Location-Based Services for Emergency Management:
A Multi-Stakeholder Perspective

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Abstract— **This paper investigates the deployment of location-based services for nationwide emergency management by focusing on the perspectives of two stakeholders, government and end-users, in the cellular mobile phone value chain. The data collected for the study came from a single in-depth interview and open comments in a preliminary end-user survey. The themes presented have been categorised using a qualitative analysis. The findings indicate that although governments and end-users believe that location-based services have the potential to aid people in emergencies, there are several major disagreements over the proposed deployment. This paper is an attempt to help determine the underlying motivations and impediments that would influence the decisions of both stakeholders and also towards providing a better understanding of the anticipated role of each party in such a deployment.**

Keywords: location-based services, emergency management, public warning, all-hazards approach, privacy, cellular mobile phone.

I. INTRODUCTION

Location-based services (LBS) are a set of applications and technologies that take into account the geographic position of a given cellular mobile device and provide the device user with value added information based on the derived location data [1]. The conventional use of LBS in emergencies is to find the almost pinpoint geographical location of a cellular handset after a distress phone call or a short message service (SMS). The services have been recently exploited, to some extent, in several countries to complement the existing traditional emergency channels (e.g. sirens, radio, television, landline telephones, and internet) as a means to communicate and disseminate time-critical safety information to all active cellular handsets about unfolding events, even post the aftermath, if the handsets are in the vicinity of a pre-defined threat zone(s) [2]. LBS applications have shown the potential to be a valuable addition in emergency management (EM), particularly, when they are utilised under an all-hazards approach by the interested government agencies.

This paper investigates the perspectives of two pivotal stakeholders in the LBS value chain, namely the prospective user and the government, about the use of the services for the purposes of EM and public warning. The investigation is expected to provide an understanding about the perceived benefits, impediments and concerns of utilising the services into relatively new contexts, and also to shed some light on the expected role of both key players in any feasible future solution. Accordingly, this paper is among the first to examine the potential dynamics between LBS stakeholders, specifically, in the realm of emergencies.

II. METHODOLOGY

This research was conducted using two methods of data collection. The first method was to use a traditional paper survey. Six hundred surveys were randomly distributed by hand to mailboxes in the city of Wollongong, New South Wales, Australia, in November, 2008. Although, this traditional approach is costly, time-consuming and demands a lot of physical effort, it was favoured as it is more resilient to social desirability effects [3] where respondents may reply in a way they think it is more socially appropriate [4]. Beside a basic introduction of location-based services and emergency management, the survey provided the participants with four vignettes; each depicting a hypothetical scenario about the possible uses of LBS applications for managing potential hazardous situations. The scenarios cover specific related topics to emergencies such as an impending natural event, a situation where a person is particularly in need of help, and a national security issue. Two of the vignettes were designed to present location-based services in a favourable light, and the other two vignettes were designed to draw out the potential pitfalls. Through the use of vignettes, participants were encouraged to project their true perceptions about LBS while, at the same time, involved with creating a meaning related to the potential use of the services in extreme events. This was highly important to establish among participants before starting to obtain informed responses from them, especially, when the utilisation of location-based services in the realm of emergency management is still in its nascent stages worldwide.

The survey which predominantly yielded quantitative results also included one open-ended question in order to solicit written responses from the participants. Despite the fact that only 14 respondents wrote hand-written comments, it should be noted that the primary goal of the open-ended question technique was to understand the solution as

perceived by the respondents and not to aggregate their responses for any quantitative representation. Therefore, the number of written responses was sufficient to fulfil the requirements of the content analysis.

The second method was to use a semi-structural interview. The interview was conducted with an official from a leading government emergency services department in Australia. The interview was conducted in November, 2008. The main objectives of performing the interview were to:

1. Explore the government's perspective regarding the various LBS technologies being considered for emergency management.
2. Define the potential role of the government in any nationwide feasible LBS-dependent solution.
3. Gain an understanding of the potential impediments, if any, to the government's decision for adopting location-based services solutions.
4. Investigate the government's understanding and position on matters pertaining to information control and privacy concerns, in relation to nationwide deployments of location-based services in emergency management.

The initial focus was to get an understanding of the similarities and differences in opinions, attitudes and sentiments of individual survey participants. Once that was done, a constructed list of extracted unique keywords was generated and then used to combine the points of view thematically. The same list was also used in the discovery of comparable themes within the interview data. This helped to ensure that the discovered themes from both methods are grounded in specific contexts related to the research being conducted [5].

The themes are presented in two sections by stakeholder type: i) the prospective user, and ii) the government. A discussion is then made based on a cross-theme analysis of the two stakeholders.

