Evacuation Database Module: Residence Inspection Process

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Abstract

The purpose of this project is to outline and design an effective digital process for the inspection of residential homes defined within an evacuation module. With past disasters, many evacuation procedures require authorities to inspect homes to ensure the safety of all residents. This process can be replicated for disaster events in which the inspection occurs prior to the disaster occurring or immediately after a disaster has affected that area. The project plans to take information gathered in the defined evacuation area and interact with the residents and authorities to help aid in faster, more efficient home inspections. This system should have the capability to be duplicated and set the standards for local, state, and federal agencies to implement and successfully use to help save lives. It will also have the capability to store data for future review of the process, which will allow continued improvements of the process as it evolves for each evacuation use. This project will present some database modeling around the inspection process, explain system design for proper use, and incorporate security fundamentals to ensure the updated information is valid and the most current information available. Lastly, this project will help identify the FEMA X-Codes that are used in search and rescue situations, allow for proper use of these codes, and turn this effort into digital, researchable, and instantly accessible information. Uses of the codes are sometimes interpreted differently, depending on the search team performing the searches, and their interpretations using spray paint on the exterior of homes and cars. The system as a whole will provide the standardization that search and rescue teams need and help aid in faster evacuations of areas that require pre-disaster assistance.

Introduction

If an evacuation is ordered, the processes and procedures for conducting the evacuation, reporting on successful evacuees of the identified area, and inspecting the residential home to verify or force the evacuation are all important pieces to the process of evacuating because of a disaster. There has yet to be a fully integrated, digital system built to handle an evacuation, which is only part of an entire disaster management communication system or DMCS. The focus of this research and theory is to focus on more details of the process of residential home inspections. This portion of the evacuation process can occur as a proactive measure to an impending or potential disaster as well as after a disaster has occurred. Evacuating residential homes prior to a fire, hurricane, and tsunami are examples of situations in which a

proactive approach would be taken, while earthquake, chemical plant explosion, and tornadoes would be examples of reactive evacuations.

As with any system that is built from concepts and theories, a list of in-scope, out-of-scope, and system requirements must be established. The system requirements should be, but not limited to, the following list shown below.

The system must

1. Interact with the public and workforce members.
2. Be accessible via the Internet or mobile device.
3. Be able to store data for report extraction.
4. Visibly show the progress and status of individual residential home inspection status.
5. Interact with residential evacuation status information and remove those households that report as successfully vacated.
6. Provide a report on only the homes that are necessary to inspect.
7. Provide feedback to the command center on resource needs for a specific residential address, for example, rescue equipment and materials beyond the team's onsite tools.
8. Allow rescue team interaction to update and detail the status of the residential inspection according to and utilizing standard codes such as those provided by FEMA called X-Codes [1].

Next are the in-scope and out-of-scope items. In-scope items are residential addresses. Out-of-scope items include vehicles, public and private businesses and buildings, industrial or commercial businesses, healthcare facilities and other public facilities such as schools, libraries, etc., and the documentation of evacuated pets. The sole purpose is to design a base, working system that is expandable to cater to the additional needs and processes in an effort for continued improvement and overall support of the system.

Inspection Process

The residential inspection process should be initiated after the evacuation area is defined. The process should also be known as either a proactive or a reactive evacuation, and it should take into consideration those residential occupants who wish to not evacuate. Elizabeth Fussel talks about many reasons why residents do not evacuate an area. Many may have always stayed to ride out the storm, while others did not have the resources such as money, transportation, or medical supplies to support a successful evacuation. Others simply were delayed as a result of trying to unite with family and friends prior to evacuating. The process as a whole should solve many issues that Fussel discusses and raise awareness to such as methods of social communication and social networking through computers, phones, and other social media applications [2].

