

Supporting Residents Evacuation and Safety Inquiry in Case of Disaster

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Abstract. Residents' Disaster Prevention Organization (or Self-protection Organization against Disaster) is defined as "voluntary disaster prevention organization based on mutual help of residents" in Basic Counter Disaster Act which was enacted in 1961 in Japan. Although the organizations have national average household coverage ratio of over 75 percent, residents often do not recognize they are registered as member of organization. Furthermore, activities such as safety inquiry, and registration and management at evacuation centers are paper based, making them unable to utilize the latest ICT technologies and resulting in ineffective and inefficient evacuation support activities. In this paper, based on a national web survey conducted in 2011, we will reveal residents' participation in Residents' Disaster Prevention Organization, as well as explore how ICT can support the organizations in times of disaster. In order to change personal data into social information, which is necessary when safety inquiry and registration at evacuation center are conducted under disaster, we propose a prototype information system utilizing QR code and GIS (Geographic Information System), which its effectiveness was validated by questionnaire responded by disaster drill participants.

Keywords: Residents' Disaster Prevention Organization, Evacuation Support, Safety Inquiry Support, QR Code, Geographic Information Systems.

1 Introduction

In Japan where simultaneously decreasing and ageing population¹ has become a social issue, increasing number of citizens such as elderly and handicapped are identified as "people requiring assistance during disasters". Protecting these vulnerable citizens from natural disasters is becoming increasingly important. The Japanese government aims to not only minimize loss of lives but also care for those vulnerable

¹ In the most recent census conducted on October 1st 2010, Japan's population is 128,057,352 and 23.1% of the population is 65 years or older. Based on a report released by the National Institute of Population and Social Security Research in January 2012, Japan's population has been decreasing since 2009 and will continue to decrease by about one million every year.

citizens during and after evacuation by capturing the whereabouts of vulnerable residents beforehand and issuing evacuation preparation orders aimed specifically for them. The idea is represented as “Guidelines for Evacuation Support of People Requiring Assistance during a Disaster” set by the Japanese Cabinet Office in 2005 or in regional disaster prevention plans drawn based on “Basic Disaster Countermeasure Act” enacted in 1961. “Residents’ Disaster Prevention Organization (or Self-protection Organization against Disaster)” based on residents’ mutual help is stipulated in the Basic Disaster Countermeasure Act as one of apparatuses to achieve the goal, i.e. to save and support each other in spirit of mutual help in times of disaster.

This residents’ disaster prevention organization covered only 43.8% (coverage ratio is calculated as number of households belonging to an organization divided by total number of households present in the relevant region such as municipality or prefecture² of households with 70,639 organizations in 1995 at the time Great Hanshin Earthquake which caused more than 6,000 deaths. The ratio has seen significant increase since then due to increased consciousness against disasters especially mutual help among residents, and encouragement from local municipalities as part of anti-disaster policies. According to Fire and Disaster Management Agency of Ministry of Internal Affairs and Communications, 146,396 residents’ disaster prevention organizations are active in 1,625 municipalities out of 1,747 nationwide, covering 75.8% of households as of April 1st 2012.

However, when we ask people whether they are members of residents’ disaster prevention organization on various occasions, only 10% to 20% answer they are, suggesting that there might be a gap between coverage ratio and actual percentage of people who are actively aware of their membership. In a July 2005 survey by the cabinet named “Survey on Flood and Landslide Disasters” only 19.1% residents answered that they are actively participating in activities of residents’ disaster prevention organization, compared to 64.5% coverage ratio at the time. This indicates that although organization of residents’ disaster prevention organization has seen progress, it may have not involved mobilization of member residents to participate in activities such as drills.

To answer these research questions we conducted a nationwide web survey with 7,133 valid responses on the topic of residents’ disaster prevention organizations in 2011, just before the occurrence of Great East Japan Earthquake. As a result it was shown that only 9.2% of respondents were aware that they were members of residents’ disaster prevention association, confirming our doubts that there might be gaps between coverage ratio and actual number of people involved in the organizations’ activities. Also, our survey indicated that there are number of respondents who knew they were members of the organization but did not know in detail about their assigned roles in residents’ disaster prevention organization.

Though it is important to organize residents’ disaster prevention organizations, it alone will not make the organization functional under disasters. We believe that publicity of organization’s significance, goals and activities is necessary for increasing participants in drills which are necessary for residents’ disaster prevention

² There are 47 prefectures and 1,747 municipalities as of January 1st 2013 in Japan.

organization to achieve its goals under normal times and disasters. However, there are no websites operated by organization for publicity. Speaking of information technology, there are also no information systems that can support the activities of residents' disaster prevention organizations.

