EDIT Your Emergency: Communication Preparedness using Emergency Description Information Technology

Research-in-Progress

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Abstract

This research-in-progress explores the capability of intelligent expert systems to guide victims or witnesses of emergency events with the collection and communication essential of safety data. Specifically, this paper utilizes a design-science approach to investigate data collection related to automobile accidents in order to provide an appropriate and timely emergency response. Furthermore, this paper examines current information collection workflows and emergency responder dispatch criteria. These are examined and optimized to improve both data collection accuracy and timeliness using mobile device applications. A process model for conducting analyses for additional emergency response processes and the development of a system that ensures the successful collection of critical information from witnesses and victims is presented. Such a system could be expanded for many traditional emergency incidents as well as collection and reporting industry-specific emergency events as found in the military, logistics and aviation sectors. Along with the initial findings, future research directions are presented and discussed.

Keywords

e-gov, egov, e-government, design science

Introduction

Denver, Colorado, a city with over 634,000 U.S. citizens, has an emergency-communications operator and police dispatcher network with a failure rate of one-in-every-five emergency calls as reported in the last two years. These dispatchers failed to meet the department’s time standards more than 1,070 times and kept callers on a wait time that was ranked “unnecessary”. Additionally, addresses of incidents have been misreported or resulted in wrongfully dispatched personnel, crucial scene information was never received, and dispatcher mistakes even have led to at least one wrongful death lawsuit due to a failure “to supervise and train its emergency-communications operators and police dispatchers (Osher, 2013).” Such concerns are not unique to Denver and impact emergency call centers globally.

According to the National Emergency Number Association (NENA), there are over 6,000 public-safety answering points (PSAP) in the United States alone (NENA, 2014). The collected information benefits not only the victims but also the first responders. Even with that many available locations, those collecting the required information that benefits not only the victims but also the first responders often times do not properly acquire it due to background noise, poor connections, or emotional callers.

The purpose of this research is to conceptualize, design and test a mobile expert system to prepare those who report an emergency for efficient communications with emergency dispatchers. Such a tool would align with global initiatives of modernizing government services to better align with contemporary technologies. Surprisingly, the information systems scholarship and more specifically eGovernment research has largely avoided addressing this important component of reporting, collecting and disseminating emergency information. For example, between 2003 and 2013, the ‘basket of eight’ top
information systems journals address this issue in only six relevant studies (Venkatesh 2013). See Table 1 for more information on these studies.

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<thead>
<tr>
<th>Journal</th>
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<tr>
<td>Information Systems Journal</td>
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<td>Information Systems Research</td>
<td>Yang, Su, and Yuan, 2012</td>
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<td>Journal of AIS</td>
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<td>Journal of Information Technology</td>
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<td>Journal of MIS</td>
<td>Fruhling and Vreede, 2006; Xu, Teo, and Agarwal, 2009</td>
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<td>Journal of Strategic Information Systems</td>
<td>Boonstra, Broekhuis, Offenbeck, and Wortmann, 2011; Leidner, 2009</td>
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<td>MIS Quarterly</td>
<td>Chen, Sharman, Roa, and Upadhyaya, 2013</td>
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Table 1. References to ‘emergency’ services in top IS journals based on AIS senior scholars’ rankings between 2003 and 2013

This paper addresses this research gap by evaluating key requirements for a mobile application that can optimize the sharing of emergency information with local emergency response resources, as well as developing a prototype of such an application. An understanding of how individuals can benefit from an intelligent system to ensure collection and communication of accurate data in an emergency situation provides a unique exploration opportunity for the IS scholarship. For instance, while numerous safety data-sharing systems exist, the greatest benefit can only be achieved if accurate information is collected. Other examples of how such a system can be deployed include safety-reporting systems in information technology, construction, manufacturing, logistics and aviation. Furthermore, such a system can be integrated with other eGovernment initiatives that address improved emergency resource dispatching and citizen communications.

