From the Perspective of Service Engineering, The Development of Support Systems for Residents Affected by the Major Earthquake Disaster

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Abstract. In a large Earthquake, the inhabitants need to protect themselves on their own. If that is difficult, residents need to help each other in between. However, there are very difficult to help each other at after the Earthquake. The supporting systems have been developed using the service engineering. This is, using ICT, an evacuate mechanism has been proposed. Moreover focusing on evacuation behavior in particular, a support system capable of safe haven has been developed. Especially a new method for measuring the quality of the evacuation has been developed too.

Keywords: Earthquake disaster, service engineering, quality of evacuation, ICT.

1 Introduction

The local government offers many kinds of public services for the inhabitants. In a disaster, this plays a very important role to the victims of the disaster. If a large disaster happens, and the service offering system is destroyed by the disaster, residents may be confused. This is very serious problem for the victim of the disaster, and very difficult problem, too. The reason is that a problem is constructed by many other problems, and these problems are complicatedly tangle. So it is very difficult to solve this problem. We must think about the correspondence method of the disaster creatively again carefully beforehand. We shall propose and discuss our new services of supporting the residents in the disaster at the time of a disaster. I considered services in particular about whether you make the offer method at the time of a disaster. We think in a situation called the ergonomics and service engineering in particular.

Discussions of disasters are not able to consider generally. The disaster is roughly divided into natural disaster and a human disaster. Furthermore, the natural disasters are classified in an earthquake, a flood, a typhoon, the volcano, etc. Recently, the Japanese people are paying attention to the disaster that will be caused by the major earthquake.

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The Japanese Government Institution announced that the major earthquake that is higher than magnitude 7 is generated with epicentral earthquake in a metropolitan area and its possibility is very high level. By this prediction of the scale of the damage is big, and a victim is expected with a majority. Therefore we need preparations in response to the disasters. Therefore, we decided to focus on when a large earthquake in the Tokyo metropolitan area has occurred.

We had four times of large earthquakes since 1995 and we suffered large damage. That is, we have experienced at the Great Hanshin-Awaji Earthquake (January 17, 1995 M7.3), Niigata Chuetsu earthquake (October 23, 2004 M6.8), Niigata Chuetsu offing earthquake (July 16, 2007 M6.8) and Great East Japan Earthquake (March 11, 2011 M9.0).

From these experiences, the policy of the government changed from the disaster prevention to the decrease of the disaster. We cannot prevent the earthquake disaster with a prior foresight for the moment. Therefore our government switched it to the conversion of reducing the scale of the disaster even if a large-scale earthquake was generated. Therefore our government requires for the people to perform. This period comes to need around ten days from 3days. It means that the local government restores during this period. That is, the residents firstly evacuate to the shelter, and to build and to manage the evacuation center and information of evacuee are accumulated, classified, and outgoing. In the disaster study, we need to consider events in time series. The requests of the victims of the disaster are changed, and the requests are associated with shortage things in the daily life, it means that the support methods in the disaster change in time series. So we focus on immediate after the large earthquake disaster in this study.

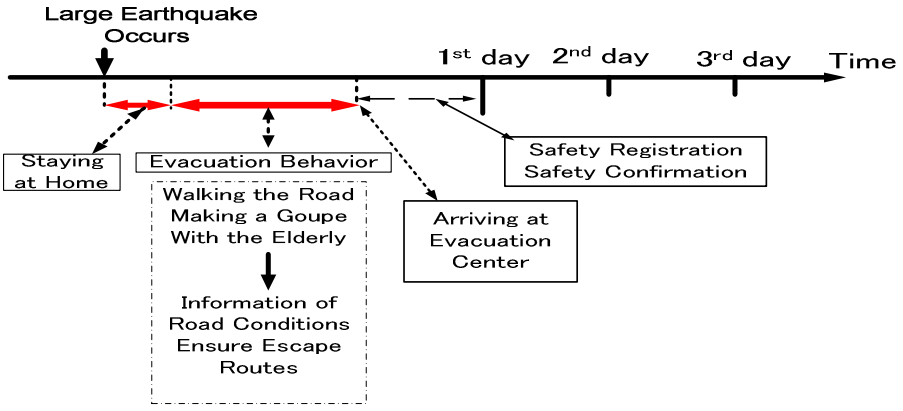

Fig. 1. The flow of the disaster research

1.1 Firstly Evacuation Is Important

In the Great East Japan Earthquake (2011.3.11), many of the victims were caused by delayed refuge. People shall be reconfirmed that the evacuation is important.

