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Mobile for emergencies M4EM: a cooperative software tool for emergency management operations

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Abstract

In serious emergencies, as in the case of floods and extreme weather conditions, where a substantial number of people are involved and over vast areas which may also involve different provinces, currently civil protection planning carries on emergency management operations within rigid schemes. A procedure that would be capable of handling events acquiring data continuously and developing real time solutions in a highly flexible manner has not yet been proposed.
This research focuses on how the systematization of information systems and communication processes can improve the management of emergencies caused by extreme weather and climate events. The objectives of improved service, levels of safety and sustainability of the intervention in emergencies would be obtained through a centralized decision support system.
The system and tools that are presented in this paper aim to respond to emergency issues dynamically responding to the dynamics of the events by taking advantage of an information system capable of sharing data, notifications, service orders, appeals for help, information on the status of the transport network and any other information.
The system would provide decision support by acquiring information from smartphones and other nomadic devices; it would so provide exchange of information in real time on one or more virtual platforms among stakeholders and between them and the citizens. Substantially, the system is based on smartphone applications coupled with a central management emergency Decision Support System specifically built to make best use of the possibilities offered by the latest telematics systems and cooperative web and phone-based tools.

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1. Introduction

In a disaster situation the role of the network infrastructures is of primary relevance in emergency management. When a disaster occurs, local and central government agencies as well as civil organizations should effectively mobilize their resources to rescue victims and to supply medical care, machinery, and relief commodities to the affected areas. In addition, some residents will be on the roads trying to evacuate the affected areas while others will try to reach the area to provide humanitarian aid and to help their relatives. As a result, transport network infrastructures play a crucial role in responding to a region's pre-disaster evacuation and post-disaster recovery.

It is commonly observed that a disaster may render some of the links of the transportation network non-functional, leading to the blockage of some routes and/or disconnectedness of some areas in need of aid. In the pre-disaster planning stage, it is important to assess the post-disaster performance of the network under possible disaster scenarios for the purpose of both strengthening the components of the network and for planning the post-disaster logistics activities.

Transportation and emergency services interact in a myriad of situations, ranging from routine traffic accidents to large-scale events that threaten public health and safety. In a large-scale event, where a substantial number of people and big areas are involved, civil protection is currently managing the emergency operations within rigid schemes. Furthermore, planning and coordination between local and central government agencies is now recognized as a critical factor during all phases of a disaster. A highly flexible procedure capable of responding to extreme events on transportation networks is needed.

Information systems (IS) have considerable potential in supporting communication and coordination for large-scale event management. IS facilitate the dissemination of real - time information among multiple stakeholders and provide various collaboration technologies and tools. As extensively discussed in OECD/ITF 2010 [1], information helps in rescheduling tasks and reduces the snowballing disruptions of schedules that otherwise might result from unreliability. Large-scale event management often requires individuals to act decisively and quickly, based on information from multiple parties. Thus, sharing and dissemination of information is critical for which reason IS are indispensable [2].

The proposed system (Mobile for Emergencies, M4EM) aims to respond to these issues by means of modern communication technology equipment and data transmission in the network (computers, smartphones, tablets, etc.). In an emergency, it would be capable of acquiring, validating, elaborating and sharing free detailed information about the status of the transport network and any other valuable information. The proposed system has the facility to provide users with exchange of real time information on the status of the transport network in addition to geo-referenced information, notification and data directly from those who appeal for help. Through the use of one or more virtual platforms, it would also provide exchange of real time information between stakeholders and between them and the citizens. In addition, the system organizes selective dissemination of information wherein the information is provided to users on the select topics of interest to the users, and from select sources of information.

2. M4EM and the reliability of the transportation network

The reliability of the transportation network is an important issue in disaster management since the re-establishment of a connected and usable transportation network is vital to allow emergency operators to reach and to operate in disaster affected areas.

Reliability of the transportation network is divided into: connectivity reliability, travel time reliability, and capacity reliability [3, 4, 5, 6, 7, 8, 9, 10].

The use of mobile devices such as smart phones in the hand of both emergency operators and common citizen can circulate information on the network status both from the point of view of connectivity and travel time. The main objective of the M4EM system is to handle the emergency management of catastrophic events by acquiring data continuously through citizen involvement with the use of new and existing technologies in a coordinated, cooperative, organized and shared way and then redistribute the data to emergency operators to enhance dynamically the response capacity to extreme weather and climate events.

The tools developed in M4EM offer solutions when a natural disaster, such as a flooding or wildfire, can change the geographic dynamics making available only a portion of the road and rail transport infrastructures. In flooding and extreme weather conditions the road system around the center of the affected area is likely to experience a short-

term collapse, while at the same time there is a considerable increase in the volume of traffic on major arteries in both inbound and outbound direction from the area affected by the disastrous event.

In large-scale emergencies there are a substantial number of people involved across extended areas which can include different local administration bodies, (as in the case of extreme weather conditions), and emergency staff often have to operate with rescue resources such as vehicles, equipment and human resources from multiple regions. Moreover additional resources may have to converge at different times in the intervention area, with emergency scenarios that are typically evolving dynamically.