This paper investigates how information technology can be leveraged to optimize the reporting of an emergency. Example research questions include, can a mobile expert system guide witnesses or victims of an auto accident to report necessary information more efficiently than by placing telephone calls? Also, can the responses to these questions be optimized to allow dispatchers to make better-informed decisions and allocate resources more effectively?

The first phase of this research project involved the application of a design science approach to discern the key information required by emergency dispatchers. This data was gathered through an open-ended questionnaire asking emergency services dispatchers about the four to five information items that are required to successfully dispatch appropriate personnel. Contacts for this phase of the study were solicited via e-mail from addresses found via Google searches of county and municipal emergency services, as well as posting the question to emergency dispatcher community groups on LinkedIn and Facebook. The results from experts working in twenty-three various sized and geographically located areas consist of five succinct questions that are to be repurposed into a user-friendly application that will present these questions to a caller, allow for a brief time to pass in order to generate sufficient answers, and then places the call to a local emergency number.

While many communities have invested heavily into emergency call centers and supporting infrastructure, evidence suggests that more can be done to ensure efficiencies of such systems responses. For example, language or cultural barriers may prevent calls, operators may have difficulty identifying key information due to noise and other distractions, tense situations may cause communication challenges, and sometimes information is incorrectly interpreted resulting in inefficient responses. When an actual accident occurs, people go through various emotions that can potentially be fueled by adrenaline that cloud communication and judgment (Howie, 2008). This state of frenzy could lead to information that is unusable, convoluted, or time delayed, thus affecting the dispatcher’s ability to process first responders. Studies have also addressed misinterpretation between callers and dispatchers caused by hysteria, emotion and anger (Garcia and Parmer, 2011; Tracy and Tracy, 1998; Whalen and Zimmerman, 1998). An additional concern is that non-emergency calls can place a burden on respondents (Snooks, Williams,
Crouch, Foster, Hartley-Sharpe, and Dale, 2002). Palumbo, Kubincanek, Emerman, Jouriles, Cydulka, and Shard (1996) found that in 74 percent of emergency call cases dispatchers and physicians disagreed on whether emergency medical services with basic or advanced life support should be dispatched.

Globally, there are numerous emergency telephone number standards and various levels of awareness. In addition, regional or international visitors may not be familiar with such numbers outside their home regions. In the United States the designated universal emergency number is 911, while in the European Union this number is 112, or 000 in Australia. Such a system could be extremely useful in a natural disaster situation in a global tourist destination, such as Paris, where the local number is 112, but a visitor from Mexico may be more familiar with dialing 066. Travelers may also encounter language barriers when contacting emergency services. This application could potentially address a universal language call-number need by gathering pertinent information in the distressed native language and processing that information to the closest emergency dispatcher in that geographic area’s language. Prototyping an application that can connect individuals with the proper emergency response infrastructure, based on need and location, could overcome several barriers, such as a lack of awareness regarding local emergency numbers, language or other communications barriers and automatically transmitting key information such as location coordinates.

The required information for first responders begins with a location question and offense or situation being reported before any subsequent personnel are dispatched. Examples of situations meriting different responders would be the information of “the intersection of 4th and Main streets” and “shooting” would result in the closest police cruiser called for, whereas the details of “127 Jerome Street” and “choking” calls for an ambulance and paramedics. However, as additional information is acquired, so can additional units and auxiliary personnel. For instance, an ambulance for the “shooting” example would be added if needed. An example of an accident decision-tree is presented in the Figure 1. As different community emergency response resources vary, such workflows must be designed and evaluated independently.

Figure 1. Example Accident Workflow
While there are some drawbacks to current emergency response systems, recent advances in mobile technology present a unique opportunity to address these drawbacks.

While the benefits of existing emergency response systems are enormous, an alternative to traditional voice-only calls may be needed and that smartphones with large displays and multiple data collection possibilities could provide additional benefits not previously available. While the global trend of consumers moving from fixed telephone systems to mobile devices presents communication challenges (Sayed, Tarighat and Khajehnouri, 2005; FCC, 2014), there could also be significant benefits. The impact of mobile devices on emergency call centers is already evident, as for example, of the approximately 240 million emergency calls made in the United States each year, nearly one third are placed from mobile devices (NENA, 2014; CTIA, 2014). This is not surprising considering that as of December 2012, 38.2% of U.S. households were wireless only and that the U.S. penetration of wireless devices had reached 102.2% (CTIA, 2014).

