A Proposed Taxonomy of Mobile Public Utility Applications

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Abstract: During the last years, the number of applications for mobile devices have greatly increased, as well as the number of developed services. Taxonomies provide an important tool to classify and help to understand this complex domain, describing it in a simpler way. This paper presents a taxonomy of services for a new class type of mobile applications that we called Mobile Public Utility, MPU. We contribute to research by providing a first classification scheme to the scenario of MPU App usage by depicting his special nature because not only this mobile application enables citizen to have a dialog with local authorities about environment safety or security, but also it improves trust through better interaction with Public Administrations and it enhances the decision-making process by local governments.

1 INTRODUCTION

Mobile devices like smartphone or tablet are getting more powerful and they are gaining fundamental importantance in everyday life. According to a recent Gartner [1] report, the worldwide sales of smartphones has grown by 9% in the first quarter of 2017 reaching 380 million units. Mobile phone buyers are willing to spend more money for better devices in order to install great mobile applications (Apps). The smartphone usage is linked to the number of services involved typically concern social media networking, financial transaction, email, information warehouse, entertainment like movies and music apps. This extraordinary new world represents an exceptional challenge for developers willing to create new mobile applications (Cocco et al., 2014).

In order to ensure better services the use of wireless digital technology has grown rapidly in the last decades. This gives a substantial increase of installed high frequency base stations attracting citizens' attention about problem caused by electromagnetic radiation poisoning. In particular, the increased daily exposure to these sources fields has generated in the public opinion a growing concern about health risks (Cousin and Siegrist, 2010), (SCENIHR, 2015).

This growing demand for information about the

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[1]Gartner, Inc. is an American research and advisory firm providing information technology. See: http://www.gartner.com

risks arising from exposure to electromagnetic fields, and the increased sensitivity to this issue both by citizens and local authorities, has resulted in requests for information and controls to guarantee public health (Organization et al., 2002). We developed Onde Chiare App, (Mannaro and Ortu, 2016), a mobile application enables to directly provide information to the people in an effective and transparent way, showing a complete and timely dashboard of electromagnetic field levels in the urbanized areas.

To the best of our knowledge, there is no work in literature that addresses these kind of application both from the design point of view and in terms of taxonomy. Mobile applications can be categorised in several ways, and to our knowledge there is insufficient information on exactly what types of classification are more appropriate for each use. Until now, there have been some attempts to develop taxonomies for mobile applications (See: (Dombroviak and Ramnath, 2007), (Nickerson et al., 2009), (Nickerson et al., 2013), (Kennedy-Eden and Gretzel, 2012), (Shroff et al., 2015)), but there is no taxonomy which has been generated for a specific mobile app such as Onde Chiare App.

In particular, Nickerson et al. (Nickerson et al., 2009) created a taxonomy of mobile apps based on the meta-characteristic of the interactions between the user and the app. Starting from the work of Nickerson (Nickerson et al., 2009), we propose here a taxonomy that classifies the specific services offered by Onde

Chiare App.

This paper makes the following contributions: i) we discuss a novel kind of mobile application named Onde Chiare , as a tool to reduce risk perception on electromagnetic field (EMF) and to fill the knowledge gap between the public and the experts about the effects of mobile phone radiations on human health; ii) we propose a taxonomy that classifies the services offered by this type of application; iii) we contribute to both the academic discussion and the practical world by providing a framework for other researchers and managers. The organization of the paper is as follows. Section 1 provides an introduction, and the motivations for the paper. Section 2 discusses the background on a specific class of mobile applications, with special emphasis on recent mobile application features, and related works about taxonomy of mobile applications. In Section 3 we classify a novel kind of mobile app we called Mobile Public Utility (MPU) app within the taxonomy developed by Nickerson et al. (Nickerson et al., 2013). In Section 4 we develop a taxonomy of MPU services and then we present a classification of services based on different users. Finally in Section 5 we present conclusions and some future directions for further research in this domain of study.

