ApPoggiomarino: A Context Aware App for e-Citizenship

Giuseppe Annunziata[1], Francesco Colace[1], Massimo De Santo[1], Saverio Lemma[2] and Marco Lombardi[2]
[1]*DIIn, Università degli Studi di Salerno, Via Giovanni Paolo II, 132, Fisciano (Sa), Italy*
[2]*SIMASLab, Università degli Studi di Salerno, Via Giovanni Paolo II, 132, Fisciano (Sa), Italy*

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Abstract: The diffusion of pervasive systems and the affirmation of the Internet network as technological glue among the individuals have deeply modified the everyday life of our society. In fact, the spread of Smartphones and Tablets has allowed the users to use contents and services everywhere. Among the environments that have been mainly affected by this 'technological' wave, the 'City' stands out. Therefore, with these new paradigms, the same concept of 'City' results altered and enriched with new potentialities. The City is able to talk to its inhabitants offering, according to the contexts, services and contents able to adapt themselves to the needs of the moment. In this paper, we intend to introduce a Context Aware methodology capable of giving contexts and services to the citizens according to their interests and their position inside the city. This methodology has been implemented in a 'hybrid app' and tested in a real context.

1 INTRODUCTION

'You take delight not in a city's seven or seventy-seven wonders, but in the answer it gives to a question of yours'. The great Italian writer Italo Calvino wrote this in his novel 'Invisible Cities'. As often happens, a writer succeeds many times in looking forward in the time and the raised issue is very topical. The citizens look more and more for answers able to satisfy their needs. Answers that often materialize in services and contents to be used on mobile devices that are widely spread now (Colace et al., 2015a). Who has not had the necessity to know the opening hours of a pharmacy or to find the nearest open pizzeria? Therefore, it is understandable how it is essential to give the citizen adaptive services and contents able to transmit right information in the right contexts (Colace et al., 2015c). A fundamental contribution to this scenery has come from the increasing diffusion of mobile devices that concretely have created pervasive and context aware computing approaches (Colace et al., 2015d; Colace et al., 2015e). Exactly the context aware computing seems to be the most important approach to realize an adaptive approach to the distribution of services and contents (Colace et al., 2015b). The Context Awareness marks the systems capable of perceiving the contexts where they and the user act, and of consequently modifying their behaviour and exchanged information. These opportunities offered by the new pervasive technologies have deeply affected the world of the services providers (Colace et al., 2014).

More recently, the literature has provided a different and wider interpretation of service, underlining its multidimensional, systemic nature in a theoretical context that has implications not only for marketing but also for organizational studies, public administration, management, social sciences, and ICT (Ciasullo and Troisi, 2013). According to Service- Dominant Logic (Vargo and Lusch, 2004; Vargo and Lusch, 2006a; Vargo and Lusch, 2008), Service is co-created through ongoing interactions between customers and service providers in the context in which the experience takes place (Zomerdijk and Voss, 2010). Thus, service influences synergic relations among the actors (Vargo and Lusch, 2011) in order to enable them to participate in the value co-creation process (Gummesson et al., 2010). It is clear that the emphasis is on interactions that lead to value co-creation (Lambert and Garcia-Dastugue, 2006; Prahalad and Ramaswamy, 2004; Vargo and Lusch, 2008). Value co-creation is a process implying the involvement of multiple actors engaged in an extensive network of interactions. Prahalad and

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Ramaswamy (2004) define co-creation in the context of experiential marketing as a process that enables the individual consumer to determine the design of future products and services, marketing messages and distribution channels where the products will be available. In this process of co-creation, service users actively collaborate with providers in the design, implementation, use, and even promotion of co-created products or services. In this sense, the service cannot be complete without active customer participation in the service creation process (Bitner et al., 1997; Zeithaml et al., 2004; Groth, 2005). Consumers' role is central in requiring personal services, quick responses and high levels of service quality.

The service used in a given context, encouraging interaction among the parties, favors the integration of resources, expertise, information and interests (before, during and after use). Value is thus determined through an integrated process of co-production, involving various parties sharing insights, needs and availability, on the basis of a networking, systems logic.