III. THE PROSPECTIVE USER

The individuals' willingness to accept LBS technologies and applications could, essentially, determine the likelihood for success in the introduction of LBS solutions for emergency management. This research discerned the need to directly elicit peoples' opinions about the consequences of such an introduction in order to have a preliminary understanding and feel for the concerns and issues prospective users might have before the actual deployment of emergency management solutions using location-based services. The following extracted themes have been categorised based on a qualitative analysis of respondents open comments.

A. The role of the government as perceived by the prospective user

The government is perceived to have a multidisciplinary role that includes provisioning, funding, maintaining, and regulating services related to civil society. Technologies like location-based services have the potential to serve the public, and their adoption and development should be highly advocated among strategic decision-making circles. With respect to LBS offerings, strict legislation should also be introduced by the government to explicitly define the legal liability, for example, in the case of a service failure, or information disclosure accidentally or deliberately.

B. Privacy concerns

In the context of LBS, privacy in the government context mainly relates to the personal locational information of individual citizens and the degree of control in which a government can exercise over that information. Such information is regarded highly sensitive, so much so, that when collected over a period of time inferences about a person could be generally made [6]. Accordingly, privacy concerns may originate when individuals become uncomfortable with the collection of their location information, the idea of its perennial availability to other parties, or the belief that they have incomplete control over that collection.

The traditional commercial uses of LBS have long raised concerns about the privacy of the users' location information [7]. The same issues arise within the context of emergencies. Survey respondents expressed genuine concerns about the possibility of being tracked constantly even during an emergency. This specific note is quite interesting to mention as it raises again the argument of whether or not individuals are willing to relinquish their privacy for the sake of continuous safety and personal security [8]. Another concern expressed was that location information could be used for other purposes besides a given emergency context. Such unauthorised secondary use of the collected information has been discerned in the literature as one of the main privacy concerns that also include excessive location data collection, errors in storage and improper access of the collected data [9]. The last concern conveyed by respondents was that information could be gradually spread or shared with third parties, who are not pertinent to the government's emergency organisations, without explicit consent from the LBS user.

C. The price of the services

Some respondents perceived the price of location-based services to be expensive, especially in the context of emergency management. One respondent was adamant that they would not be willing to pay in exchange for using location-based services in an emergency, believing it was a public right. This may suggest that the usage context may have little to do with impacting an individual's decision to use location-based services. Nonetheless, a more rational explanation is that respondents may have a lack of awareness and appreciation of the associated benefits.

In general, the comments suggested that the fees should be borne by the government through the allocation of taxes gathered from the working population, to cover the costs of providing and maintaining vital civic services.

D. *Assurance of control mechanisims*

One emphasis in the respondents' comments was the need to assure the prospective user's control over who would collect the information, how the location information would be collected, who would have access to that information, where the information would be stored and for how long, and what information would be kept after the occurrence of an emergency incident. For example, it is envisaged that such data would be extremely vital in coronial inquests post natural or human-made disasters. In the state of New South Wales, in Australia, for instance, coroners are exempt from privacy laws and can legitimately gain access to medical records, financial transaction data and even telecommunications records. As a result, a need to create safeguards to protect users' right to control their personal location information was profound among respondents.

Zweig and Webster [10] argued that individuals would accept a new technology, if they perceived to have more control over their personal information. Therefore, an important issue concerns the potential use of location-based services in emergencies, is how the users perceive the most dependable safeguard that is capable of protecting their location information, thus alleviating any concerns they might have to begin with.

Xu and Teo [11] have defined several control mechanisms in order to alleviate similar concerns. One mechanism is the technology self-based assurance of control, which refers to the ability of the LBS user to exercise a direct control over his/her location information via the technical features of the LBS device. For example, a user can determine when to opt-in or to opt-out from a service or can define the preferred accuracy level to which the solution provider is able to track his/her handset. This has been expressed in one of the respondent's suggestions of having some technical features in the handheld device itself in order to be able to "switch on/switch off" the location-based service anytime.

Another assurance of control is a mechanism that is institution-based via legislation. In this case, relevant government laws and regulations exist within the legal system to ensure the proper access and use of the personal locational information [11]. Forces in power (i.e. in this context, government agencies tasked with emergency response) could exercise proxy control over the location information on behalf of the user in the case of an emergency. However, the control should be safeguarded by the assurance that unauthorised behaviours will be deterred through the legal system in use. One respondent actually advocated the idea of introducing explicit relevant legislation, before presenting the services to the public, as it would provide powerful and foolproof safeguards for protecting users' control over their private information.