In the United States, 61 percent of all mobile subscribers utilize a smartphone (Nielsen, 2013). In 2014 all of Western Europe, Australia, South Korea, Japan and Canada will also achieve a greater than 50 percent smartphone penetration, and by 2017 the global smartphone penetration is expected to reach 50 percent (eMarketer, 2013). This continued trend to global adoption of smartphone technology presents a unique opportunity to enhance emergency services data collection by leveraging the capabilities of such devices instead of relying solely on voice and limited SMS capabilities.

The benefits of similar systems, such as vehicle telematics which can place calls based on environmental conditions, for instance an airbag deployment or collision detection, have already reduced the amount of time between an incident and a call (911.gov, 2014).

One of the core requirements to dispatch emergency services to the site of an emergency, is to identify the exact location of the emergency. Specifically, the Federal Communications Commission (FCC) in the U.S. and the Directive for Mobile Communication in the E.U. required the capability to determine a caller’s location (Junglas and Watson, 2008).

In addition to the automatic communication of location information, critical medical information could also be transmitted. For instance, medial allergies or pre-existing medical conditions could be transmitted automatically along with the dispatch communication. This would be the equivalent of a digital medical bracelet. It has been documented that emergency medical services (EMS) providers often do not have sufficient access to pre-existing medical information when responding to incidents (Finnell and Overhage, 2010). While there has been an effort to link such data to EMS services, these may only be available locally or regionally. When travelling internationally it would become increasingly difficult to notify a dispatcher of specific pre-existing medical conditions.

In addition to medical information, details regarding psychiatric conditions could be transmitted as well. This could be especially helpful, as previous studies have discovered significant benefits of responding with a mobile crisis team to deal with psychiatric emergency services. For instance, such a response can provide a positive intervention and can reduce hospitalization (Scott, 2000; Sabnis and Glick, 2012).

While the global implementation of such a system would take substantial resources and planning, implementations for large-scale, international events such as the FIFA World Cup or the Olympic Games could provide immediate value. Such events would be ideal test environments for such a system as a heavy emphasis is placed on safety, visitors may not be familiar with local emergency response numbers and because visitors may represent a variety of cultures and languages that such a tool must accommodate. Additionally, such a system could be deployed specifically to deal with emergency communications during a large-scale disaster. The benefits of mobile decision support systems to aid disaster response have been demonstrated and explored in several studies (Thompson, Altay, Green and Lapetina, 2006; Erskine and Gregg, 2012; Erskine, Sibona and Kalantar 2013).
A Design Science Approach to Optimizing the Communication of Emergency Information

To better understand the key information necessary to successfully dispatch the appropriate resources in an emergency, the researchers attempted to discover key patterns in those situations. Since this research project will benefit from the gathering of data from actual emergencies, using qualitative research methods that rely on an inductive, discovery methodology in order to utilize the information gained, latent knowledge gaps could be addressed (Heredero, Berzosa, and Santos, 2010; Myers 1997). This type of approach has already benefited information systems, such as those that rely on systems built through communal assistance (Dedrick and West 2005). The first step was a Google search using the term ‘county 911’ which produced over 696,000 suggested results. As many of these suggested sites were duplicate or class/sub-class sites (example: Genesee County 911 Consortium Index Page, Genesee County 911 Consortium - Active Events, etc.), the results needed to be narrowed down. From the initial search, fifty-five emergency agencies were evaluated for any educational material to assist callers. Data was collected, transcribed, summarized into descriptive codes to organize the observations and then categorized as patterns emerged. Then the codes were refined based on the patterns and interactions among the concepts. Linkages were reported that further support the need to formulate a theory that will support the development of a model assisted with observed facts (Myers 2009). This is where design theory benefits this research.