Customers co-create unique experiences through their interaction with service providers across several touch points, responding to the various designed elements, along with others that are outside organizational control, such as the social environment (Verhoef et al., 2009). In this context, customer's experiences cannot be designed by the organization, but services can be designed for the customer experience (Patrício et al., 2011). Thus, customers can co- construct and personalize the service experience, integrate the inputs of firms into their practices with value interpreted through the social meaning of such practices (Holttinen, 2010).

In particular, the use of services by consumers generates experiences for the other involved actors, in terms of performance, feedback, knowledge and emotions. In short, the customer is no longer conceived as a consumer or destroyer of value (consumer) but as a participant in the production process (prosumer) (Vargo and Lusch, 2006b).

The active involvement of customers pivots on acquiring in depth knowledge of experience, perceptions and opinions about the service as a whole. While the customers are using services, ideas are exchanged, potentially creating an effect that enables them to develop new lines of thought, which may not have occurred independently (Ulwick, 2002).

On the basis of what has been previously described, this work will be organized in this way: in the following paragraph, we will describe the concept of context and how it can be declined in a modern way thanks to the use of new technologies. Then, we will introduce a context-based approach able to give, inside a little town, services and contents useful for the user. Some experimental results will be presented in the last part of the paper.

2 CONTEXT AWARENESS AND ICT

The human being has always used the concept of context, which belongs to that kind of concepts known by the majority of people, but that are difficult to describe with words. In (Schilit et al., 1994), there is the first attempt to describe the relation between the context and the context-awareness in the field of information technologies. The three main aspects of the context are: 'where you are', 'who you are with' and 'what resources are nearby'. If we put together the three just mentioned sentences, we realize that they can be seen as a first definition of context based on some observable characteristics. Another definition of context has been proposed in (Ryan et al., 1997) where the context is defined as a series of environmental features (environment), such as, for example, the place, the temperature and the considered user's identity. The definition of context that usually is taken into account is that proposed by (Dey and Abowd, 1999): 'Context is any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves.' Directly linked to the definition of context, there is that of context-awareness applications: applications that in some way are aware of the context where the user is and the capability to detect and react to the changes in the environment where it is located (Colace et al., 2015f). Again in (Dey and Abowd, 1999), there is a definition of the context-aware system: 'A system is context-aware if it uses context to provide relevant information and/or services to the user, where relevancy depends on the user's task.' In practice, a system can be defined context aware when it takes advantage of the context to give important information and/or services to the user, where the importance depends on the user's request and features. If we wanted to classify the context-aware applications, we could consider that presented in (Schilit et al., 1994):

1. Proximate Selection, which literally means 'selection of proximity', is an interfacing technique

that considers that the user gets close to a particular place to receive some relevant information and/or to make elaborations, both on request and automatically.

2. Automatic contextual reconfiguration is the process of addition of new components, removal of already existing components or alteration of the connection among the components of a system. In actual fact, there is the change of the system according to the context. Typically, the components can include: driver modules directly downloadable by the user, modules of programmes.

3. Contextual information and commands: often the operations that people make can be predicted. In fact, usually, there are some recurring operations made in particular places (e.g. universities, libraries, offices, etc.). The applications that use this kind of 'contextual information' are made to accomplish certain orders (contextual commands) in place of the user according to the context.

4. Context-triggered actions are those applications that automatically carry out an operation when there is a particular condition (trigger) in the context.

Although as time goes by new classifications have been introduced, the previous ones are still valid. It is important to precise that a context-aware application has not to necessarily belong to one of the listed categories, but it is possible to have some 'hybrid' applications that have features belonging to more categories.

