A Study on the Usage of Smartphone Apps in Fire Scenarios
Comparison between GDACSmobile and SmartRescue Apps

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Abstract: In this paper, we present a thorough overview of the two recently developed applications in the field of emergency management. The applications titled GDACSmobile and SmartRescue are using mobile app and smartphone sensors as the main functionality respectively. Furthermore, we argue the differences and similarities of both applications and highlight their strengths and weaknesses. Finally, a critical scenario for fire emergency in a music festival is designed and the applicability of the features of each application in supporting the emergency management procedure is discussed. It is also argued how the aforementioned applications can support each other during emergencies and what the potential collaboration between them can be.

1 INTRODUCTION

By looking at the news or crisis mapping tools such as Ushahidi (Ushahidi, 2014), Twitcident (Twitcident, 2014), and Crisis Tracker (Tracker, 2014), this fact can be understood that crises are happening all around the world every day or even every hour. These crises or disasters can be man-made or natural. They can have impact on a limited area, national, regional, or international level. The aforementioned tools and many other existing applications developed in different countries prove the fact that the power of information technology is vastly assisting societies to prevent and handle disasters in the best possible way. An example is the vast use of Ushahidi platform in emergencies such as Haiti earthquake in 2010 and the attacks on Westgate Mall in Nairobi in 2014.

Mapping the hazard, getting an overview of what is happening during and after a disaster, and communication possibility among rescuers and victims are the most challenging and critical tasks in emergency management. Using smartphones and their newest technologies in one hand and using social media such as Twitter or Facebook on the other hand, have become the most practical sources and solutions to overcome these challenges.

For collecting desirable information and enabling a timely emergency management response, smartphones and their embedded sensors including, but not limited to accelerometer, gyroscope, barometer, humidity, and GPS have become extremely popular. Besides, social media is also one of the most common sources for real-time data from disaster-affected areas to disaster managers (Link et al., 2013). Among many social media sources, Twitter became a frontline candidate because of its status of being a "what's-happening-right-now"-tool (Bifet and Frank, 2010). These systems are used to reduce uncertainty caused by disasters.

In this paper, we focus on two crises management tools that authors had worked closely with during their research, i.e. GDACSmobile (GDACSmobile, 2014) and SmartRescue application (SmartRescue, 2014). The former is an information system that acts as a real-time multi-hazard platform using smartphones and Twitter. The latter is an application for both monitoring hazard developments and tracking victims during a disaster applying smartphone sensors and ad-hoc networking. The reason for selecting these two apps is that the authors had the opportunity to employ them both in their research and in a serious emergency game designed by ISCRAM summer school. This paper reviews both platforms in details and compares their functionalities and features and at last investigates potential collaboration of these two platforms within a designed scenario.

The remainder of this paper is structured as follows. Section 2 describes the literature review.

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Section 3 explains the two selected applications in details. In Section 4, the role of these apps in two emergency scenarios will be studied. Section 5 concludes the paper.

2 LITERATURE REVIEW

By the concern of disasters and the rapid improvements in technologies, governments of nations around the world are concentrating significantly on the use of different technologies in all aspects and phases of emergency management. Even though, most of the disasters have impact on a limited area or are in national level, other countries especially neighbouring ones involve in the emergency management activities.

A recent example of this motto is the cooperation of 26 nations in the massive international search for the Malaysia Airlines jetliner MH370 that disappeared on March 8 with 239 people on board in 2014. Therefore, most of the systems, platforms, or applications developed in order to be applied in disasters can cover a wide scale of an area. These systems involve many countries from different continents while there are some other systems that cover only a limited area such as a building.

There are hundreds of platforms with almost the same goals and concepts available in the market now. A literature review on some currently available emergency management platforms and tools is discussed in this section. These tools are carefully selected as they are the most related tools to our case studies.

In (Radianti et al., 2014) some of these emergency management platforms have been discussed and compared in details. About 16 Disaster and Crisis Apps for iPhone and iPad are also reviewed in (MissionMode, 2014). There is a long list of applications and projects with the concept of emergency management. These projects are such as DC HSEMA (DC.gov, 2014), FEMA (FEMA, 2014), ArcGIS for Emergency Management (ESRI, 2014). Besides, there are many researches (see, e.g., (Boloni et al., 2006; Lee et al., 2011; Tao et al., 2013)) on the best possible approaches such as agent-based, cloud computing, and GIS-based for developing disaster response applications.

