Information Systems in healthcare: Potential of Mobile systems. The case of INEM

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Abstract: The information systems are an asset in the capacity of institutions to improve their business. As the potential of mobile systems is increasing, especially in healthcare, it is diagnosed the information system of INEM (National Institute for Medical Emergency) in some of its weaknesses and changes. In the case of human lives, which require speed and quality of care in a specific context and location, it is essential that healthcare institutions implement mobile and context-aware systems in order to prevent gaps in care since the first contact with the patient. This paper shows a system's architecture, provided by the technical and functional development department of a company (*Algardata*) for context-oriented systems in dynamic environments. The aim is, whenever the patient changes his location, to immediately discover the services that best fit his needs and determine the resources required, including the position of professionals who are on duty nearby.

Key Words: Information systems, ubiquitous systems, mobile systems, INEM, healthcare.

1. Introduction

One way to manage and process the information that organizations need today is the creation of a supportive structure based on technology that integrates mobile and easy-to-use tools. Some of them are ERP systems (Enterprise Resource Planning), CRM (Customer Relationship Management), CMS (Content Management Systems) and SOA (Service-Oriented Architectures). These have contributed to the development of new processes and services, or improvement of existing processes, in real time. Given their enormous potential, which can range from changes in procedures to a complete reconfiguration of the business model, professionals and users must be familiar with this kind of tools and be involved in their implementation from the beginning.

In particular, health services require a significant transformation in order to achieve greater interoperability, efficiency and quality. Most information systems (IS) in healthcare require a rapid delivery of services at the appropriate local and context. The method for managing patient's care is not always personalized and nimble. Especially when there is an interaction between several entities such as hospitals, health centers, firemen, insurance firms, etc. This also involves a variety of contexts, including a range of physiological and behavioral factors. Healthcare providers make decisions based on a series of data to know which services provide real-time information such as: how much of which product is needed; how best to administer it; how to organize the treatment; where it should be done; etc. This requires the use of tools specially based on integration processes and simultaneously mobile and flexible to the context.

2. Trends in information systems

Before analyzing the information system of INEM, a survey was conducted in order to know the trends of IS in different sectors, including healthcare.

Most organizations interviewed, under the SWOT analysis (strengths, weaknesses, opportunities, threats), do not have an integrated view of problems in their activities with the potential of the IS to solve them. Once examined how opportunities can solve some weaknesses (or how threats may turn out to take advantage of certain opportunities), they do not explore how their IS can be restructured to incorporate other emerging tools in order to realize more fully those strategies. In the organizations that have this view, particularly those engaged in the technological sector and in distribution channels, there is a greater alignment between the IS infrastructure and its activities with resulting improvements in speed, efficiency and image. This is mainly related to the fact that the technology sector dominates IS management and implementation and, in the case of distribution channels, to their considerable organizational capacity and the nature of their business processes.

On the other hand, it is interesting to perceive that sectors with more mobile activities such as INEM

(medical emergency), Ctt (post office) and Algar (waste/eco-points), as well as banks which increasingly depend on real time knowledge about financial markets, recognize the growing potential of mobile IS platforms. They highlight the mobility that is achieved through a PDA (Personal Digital Assistant) or a simple mobile phone, as well as the easy access to these devices regardless their location from the central system of the organization.

3. A diagnosis of Inem's information system

The INEM is the Ministry of Health's responsible institute for coordinating medical emergency in Portugal through an Integrated Emergency Medical System (SIEM), in order to ensure that victims of accidents or sudden illness patients receive a prompt and proper healthcare. To carry out its activity, INEM has means such as ambulances operating directly or through protocols and agreements/contracts with other entities like firemen, Portuguese Red Cross institution and hospitals. INEM's mission is to organize, coordinate and evaluate the activities and operations of the SIEM in order to ensure the victims an effective healthcare.

Interviewing one of the INEM's executive, one of the strengths pointed out is the existence of efficient means for appropriate support from the SIEM such as modern software that displays the original location of the emergency call while another screen presents the defined itinerary with the optimum route for the ambulance.

As to weaknesses, there are several testimonials from users about the provision of emergency services, saying they often become ineffective. For example, despite having aircrafts for rescue in areas of difficult access, they often do not have permission to use them. Another case is the process of victim's assistance, which includes filling out a form by hand with personal data. After having ministered the service, the medical team carries out a manual entry of information about that service. Some errors have resulted from this process, due to discrepancies between those records or to confusion between terms because they do not understand the handwriting used. Therefore, it has been projected that SIEM will allow teams to meet those records through an electronic form. It is also proposed an automatic call-back process which will allow the return of an incoming call that was interrupted or lost due to any technical problem.

