Industrial Paper

Proposal on Victims Information Management System

Kosuke Akasaka [*], Takayo Namba [**], Masao Isshiki[*], and Keiichi Abe [*]
[*] Kanagawa Institute of Technology, Atsugi City, Kanagawa, Japan
[**] Tokyo Metropolitan University, Hachioji City, Tokyo, Japan
abe@he.kanagawa-it.ac.jp

Abstract - In this paper, we propose a victims information management system that collects and transmits information on disaster victims and relief needs in evacuation refuges even when the lifelines such as communication and electricity are disrupted, assuming a large-scale disaster occurrence at the Tohoku Earthquake level. In addition, we propose the management of the health status of the victims living in the refuges, and also the function that can centrally manage the refuges around the country. Since the system scale of the disaster victim information management system proposed by us is large, this paper describes the realization of a system to manage the information and health condition of victims in refuges. Also, we will describe in detail the prototype development and evaluation of the proposed system.

Keywords: Disaster, Refuge Management System, Victims, Persons requiring special care, ICT, Solar Panel

1 INTRODUCTION

At the time of past large-scale disasters such as the Hanshin-Awaji Earthquake in 1995, and the Tohoku Earthquake in 2011, it took a considerable amount of time to collect information on the victims [1]. In particular, refuge administrators couldn't capture relief needs such as the presence of refugees who need special care and their allergy information. Also, due to the disruption of the infrastructure at the time of disaster occurrence, managers were unable to make the most of the Information and Communication Technology (ICT) and its power, and they could not collect and transmit information on the victims promptly [1] [2].

In addition, past measures put more emphasis on disaster prevention (such as collapse of buildings) rather than preparation for disasters (such as securing disaster supplies). Therefore, the quality of life (QoL) of the victims has not been sufficiently considered in the long-term refuge life after the occurrence of a disaster. In fact, in the Tohoku Earthquake, there were many victims who could not cope with the refuge environment and suffered from health problems [3] [4].

Therefore, we developed the Refuge Management System (RMS) that consistently manages the health condition of victims by collecting information on disaster victims and creating an evacuation list using ICT even at the time of the disruption of lifelines such as communication and electricity [5] [6]. The final goal of this study is to develop a system that installs RMS in refuges all over the country, and uses cloud servers to centrally manage the disaster situation and relief needs in each refuge area. We call this system the “Victims Information Management System (VIMS)” and are developing it. Since the development scale of the VIMS is large, in this paper, we describe the contents of the research and development project and the realization of the system to manage personal information and health condition of the victims in the refuge currently under development.

2 RELATED RESERARCH

After the Tohoku Earthquake, research on victims’ support systems using ICT is underway by many researchers, companies and universities in various places [7].

Similar representative existing technologies include "Earthquake disaster recovery support system" provided by Microsoft [8] and “information center victim support system" provided for free by Nishinomiya city [9]. These systems collect information such as the number of victims, the proportion of men and women, safety information, etc. On the other hand, these systems are not designed to pick up and manage the needs information of persons requiring special care (patients with allergic diseases or intractable diseases, disabled people, elderly people who need nursing care, pregnant women, etc.) within the refuge. In addition, these systems have the problem that they cannot detect and manage victims who have become ill due to a long-term refuge life.

Therefore, the problems of the various disaster victim supporting systems are as follows.

① The existing disaster victim support systems cannot operate when there is a power and communication infrastructure disruption immediately after the disaster occurs.
② The existing systems cannot adequately collect the needs of persons requiring special care.
③ It is difficult to manage the presence of victims among multiple refuges.
④ The QoL of the victims declines in refuge life.
⑤ It is impossible to centrally monitor damage situation of each refuge and relief needs in real time immediately after the disaster.

The VIMS proposed in this paper aims to solve problems ① to ④.