As can be seen, most of these platforms function entirely or partly only when the Internet is available. Besides, some of them are able to cover just a limited area during a disaster. Therefore, the author chose two other useful applications to study and investigate in the next section. The first one is GDACSmobile and it is chosen as it covers disasters all around the world but is still reliable on Internet connection. The second one is SmartRescue application that it is working in the idea of ad-hoc networking (not yet implemented) but covers disasters happening in limited areas. In this paper, it is tried to investigate the possible collaboration of these two systems with their unique abilities for gaining the best possible solution in emergency management.

3 STUDIED APPLICATIONS

In this section, we study the two selected emergency management tools. Later in this section, we summarize the differences and similarities of both applications and their strengths and weaknesses in Table 1.

3.1 GDACSmobile

The GDACSmobile project is a collaborative work between the Information Systems Department of the University of Münster and the Joint Research Centre (JRC) of the European Commission with the aim to expand GDACS by community involvement.

The goals of GDACSmobile project are; increasing the quality of disseminated information using smartphone apps and Twitter, decreasing the uncertainty of the information received from Twitter using bounded-crowdsourcing, and using smartphones for information exchange/sharing and coordination support in the first phase after a major sudden-onset disaster.

To accomplish these goals, the GDACSmobile team implemented a mobile phone client application. The client app, primarily used for accessing content and sharing/updating information, is supported by a server application which is responsible for data retrieval, storage and analysis.

The resulting solution, “GDACSmobile” enables disaster management professionals and the affected population to share their observations from the affected area as “situation reports”, both via the GDACSmobile client application for mobile devices, and via Twitter. Via the client application, professionals and population can also receive situation reports that provide valuable information to their decision-making. GDACSmobile has been developed both as an application on smartphones and as a web-based application.

The GDACSmobile target groups, i.e. disaster management professionals (“authorized users”) and

affected population ("public users" or can be "authorized users"), share their observations from the disaster-affected area. Figure 1 shows how the information flow is handled in GDACSmobile system.

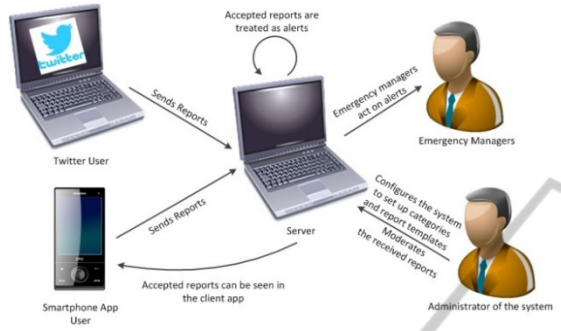

Figure 1: Simplified workflow of GDACSmobile.

3.2 SmartRescue

It has been developed in the Centre for Integrated Emergency Management (CIEM, 2015) at the Universitetet i Agder (UiA). The main idea of the SmartRescue is to use smartphone technology for assisting in a crisis, particularly in the acute phase, when victims are left to themselves but still need help, while delays occur in the evacuation process.

The SmartRescue project has several goals including but limited to: detecting and predicting hazard using advanced sensors in newer smartphones to help crisis managers and the public in acute crisis situations, mapping the threats and helping people in the evacuation process, constructing risk-minimizing evacuation plans, hindering congestion, and avoiding threats.

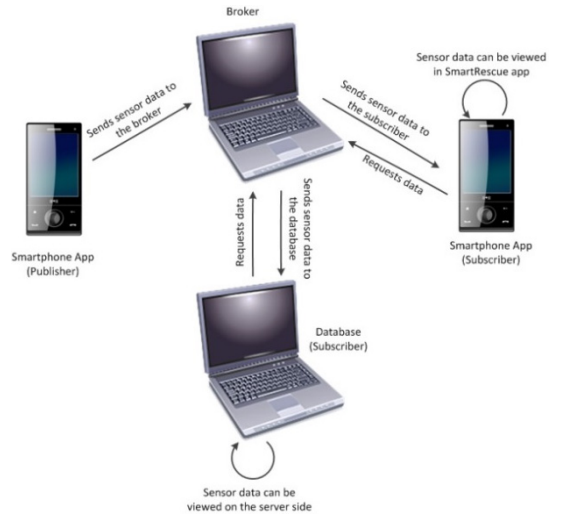

Figure 2: Simplified workflow of SmartRescue.

To achieve aforementioned goals of this project, a novel smartphone-based communication framework using machine learning techniques is proposed that intelligently process sensor readings into useful information for the crisis responders. Core to the framework is a robust content-based publish-subscribe mechanism that allows flexible sharing of sensor data and computation results. Figure 2 shows how the information flow is handled in SmartRescue system.