What are the context-aware applications for? For some years, more and more often we hear talking about smart environments aimed to the improvement of the quality of life, both in domestic environment (domotics) and in city environment. In particular, there is an expression that recurs a lot in the several mass media: 'smart city'. The smart cities are the so-called intelligent cities. This subject is interdisciplinary and encompasses all the fields: from the energy saving, to the improvement of life and the fastest and more natural access to information. It is exactly in these two latest fields that the context-aware applications insert themselves. In fact, in the future cities, there will be more and more smart spaces (domestic and not), which will take care of the users making easier and more immediate their access to information and, under determined conditions, will be able to foresee the user's desires and therefore to anticipate some operations on behalf of the user. As an example of smart environment, we can think of a room that has the capability of automatically regulating the temperature of the environment according to the user's preferences, or, through a centralized stereo system, can change music according to the user's tastes. And moreover, we could think to a public park where people, by tagging, can leave their own messages on a virtual wall, so that in the future the users of this same park can take advantage of the advices of who has been previously in that place. A further example could be that of a smart shopping centre, where when a user enters in a shop directly receive information about the products on sale that he/she could be interested in. This processing can be made on the basis of the previous purchases and/or of a series of indications given by the same user (for example, through an electronic questionnaire made available by the shopping centre). This kind of applications can become very important also in the field of the improvement of disabled people's life. In fact, it is possible to study some areas that change according to the specific need. For example, let us consider a blind person that enters a smart public building, this environment, after having received context information about the user, has to be able to guide him/her towards his/her destination using audio messages.

In the following paragraph, we will present an approach to the management of the context and its associated services to make the previously introduced approaches concrete.

3 A CONTEXT DIMENSION TREE BASED APPROACH FOR CONTENTS AND SERVICES CONTEXTUALIZATION

A key element in the design of a contextual application and a Context Aware System is the representation and management of the context itself.

To better understand formal concepts, it has been carried out in the paper an example based on a simplified citizen domain, on which it is now being developed a Context Aware System that assists residents and tourists in their activities.

The goal is to provide a mechanism of dynamic and automatic invocation of services considering the context through the Context Dimension Tree (Tanca et al., 2006).

CDT is a tree composed of a triad <r; N; A> where r indicates its root, N is the set of nodes of which it is made of and A is the set of arcs joining these nodes.

CDT is used to be able to represent, in a graphic form, all possible contexts that you may have within an application.

Nodes present within CDT are divided into two categories, namely dimension nodes and concept

nodes. A dimension node, which is graphically represented by the color black, is a node that describes a possible dimension of the application domain; a concept node, on the other hand, is depicted by the color white and represents one of the possible values that a dimension may assume. Each node is identified through its type and a label.

The children of the root node r are all dimension nodes, they are called top dimension and for each of them there may be a sub-tree. Leaf nodes, instead, must be concept nodes. A dimension node can have, as children, only concept nodes and, similarly, a concept node can have, as children, only dimension nodes.

In addition to nodes, you can use other elements: the parameters, which may arise both from a dimension node (graphically represented by a white square) and from a concept node (white triangle), submitting them to particular constraints. In fact, a concept node can have more than one parameter, while a dimension node can have only a parameter and only in case it has not already children nodes. The introduction of parameters is due to their usefulness in shaping the characteristics that can have an infinite or very high number of attributes. For example, a node representing Cost dimension risks having a high number of values that should be specified by as many concept children nodes. In a similar case, it is therefore preferred to use only one parameter, whose value will be specified in each case. Leaf nodes, in addition to concept nodes, can also be parameters.

In general, each node has a parameter corresponding to a domain, dom(nP). For parameter nodes connected to concept nodes, the domain can be a set of key values from a relational database, while in case of parameter nodes connected to dimension nodes, the domain is a set of possible concept nodes of dimension.

In figure 1, it is shown a general designed CDT, called Meta CDT, which is the starting point for the design of a specific CDT that can be exploited in contextual applications.

You may note six top dimensions, which correspond to the questions of the 5W1H method: Location (WHERE), Role (WHO), Time (WHEN), Situation (HOW), Interests (WHAT) and Utilization (WHY).

In particular, there are two types of users and eleven categories of interests.

A context element is defined as an assignment $d\_name_i = value$, where d_name_i indicates a possible size or undersize of CDT (it is the label of a dimension node), while *value* may represent the label of one of the concept nodes that are children of the considered dimension node or the value of a parameter referring to one of these concept nodes or the value of a parameter referring to the considered dimension node.

