Carelessness • Weather event • Other • Unknown
4	✓ Decay and/or fall of material	• Plaster • Frescoes • Other
5	✓ Damage to water harvesting system	• Carelessness • Weather event • Other • Unknown
6	✓ Presence of water inside or near the building	• Flood • Water leak • Infiltration • Other • Unknown
7	✓ Building damage due to vandalism	• Graffito • Illegal billposting • Mechanical action • Fire • Explosion • Other

(*Continued*)

Table 14.1 (Continued) Questionnaire That Users of SaveHer Can Fill in to Identify Carefully the Nature of the Problems Affecting Heritage

Demand	*Type of Damage*	*Cause of the Damage/ Object of Damage*
8	✓ Damage to works of arts (e.g., frescoes, mosaics, hangings)	• Graffito • Mechanical action • Fire • Explosion • Other
9	✓ Theft	• Sacred furniture • Works of arts • Other
10	✓ Other (to be filled in by the users)	...

carelessness such as the detachment of plasters or the rainwater picking system leakage.

Question 6 considers the effects as a consequence of natural events such as floods or water leak. Questions from 7 to 9 regard the consequences of vandalism actions on monuments or works of art. The last question was not predefined by the authors: in this way, the user can include another type of damage cause (and the causes of it) that was not considered in the previous nine questions.

The main focus of SaveHer is to involve citizens/users to supply a support to the institution to put into the field timely measures to safeguard cultural heritage. The aim can be reached if at least three main conditions are met: user-friendly features of the app, clearness of the questions proposed by the questionnaire, and awareness by people and institutions that a collaboration between them is desirable to ensure the posterity of heritage. The third point, which is taking up and will take up the authors in the next months, is crucial: massive information campaigns to awaken all the actors, both private citizens and institutions in charge of the heritage safeguard (e.g., monuments and fine art office, town council), which will be focused on the usefulness and the potentiality of SaveHer in

1. Making easier the relationship between the citizens and the institutions in charge of safeguarding the tangible cultural heritage;
2. Getting timely and suitable data about problems affecting monuments;
3. Identifying, on the basis of the statistical analysis of data produced by the users, the areas to monitor with regard to particular causes of damage (e.g., vandalism or theft); and
4. Spreading the knowledge of less known heritage (e.g., rural churches), of which the Italian heritage is rich.