3 VICTIMS INFORMATION MANAGEMENT SYSTEM (VIMS)

In refuge support, the measures to be taken in refuges change with the passage of time from the occurrence of the disaster. For example, even if the power and communication infrastructure are cut off immediately, it is necessary to

quickly grasp the situation of the victims in the refuges and inform external organizations of the situation after the occurrence of a disaster. On the other hand, there are many victims who are forced to live in refuges even after the restoration of infrastructure is completed and a long time has passed since the disaster occurred. For such victims, refuge managers need to manage their health status and prevent infections, economy class syndrome and so on. Furthermore, it is also necessary to grasp the damage situation regarding the collapse of the houses owned by the victims with the passage of time.

Therefore, in this research, as shown in Fig. 1, research and development are being carried out in the following four phases aiming for the realization of the final goal, VIMS. We assume that Phase 1 of VIMS will collect victim information, send it to Disaster Countermeasures Headquarters, and manage it in shelters immediately after a disaster occurs. We suppose in Phase 2, there are determined the transported destination and refuge spaces of the victims appropriately from the disaster situation and medical condition of them. We assume that in Phase 3 we will manage the health status of victims in long-term refuge life in real time. In Phase 4, we will devise a system that is able to monitor centrally the disaster situation and relief needs in a large area refuge. The main feature of VIMS is the support and management of victims in single system, from the immediately after a disaster occurs to the long-term shelter life. This feature is not found in the existing technology, so it can be said to be a great strength of this research.

Specifically, we will develop the Refuge Management System (RMS) corresponding to Phase 1 to Phase 2 shown in Fig. 2 and aim to install the proposed RMS at evacuation sites all over the country. The final goal is to realize a system that visualizes the disaster situation of refuges nationwide and the relief needs information of the victims by listing the victim information collected by the RMS as a cloud server by wireless communication etc. and mapping it with map information. In this paper, we describe the research results of Phase 1 and Phase 2 of this research project and the overall concept of the information management system of the victims in the refuge.

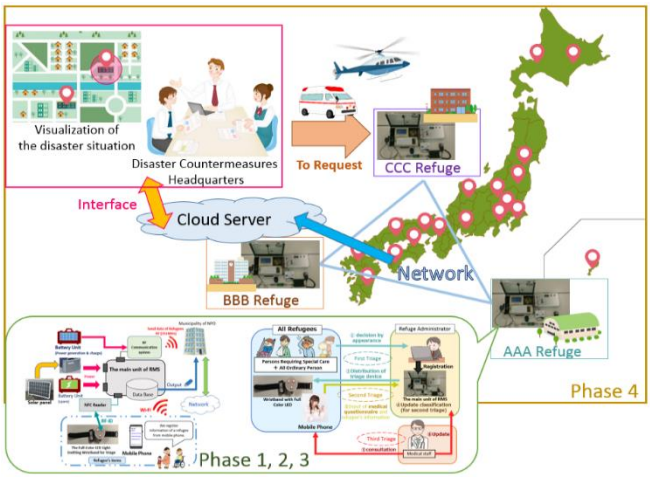


Figure 1: Outline diagram of VIMS

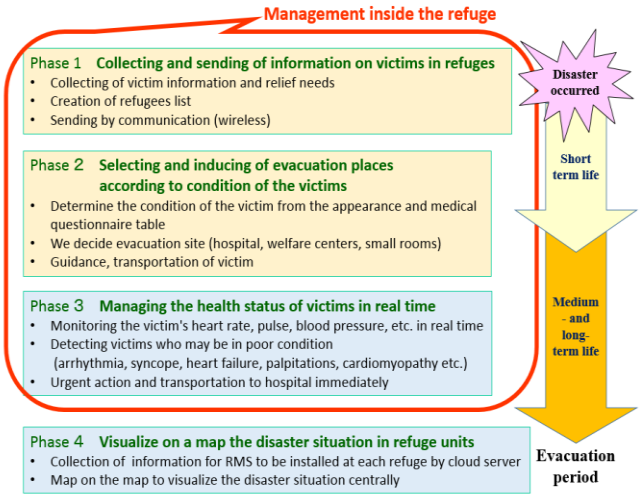


Figure 2: Phased timeline

4 REFUGE MANAGEMENT SYSTEM (RMS) DEVELOPMENT CORRESPONDING TO PHASE 1

Chapter 4 describes the design concept and system development for the RMS corresponding to Phase 1 of the VIMS research and development.