In response to the initial findings a design science approach was used to develop a prototype mobile application to provide a more efficient data-gathering tool. Most of the initial information from websites help determine what is classified as an actual emergency verses a personal emergency. For instance, a suspicious vehicle in your neighborhood should simply be reported to police, but not necessarily by dialing the emergency dispatch center. A few websites provide answers to frequently asked questions and others, such as Wood County 911, provide instructional material of what to do in an emergency (Wood County 911, 2014). However, such educational materials provide little benefit in an actual emergency as someone may not have read the information or have forgotten it during the stress of an actual emergency situation.

Of the fifty-five websites evaluated, thirty-nine emails were sent to the individual in the position equivalent to manager of the dispatchers (Division Manager, Head of Operations, etc.). Outside of the formalities of a traditional e-mail communication, the message consisted of one open-ended question: "What are the 4 or 5 questions that a caller needs to be prepared to answer upon calling 911?" Of those contacted, only five responded with answers, though others did respond with the intent to respond at a later time. To retrieve additional responses, the same question was posted to various LinkedIn and Facebook groups of which emergency call center dispatchers and managers were members. This led to the most feedback. Threads of dispatcher-building-upon-dispatcher comments presented this research with detailed frustrations that those that needed the answers to our upcoming crucial questions. Comments such as "I wish they would just educate people about the overall system itself", "In an emergency, you do what you have been trained to do. Train yourself now; when it counts, you will not have time to think about it," and "As bad as the situation is, the caller must remember to listen to the operator. "The caller must listen to what the dispatcher is asking. I find that many times the caller is so agitated they don’t pay attention." These comments, as well as the five questions developed from these communications, propose a practitioner need in dealing with crucial information involving an accident. Due to the various contact methods, there is no meaningful way to present response rates.

With over 5.3 million citizens under their protection, when former and current emergency dispatcher’s were asked what were the four or five most important pieces of information a caller needs to relay in a crisis, they could just as easily have been chanting the real estate mantra of “location, location, location”. Those interviewed represent twenty-three counties and cities in the United States as small as 6,625 (Chartham, MA) to as large Detroit (706,585) and Franklin County, Ohio (1,179,000). Of the twenty-four interviewed, “location” or “where” was in those five answers twenty-two times, with it landing at number one more than any other answer (seventeen times). The second most important piece of information was “what”, “what’s wrong”, or “what’s the problem/situation” (fourteen times). Coming in third is “who”,
“name(s)”, and “parties involved” (ten times), with fourth being a phone number in case of the call is dropped or background noise interference (five times). Interestingly, the fifth most popular answer may be asked more for the benefit of the first responders: are there any weapons at the scene (six times)?

Prototype Development

While the prototype was developed to focus on an auto accident emergency event, such a system could be expanded to address more sophisticated events including medical emergencies and natural disasters. The prototype application developed would represent the first implementation of an emergency description information technology (EDIT) designed to collect essential information from citizens in stressful emergency situations.

One of the first steps is to capture the existing response workflows and utilize the opportunity to optimize such workflows. Next, the workflow is applied to the application development process and integrated into the existing PSAP workflow. See Figure 1 for a visual presentation of this workflow.

The EDIT prototype was developed using MySQL, HTML5, CSS, jQuery mobile, PHP, and tested using various mobile platforms including iOS and Android. The prototype also utilized an external web server to host the application. Future enhancements will include the development of native applications to improve responsiveness and reduce the amount of communications between the client and server.

EDIT must provide succinct information in a timely fashion while working in crisis environment. Upon launching the application the first feature would be to detect the exact position of the smartphone using the device’s native location-based services. This data would be transmitted immediately, providing essential location information to the emergency resources dispatcher. Next the system would provide a series of simple, yes and no questions initially based on broad circumstances that drill-down the emergency to guide the first responders. Finally, it needs to be able to send all of this information to the closest relay station and then to dial that area’s emergency number. This would allow for the application to produce initial results for the incident and for the caller to provide additional information based upon the dispatcher’s needs. The application would need to be customizable for different agencies and municipalities due each department’s design flow, and the collected information would need to be coded properly to match existing data classification and prioritization schemas. An example of this would be that Miami Beach residents would need access to their coast guard and may deal with nautical emergencies, while people in the landlocked area of Topeka, Kansas would not.