2 STATE OF THE ART AND RELATED WORK

This section highlights and discusses some taxonomies for the classification of mobile application and then briefly discusses the state-of-the-art of mobile application developed in terms of environment safety or security.

A Taxonomy is a powerful tool for classifying a domain content. It helps to understand better the hierarchies and relationships between elements. A Taxonomy is a map of a knowledge domain, in recent years, different types of taxonomies in the mobile area have been proposed.
Tarute et al. (Tarute et al., 2017) investigated how to design mobile applications based on user preferences to better understand which features stimulate consumer engagement. Riggs and Gordon (Riggs and Gordon, 2017) provided a taxonomy, about mobile technology, as a tool for increasing transactive exchanges between local government and citizens in the future. Kennedy-Eden and Gretzel (Kennedy-Eden and Gretzel, 2012) proposed a taxonomy of mobile apps in tourism domain from two point perspectives to provide insights into app development trends from a marketing perspective. Ernsting et al.

(Ernsting et al., 2017) explored the extent of smartphone and health app use, as potentially promising tools to change health-related behaviors and manage chronic conditions. Heinonen and Pura (Heinonen and Pura, 2006) developed a conceptual classification for mobile services giving indications how to categorize them from a customer centric perspective. Their taxonomy evaluated important aspects that influence mobile services, such as context, social settings and type of consumption. In (Dombroviak and Ramnath, 2007) authors presented a taxonomy of mobile and pervasive application based on abstracting application characteristics.

In (Nickerson et al., 2013) Nickerson et al. suggested an iterative method for taxonomy development and they applied this method to mobile applications domain. Starting from that work (Nickerson et al., 2013), we propose here a taxonomy that classify the specific services offered by a novel type of mobile application: a mobile app that aims to promote a proper form of active involvement of citizens, and real-time information sharing of electromagnetic field levels in a given geographical area. Currently this application is a prototype for Android designed and tested internally at the University (Mannaro and Ortu, 2016). This novel kind of mobile applications, named "Onde Chiare" can be classified as Mobile Mobile Public Utility (MPU App) and to our knowledge there is no taxonomy in literature that has been generated for this particular type of mobile app. In recent years, several mobile applications in terms of environment safety or security have been developed. Disaster Reporting[2] is a mobile app which allows users to report disaster event such as blaze, building damage, landslide, with some related information. In the United States and Canada different types of mobile applications classified as 311 services[3] are available. This number supplies access to non-emergency municipal services and information. Some examples are: "YourGOV", "City Sourced", "Connected Bits", "EPA", "Orange County California Public Works", "Ping4", "SeeClickFix Inc". This kind of mobile applications can be classified as Mobile Environment Monitoring app, users can report incidents, pollution, abusive dumping, potential health risks and so on, but there is not an interactive comunication with local government. Public Administrations do not share their information in this type of applications and there is not a Community aspect such as in MPU app. The main contribution of this paper is to provide a taxonomy

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[2]Available at http://www.icimod.org/?q=18659

[3]http://www.pwmag.com/mobile-technology/Mobile-apps-for-public-works-professionals-contractors-and-residents.aspx

that classifies the services offered by a novel kind of mobile application that we called Mobile Public Utility and to contribute to both the academic discussion and the practical world by providing a framework for other researchers and managers.