One proposed use of the inspection process is to allow evacuees to report on their evacuation status and allow other household members visible access to that information as well as to also report their evacuation status. This information is very valuable to family as well as for

the command center. The command center will be able to quickly review on a map which homes have been completely evacuated and which homes need immediate attention. Time spent inspecting a home for residents that have already vacated can be time spent on citizens who do not have the means to communicate or evacuate the area.

Designing the System

Designing the inspection portion of the evacuation system can become very complex very quickly. The approach taken was to find a logical common ground by using the base processes of the United States Search and Rescue teams along with the FEMA Codes, review the issues around these procedures, and find a method by which technology can help reduce errors, provide faster response, and yield more accurate information in a timely fashion. After all, time is critical in emergency situations.

After defining the requirements, in- and out-of-scope items, and the overall process, the next action could be to develop a prototype of the interface. What will the users see and interact with? What data are necessary to capture and store? How will the rescue teams know which houses to inspect next? And how will families know when all the household members reported as evacuated? The first step is to define the information from the residents to collect, data such as first and last name, how many reside in the household, who is head of house, ages, any medical conditions or physical disabilities that emergency personnel may need to know, address of the residence, evacuation status of each member in the household, and possible evacuation location. The next step would be to define the information in which to gather from the search and rescue teams, such as the state the team is from, the task force team code, the team number, the time and date stamp in which the inspection has started and completed, the status of the survey, the address being surveyed, the structure status, personal hazards status, and residential status information. The display for the search and rescue team should have a residential status that would stay up to date during the inspection in the event that a resident reported successful evacuation and there is no longer a need to look for that person at the residence.

Other processes within the evacuation module would need to store and gather the information that the inspection process would utilize to report on information critical for search and rescue efforts. The data collected and calculated within the inspection process also need to be stored in a database for further reporting and post-disaster evaluations. This is data that are currently not easily accessible or organized to help provide crucial information in planning and preparing for disasters. Many manuals and policies are in place to instruct federal, state, and local agencies on expectations of services and responsibilities; however, that information is easily lost or inaccurately utilized due to interpretations, chaos, and lack of training and practice prior to an event. The system can bridge the gap and expand beyond this basic foundation to tailor to the needs of each agency involved, educate users about procedures to follow and data to collect, and provide more accurate information after the disaster is over on how well the response actually functioned. Improving on the process will only help in aid for those in need as well as proper spending and allocation of resources when correcting issues or areas in which the needs were guessed and not based on current and accurate data.

Security and Reporting

Collecting and storing the data may seem the easy portion to design, and that may be the case. However, proper thought on how to collect the data in such a way to reduce normal human errors is the crucial portion in data collection for the system. For example, building into the design of the interface error trapping events will help force data to be much cleaner than allowing free text and selection. There are some valid areas in which free text or manual data entry can be necessary, but should be avoided if possible to reduce human errors and allow the data to be easily queried for reporting and statistical purposes. In Figure 1 below, I have developed a simple screen to give examples of how to collect the data. The task force team codes are already known and established by FEMA; thus listing just the team options will reduce the risk of mistypes and variations of upper and lower case letters.