M4EM mobile application module in this kind of road traffic scenario would both collect and disseminate information in real time. The mobile phone application can in fact collect satellite established positions of both citizen and helpers, transfer this information to the central system and after information elaboration give back information regarding the state of the transportation network and also give guidance to both citizens and helpers. Evacuation plans implementation, lifesaving operations and huge movements of people in emergency affected transportation networks would be greatly assisted by the system.

3. Emergency management

Network operations can be characterized by the involvement of many partners in the delivery of services. Different organizations are involved in road network operations depending on the network hierarchy, transport mode or the type of service. Therefore, effective road network operations require functional, organizational, and inter-jurisdictional coordination, cooperation, integration and interoperability within a geographic region [11]. The use Intelligent Transport Systems (ITS) can be useful for the purpose of both creating new strategies for network operations and for enhancing the existing strategies. ITS also ensure the widespread propagation of information to the citizens, administrations and the emergency management operators, thus allowing users to make informed travel decisions based on such factors that potentially impact on their travel time and safety.

The M4EM system is designed to focus on current operation allowing the management and control of movements of materials, goods and people in emergency zones. The M4EM system is also designed to cover the whole crisis from before it happens to when it is completely resolved allowing the coordination of responders by the use of specific adapted real-time cyber technologies that can help gain time and improve coordination in emergency situations.

The operational improvement will come from a more organized and better structured flow of information and also from the vast quantity of localized information that can be gathered by transforming the mobile devices of the citizens into smart monitoring and data gathering networks.

Logistic of materials and services for the emergency would be assisted by the informatics platform reaching every useful mobile device with the dedicated applications this would facilitate civil protection intervention and also reduce expenses and corruption by standardizing and controlling all important information.

4. System and sub-systems description

The proposed mobile phone app system aims to respond to the improving reliability of transport network and emergency management issues through the widespread propagation of information to the citizens, administrations and the emergency management operators. It would provide users with a tool for optimizing the collective response in case of emergencies and for planning the post-disaster logistics activities.

Post-disaster applications are associated with response and recovery efforts. Response is related to the immediate and short-term effects of a disaster, while recovery refers to activities that restore communities to pre-disaster conditions, such as reconstruction [12].

The system follows an idea of unification and integration of the emergency management services through an approach based on interoperable, modular and scalable solutions that are focused on the flow of information.

The system would be composed of three main subsystems:

1. The Decision Support System (DSS);
2. The mobile application;
3. The Web Platform.

The project is meant to define a reference strategy and the rules for a Decision Support System (DSS) for emergency management based on telematics applications with specific reference to info-mobility technologies and structured with a specific set of objectives.

As shown in Figure 1, the system would gather information and data from various sources. Once information is collected, it would be structured, enhanced, validated, user-related and updated within the system to be available when requested by the users. Operators and citizens become involved in the process of feeding information to the central database as well as users of the information. In fact, users would be able to access information gathered and generated by the community itself. This way exchange of real time information on one or more virtual platforms among stakeholders and between the emergency operators and the citizens is facilitated.