This analysis also overlooked possible threats: one is that the SIEM is facing a stream of false calls and another is some negligence in giving information on the phone putting a serious threat to service efficiency. Hence the commitment of SIEM workers is essential in all its services to develop a good integrated emergency care. Currently, the INEM subdivides its IS in two parts: operational and logistical. The logistical part covers the targeting of emergency vehicles to the required destination and also the areas of institutional storage and accounting.

One should note however that the main aim of this institute is to save lives. So, in the operational part, each emergency call handled by the emergency number (112) is forwarded to the Center for Urgent Patients' Orientation (CODU) where a summary action is generated from the collected data. After having it, this center sends an email to the SIEM which automatically sends an *sms* to the on duty healthcare team. On receiving it, as the *sms* refers to the car already established after a screening of the incident's level of urgency, the team develops its intervention with means available in the respective car from knowing already the severity of the accident. Current situation could be an impasse if the rescue team realizes whether the received information actually coincides with reality. What can often happen is an 'added supply' of an event making several cars travel to the local when in fact only one would suffice.

Importantly, the CODU, upon receiving the information about what happened, usually screens it with a clinical point of view which determines the kind of answer it gives to the situation. The function of CODU is not making diagnoses, but rather examining the signs of severity. This center aims at sensitizing the persons doing its services to be aware of false calls and other disturbing aspects. Users are recognizing a growing awareness and competence from call handling personnel. After first aid being ministered, the team completes a form concerning the incident along with a report of all the services provided. Today, the form is filled in the base unit supplementing the data already provided by the first phone contact. To improve the data flow, the system should allow such reports to be sent directly from the mobile units. That is, by means of a mobile system the team could send a report of any occurrence, at any place, in real time.

Recent reports show that the public is not sufficiently satisfied with INEM's services. They refer errors, delays, information incomplete and insensitive to the context. It should be noted that several improvements made through some new processes, have solved problems such as: lack of information, missed calls (forwarding them), retracing the set of medical teams (for its computerization) and breaks in the system

(the call is forwarded to a terminal that is available enabling a call to be answered by the CODU of another region). It is also worth mentioning that the SIEM is integrated with the communication system of the institute, including cars and mobile equipment that work in an integrated manner for enabling higher speed of response. However, there are major weaknesses on binding SIEM with various entities that cooperate with INEM in assisting victims of accident or sudden illness, such as the police services (PSP/GNR), the Portuguese Red Cross institution and medical units like health centers. This system requires then ubiquitous mechanisms, both mobile and pervasive, for allowing entry, selection and transmission of data in each context. The aim is, whenever the patient changes his location, to immediately get the services that best fit his needs and determine the resources required, including the position of professionals who are on duty nearby. This will contribute to turn medical practice more agile and dynamic across different related health entities.

4. Potential of mobile systems in healthcare

The economic relevance of IS continues to intensify and is normally the core of discussions on growth and performance, especially related with trends in the support technological systems and platforms can provide. For example, one relevant trend is the widespread use of global navigation system (GNSS). Its equipment gives an autonomous spatial position, which has become a local information ubiquitous element of new technological applications as time and position are important attributes of a service. The geographic information is quite valuable when combined with other data in models and diagnostic tools, allowing to filter/customize the information according to the position of the receiver at a given time. In turn, intelligent transport functions can provide data on trafficking in a given area to capture the existing professionals around the area. The GNSS is currently being used to coordinate multiple mobile platforms, which are especially useful and efficient in air traffic management, fleets of taxis, INEM services, etc. The combination of the potential of GNSS with information and communication technologies is becoming a key element of new IS infrastructures.

What emerges most in mobile platforms is their ubiquity which is an attribute that has to do with the critical role played by time in communications. In geographical scale and time-sensitive services, such as healthcare, their application is making the difference. Under the provision of rescue services, one of the potential of mobile systems is the controlled execution of activities in the field by creating processes that will resolve many problems related to the on time care rendered in the local. In order to ensure that packets of information (voice, text, video and image) are delivered in the correct sequence, it is important that the recipients of communication, physically distant, are properly synchronized. It is essential that the ubiquitous system provides mechanisms for selection and discovery of services that meet the aspects of the context and accurately reflects its constant changes.

The pervasive nature of ubiquitous technology and its growing practice have changed the way of conducting activities and interacting with stakeholders at various locations and using different systems. When it penetrates activities and institutions, many aspects of management and organizational structure change radically. The speed and extent of connectivity it allows enable the creation of new processes and improvement of the existing ones, some of which involve new risks and challenges. One of such challenges is related with the confidence or acceptance from people (professionals and users) of new equipment and ways to interact. Another challenge is to ensure data protection due to the interoperability of mobile platforms. There is also a need to ensure total privacy in such environments, facing the widespread manipulation and dissemination of critical information.