In this paper, we will discuss the issues and possibilities of supporting residents' disaster prevention organizations through ICT based on our web survey of 2011 and a series of empirical studies on evacuation and safety inquiry support including the latest study conducted on February 26th 2012 in Minagidai school district of Miki City, Hyogo Prefecture. We will also show the effectiveness of using QR code to collect personal data needed in process of safety inquiry and registration at evacuation center correctly, promptly and simply.

2 Current State of Residents' Disaster Prevention Organizations

As mentioned above, we conducted a survey titled "Web Survey on Residents' Disaster Prevention Organizations" from January 19th 2011 to February 24th 2011.

The survey was a voluntary web survey consigned to Data Service Incorporation. Asked items included: 1. Personal attributes; 2. Experience of struck by disaster and evacuation, and knowledge of nearest evacuation center; 3. Membership of residents' associations³; 4. Knowledge on disaster prevention associations, participation in its activities and evaluation of its activities; 5. Whether respondent wish to join residents' disaster prevention organizations' activities and what kind of activities are preferred (in case respondent did not participate in activities); 6. Necessary policies that will result in more active residents' disaster prevention organizations; 7. Measures taken personally against disasters; 8. Whether respondent is willing to help elderly or handicapped neighbors; and 9. Evaluation of self, mutual and public help by ordering them by importance and allotting points out of 100 to each of them. 7,133 valid responses were obtained.

Although we have to take into account possible bias caused by sampling selection through voluntary web survey, it was revealed that national recognition ratio of residents' disaster prevention organization was 37.6%. Fig. 1 shows scatter diagrams of prefectural recognition ratio, interest ratio, participation ratio and willingness to participate ratio against coverage rate. From Fig. 1 we can observe large gaps between activity coverage rate and recognition ratio, consciousness of participation ratio and willingness to participation ratio.

Furthermore, although 9.2% responded they are aware of their membership in residents' disaster prevention organizations, there were 59.6% who were not aware of their role in the organization, 48.6% who did not actively participate in activities,

³ Residents' association is another voluntary based neighborhood level organization which manages local common assets such as garbage collection sites, parks and neighborhood meeting places. Residents' associations have a long history and are different from residents' disaster prevention organizations, but residents' disaster prevention organizations are usually established based on residents' associations.

38.9% who felt that the organization was not active enough, and 25.7% who did not evaluate the organization's activities. These results show that even amongst conscious members, participation and evaluation varies from respondent to respondent, which makes effectiveness of residents' disaster prevention organizations questionable.