For example, these assignments are possible context elements: Interest = tourism, Location = LocationID (ID = 3), Role = user, Utilization = holiday.

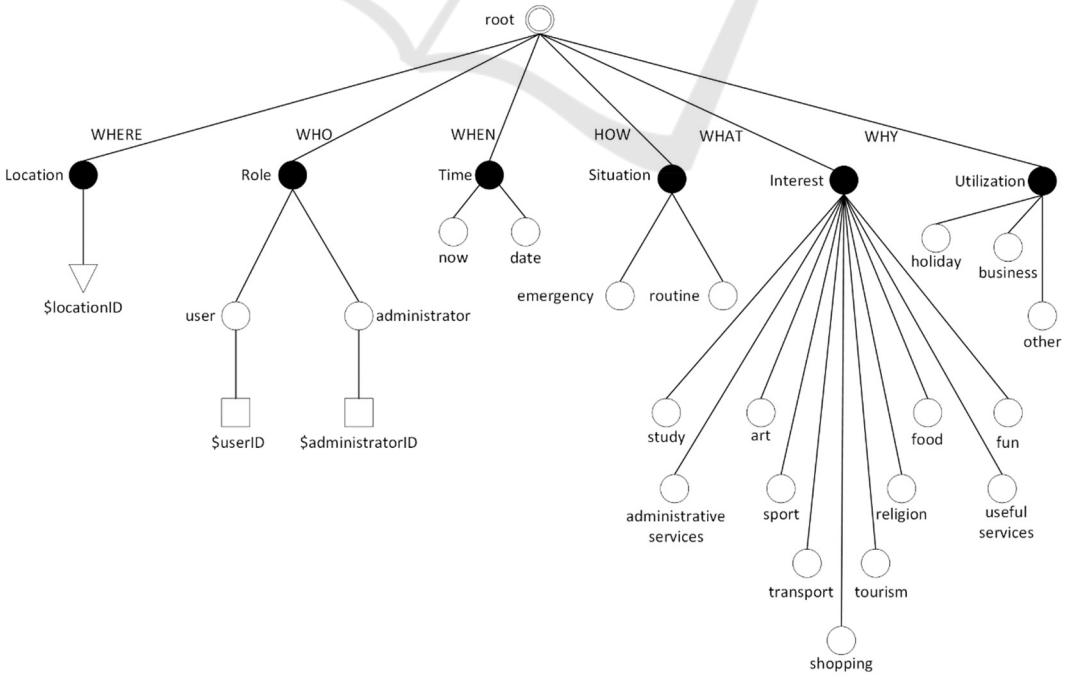

Figure 1: Meta CDT for contextual applications.

A context is specified as: ∧ (d_name$_i$ = value).

It is defined as an **"and"** among different context elements.

Several context elements, combined with each other by means of an **"and"**, damage, therefore, the origin of a context.

For example, a possible framework that can be obtained from the previously seen CDT, through the context element that we have listed, is:

C= (Location = locationID (ID=3)) ∧ (Role= user (ID=15)) ∧ (Time = now) ∧ (Situation = routine) ∧ (Interest = tourism) ∧ (Utilization = holiday)

The context is defined as a user, interested in tourism, who uses the contextual app on vacation, in a called place.

Therefore, through the Context Dimension Tree, it is possible, after analyzing the domain of application, to express the size characteristics and values they can take in a graphical way by, respectively, dimension nodes and concept nodes or parameters. The assignment to a dimension of one of its possible values is a context element. The context element can be considered the main feature of the application, by which a context can be decomposed. The moment you make the formulation of the context, you must specify all the context elements that are part of it and that enable its creation. Any context is expressible by an **"and"** combination of the context elements to which they are peculiar.

By definition, you can begin to understand how you will create views based on data relating to each context; in fact, they will be built starting from the portions of the database and then from the partial views, associated to the context element that takes part into context information.