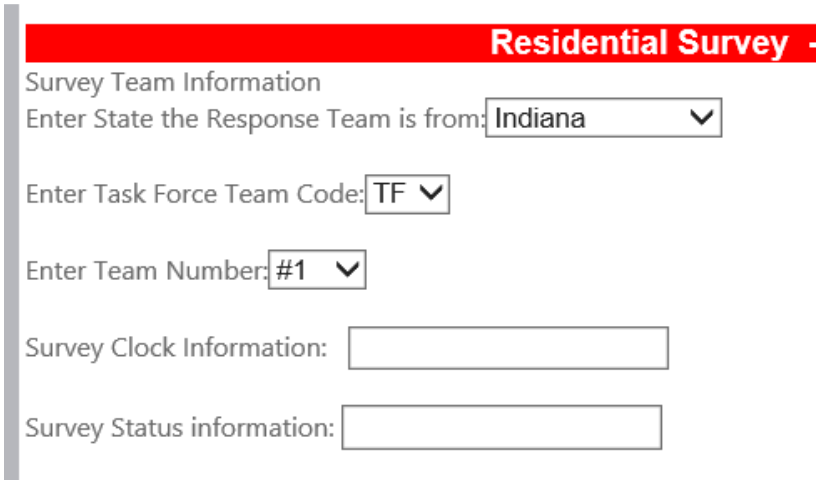

Figure 1. Sample residential survey search and rescue data collection screen

The state in which the task force team originates is also important, as resources from many states or areas may come to help in the search and rescue efforts [3]. The clock information and status will be automatically populated by the system. For example, the clock information can show the current time spent on the inspection. Behind the scenes, the database has collected the start time and date of the inspection at the time the team has entered this screen to begin the inspection process for a residential address. The status information will also be automatically populated by the system; if this is the first inspection, the status could be "In Progress". If this is the second or third inspection, the status could reflect that and state "In Progress #4", indicating this is the fourth inspection on the home.

FEMA has established what is known as the X-Codes. These are generally seen on buildings, structures, cars, or anything that was inspected in the search and rescue process. They use spray paint or what is provided to the teams by FEMA or the command center. Figures 2 and 3 show examples of the master code and a picture of what it looks like in use.

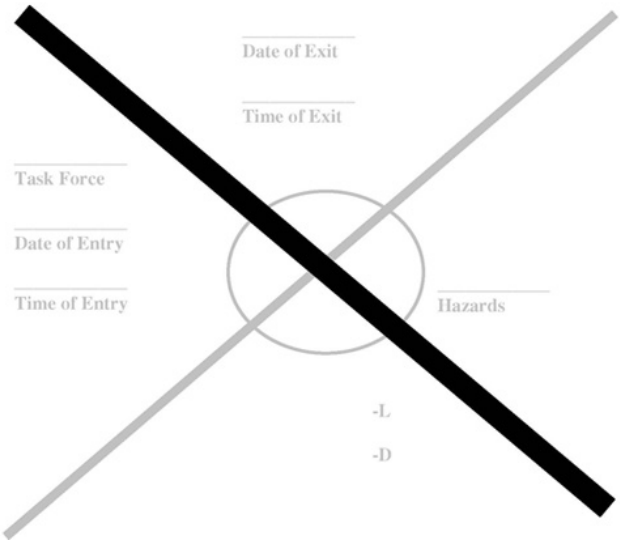

Figure 2. FEMA X-Code master [4]

Figure 3. FEMA code on building [4]

One point of Dorothy Moye's article, along with viewing the pictures on Southern Spaces, is that interpretation and use of the X codes are not uniform; therefore, when visual inspections are reviewed, interpretation of the hazardous materials and task for team codes may be up for further interpretation or misinterpretation [4]. Moving this process to a digital format and providing the task force teams with a digital means to store and upload information into the system can reduce or remove any misinterpretations as well as provide a format for viewing this information remotely instead of onsite inspections. There may be situations in which a structure is missing or gone. Where is that information collected to be viewed? Or how will the search and rescue teams know if and where a house should have resided? Through the

use of Google Maps and street/aerial views, the interjection of this technology with the system can allow for immediate view and position in the area where the house should be. It can show the teams if the house was 1-story or 2-story, the color, the approximate size, and the location of neighbors. Much of the documentation created by the search and rescue teams is simply their own drawings in the field. Removing the drawings and providing that information digitally can only help speed up the search and rescue process and also provide more accurate feedback necessary for proper research and evaluation of current situations.