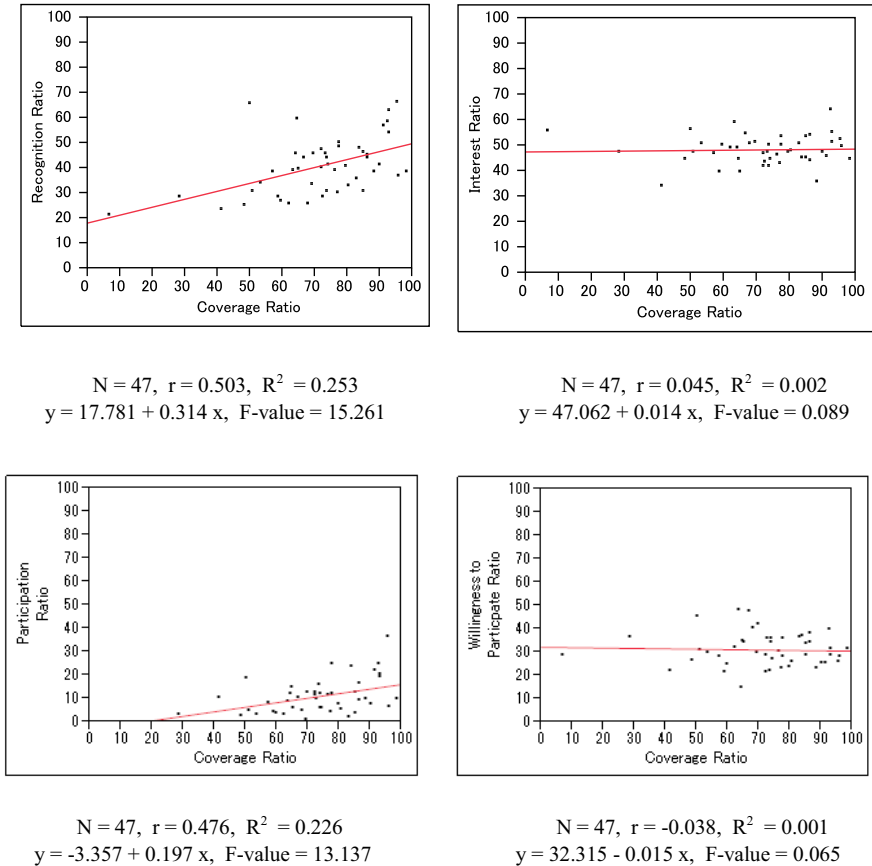


Fig. 1. Relationships between Prefectural Activity Coverage and Recognition, Interest, Consciousness of Participation and Willingness to Participate of Self-protection Organization against Disaster

Lack of publicity of residents' disaster prevention organization's presence and activities is one possible cause that results in these gaps between nominal coverage ratio and actual recognition and awareness of membership. Although there are a number of local municipalities that introduce residents' disaster prevention organizations on their media, giving updates on events and activities, from our survey their effect seems to be limited. Also, because each local municipality provides their information in their own different manners, it is unclear where to look in order to obtain needed information. This

might be an obstacle for residents to find information on residents' disaster prevention organization which they are unaware of in the first place.

In order to activate and functionalize the activities of residents' disaster prevention organization, support in terms of information systems is also necessary. Activities of residents' disaster prevention organization under normal times cover: 1. Publicity of disaster prevention measures; 2. Mapping level of danger or hazard in its region; 3. Disaster prevention drills; 4. Checking safety of homes; 5. Maintaining materials and equipment; 6. Planning measures for vulnerable residents; and 7. Cooperation with other organizations. Activities under disaster will include: 1. Collection and communication of information; 2. Preventing fire; 3. Initial stage firefighting; 4. Rescue and first aid; 5. Evacuation support; 6. Operation and management of evacuation centers; and 7. Supplying food and water.

Information systems will be beneficial in aiding these residents' disaster prevention organizations' activities. For example, lectures on firefighting and first aid can be given through websites or applications to enhance effectiveness, and GIS (Geographic Information System) can be used to visualize regional information and hazard levels to aid planning and management of evacuation. During disaster, disaster resistant lines of communication can be used to share needed information between each local evacuation center and an anti-disaster headquarters organized in each municipality in times of disaster. Currently residents must rely on analog bulletin boards and posted papers to know safety of their relatives and friends, but if information could be shared and centralized to the anti-disaster headquarter, information needed safety inquiry could be provided on a single point of contact instead of residents having to travel around multiple evacuation centers.

3 Evacuation Support System Using QR Code

We have been conducting a joint study with Miki City in Hyogo Prefecture from 2006 in order to develop information system for anti-disaster headquarters and residents' disaster prevention organization, involving a number of field studies in cooperation with the city and PASCO Corporation [1, 2, 3, 4]. Fig. 2 shows a sample screen of information system for anti-disaster headquarters which support manager of anti-disaster headquarters to grasp the status of region where evacuation order might be issued.

From fiscal year 2011 to 2012 we conducted an empirical study using a prototype of our evacuation and safety inquiry support system developed with PASCO Corporation, with financial support from Japan Science and Technology Agency. The study was conducted in a disaster drill of Minagidai elementary school district on February 26th 2012.

In Miki City, when a resident enters evacuation center, he or she is required to fill in a household based and A4 sized evacuation center registration form with fields such as names of family, phone number, residing address, and emergency contact