4.1 Concept of RMS for phase 1

We designed RMS with the following concept.

I. The system user

The administrator of the RMS is preferably a civil servant etc. Because, the administrator deals with victim information.

II. Collection and management of victim information

We assume that the installation site of the RMS has a capacity of about 1000 individuals per refuge, such as schools and community centers.

III. Power supply of RMS

Lead battery units charged with electric current generated by solar panels are used as the power source of the RMS. this makes the RMS available even when the infrastructure is not working.

IV. Data collection content

The contents of data to be collected shall be the name, address, gender, age, nationality, emergency contact information, damage situation, and stockpile status of evacuation supplies, items requiring long-term care (pregnancy, chronic illness, and allergy). These items of information concerning the necessary nursing care were added to the questionnaire because they were actually used at the refuges of the Tohoku Earthquake. Additional items to be entered include a User Identifier (UID) to identify the victim and a questionnaire to confirm the health condition. These information is input by victims themselves or staff members who support refugees.

V. Identification for victims

As a method to identify each victim, we use the UID of NFC (Near Field Communication) or RF-ID information with a full-color LED light-emitting wristband distributed in the refuge. By using these data to manage entry and exit in the refuge, we can grasp the situation of the victim's presence in the refuge and track transfer of other victims to other refuges.

VI. How to send victim information

We consider two patterns of transmission methods for victim information when the communication infrastructure is not working. The first method is to connect a wireless unit (simple type radio, amateur radio) to the RMS. By this method, we can send information to the national disaster response headquarters using character data in JSON format or CSV format through any communication protocol. Another way is to save it in a USB flash memory and take it out. After the infrastructure is restored, the system can acquire the victim information through the Internet.

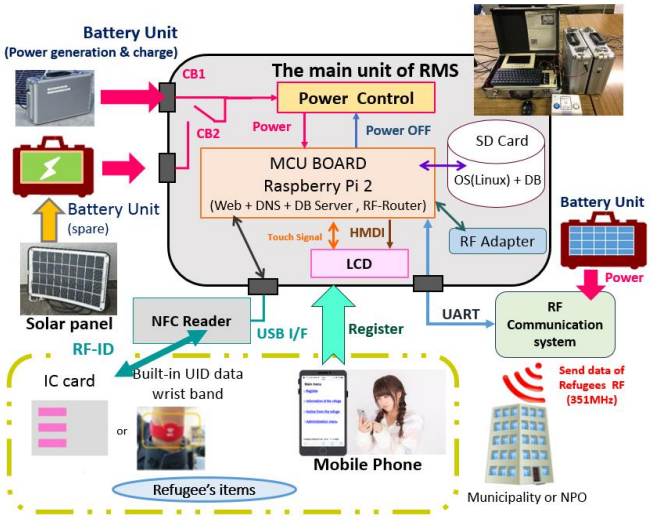
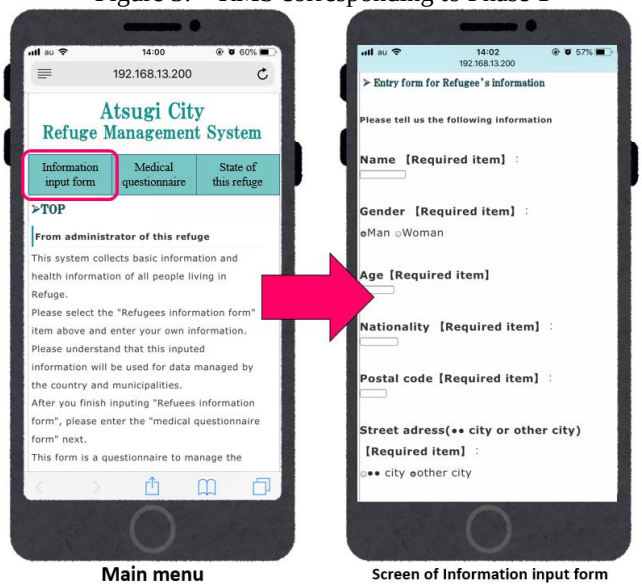