An evacuation is very important action for inhabitants in early phase of an earthquake. Therefore, we focused on the evacuating action of victims to evacuate to shelters in immediately after the disaster. Be carried out inhabitants have led to this evacuation is required. Then a new support refuge system is required, and we make adjust to be performed this system smoothly by using ICT.

In this paper, we assume that the victims of the disaster go to the evacuation center from their home after the large earthquake stopped, and we consider how to perform the victims of the disaster safely at the refuge action. The evacuation center has a hub function as the base of local inhabitants at the refuge. In other words, a refuge is an accumulation place of food, drinking water and necessary supplies. It is important to have the information of inhabitants to succeed in the distribution of the supplies to the victims of the disaster at this refuge. In addition, the local government and the exchanges of the information of the refuge are necessary. Our system becomes the premise to be provided with the mechanism mentioned above. Therefore the victims of the disaster go to the evacuation center, and it becomes necessary to convey safety information themselves.

We considered the safety of the information and we put the information at the time of the disaster to the remote outside server from the stricken area. In other words, we thought about the use of the cloud system. At first we thought about the refuge action support at the time of the disaster based on this information infrastructure system.

Refuge Support. Japanese government and the local government prepare the hazard maps. Based on the research of hazard areas in Japanese hazard research institutes, our government presents the dangerous area and illustrated to disaster areas as the hazard map. This purpose is that the inhabitants will prepare for a disaster while seeing this map. And our government expects that many people can search the evacuating route from the hazard map. However, the existing hazard map is not used.

The reasons seem to be as follows;

1. As for the hazard map contents are coarse.
2. The map is made from paper and people forget it put away.

Method to Support a Refuge Action. We put map information on a tablet terminal on the our based system and added support information more. We make the residents go to a evacuation center using the tablet terminal. Subsequent to evacuation, we make residents evaluate the usability of the tablet map. Furthermore, making the structure to evacuate to while helping an elderly person is necessary because the elderly person cannot evacuate alone.

Furthermore, making the structure to evacuate to while helping an elderly person is necessary because the elderly person cannot evacuate alone. In addition, we made hazard map and showed the effectiveness to raise quality of the refuge. we applied the service engineering about a disaster as above and showed the effectiveness of the aid package of the disaster action.

2 Purpose

We assume large earthquake has occurred in Tokyo metropolitan area, we will make a mechanism to help the victims at that time. The information based system at the time of the disaster using the ICT is made. In addition, in order to raise quality of the refuge, the electronic hazard map is made and the effectiveness is evaluated. Applying the service engineering about a disaster as above and the effectiveness of the aid package of the disaster action is shown. We assume earthquake has occurred; we will make a mechanism to help the victims at that time. As described above, by applying the engineering services related to disaster, we show the effectiveness of the support measures of behavior disaster.

3 Method

3.1 Creating a Scenario Immediately after the Earthquake

From 2007, at the Tansumachi Shinjuku area of Tokyo, We have made the investigation of residents' awareness about earthquake. Inhabitants of this area is about 36000 people, the total number of survey respondents was 10%. Is carried out evacuation drills further, we examined the evacuation of Inhabitants. We observed carefully their evacuation actions. We conduct evacuation drills along with the residents, I investigated the evacuation of residents. From this result, I made a proposal for evacuation scenarios below. Unlike the evacuation training until now, was the policy not to evacuate alone the elderly. We make a safe system to move along with the elderly and Inhabitants of the neighborhood. Of course, it uses ICT.