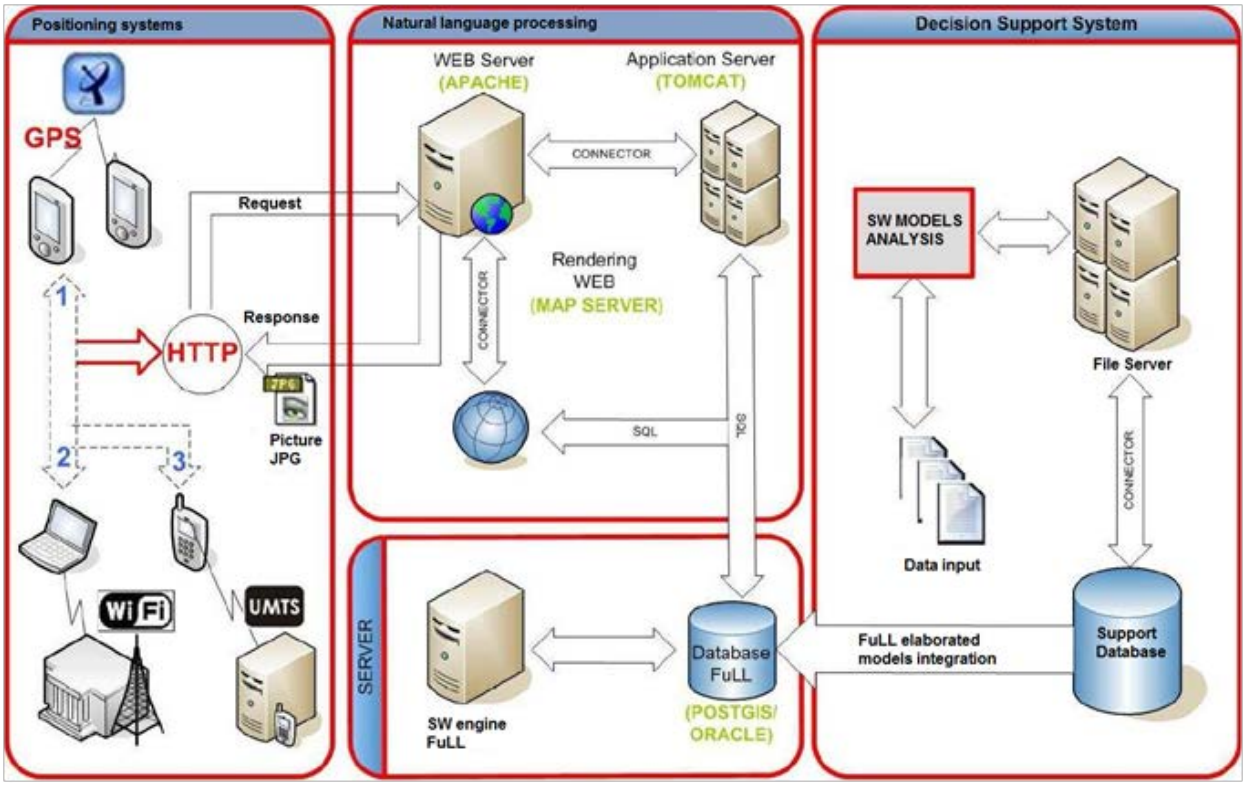

Fig. 1. Schematic platform architecture of M4EM.

The proposed mobile phone app system would integrate/store data from various sources. In fact, it is vital that better and more accurate information be incorporated so that the system can use its protocols to improve emergency solutions. Included data material are for example the presence of dangerous events for the community itself, citizens requests, GPS photo and georeferenced information reports, professional operators and vehicles real-time geolocation, the status of each segment of the road system, weather forecast, historical events information, etc. The basic idea is to involve citizens and specialized operators in gathering and exchanging information. In fact, through the use of a personal device, citizens and operators can inform other citizens, operators or managers on critical issues and on the status and on the quality of emergency management intervention. Through vehicle tracking and through the widespread geolocation of personal devices cell phones and smartphones can grow to be real monitoring stations making such information and data available to anyone who can provide a useful aid in emergency situations.

The decision model would be implemented with the help of software capable of collecting, delivering and sharing information for the purpose of continuous optimization both of rescue services and for planning and scheduling

assistance to the population in a system in constant evolution. The database of historical events can be analysed through an automated process. In addition, by querying the database of historical events, the platform would be able to recognize situations similar to that in progress. Through professional operators and vehicles real-time geolocation, the system would provide users with an optimized selection and management of the available capacities in terms of rescue/fire brigade vehicles/units. The processed information would help the work of different types of emergency management operators and public administrations involved.

The Decision Support System has to provide an exchange of real time information and data on one or more virtual platforms among stakeholders and between the emergency operators and the citizens. Therefore, the essential task of the system is to guarantee real-time communications and data transmission among users (citizens, first responders, emergency managers, etc.).

The proposed system involves the development of a mobile application coupled with a central emergency management Decision Support System (DSS) specifically built to make the best use of new possibilities offered by the latest information and telecommunications cooperative systems. It would be designed for mobile devices such as smartphones and tablet. The mobile application would allow users to transmit information, appropriately through one or more computing platforms making available such information, once it is properly processed, to the various levels of management and decision-makers and also available to citizens themselves and emergency workers. Static or dynamic information collected by the smartphones or from different relevant data sources is transmitted to a central database that becomes a tool capable of providing citizens themselves or emergency operators on the field with the processed information.

The web-based collaborative platform is characterized by high safety standards, interoperability and scalability. It would be able to connect operators, operating rooms, citizens and brigade rescuers, in a structured and safe way. In fact, it would ensure the analysis and sharing of data to multiple levels of management. In addition, it would give access to citizens. Citizens would access to the web platform for reporting, assistance and/or any kind of useful online service. The web platform allows the generation of a universally accessible channel of communication, from any interconnected device, ensuring interoperability of its modules while keeping the application logic completely decentralized.

5. Conclusions

The goal of the research is to present an information system, which would provide users with a tool for optimizing the collective response in case of emergencies and for planning the post-disaster logistics activities.

The submitted system follows an idea of unification and integration of the emergency management services and aims to reduce the information overload considering that data requirements vary in different user groups and in different scenarios. The mobile application would be customizable to different user groups and would allow users to create their own personal profiles. The web platform would provide different access to different forces involved in emergency operations (restricted areas) and also access to citizens.

Once deployed, the system would provide a reference strategy and the rules for a Decision Support System (DSS) for emergency management based on telematics applications with specific reference to info-mobility technologies and structured with a specific set of objectives. The strategy and the intervention capacity would be characterized by high flexibility and with the characteristic of involving citizens themselves in the process of feeding information to the central database.

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