E. *The usefulness of the services*

The frequency of emergencies and natural and human-made disasters, and the highly unanticipated nature of such extreme events present opportunities for initiatives based on LBS solutions as a promising and a valuable addition to the existing utilised approaches for managing all identifiable hazards and their possible aftermaths. However, for any initiative proposed usefulness is a principle reference point for judging its suitability to people. If people do not perceive any usefulness behind LBS for emergencies, then it is most likely that they would not consider the use of the services. The comments from the respondents overwhelmingly perceived LBS to be highly useful in emergency situations. One suggestion is that the technology should be utilised for emergency purposes only as their usefulness in such situations far outweigh any privacy concerns they might raise. However, most of the respondents perceived a potential for LBS to be utilised as an important medium to assist communities in emergencies beside their obvious practical possibilities for commercial application as well.

IV. THE GOVERNMENT

Former worldwide experiences have clearly revealed the indispensable role of the government in emergencies since only governments usually have the capabilities to fund and control the financial, human and technical resources needed to managing such situations. As a result, it could be argued that the realisation of a consistent LBS solution for emergency management would be highly conditional upon perceiving the government as the main stakeholder and as a proponent of the services. The following extracted themes represent a "framework of meanings" elicited from the interviewee. The interviewee is an official from a leading emergency services government department in Australia.

A. *The role of the prospective user as perceived by the government*

Being the focus of the LBS solution, an expected role of the prospective citizen user will not only to be as a mere recipient of the warning message sent by the government but also as the initial point of safety information to others as well. The recipients would have the responsibility to act and convey the warning message to the people who are effectively within their care at the time of the event (e.g. the elderly, the children, the disabled, and the sick). Another example could be a manager of a shopping centre where there is a potential for a large gathering of people in one place, and that place of interest is within the defined emergency area.

B. *Where does LBS fit among the exisiting emergency management solutions?*

The European Telecommunications Standards Institute (ETSI) has defined two types of location-based emergency service applications [12]. The first is initiated by the individual in the form of a distress mobile phone call or SMS. In these cases, the telecommunications carriers are obliged to provide information regarding the location of the originated call or message within accuracies between 50 to 150 metres. This service is known as wireless E911 in the United States and E112 in the European Union. The second

type of LBS applications are initiated by the solution provider in which alerts, notifications, or early public warnings are disseminated (pushed) to all active handsets, which are within a predefined threat area(s) at the time of the unfolding event.

From a governmental perspective, both approaches (i.e. the emergency phone call/SMS and the LBS warning system) are only two ends of the same spectrum. As a result, LBS solutions for public warning are perceived as an additional extension of the existing emergency and warning systems. Accordingly, the same organisations and agencies handling the conventional inbound emergency phone calls should be assigned the responsibility of handling the LBS emergency public warning system.

C. *The perceived benefits of LBS for EM*

Location-based services have the potential to act as the primary source of safety information. They can also be utilised to point people in the direction of other safety information channels. The messages delivered through the LBS solution could be the initial warning the public receive if they are within the area that is likely to be affected at that time. Once the message is received, people could then turn into other forms of media, such as television or the radio, for more information.

Through providing people with early safety information, the LBS solution may have the potential to save lives by allowing the individuals to make more informed decisions; thus putting them into a safer position. It should be noted here however that even with such powerful applications, it is government policy during emergencies such as bushfires that still override the capabilities of the new technologies. A technology may be fully functional however, the stance taken by government on what to communicate during a disaster may not be effective or even plausible.

Despite the possibilities, the fact that the cellular handsets are the most prevalent among individuals makes the LBS solutions highly valuable in emergencies. Moreover, contrary to other forms of media, LBS do not require the individual to be anchored to a device in order to receive the information. A warning message could reach all the active handsets within the threat zone, allowing people to understand that something is unfolding around them.

D. *The cost of the LBS solution*

As every individual has the right to be advised by the government in the case of an unsafe situation, the funding of any possible LBS solution would basically lie on the shoulders of federal and state governments. Due to the specific nature of the solution, it could not be financed through any kind of advertising or sponsoring. The cost will, essentially, depend on the final form of the solution. However, a possible impediment for the government's decision to adopt LBS for emergencies could be the cost-per-message delivered. As every message being delivered theoretically represents a commensurate revenue expectation for telecommunications carriers, long-term partnership arrangement and agreements between carriers and the government, early involvement of the carriers as a major stakeholder could partially answer the cost burden of the solution. Nevertheless, the solution will primarily rely on the practices of the telecommunications carriers and their willingness to extensively share their resources in emergencies with the government. The buy-in of carriers, especially incumbents cannot be overstated, although traditionally carriers have complied with government mandates that have been concerned with the greater good of society.