An important consideration during the visual design of the application will be the development of a concise and calming layout. High stress situations often cause individuals to easily lose concentration; so simple questions will allow witnesses and victims to concisely provide key information. Additionally, the colors involved in the application will include various shades of green, which has been found to ease a nervous individual or an individual about to put in a high-pressure situation. This is one of the reasons that, before television interviewees enter a television studio, they are put in the “green room.” (Rousseau 2008). While research supports that the color blue is considered calming, it also can evoke feelings of sadness, which may impact the way a person responds under questioning (Color Psychology: Blue). Whereas the color green not only can evoke a calming effect but also can relieve stress and improve...
reading skills, a vital component to this application (Color Psychology – Green). See Figure 2 for a visual representation of the concise and calming interface.

![Figure 2. Concise and Calming Interface](image)

**Initial Results of Design Science Approach**

The research-in-progress has suggested a process-based approach to providing efficiency in an emergency situation. While an initial prototype has been developed, significant work will need to continue to develop a production ready implementation.

The results of this study suggest that contemporary mobile devices could augment voice communication with text-based information and data collected automatically through sensors. While this study applies such a concept to augment emergency communications, such technology could be used to aid in communicating when language barriers are present or when information is better presented visually. Furthermore, this study benefits those who develop mobile applications for use in high-stress environments through the continued exploration of concise and calming interfaces.

This study includes several limitations. For instance, this study has only contributed through the development of a mobile device platform and has not yet addressed simulated or actual emergency communications. Furthermore, while mobile communication networks have experienced significant growth, there are many remote areas that continue to lack the necessary reception.

**Future Research**

The final step of this project will be to test side-by-side comparisons of recreations of actual emergency events using traditional telephone dispatch and the prototyped expert system. The authors expect that using a laboratory setting to record the information acquisition times of the prototyped software verses a simulated emergency phone will result in software acquiring said information more rapidly than the traditional oral communication. Previous research supports that, given the same information electronically as orally, the electronic mechanism provides the same results yet is preferred due to its faster response (Pepper, Aiken and Garner, 2011). Another interesting long-term idea would be to utilize actual 911 dispatch information and calls and compare these to use of the 'app' in order to quantify efficiencies. Additionally, benefits and drawbacks based on environmental and user characteristics will be explored to determine how versatile such a system would be in actual use. Furthermore, exploration will need to be performed in determining how to most effectively integrate such a system into an actual
dispatch facility or how such a system should behave outside a compatible region. Specifically, if such a system could augment an existing computer aided call handling (CACH) systems.

While there are initiatives to support the submission of emergency information using short message service (SMS) communications, organizations such as the FCC, CTIA and NENA continue emphasize the importance of voice communication in emergencies unless there are significant reasons that prohibit someone from doing so (CTIA, 2014; FCC, 2014; NENA, 2014).

This research evaluates critical information necessary to dispatch emergency resources effectively. Subsequently, an evaluation process of existing dispatch procedures is suggested. Finally, a design-science process is utilized to prototype a mobile application that is thought to be superior in establishing communications with emergency dispatchers than current voice only processes.

**Conclusion**

This paper utilizes a design-science approach to address a global problem: the efficient collection and effective communication of data that is essential to those in and responding to an emergency. This capability would closely align with other eGovernment initiatives that leverage contemporary technologies to enhance government processes. By focusing on retrieval of pertinent information about automobile incidents in a expedited fashion, including mobile device decision-trees that gather user information while automatically sending location variables, this optimization process may decrease response time, diminish lost or undecipherable vocal descriptions, and address current communication issues that arise from traditional emergency response systems.

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