3.1 Methodologies and Phases to Obtain Contextual Service

The methodology, shown in figure 2, has been realized in order to manage the database and to carry out reductions of their content based on the context.

The purpose is to help the designer in the definition of all contexts relevant to the considered application and, later, in the association to each context of the portion of the database containing the relevant data about the context.

The methodology consists of three main phases, which we will see in detail later: design phase of the Context Dimension Tree (CDT), definition phase of partial views and composition phase of global views.

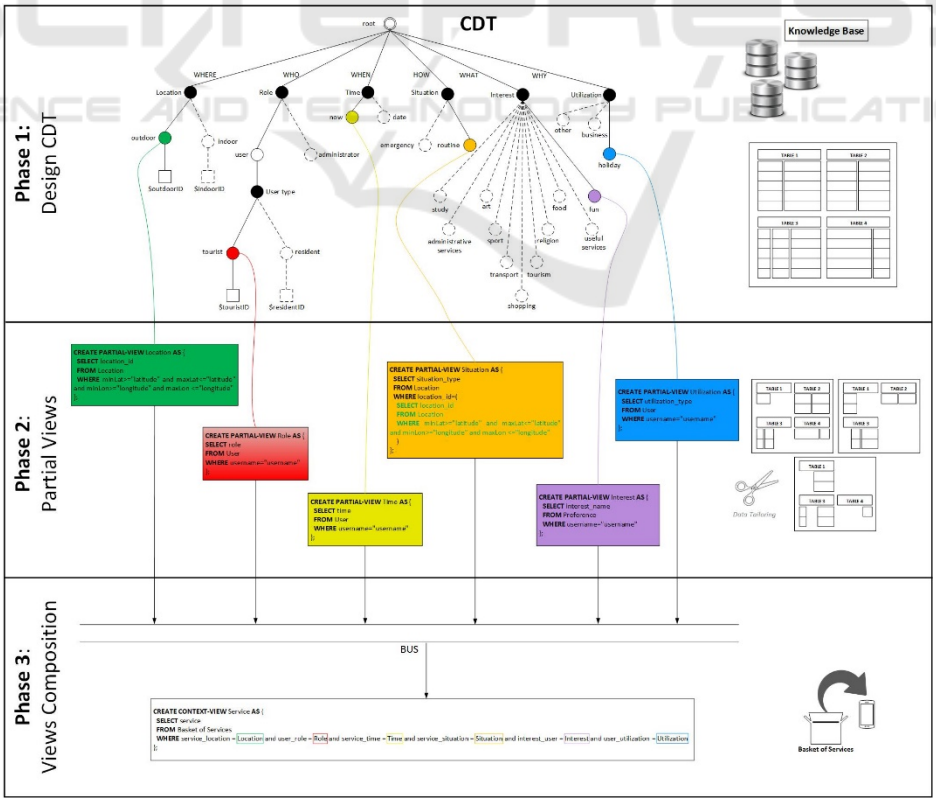

Figure 2: Phases to obtain contextual service.

1. Design phase of the Context Tree: in this phase, the Context Dimension Tree is designed to identify significant context elements for the considered application. In fact, it focuses on the definition of contexts and on the elements that compose them. These contexts must be identified and shaped, indicating particular elements that characterize each of them. As it has been said, it is available a special tool called Context Dimension Tree (CDT) to make context design.
   Three CDT were made for specific environments in order to represent and manage a multitude of different contexts and in order to identify, represent, preserve and make available cultural points for each type of user.
2. Definition phase of partial views: after the definition of all the contexts and their context elements, in this step a different portion of the database is associated to each context element, containing the relevant data for it.
   In practice, the goal is to find the appropriate value for a given dimension, in order to obtain, by means of the values of all the dimensions, a valid query and specific to the context in which the user is located.
   A partial view could be related to dimension "Role": once logged in, the application is able to recognize the user and to know more precisely whether he/she is, for example in tourist areas, a resident or a tourist. Thus, the value "tourist" of dimension "Role" is a partial view for the current context: using this knowledge, you can exclude certain services, not suitable or useful to the tourist role.
3. Composition phase of global views: this is the phase where you have the automatic generation of views associated with each context, which is made starting from partial views associated with context elements. After the creation of the global views of the contexts, the answers to questions that will be asked to the system will be developed from these views and, in particular, from the view associated with the context in which you are located when the query is performed.
   In particular, once defined the values for each dimension, you can use all the information obtained in order to identify the right context and offer data and services customized for the user.
   It is assumed the example of a tourist who is walking near a beach who gets initially a notification of his/her proximity. Later, he/she needs to deepen such notification. Therefore, it will propose him/her services that they might be interested in, such as the site of the nearest beach, where he/she can get the price list.