E. *Privacy concerns*

Due to the fact that any achievable location-based emergency warning system is meant to be only used for public safety, the privacy associated with it should not be a major issue. LBS public warning solutions are perceived as one end of a spectrum that includes the traditional emergency response services number on the other end. The same organisations will be handling the information from both systems. The sole purpose will be to identify the handset number within the emergency area at the time of the event. The number is perhaps the only mechanism by which a notification could reach the handset if the user is in an imminently dangerous situation.

Any proposed solution could neither be an opt-in nor an opt-out system. If individuals opt-out and did not receive the warning message, and then the unfortunate event occurred where they lost their lives, it would not be well received by the public. The message is provided as a means of maintaining the safety of all individuals that are within the likely affected area. Accordingly, prior consent from the prospective user will not be a prerequisite for initiating the service directly to him/her.

V. DISCUSSION

An examination of the themes presented reveals an agreement between both stakeholders on the potential benefits of location-based services for emergency management. There is also a consensus that the solution should be funded by the government and regulated, operated and maintained by related government emergency organisations. However, a comparative analysis of the extracted themes shows several disagreements between the two stakeholder types. For example, although there was recognition of the indispensable expected role of the private sector, the prospective users expressed concerns that the telecommunications carriers may view the utilisation of the services in the domain of emergencies as a chance to raise revenue rather than being for the public interest, resulting in unsolicited commercial-based services. Other differences such as the need to address the privacy concerns and some of the design features of the recommended system have also appeared. The analysis is presented in Table 1.

TABLE 1: A COMPARATIVE ANALYSIS OF THE PERSPECTIVES OF THE STAKEHOLDERS

The perspective	The government	The prospective user
The role of the telecommunications carriers	Carriers are indispensable partners who must be involved as early as possible in any LBS initiative for EM.	Although the carriers' role is perceived as indispensable, there are fears that the companies would allocate minimal resources towards these public safety services unless there was a chance for earning premium tariffs and subsequent revenue.
Privacy concerns	Since the LBS solutions are meant to be only used for public safety, the privacy associated with them should not be an issue.	There is the potential of misusing location information. Inferences about the identity of the individual could be made from the information at hand. The same technology could be used by other government organisations (e.g. security intelligence organisations) to "track" specific individuals.
The consent of the user	As the message is provided for safety purposes, the prior consent is not a prerequisite for initiating the service.	As there are some concerns that the user could be "tracked", a prior consent, registration, or a subscription is essential to receive the service.
Marketing and advertisements	The LBS warning system is purely for public safety, no advertisement-related issues will arise.	Since every warning message going to a cellular handset represents possible revenue to the telecommunications carriers, there are concerns that the carriers would utilise comparable services for market solicitation purposes.
The design of the system	Could neither be an opt-in nor an opt-out system.	Has to be an opt-in/opt-out system to completely guarantee the privacy of the individual.
The cost/price of the system	All of the costs and the funding of the solution would be supported by the local, state and federal governments.	The price of the services provided should be borne by the government.

Technologies such as LBS have the potential to serve the public. Therefore, the adoption and the development of such technologies should be highly advocated in the higher decision-making political circles. Initiatives to involve the private sector early in the proposition of location-based services in emergency situations need to be instituted. For example, consider the Warning, Alerts, and Response Network (WARN) Act in the United States, which encourages telecommunications carriers to participate in government warning systems used to target a broad variety of media including cellular mobile phones. The act, specifically, obligates the carriers who do not wish to participate to clearly indicate it to their potential users at the point of sale [13]. In addition, strict legislation should also be put in place to explicitly define the legal liability, for example, in the case of a service failure, or information disclosure accidentally or deliberately.

As the deployment of the proposed solution could be hindered by the misconceptions people might have about the misuse of the technologies, some of the earlier differences could be partially solved by underpinning the possible deployment with a substantial educational campaign about location-based services, their limitations and their potential benefits.

VI. CONCLUSION

The paper investigated the perspectives of two pivotal stakeholders in the cellular mobile phone location-based services, namely the government and the prospective user, concerning emergency management solutions. The findings indicate that despite the general agreement of the massive potential of location-based solutions in emergency management, both key players have differed considerably on some of the issues raised such as the design of system and the need to address privacy concerns. A general consensus among the stakeholders is that location-based services is an important tool for disseminating relevant customised warning and safety information to people during and after emergency crises. Utilising LBS technologies could have the potential to allow people to make more informed decisions, leading them potentially into a position of safety, which will ultimately create a more resilient society towards the onslaught of extreme and unexpected events.

ACKNOWLEDGMENT

This research was supported under Australian Research Council's Discovery Projects funding scheme (project DP0881191). The views expressed herein are those of the authors and are not necessarily those of the Australian Research Council.

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