There are several ongoing projects on mobile systems in healthcare, seeking to integrate more and more ubiquitous, pervasive and mobile computing (Lupu *et al.*, 2008, Kim *et al.*, 2007, Lee *et al.* 2006). Some of these projects use RFID (Radio-Frequency Identification) technology for integrating local services into a system of healthcare by the intelligent recognition of the physical entities involved in the real context and their connection with the virtual objects in the digital system where the application is, allowing quicker reactions from the real world (Santos and Rossetti, 2009). For example, in the work of Lee *et al*. (2006), the RFID devices use personnel and logistics flows to identify bottlenecks in patient flow, which allow the application to analyze and improve the management of information for a patient. Other applications allow better control of hospital quality through their connection with monitors placed in patients' beds, enabling detection of closest health professionals to achieve greater accuracy in the distribution of treatments and medication through better access and navigation in the patients' schedules.

Figure 1 shows a model made available by the technical and functional development department of a company (*Algardata*), after an interview with one of its executives, which corresponds to an architecture with service-oriented middleware for dynamic environments such as ubiquitous ones. The purpose of this architecture when applied to the provision of healthcare is, whenever a particular user changes location, to select the services that best fit his needs in the context of that location and also to assist the management of the required resources and to monitor the professionals who are close. The increased use of Web service technology, implemented on today's GPRS or 3G mobile phones, along with the supporting middleware, adds new options for the mobile direction and context-sensitiveness of this kind of environments.

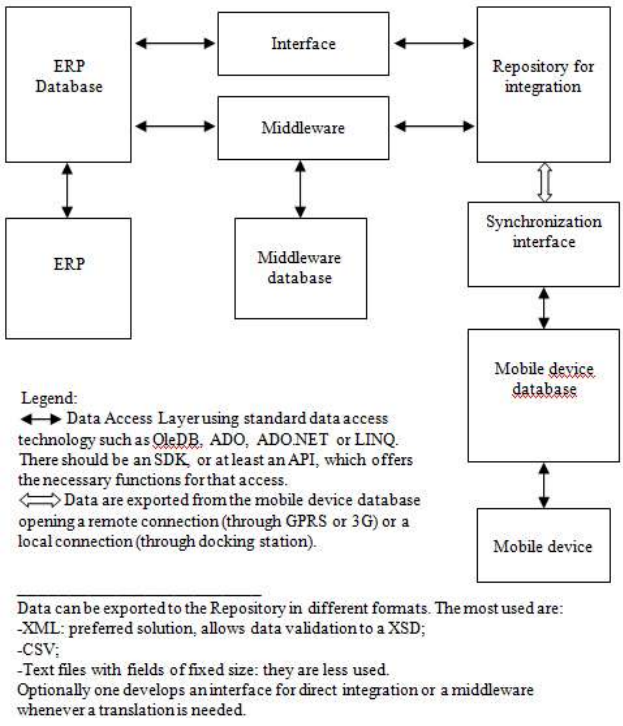

Figure 1. Model for integrating an information system and mobile devices for mobile platforms of action (source: technical and functional development department of *Algardata*)

5. Conclusion

Given the opportunities described here for information systems running on mobile and ubiquitous platforms, it is essential to set an early business plan and, in case of the need to support it with a mobile system, evaluate the results obtained within that plan on the basis of appropriateness between the mobile activities and organizational needs. The implementation of effective information systems involves planning and assigning personnel, skills and opportunities assessment along with the objectives pursued, as not all activities need to be supported by mobile operations.

The use of mobile platforms and its experience from several projects underway or others already achieved, explain the growth of these systems in healthcare as they are helping organizations, professionals and patients to enjoy better and faster services. This new paradigm of computing, initially discussed on a theoretical basis to which have contributed ontologies and other software engineering tools, is increasingly applied to new dynamically monitoring devices of resources and people in space becoming sensitive to their change and context. Hence they are adding value to existing healthcare systems through more comprehensive and targeted services.

INEM is an institution where the information system is quite important for the efficiency of organizational processes and activities. It is through it that the beginning of the process of rescue takes place. Its proper functioning is of great importance because it deals with human lives. Although it involves all direct and indirect mechanisms of an enterprise (whose main aim is profit), INEM requires respect for life and commitment of the teams involved in rescue. The middleware architecture presented before can serve as a basis for the development of the required functional ubiquitous modules.

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