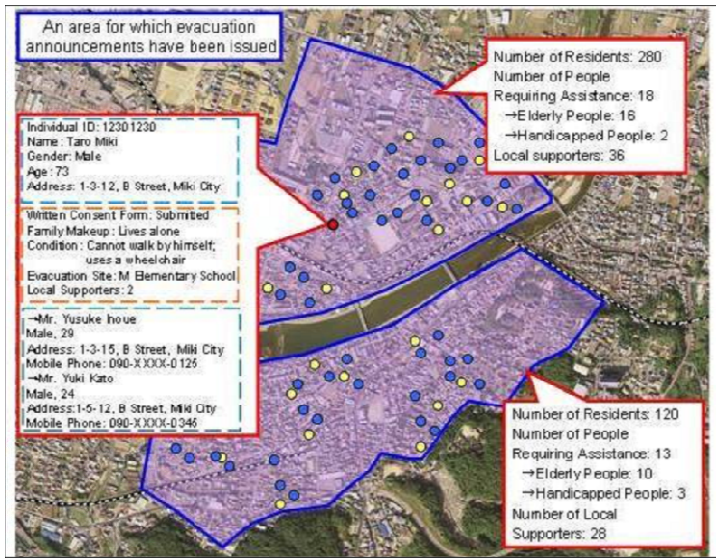


Fig. 2. A Sample Screen of Our Prototype System for Anti-disaster Headquarters

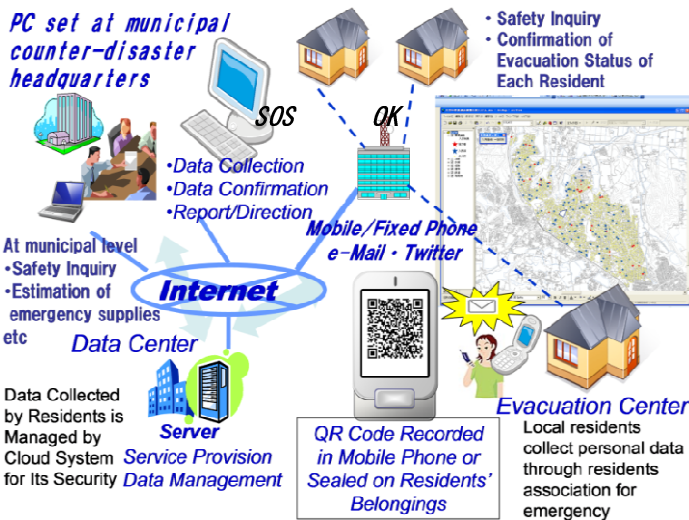


Fig. 3. Overview of the Developing System

address. These forms take considerable time to complete which causes congestion at evacuation center registration. In addition, because evacuation forms are paper based it is difficult to keep track of number and structure of evacuees in a real time manner. Furthermore, in an emergency situation handwritten forms may be difficult or impossible to read, all which could lead to problems in management of evacuation centers

and safety inquiry. Our system aims to digitalize this registration process as shown in fig.3. Information required in evacuation registration form is pre-registered in a database so that registration can be done using name or phone number as matching key, improving efficiency in registration. For those who fear exfiltration of personal data and do not wish to be pre-registered, QR code is used to digitalize the necessary information so that registration can be done by scanning the evacuee's QR code as shown in fig.4. The reasons for using QR code are: 1. Others cannot read the contents without scanning the code; 2. It can be carried easily by printing it on a name card sized paper or saving it on mobile devices; and 3. It can be read quickly by a common two-dimensional barcode reader. For those who prefer neither of our solutions, conventional method of paper based registration is provided as well.



Fig. 4. Example of QR Coded Personal Data

Also, as shown in fig.5, status check of evacuation and management of evacuees is enabled by linking the registered information to a GIS based evacuation support system. Furthermore, for those who are safe at home or require assistance, we plan to prepare two mobile phones—one for reporting safety and one for requesting assistance or rescue—so that residents can make one ring calls to notify the manager of residents' disaster prevention organization or the staff of municipal anti-disaster headquarters. If phone number is pre-registered in the database, it can also be marked in our system to update the visualization.

In order to test effectiveness of our newly developed residents' evacuation support and safety inquiry system, we distributed questionnaire surveys to each participant upon completion of registration procedure and collecting them at end of the drill. Out of 214 survey sheets, 148 were retrieved. The survey sheets asked evaluation of the following in addition to personal attributes such as age and gender: simplification and speedup of registration, increasing accuracy of registration, supporting operation of evacuation centers, effectiveness of safety inquiry using GIS, effectiveness of registration using QR codes, effectiveness of safety inquiry using one-ring calls, whether respondent have fear of information leakage upon pre-registration, whether respondent wishes to register to our system, and whether respondent wishes to use QR code.