3.2 The System Architecture

We have made a Context Aware System, whose architecture is shown in figure 3, able to adapt useful data and services to users based on the context. Context awareness of interaction is particularly important in ubiquitous systems and mobile applications for groups of users.

In fact, given the ever-increasing variety of interaction devices (fixed and mobile) and application use contexts, it becomes increasingly necessary to develop Context Aware systems that manage information that make unique and distinguish each human-machine interaction.

The architecture of our model is composed of: the Context Aware Module (CAM), which is the main engine and considers the context in reference to the obtained data (contextual information), in particular position (GPS location), interests and role (obtained during registration) of each user; the Knowledge Base Module, a special type of database for the management of knowledge and information: in particular "Users", representing all users of the

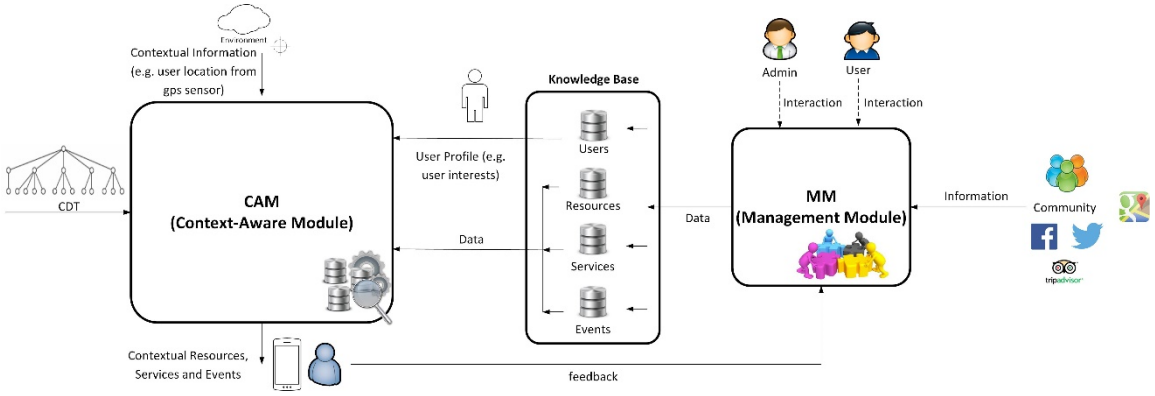

Figure 3: The System Architecture.

application, "Services", which describes all the services of every possible application context, "Resources", which forms all the points of interest and "Events", which describes all events; and finally the Management Module (MM), used both by the administrators of the app and the users themselves.

This module deals with some important issues, including: POIs management, where the insertion can be done directly from map, manually or by search of interests, interacting in the last two cases with Google Maps; services, comments and events management, interacting with TripAdvisor and Facebook/Twitter API.

In figure 4, for a greater immediacy, it is shown a deepening of the architecture realized: the set of user profile, such as preferences and interests, of user context, such as his/her GPS location, of CDT, which provides the rules and allows the representation of the specific context in which he/she is located, of data, including the points of interest and services, allows obtaining the contextual resources tailored for the user, through the use of a contextual application.

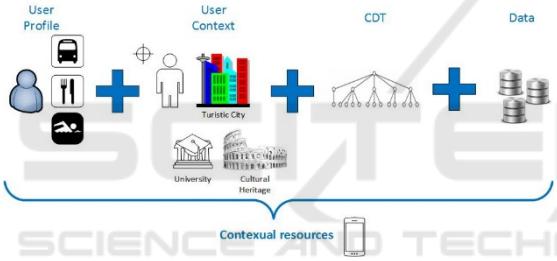

Figure 4: Contextual resources as final result of App.