In addition, rather than a fixed route, made a scenario that gives the suspension of traffic in this evacuation drill. It is not taught to the participants before training. This training is how to consider people to avoid traffic cutoff points, and to build the route of the destination to the evacuation. We were also observed behavior of Inhabitants at that time. Participants of this training in the 250 total, we have created the evacuation scenario based on this. We investigated the quality of further evacuation.

General Rule. We show the general action of the victims of the disaster. This rule may vary according to an area. The victims of the disaster go to the refuge after the shaking of the earthquake is stopped. Therefore each resident informs his or her address where he or she is staying. Mainly it is the inhabitant's house, the parents' house, acquaintance's house or the evacuate center. The local government can grasp the personal safety of inhabitants at each refuge. The local government can get grasp of a local refuge population and residents' situation from the enrollment of each refuge. When an elderly person evacuated, we found out many barriers to move elderly person from pre-conducted evacuation drills. For example, in the evacuation streets, destruction of telephone poles, fences and walls will be blocking the road. And also destruction of the road itself will be a factor of shut off further. In practice our study, windowpane of the building facing the road will be destroyed and fallen on the

road. This is very danger for walking people. And the collisions between cars at the intersection of many occur more often was expected. These are our results of research since 2006. Therefore we thought about a method to evacuate an elderly person safely first.

3.2 Our Proposing the Evacuation Support System

It will be described based on the schematic diagram shown in Figure 2 system. The numbers enclosed in parentheses shows the order of evacuation behavior from after the earthquake. We explained with the procedure and ICT system as follows;

(1) A Wi-Fi Mobile Terminals to the Elderly Person's House Beforehand are Distributed. In normal situation, the information about the disaster prevention is displayed on the screen. If the earthquake happen, screen changes immediately, and the instruction to touch the button on the screen directly is displayed (see figure 3). This mechanism is to be sent to automatically from the information center of the municipality when the earthquake occurs. If the earthquake happened, an earthquake early warning and an earthquake breaking news are displayed. This operation becomes the confirmation of an elderly person being in the home. And the safe information of elderly go to the evacuation center. The evacuation center direct the supporter to pick up the elderly with his information. If the earthquake happened, an earthquake early warning and an earthquake breaking news are displayed. This operation becomes the confirmation of an elderly person being in the home. And the safe information of elderly go to the evacuation center. The evacuation center direct the supporter to pick up the elderly with his information.

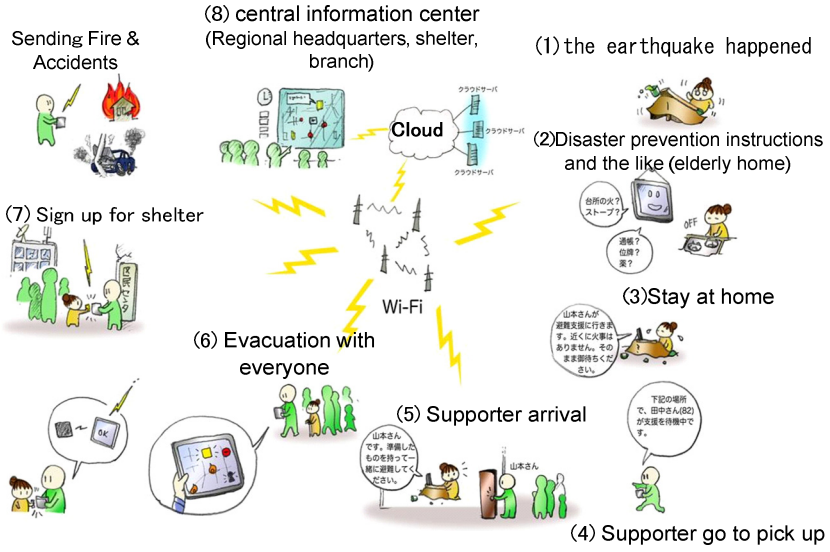

Fig. 2. Our Proposed the evacuation support system

(2) What is Displayed Next. Following two information are displayed repeatedly successively.

a) Fire off the stove in the room and turn off the stove in the kitchen.
b) Ready to bring out passbook, ancestral tablets, medicine, and other objects.

(3) Stay the Home Until Someone Will Pick Up You to Go to Evacuation Center. A supporter is coming to you and you are waiting for a moment.