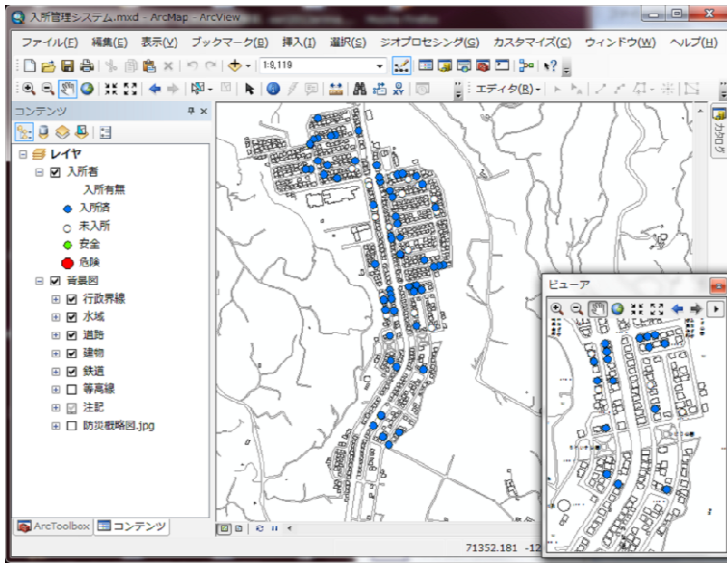


Fig. 5. A Sample Screen of Our Prototype System: White circle, blue circle, green circle and red circle mean pre-registered household, household already evacuated, household staying at home safely and household requiring help or rescue.

Number of respondents who registered through our system and number of respondents who registered by conventional method are roughly equal. Through the survey it was shown that a high proportion of 73.0% have some fear regarding information leakage. As to our system itself the majority—over 80%—of respondents have evaluated it favorably: 89.9% for simplification and speedup, 87.8% for increasing accuracy, 83.1% for supporting management of evacuation centers, and 91.9% for safety inquiry utilizing GIS. Also, responses are also positive for safety status confirmation through telephone calls (74.3%) and embedding personal information in QR codes (79.1%) leading to a positive feedback to our system in general where 89.2% responding they wish to consider about pre-registration and 79.0% responding they wish to consider using QR coded cards. We believe that this confirms effectiveness of the system we have developed in this study.

4 Need for Systems to Support Residents' Disaster Prevention Organizations

One example of information system in action during disaster would be the “Osaka 8.8 Million Drill” conducted in Osaka Prefecture on September 5th 2012. In this disaster drill emergency earthquake information was sent through emergency radio and email networks of mobile phone carriers—NTT DoCoMo, AU and Softbank—on 11:00 AM, urging citizens to simulate how they could ensure safety and reflect upon what should be done after securing safety. In this drill several problems such as certain

models of mobile phones not receiving the mail and Osaka prefecture's website becoming overwhelmed by traffic were discovered. It was shown however, that the scheme of informing emergency information through mobile phone carriers' network was an effective solution.

In the evacuation stage that follows this stage however, there has not been an establish scheme to support evacuation such as checking status of each residents' evacuation, safety inquiry and managing evacuees at evacuation centers. Challenges at this stage have been pointed out in the Great East Japan Earthquake, where people had difficulties checking the safety of their relatives and friends.

In order to solve such problems, it is best to manage the information of evacuees and safety status of residents in a digitalized manner so that information can be obtained instantly, with necessary measures to protect personal information. In other words, we need to construct a scheme where appropriate information can be distributed under emergency while ensuring their secrecy is kept under ordinary times.

5 Conclusion

To make activities of residents' disaster prevention organizations more effective, first it is necessary to increase the number of people participating by informing the presence and detailed activities of the organization. In publicity it might be beneficial to apply consumer behavior theories such as AIDA (attention, interest, desire, action), AISAS (attention, interest, search, action, share) and SIPS (sympathize, identify, participate, share and spread). The latter two applies especially to web based marketing, and media such as websites and social networking services could prove useful for this purpose. Efforts in making such media more attractive such as integrated and interactive design of webpages and utilizing multimedia contents will be necessary as well.

Also, considering that the digital era has already arrived, support of residents' disaster prevention organizations should shift from papers to digital, utilizing ICT. It must be noted however, usability and durability under emergency situation is required for such ICT measures to be effective, which poses us challenges such as securing electricity and developing interfaces which everyone can use. Furthermore, systems must be of use under ordinary times as well as emergency times, or users will not be able to fully utilize the system when disaster suddenly strikes. Considering that residents' disaster prevention organizations are organized based on neighborhood associations, name lists and membership fee collection lists will be resources that we can utilize.

Although our system currently uses dedicated barcode readers combined with QR codes printed on paper, dedicated devices are costly and can become single point of failure if they are broken or lost. Printed QR codes also have problem of being vulnerable to wears and tears. To solve these problems we plan to use the ubiquitous mobile devices to read and display QR codes. Tablet PC might be easier to use than ordinal PC and yet more powerful than mobile phones in times of disaster. Because municipal information systems were destroyed in the Great East Japan Earthquake,

cloud systems could be utilized to increase resilience of systems under disaster. We will continue to improve our system based on these ideas.

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