On this subject, for the different environments described, we have realized hybrid mobile applications, both in Android and iOS, with many features, some of which are shown in figure 8: contents, including descriptions, images and services, tailored to interests, profile and location users, planning a route based on user's interests and his/her preferences of travel, exploration of the surroundings from the current position, custom QR Code reader, weather and news on the site, search and insertion of events, the comments section, display position and points of interest on the map, with integration of the navigator on the smartphone to reach specific ones.

4 ApPoggiomarino: A CONTEXT AWARE APP FOR CITIZENSHIP

In this section, we will present ApPoggiomarino, a contextual app designed and implemented according to what was described previously. In particular, we have thought to apply the approach in the context of the little town of Poggiomarino, a municipality in Campania (Italy) of about 21,000 inhabitants and with an extension of 13 square km. Along with the Municipality of Poggiomarino, a reference CDT has been designed. In this phase, we have collected the services and contents potentially useful for the citizens and situate them on the map defining the activation zones (fig. 5).

Figure 5: Definition of the activation areas of services and contents.

Moreover, we have defined the different typologies of citizens (elementary school's students, users with kids at school, university students, …) associating them to a previously established set of services and contents. Having the town a series of artistic contents, we have developed services and contents in support of them too. A series of services and contents considered transversal, such as the opening hours of the City Hall, the Library, the Cemetery, the pharmacies, have been made available to all the typologies of users.

All information about places of worship and shops has been uploaded, for any building or area of potential.

The App has been developed with hybrid technologies (Cordova and PhoneGap) to allow an easier publication both in Android and Apple environment (figure 6).

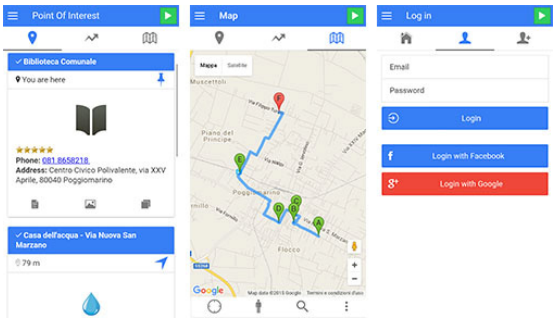

Figure 6: Screenshots with some features of contextual application.

The App has been presented to the population in September 2015 and has been installed by about 500 people.

Therefore, by the installations we can infer that the App has had a remarkable success among people aged under 20 and over 50. This is not surprising because exactly these ranges are mainly interested in services and contents of the town, living it for more time. In figure 7, it is presented the use, in terms of daily requests of the several services, of the app.

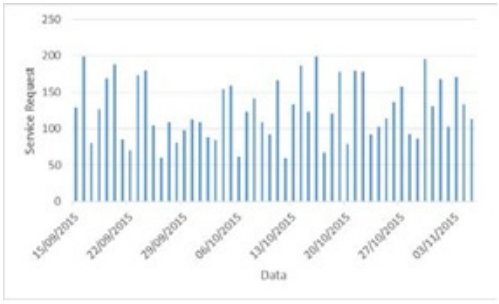

Figure 7: Service Requests in the period 15/09/2015-03/11/2015.

From a more detailed analysis, we can deduce that generally the most popular services are those linked to the request of opening hours of shops and public offices. Instead, during weekends, the requests of services and contents concerning activities linked to free time become more substantial.

5 CONCLUSIONS

In this paper, we have presented an app able to offer services and contents personalized for the needs of the user according to the context where he/she is. The app bases its 'contextual' functioning on the adoption of the CDT that is able to shape the context and the actions to implement. The app has been developed for the needs of a little Italian town and the first results have been satisfying. The following activities have as purpose the application of the proposed methodology to more complex environments, for dimension and number of potential points of interest to manage.

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