Fig. 3. When an earthquake occurs, the screen display is changed immediately as this

(4) Supporter Go to the Elderly Home. Supporter has a terminal toward the elderly person's house, and a supporter understands whether he should go to what elderly person's house at the terminal.

(5) Supporter Arrived at Elderly Home. Supporters went to the house of the elderly, and he went with the elderly to the place where people in the neighborhood are gathered together. Go to the home of the elderly other, other supporter went to the place where everyone is gathered together. And they have been moved to the shelter in them all. And they have been moved to the shelter in them all. Series of flows up to this point are classified two types of instructions. The first is by the situational judgments of the regional headquarters, and the second is instructions that are prepared in advance.

However indication of regional headquarters will be able to replace the contents of the instruction by the situation.

(6) Refuge. The supporter, the elderly and neighborhood people evacuate to the evacuation center. While watching the disaster situation to the road map, the leader watched the terminal and continue to evacuate while also finding the desired route. Moving the symbols as shown in Figure 4 is displayed on the portable terminal, and it helped the leader as a clue for looking up the bypass line. The leader is moved to the shelter while operating the zoom function of the map displayed on the mobile terminal at this time. We made to artificially disasters of traffic accidents or fire, as shown in Figure 5. And happened disasters over time, was displayed on the map, We made experiments actually and researched the evacuated route. In Figure 5, resulted routes were shown.

(7) Register the Residents' Safety Information. The victims of the disaster went to the shelter for safety registration. They have registered in writing the information of victims in registration form of paper. The IC-chip Card or the QR code printed on the card will be distributed to people who registered further. Therefore it is necessary to convert to electronic information from the paper. It is necessary to input from the PC to do so. We have proposed that the residents there are shelters to the input. At that time, with a focus on the pull-down menu, I elaborated so as to reduce the keyboard as much as possible. Data are thinking that you put in a server of shelter, and sends it to the server of the municipality it. We thought that you save the data to an external server in this system for that. That is, a cloud.

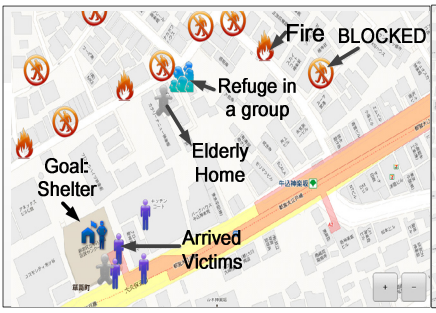

Fig. 4. The Screen of the group on the Tablet. The display in the evacuation center display same screen image.

Fig. 5. The resulted routes on the leader's tablet

(8)The Central Information Center . This is put in the local government (branch office) or each refuge and, by the Wi-Fi function of the terminal which the leader of inhabitants group has, can grasp course information in the local governments.

3.3 Cloud System

Next figure 6 showed the disaster information system using the cloud and a diagrammatic view of the refugee support system.

3.4 Evaluation of Evacuation

We conducted evacuation drills in the region based on the proposed scenario. We have set the two regions. One is an elongated town in complex narrow road in the area with a complicated escape route.In the other area, there are factories and warehouses has simple road network, and their width of are not narrow. The escape route