3.3 Comparison

Table 1 presents the similarities and differences of these two applications and highlights the strengths and weaknesses of both apps.

4 SmartRescue AND GDACSmobile IN PRACTICE

In this section, an emergency scenario is defined. This scenario is a fire happening in an open-area music festival with more than 3000 participants. The aim of having this scenario is to investigate how the aforementioned apps can work in practice and collaborate with each other in potential disasters.

4.1 Defining the Scenario: Fire in a Music Festival

Few participants of the music festival have noted the fire in the corner of the music festival location. They have called the emergency service (110) and informed them about the fire. Fire responders note down the information regarding callers' ID, location, and the emergency type. Based on the received information, fire responder alerts other emergency services like police and ambulance staff and decides how many staff and resources have to go to the emergency location. When the fire service responders arrive at the scene, first they try to find out the fire location, its condition, and number of victims. If they find out that there are any participants trapped in or near the fire, they try to evacuate them. If the fire is steadily spreading over the other parts of the site and is difficult to extinguish, then the fire responders consider this incident as an emergency and ask other fire responders to join and assist them in extinguishing fire and evacuating people. Emergency responders from other services like police and ambulance staff will also reach the site.

Table 1: A comparison between GDACSmobile and SmartRescue apps.

GDACSmobile	SmartRescue
Planned for weeks after the disaster	Planned for first hours after the disaster
Has a smartphone application and a web-based server	Has a smartphone application and a web-based server
Stores data in the phone when it is offline and transfers data to the server when it is online.	The publisher loses the data when network connection is not available. Broker buffers data in the phone/server when it is offline and transfers data to the subscriber when it is online.
It is for large-scale disasters e.g. for national or international level	It is for small-scale disasters e.g. inside building, ships or limited areas
Uses bounded-crowdsourcing (Meier, 2013) for data collection	Uses crowdsourcing for data collection
Uses tweets, registered users, and public users for bounded-crowdsourcing	Uses sensors for crowdsourcing
Helps and supports decision making of the disaster managers, rescue members, and victims	Helps and supports decision making of the disaster managers, rescue members, and victims
The smartphone app (client app) needs human-computer (phone) interactions as smartphone users should use the app for reporting.	The smartphone app requires very limited human-computer (phone) interactions, users only need to turn on the "Wi-Fi" and choose to be a "subscriber" and/or a "publisher" by a simple click.
In the smartphone app, the user can be an authorized (registered) user or a public user. Public users do not have access to all the features available on the client app.	In the smartphone app, there is no registration needed, everyone who has installed the app can use all the features of the app.
In the web-based server, the user can be either an admin or a registered user.	In the web-based server, the admin has the control of the systems.
Supports iOS and Android operating systems.	Supports Android operating systems.
The smartphone app needs the Internet connection only.	The smartphone app works with any wireless networks.

After their arrival, police is in charge of the location and the site. Police acts as the commander at the site and he takes all the decisions. Police will make sure that all risk areas of the site are accessible by emergency vehicles. They implement plans to remove vehicles blocking emergency routes. Police will appoint an on-scene commander to communicate with the command and control room. In command and control room, a group from all emergency response organizations such as police, fire, ambulance, media, priest, and mayor will be formed to take decisions at off-site. Command and control room will get the required information from the on-scene commander about the situation at the site. Participants of the festival will be evacuated by emergency responders. Ambulance service emergency responders help participants who are suffering with semi or full burns. They apply the first aid and shift them to the nearest hospital for the further treatments and then report the cases. If any deaths are noticed by participants they inform to the emergency responders.

4.2 Utilizing GDACSmobile in the Scenario

As mentioned earlier, the GDACSmobile app can be used by both emergency management professionals as well as participants for reporting emergency situation and collecting information (via text and image) both in offline and online mode. In the above described scenario, all the participants can report and collect data using the client app or Twitter. The detailed description of the employment of the GDACSmobile app is described for both emergency site as well as coordination (command and control room) centre.

4.2.1 Employing GDACSmobile at the Emergency Site

A public user means nothing but participants of the music festival. When the participants of the music festival or other people near by the music festival note that there is a fire emergency, they can start using GDACSmobile app or their Twitter account to report about the emergency situation by sending messages with text and image. For example, they can share their location in the emergency site with directions in form of text or else they could take the picture of the location. This information is received by the emergency responders in order to help the victims. When participants use the app, they can send message as public users to get help or to report about the situation. It is worth mentioning that by using tweets for information sharing, they have to use hash-tags. These hash-tags are used for categorizing the information, for example, location of the fire, logistics needed for helping the people, and so on. Victims of the emergency can view the other submitted reports as a list or on the map when the administrator makes the reports available. With the available reports, participants as well as emergency responders can get the overview of the

situation by viewing the map. Reports coming from authorized (registered) users are accepted by default. These reports are used for evacuating and helping the victims of the music festival.