Additional Features

FEMA has a National Urban Search and Rescue Response System: Rescue Field Operations Guide [5] that explains the proper policies and procedures of how to conduct the inspections, along with the X-Codes and other structural codes necessary to direct teams for re-entry into the building safely. What it lacks is the definitions of hazardous material identification and codes; however, with proper review and possibly coordination with HAZMAT, a definition of the codes necessary to cover most situations seems achievable. Other features could allow search and rescue teams to take live pictures and insert them into the system, while providing an overlay or injection into the street view so that command centers, homeowners, and possibly insurance agencies can view the information quickly and potentially warn residents about returning to an unsafe area. It could provide immediate information to process claims and quickly start the calculations of total damages instead of inaccurately estimating the damages.

Once the process and system is tested on a base level, it will be ready for additional features and functionality. Defining the requirements and scope items will aid in proper planning of the additional features and show whether additional databases are necessary, space, and deliverables. It also will help in the design to show the data necessary to collect and what outside sources or technology to incorporate into the system. Lastly, it will help design the security and error-trapping structure of the system as well, fields to auto populate, have pre-defined lists, or allow for checks or decisions to be recorded.

Conclusion

After researching FEMA's field guide and reviewing how the system was used, it became more apparent the inspection process of an evacuation system is a critical and valuable process that, if developed into a digital, accessible system, can lay the groundwork for improvements and a faster method of information delivery. Information during a response to a disaster needs to be fast, and during the age of social media, smartphones, tablets, and television, the expectations of information to be provided quickly or easily accessible is becoming more of a norm. Spinning up hotspots are not in forms of backpacks, vehicles, and as of this July 2013 and Google's Project Loon-balloons [6]. The use of smartphones, tablets, and other digital devices are very powerful tools and the use of the Internet as means of communication and connection to systems provides a very powerful catalyst to support the necessary requirements of responding to or preparing for an evacuation. Being able to see a picture of the home as a result of a hurricane or impending fire without traveling back into a

hazardous area is priceless for the homeowner. The trapped resident who may have been found and rescued in days may now be rescued in a matter of hours because the team can bypass the homes that have a status of successful evacuation. Also, the command center can gather statistics on the number of homes to search and request the appropriate number of resources, deploy or assign streets or homes to teams, and watch the progress of the inspections as they occur. This is invaluable information and can provide a glimpse not yet seen to help in more efficient evacuations. Future plans are to take this database design and implement a working prototype to build and mature for use to help the public, the government, and the response teams.

References

[1] Department of Homeland Security, & Federal Emergency Management Agency. (2006). *National Urban Search & Rescue (US&R) Response System: Rescue Field Operations Guide* (US&R-23-FG). Retrieved from http://www.fema.gov/pdf/emergency/ usr/usr_23_20080205_rog.pdf

[2] Fussell, E., & The Social Science Research Council. (2006, June 11). *Leaving New Orleans: Social Stratification, Networks, and Hurricane Evacuation.* Understanding Katrina: Perspectives from the Social Sciences. Retrieved from http://forums.ssrc.org/understandingkatrina/leaving-new-orleans-social-stratification-networks-and-hurricane-evacuation/

[3] U.S. Army Corps of Engineers Readiness Support Center. (2009). *Urban Search & Rescue : Structures Specialist Field Operations Guide (FOG)*. (6th ed.). Retrieved from http://www.disasterengineer.org/LinkClick.aspx?fileticket=YZy4Fh%2BBzS8%3D&tabid=57&mid=394

[4] Moye, D. (2010, August 26). *Katrina + 5: An X-Code Exhibition.* Southern Spaces. Retrieved from http://www.southernspaces.org/2010/katrina-5-x-code-exhibition

[5] Federal Emergency Management Agency. (2011). *Emergency Support Function #9 - Search and Rescue Annex* (ESF #9-10).

[6] Fitchard, K., & GIGAOM. (2013, October 21). *With Project Loon, Google Is Engineering a Mobile Network in Reverse.* Tech News and Analysis. Retrieved from http://gigaom.com/2013/10/21/with-project-loon-google-is-engineering-a-mobile-network-in-reverse/

Biographies

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