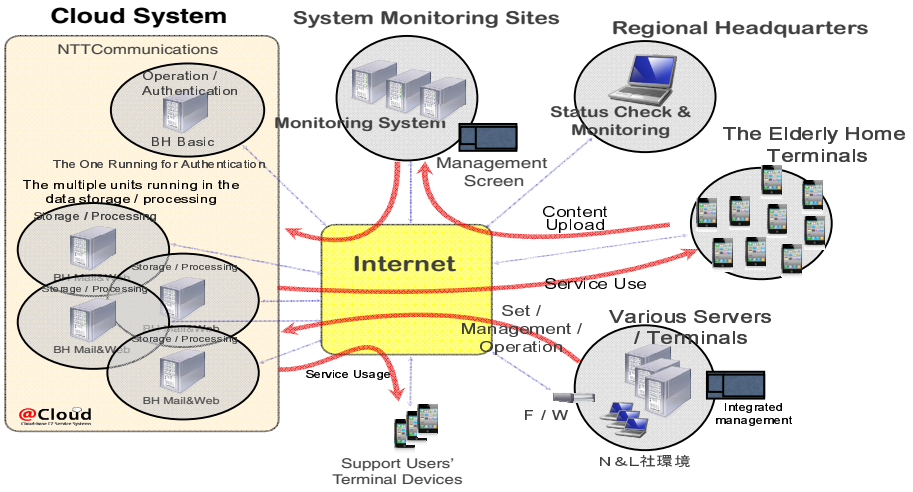

Fig. 6. The framework Concept of the Cloud System

is shorter than the complex town. Clearly, the evacuation route in complex town is longer than in small town.Therefore, measuring of the evacuation time and distance cannot be a correct comparison.

Participants were 21 people, and each participant is made an evacuation. Since assessing the quality of evacuation procedures in this experiment, on the assumption that the elderly could not escape alone, we did not experiment.

Observing the participants, we found that all people showed us the many types of evacuations between the start point and the goal point in some road closures according to the scenario.

We recorded the participant's utterances when each participant was moving, and analyzed them and we were able to find two factors. Those factors are composed of several elements.

That is as follows;

– State of grasped of the current position

1: State of grasping the location
2: State that does not grasp the current location
3: State of mistaken for a know the current location

– Strategy of route selection

a: Trying to search exactly route for goal point
b: Trying to go to the goal direction roughly
c: Trying to grab clues to understand his place
d: Trying to turn back to the middle

We were evaluated as a quality of refuge with a combination of twelve elements, this means, multiplying in 3 elements (in the State of bgrasped of the current position) and 4 elements(in the Strategy of route selection) . These combinations of the elements between assessing indicated the quality of evacuation.

Figures 7 and 8 were results of experiments. Figure 7 was the result of easy to evacuate area (small town) indicated an high quality of evacuation, and Figure 8 was shown an worse the quality of evacuation.

These results reflected town phase, however, the better results subjects existed in both town.

So we should be research better subjects' action more.

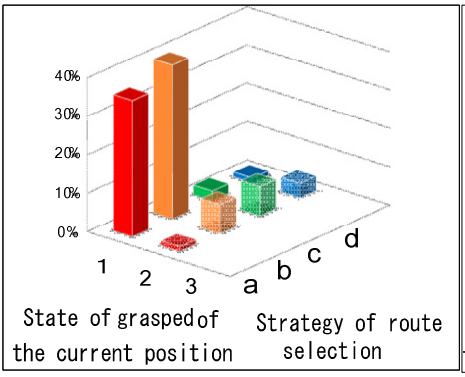

Fig. 7. The results of evacuation at small town

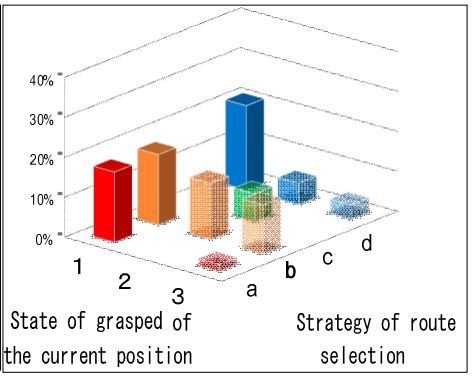

Fig. 8. The results of evacuation at complex town

We indicated one direction of the effectiveness for evaluation method for the evacuation.

3.5 e-Hazard Map

We researched other points. That is e-Hazard map. Residents are thinking that to survive a disaster while watching this map. Of course, municipalities thought that residents to avoid a dangerous place by using the map, and perform evacuation. However, existing hazard map is made of paper. Therefore, it is difficult to determine the root and to make up-to-date information. The public institutions make, there is also complained that it is difficult to use coarsely content. Go and use it to display on the tablet this. Is shown in Figure 9 is the schematic.

We made a verification experiment using the e-hazard map was 21 people. The breakdown was 12 people using e-hazard map on the Tablet(iPad air), and 9 people using usual hazard maps have been published in the paper.