4.2.2 Employing GDACSmobile at the On-scene Coordination Centre

When the reports are submitted by both participants and emergency responders through GDACSmobile app or through Twitter, administrator (on-scene commander) views and moderates the reports (public accept, accept, reject, and not evaluated). Alerts are appointed to any accepted reports. So the on-scene commander uses these alerts to assign the tasks to the corresponding responders. Authorized users can send messages like "where they are and what they need for what". Administrator can have the chance to add extra information such as description and comment on the available reports. By using GDACSmobile app, emergency responders can use the emergency related data to get the overview of the situation as well as to help the victims by alerting the public via Twitter or the client app.

4.3 Utilizing SmartRescue in the Scenario

As mentioned earlier, the SmartRescue app can be used by both emergency management professionals and participants. This app is mainly used for publishing to and subscribing for the information and getting overview of the emergency situation. In the described scenario, all the participants and emergency responders can report and collect data by using the smartphone app. The detailed description of the app usage is described for both the emergency site and the coordination centre.

4.3.1 Employing SmartRescue at the Emergency Site

In order to use this app, participants of the music festival should have this app installed in their smartphones before the festival starts. So they can send the information to the emergency responders when the fire happens. When fire is noticed and informed, emergency responders will go to the emergency site. Right after reaching the site, emergency responders start using the SmartRescue app. Either emergency responders, firefighter, police, or health staff can act as either publisher (to send information) or subscriber (to receive information). When participants act as publisher, they publish data gathered from sensors.

This published data is available for the responders as subscribers. Using the smartphone sensors of the people inside the fire location, the app can deduce how close they are to the fire and how is the status of the fire nearby them. They will also know if the participant is moving or not, or they can check the humidity and the pressure of that area by the data publishing from the smartphone sensors. This generates a global or a local picture of the fire. Using this picture, the app can also predict how the fire is going to develop in the near future using Bayesian networks approach. This supports firefighters in making decisions and plans about extinguishing fire, evacuation routes and so on.

4.3.2 Employing SmartRescue at the On-scene Coordination Centre

At on-site coordination center, on-site commander will be in lead. SmartRescue mobile app will be used by him in order to get the overview of the emergency situation. When the participants and emergency responders in the scene act as publishers, then the on-scene commander can receive the published information. Based on the publishers' mobile phone sensors, on-scene commander can know the position of the victims and rescuers (firefighters) as well as the severity of the fire. The received information and the ability of SmartRescue app in predicting fire condition will support him/her in making decisions. They can also make required decisions easier in the on-scene coordination center while they can get the overview of the situation real-time and with no extra intermediate.

4.4 Possible Collaboration

As mentioned above, GDACSmobile works with the Twitter and smartphone app and the other one, SmartRescue, works with smartphone app and its embedded sensors. GDACSmobile is for reporting and receiving the emergency information while SmartRescue is not only for reporting and receiving emergency information but also for predicting the growth of the fire.

In our designed scenario, fire in a music festival, the felexibility of SmartRescue and its ability to work with the least possible human-interaction comparing to GDACSmobile app can significantly help participants trapped, injured, or suffering from panic attack, as they do not have to be engaged with their smartphones. On the other hand, the reporting system in GDACSmobile allows users to send detailed reports about different catagories such as

health, logistics, and food using text and image. Participants can send images of the situation with their location to the server.

Social media is another aspect that is not covered in SmartRescue, so it can be supported through GDACSmobile. Participants can tweet their situation or what they have witnessed during the emergency. This information can be used by emergency responers during the emergency or after that.

If both apps collaborate, then the emergencies will be handled very efficiently as both social media and sensors can be used for threat mapping. Besides, interaction and communication between those that are involved in the crises will be done faster and smoother if both applications are integrated. This allows a better understanding of the situation and a more efficient reaction to crises due to the integration of an intelligent system that achieves information from smartphones and social media.

5 CONCLUSIONS

This paper studied two emergency management tools that are developed in two universities in Norway and Germany. The information and work flow of the apps and a comprehensive comparison of the features of them were presented. Then the role of the apps in a proposed emergency scenario was discussed. Finally the potential collaboration of the apps in an emergency situation was argued. It is proposed to use both systems in drills and games to study the potential collaboration between them and how they can support each other during a real crisis. This also helps the developers to improve the weaknesses and lacks of both apps.

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