Figure 3: RMS corresponding to Phase 1



Main menu Screen of Information input form

Figure 4: RMS prototype

VII. Communication method between RMS and various information terminals

When inputting victim information, Wi-Fi is used for the communication between the information terminal such as a smartphone and the RMS. If the number of connections with information terminals is insufficient, we can increase the number of repeater devices.

4.2 Refuge Management System (RMS)

In R & D for Phase 1, we prepared an outline design of the refuge management system. The outline is shown in Fig. 3. A commercially available microcomputer board Raspberry Pi Model B (RPI) was used for RMS hardware. We installed an embedded Linux OS (Raspbian) on this hardware and designed a system that can launch Graphical User Interface (GUI) applications. The reason for adopting embedded Linux on hardware is to save power of the RMS itself. The power consumption of an ordinary notebook PC is about 40 ~ 50 [W], which can be reduced to about 1/10 by using RPI. In addition, with regard to the information input of evacuees described in Design Concept Ⅳ, it is necessary to allow for the input of refugee’ s information from a web browser on a smartphone or mobile phone owned by the victims. Therefore, we constructed a web server using apache2 and developed a PHP application for a disaster victim information input screen. As shown in Fig. 3, the refugee’s information registration application was developed using a server-side application that does not depend on the client environment so that victim's information can be input from the WWW browser installed on the client side.

Victims are requested to input personal information such as the name, address, gender, and age using the input screen shown in Fig. 4. In addition, we have added selective buttons asking whether or not the respondent is a pregnant woman, a person with a disability, or requires nursing care, etc., as well as check boxes to input food allergy determined by law [13]. (Wheat, egg, milk, buckwheat, shrimp, crab, peanut, etc.) In consideration of a more detailed description and answer which doesn't correspond to any items, we have also provided a text box for free description. By summarizing such information, it is possible to create a victims roster including the relief needs within the RMS. Based on the above, we will realize a system that picks up the relief needs of the affected people, including those with special needs, and will eventually solve Problem ② in Chapter 2.

By the way, the system of Phase 1 assumes operation at an actual refuge. Therefore, the system must be able to operate even when the power infrastructure is not working. Therefore, we will develop a battery unit with a solar panel and a lead storage battery as the power supply of the RMS, and use two or more such battery units to operate the system. The operation method is described in the next section.

In addition, we developed a method for managing the evacuation using the RMS in preparation for the case where victims irregularly enter or exit from the refuge. We conceived the idea of using NFC cards which the victims usually carry with them. Typical examples of the NFC cards include Edy and Suica etc., and the total number of NFC cards issued in Japan was 33.346 million as of January 2017 [11].

From such background, we thought that we could use an NFC card effectively as a victim's personal identification. Entering and exiting of refuges for victims is done by holding the NFC card over the NFC card reader. By associating the UID of NFC with the already registered victim information in the RMS, it is possible to quickly manage the entry and exit of each victim.

The refugee's roster created by the RMS is organized as an electronic file, and can be saved in a CSV format and a JSON format on an electronic medium such as a USB flash memory. As a result, the data list of evacuees can be taken out to external facilities such as the disaster response headquarters. In addition, amateur radios and simplified radios which are available for the communication even during a large-scale disaster can be connected to the RMS with a serial cable to send a relief request to the disaster response headquarters.