3 A CASE OF MPU: Onde Chiare APP

Onde Chiare is a prototype for Android we designed and tested internally at the University. Onde Chiare is a valuable tool to enable community members to report specific information to the community, and to improve the communication efforts by local authorities. Detailed description of Onde Chiare App can be found in a previously published paper (Mannaro and Ortu, 2016). In this section, only a brief description of the app will be presented before explaining the classification of this app in a new class that we called MPU app. Onde Chiare aims to promote a proper form of active involvement of citizens, and real-time information sharing of electromagnetic field levels in a given geographical area. The typical scenario is represented by users carrying a smartphone loaded with the Onde Chiare application and moving in a geographical area. Some services that the application can manage are: i) Measurement of environmental data; ii) Geolocation of the measurements; iii) Sending geolocalized reports (i.e. broken antennas); iv) View geolocalized information on the map. A remote server is the part of the system demanded for the communication with the mobile application. It is responsible for processing the geolocalized point received from the application client. The remote servers response contains information about the field measure (either real or estimated) in that area and the position of possible electromagnetic pollution sources in the surrounding area. In addition to the involvement of experts using tracking technologies to read data and information related to the environmental status, active participation of individual citizen has a fundamental role. Users in this context are an active stakeholder of the system, they can send report that can be shared. Users report may be a real measure of environmental data, i.e., an EMF measure, or more general report i.e., a broken antenna or apparatus. These report are validated by experts before being shared. Our mobile application offers the possibility to every smartphone owner of becoming part of a network of distributed information made up of citizens interested in environmental issues and quality of life related to the urban area. The participation will take place through an active use of the app. To the best of our knowledge, in the app store there are no similar mobile applications and they are not intended as tools of this type. Onde Chiare will make it easier for citizens to report public-facing issues, taking a picture, locate it, categorize it, and quickly and conveniently notify to the appropriate parties for a better response related to exposure to electromagnetic fields, but also for more general issues.

4 A TAXONOMY OF MPU APPLICATION SERVICES

We indicated with term MPU apps all those applications that provide to users public utility services, and allow also a dialog with local authorities. In our case, we considered a particular MPU app that promotes a proper form of active involvement of citizens and the real-time information sharing of electromagnetic field levels in a given geographical area (Mannaro and Ortu, 2016). Through the app, citizens can report a problem directly to government officials by snapping a photo and sending a report, authorities receive the report and can send a response. This mobile application aims to make information accessible to the local stakeholders (for example local residents) and public stakeholders (for example, local officials, leaders or politicians, decision makers), via a click.

In this section we show the taxonomy that we created on basis of the services offered by MPU apps from users perspective. We adopted the taxonomy development method of Nickerson et al. (Nickerson et al., 2013). This method is iterative and consists in 7 steps. In the first step, a meta-characteristic needs to be determined. Meta-characteristic represent the perspective of classification which guides choosing the application characteristics in the taxonomy. We determine as meta-characteristic "Services offered by Mobile Public Utility applications from users perspectives". We assumed that users of the taxonomy are citizens, public administrations, certified authority.
In the second step one has to determine ending conditions. We assume that to reach ending condition our taxonomy must be concise, robust, comprehensive, extendible and explanatory. From the third step to seventh step the process is iterative. The seventh step checks if the ending conditions are reached. In Figure 1 we show the created taxonomy as results of the method we have just mentioned, totally we did four iterations. According to the method, each step can start chosing between two different approach: Empirical-to-conceptual or Conceptual-to-empirical. Usually, one chooses "Empirical-to-conceptual" approach if there are enough available data. Instead,

"Conceptual-to-empirical" approach would be more appropriate if one has a few data available and have a good knowledge of the domain of interest.

In our taxonomy, we identify the first level as macro-dimensions, the second level as sub-dimensions. Each sub-dimension has different characteristics mutually exclusive and collectively exhaustive. In this paper, each sub-dimension with its characteristics is deduced from the features of the mentioned mobile app (Mannaro and Ortu, 2016). We think that an application, to be considered as MPU type, must have at least the first macro-dimension level in terms of services. For that reasons we decide to describe only the first level of the proposed taxonomy. However, we believe that the sub-dimensions in Fig.1 could be used as starting point to design mobile applications providing similar services.

- *Security & Emergency-System service*.
  To obtain important information the MPU app must be supported by a complex management system designed to perform massive calculation or evaluation. The system behavior is designed in order to prevent a disaster, or monitor a particular critical situation in progress. In most of the cases, Public Administrations have already this type of platform to manage or monitor emergencies. We assume that MPU app interfaces with this type of systems, to obtain proper information. The interaction between monitoring system and application is managed by public administrations.