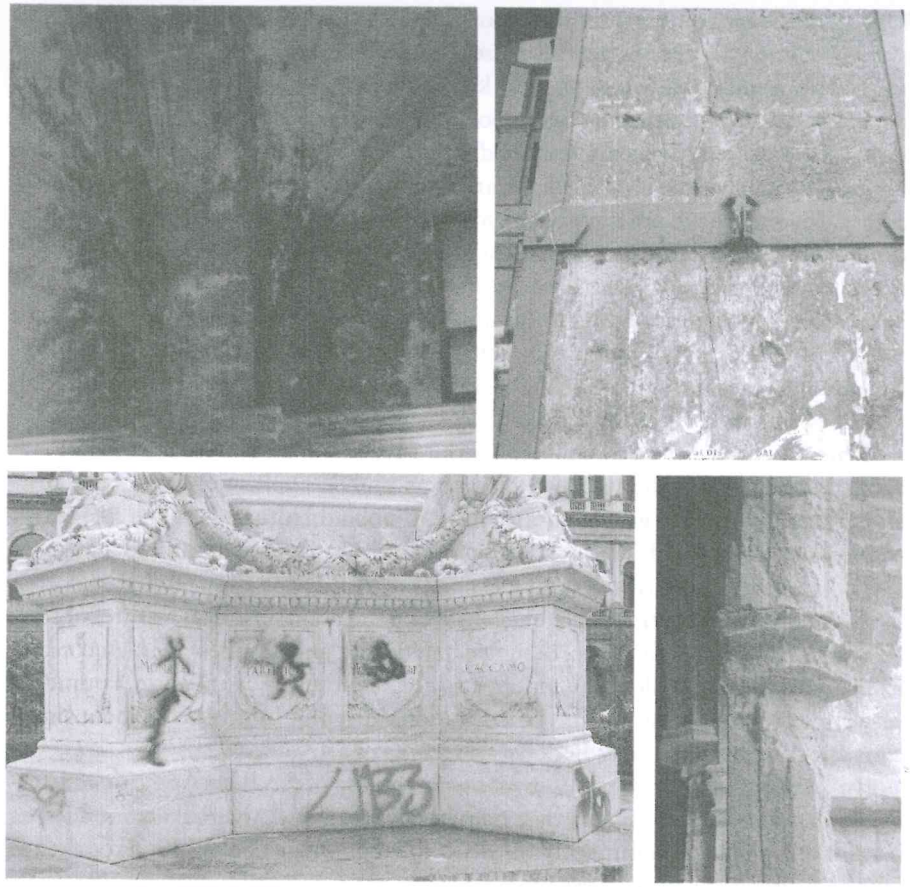

Figure 14.3 Some typologies of problems affecting heritage: biological colonization (upper, left); fractures and cracks (upper, right); graffiti/paintings (lower, left); and disaggregation and loss of 3D elements in columns (lower, right).

Summarizing, the philosophy on which SaveHer is based starts from the consideration that the heritage protection is a challenge that needs more and more efforts and synergies between all the actors. With this in mind, an information and communication technologies (ICT) tool such as SaveHer can contribute in this perspective, facilitating the profitable collaboration between people and authorities.

Conclusions

An important consideration can be done comparing the impacts of Executive Order 12906, "Coordinating Geographic Data Acquisition and Access: The National Spatial Data Infrastructure," after 23 years, Google Hearth after 12 years, and

OpenStreetMap after 13 years. Traditional approaches to geographical information system require a high expertise level of users, while Google Earth and OpenStreetMap are wider communities without a great knowledge in the field of cartography, spatial database, computer science, image processing, etc. Consequently, the main advantage is the possibility to have a mass of disseminated volunteers, very motivated, able to populate databases. Another important advantage is resource optimization. Local authorities or agencies are not obliged to continuously produce new maps, but they can use Google or OpenStreetMap data as official cartography. These public administrations can build new information at the local scale also using part of volunteered data modifying them according to administration needs. When great part of data are ready, it is important to publish and share them on a cloud service using citizens' collaboration in checking and updating them. Cloud services are fundamental in saving resources; in fact, their use can avoid the costs and management of servers.

This approach has been adopted in the SaveHer app experience, where mass cooperation through the use of ICT such as mobile applications can be a cost-effective and pervasive way of contributing to uphold cultural heritage safeguard, particularly in a period in which national funds are diminishing more and more and no prospect of turnabout can be expected.

With this in mind, this paper has considered the main technical features of free-of-charge SaveHer mobile app designed for tablets and smartphones. According to the participative philosophy of citizens, the community is called to assume an active role consisting in putting at institution's disposal information about problems affecting both the built heritage and works of art.

In keeping with the Open Government, the use of SaveHer App can contribute to the raising of awareness that mutual cooperation among all actors, such as institutions, the local community to which the monuments belong, and tourists, is crucial to preserve cultural heritage.

There is a widespread belief that the realization of a Smart City is based on extreme use of applications for smart phones and tablets. Very often, attention has been focused exclusively on device applications, forgetting that there is a city. Whenever automation through mobile applications is proposed, it is important to consider its effects on the city. When someone proposes a complex technological system, it is important to ask "is it really useful for the city?" The SaveHer application is a case where technologies have a central role in preserving cultural heritage, avoiding the typical situation of technologies developed without a specific purpose, solutions looking for a problem, or technologies for technologies (Murgante and Borruso, 2014).

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