4.3 RMS Prototype to Phase 1

Figure 5 shows an outline of the proposed RMS prototype system. The RMS consists of an RMS server, a battery unit, an NFC reader panel, and a wireless communication device. The main power of the RMS server is supplied from the battery unit. By connecting this unit to a solar panel, the generated electricity can be stored in the lead battery. The lead battery unit is made of an attachment case containing a lead storage battery and a thin solar panel, making it easy to carry. The battery unit requires a minimum charging time of 5 hours under fine weather condition. In order to operate the RMS power supply in the long term, we developed two lead battery units which should be used alternately.

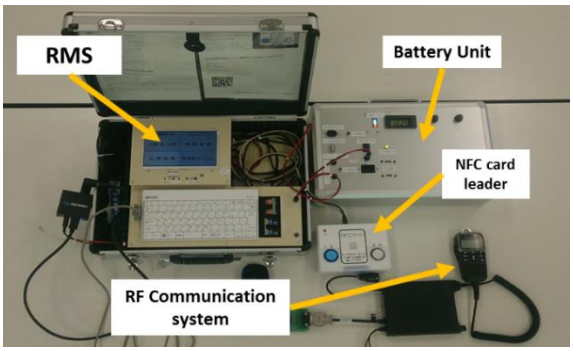


Figure 5: RMS prototype

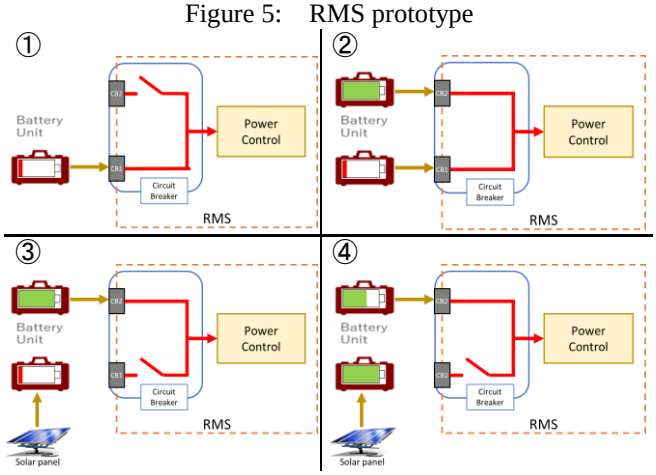


Figure 6: Replacement method of the battery unit

Table 1: Criteria and classification of triage for persons requiring special care [12] [13]

color classification	Class	Decision Criteria	Area
1 (Orange)	Person who needs urgent treatment	Injuries with bleeding Fever, Diarrhea, Nausea, Vomiting, Dialysis patient , Oxygen suction patient	Hospital
2 (Pink)	Person who needs full assistance in daily life	Person who can't eat, walk or excrete independently Bedridden person	Welfare center
3 (Purple)	Person who needs some assistance in daily life	Pregnant women Infants under 3 years of age Half paralyzed person People with intellectual disabilities Wheelchair user	Small room (classroom etc.)
4 (Blue)	People who can act without problems	Person who can walk independently	Large room

Figure 6 shows the procedure for replacing the RMS lead storage battery. The system user confirms that the voltage of the battery unit in use has fallen by looking at the indicator lamp of the battery (Fig. 6 ①). The user then connects the charged battery and performs manual circuit breaker replacement. This makes it possible to replace the battery without shutting down the server power (② and ③) . At the same time, the user charges the low voltage battery using the solar panel (④). By alternately performing these operations, we enabled the RMS to operate for a long time. We actually operated the system using this method for a week. As a result, there was no problem with the RMS MCU. Also, we confirmed that the operating time can be extended without shutting down the system power.

This will allow the RMS to operate even when the power and communication infrastructure are disrupted, and we believe that we can solve Problem ① in Chapter 2.