Method. It had been displayed hazard information in e-hazard map as same as on usual hazard map. This is in order to compare an e-hazard map and usual Hazard Map. We had registered in the information infrastructure of our system in existing hazard information. Using the e-hazard map on the tablet, we firstly tap the current and goal location.

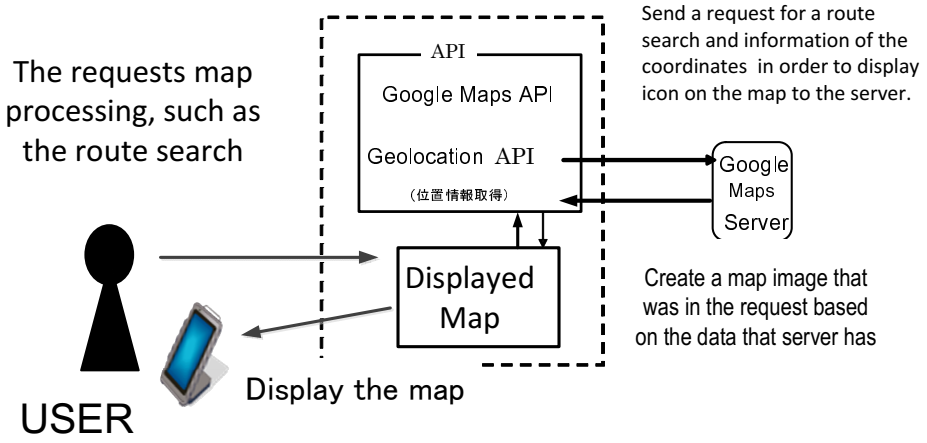

Fig. 9. The Schematic figure of the r e-Hazard map using Tablet

Route is shown by pressing the route button and then root was displayed. In the case of a hazard situation on the route or near the route, we touch on the route with the finger and shift to a safe direction. Then another route is shown. When you stop at the house of the elderly on the way, you shall tap the current location, the elderly home and the goal location. If so, then the root is shown on the order. We are shown in Figure 10 result.

Fig. 10. The example of the route changing on the Tablet

Subjects of using e-Hazard map showed the higher quality of refuge than subjects with usual hazard map. Because e-hazard subjects highly grasped the situation of the current position as compared to the usual hazard map, the route selection policy is clear, evacuation high quality are made(see Figure 11and 12).

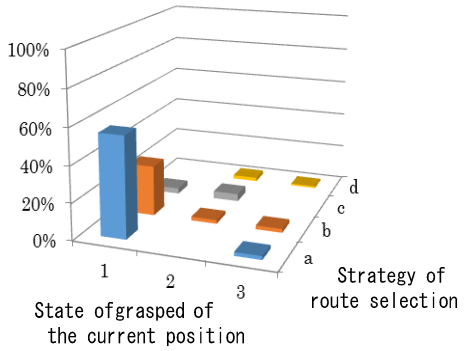

Fig. 11. The result of the using usual hazard map

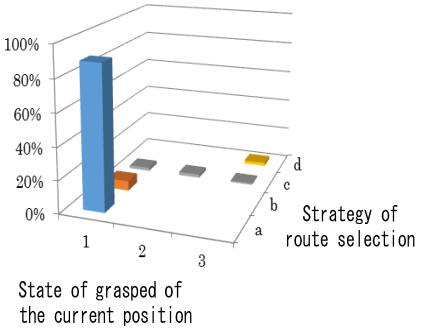

Fig. 12. The result of the using e-hazard map

The e-hazard map can be seen that the evacuation of high quality are made, we have confirmed that this effectiveness.

4 Conclusion

We proposed a mechanism of evacuation of Earthquake. In order to perform the mechanism of this evacuation, we made a support system, that is, the foundation information system of disaster. This system based on the ICT. We have experimentally verified the performance of this system. Focusing on the quality of evacuation, we built the new measurement of evacuation based on the introspection. This idea was considered by perspective of service engineering. This was verified by evacuation practice its effectiveness and was verified at an e-hazard map further.

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