- *Civic Engagement service*.
  By using a MPU app, users can send reports (i.e text message, photos, videos) to signal a problem or to suggest a danger situation. If the user is a professional public operators, he can use MPU application to send measures taken with a valid instrument to Public Administrations.

- *Information*.
  This service manage several data type from different sources. Public sectors choose and filter the information in order to share and make them public. Information can concern for example citizens report, certified measure and all data coming from monitoring system platform.

- *Community*.
  That level represents the application usage oriented to collective interest, with well defined roles, and where each user actively contributes. This service allows citizens to communicate each others to express their opinions, or their discontent, about certain issues. Moreover, public administrations can feel citizens mood about particular situations or demand their opinion with different surveys. Inhabitants voice is important to make difficult decisions and to avoid unpleasant unrest.

- *Navigation*.
  It represents the common service of navigation that works with GPS service. When the user starts the application, it locates his position and shows points of interest containing information in the same area.

4.1 MPU: TYPOLOGY OF THE ACCESSES

MPU application enables different types of users that should have specific access levels, there are different permission to interact with the application by using different access interfaces, it enables different types of users, who should have specific access levels. We show in Table 1 a specific example applied to Onde Chiare app, we considered as mentioned before as an MPU application. In that case some services are managed only by the public administrations such as reports validation, choice of data sharing or interaction with the monitoring platform. To simplify, we indicate two different permissions: PA/CA (Public Administration/ Certified Authority) and Public. Starting from the previous taxonomy and considering the different dimensions, each sub-dimension may have several type of access. Table 1 shows the type of access for each sub-dimension. We indicate with "PA/CA" the services reserved only to Public Administration or Certified Authority, and with "Public" the access for a generic user (citizen or PA). Some services described in the created taxonomy are managed only by the Public Administrations such as reports validation, choice of data sharing or interaction with the monitoring platform.

5 CONCLUSIONS

In this paper we proposed a taxonomy that classifies the services offered by a novel type of mobile application. This taxonomy should not be considered as definitive but a starting point towards a more exhaustive categorization of the dimensions of a specific kind of mobile application for public utility that aims to reduce risk perception on electromagnetic fields and to fill the knowledge gap between the public and the experts about the effects of exposure to electromagnetic fields on human health.

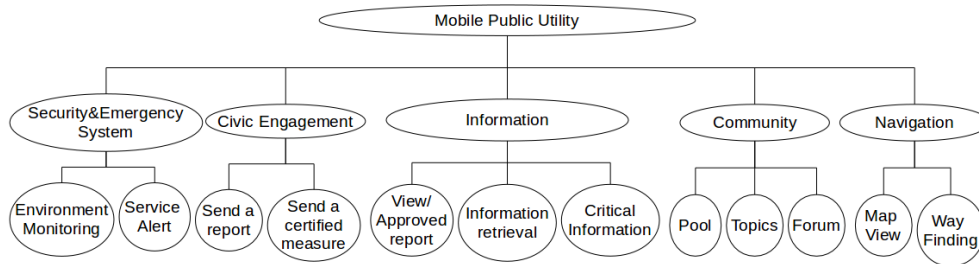Finally, we are contributing to both the academic discussion and the practical world by providing a

Figure 1: MPU services Taxonomy at the end of fourth iteration.

Table 1: Typology of access.

Services		PA/CA	Public
Security & Emergency System	Environment Monitoring	X	
	Service Alert	X	
Civic Engagement	Send a report		X
	Send a certified measure	X	
Information	View/Approved report	X	
	Information Retrieval		X
	Critical Information	X	
Community	Pool		X
	Notice		X
	Forum		X
Navigation	Map View		X
	Way Finding		X

framework for other researchers and managers, because we show that using the proposed taxonomy may facilitate designers to identify requirements and to fill gaps.

Mobile apps for public utility present many challenges for developers that must be addressed in order to produce a successful mobile application, because at the moment there is insufficient information on exactly what types of appropriate contents are capable of enhancing the collaboration between citizens and public governments about such delicate issues as environmental ones.

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