5 RMS DEVELOPMENT CORRESPONDING TO PHASE 2

Chapter 5 describes the contents corresponding to Phase 2 of the VIMS research and development. Specifically, we developed a system to perform color coding according to the physical and mental condition of the affected people, including persons requiring special care. In addition, we will explain the method to guide victims to appropriate living spaces in the refuge based on judgment from their physical conditions.

5.1 Triage for Persons Requiring Special Care

As prior research corresponding to phase 2 of this paper, M. Ohara. *et al.* proposed "Triage for persons requiring special care" [12] [13]. Table 1 shows the criteria of triage for persons requiring special care proposed by M. Ohara. The table provides decision criteria for the leader of the residents to decide the room allotment for persons requiring special care when entering the evacuation refuge and the priority of

transfer to the welfare evacuation refuge. It is different from the Simple Triage and Rapid Treatment method. The proposed triage method uses four colors: orange, pink, purple and blue. Because of this, the colors do not mix, so the two triage methods can be used simultaneously.

5.2 Problem of the proposed triage and solution

This time, we considered an RMS that incorporated the "triage method for persons requiring special care " proposed by M. Ohara et al. In small-scale refuges, medical staff may not be present. Even under such circumstances, we consider it is necessary to use the proposed triage to make classification decisions according to the condition of the affected person smoothly. So, we have devised a system that will determine color classification automatically to some extent even without medical staff, by having the victims respond directly to an electronic questionnaire.

Considering persons requiring special care to change their condition, our proposed electronic questionnaire form (e-questionnaire) is a system that can respond anytime during the life of a refuge after a large-scale disaster. This makes it possible to constantly monitor and check the health status of the victims.

A full-color LED light-emitting wristband is used as a method for identifying the condition of the victim. As a result, the target person in victims can be instantly identified by the color of the LED light, so refuge staffs can quickly navigate them to the appropriate refuge space. However, if the subject is color-coded by triage, the surrounding eyes may be worrisome, which may lead to mental and psychological stress. For this reason, we have developed a system that allows victims to identify triage colors by emitting light only when necessary using a full-color LED light-emitting wristbands distributed by the refuge staffs.

5.3 Positioning of Related Research and Our Proposal Methods Concerning Triage

By the way, various companies and universities are currently studying electronic triage devices for use in emergency medical environments during disasters [14] [15]. A typical example is the “Electronic Triage Tag” developed by T. Higashino et al [16] [17]. This is a system in which a sensor device with a small CPU is installed in a device that measures the pulse, respiratory rate, blood oxygen concentration (SpO2), etc. of injury persons. This enabled START (Simple Triage and Rapid Treatment Triage) method assessment to be performed on the device. In addition, it is a system that can monitor the position and medical condition of the victim in real time by transferring their data to the server via the ad hoc network.

Compared to these studies, our proposed system has many similarities in terms of managing the health of victims using triage. However, the proposed system has a different use from the traditional electronic triage system. This is based on the “triage method for persons requiring special care” proposed by M. Ohara, and is intended for all victims living in refuges for a long time after the disaster.

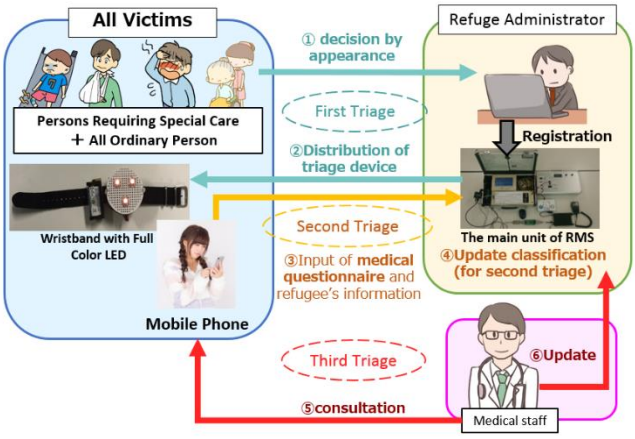


Figure 7: Victims Management Triage

Therefore, in the phase-2 system of this proposal, we have devised a system of additional functions combining the " triage method for persons requiring special care " proposed by M. Ohara with the RMS of phase 1 and a full-color LED light-emitting wristbands described above.

5.4 Victims Management Triage（VMT）

The method proposed by M. Ohara is a two-step classification method including the "primary triage" to judge by appearance, followed by the "secondary triage" based on the decision of medical staff [13]. On the other hand, the triage we propose is a three-stage system, which we call the Victims Management Triage (VMT). Figure 7 shows the VMT system. Section 5.3 describes how to use the VMT. Figure 7 shows the management method in the refuge using the VMT. This system should be used at least three times to perform three types of triages which we call “First Triage”, “Second Triage”, and “Third Triage”. "First Triage" is an initial classification by refuge administrators and staff. "Second triage" is done by the evacuees themselves by entering the questionnaire. After that, the method of making a judgment based on medical examination by a doctor etc. is called "Third Triage". We describe the method of each triage below.

In the first triage, the refuge manager and staff will determine the triage classification from the appearance for all victims entering. At this time, the staff will distribute a full-color LED light-emitting wristbands (VMT wristbands) to all victims. The reason for judging the status of evacuees only by appearance in the first triage, is to prevent congestion at the entrance and reception of the refuge.

After several hours from the start-up and looking at the people inside the refuge, the second triage is performed at an arbitrary timing. In the second triage, victims can enter mental and physical information by selecting the item of the e-questionnaire table from the RMS registration application shown in Fig. 8. Concretely, they register their personal information (name, address, disaster situation etc.) in the RMS, and at the same time, make an inquiry by self-report which inputs the health condition such as the presence or absence of injury or disease.

The third triage is to re-determine the classification from the information obtained by the second triage and from the

consultation of victims by a patrol doctor and medical staff. Because the conditions of all victims change with the long-term life in the refuge, the e-questionnaire table can always be changed by the victims themselves, and the color of the triage can be instantly updated according to the condition of the person requiring consideration or the judgment of the traveling doctor.

At this time, the refuge administer can easily find the person who corresponded to the 4 triage colors by turning on the switch of their VMT wristbands. As a result, the staff will be able to quickly guide the victims to the appropriate evacuation space. On the other hand, when the transport destination such as a hospital or a welfare facility is not ready, the victim turns off the light of the VMT wristbands and stands by at a waiting place or the like until the preparation is completed.

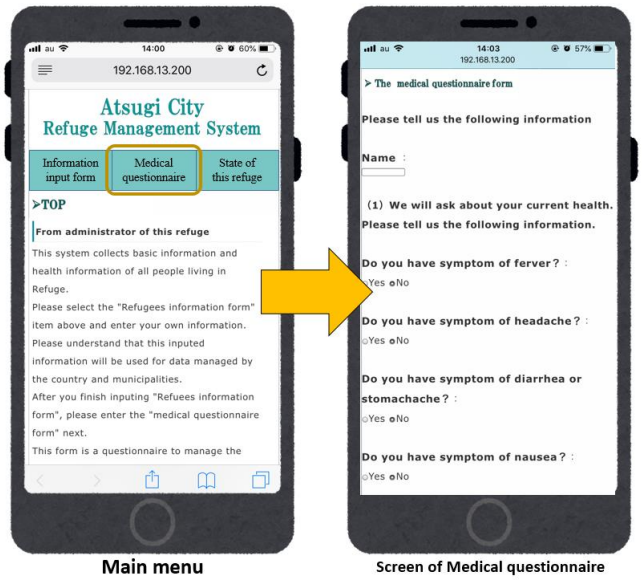


Figure 8: Screen of Medical questionnaire

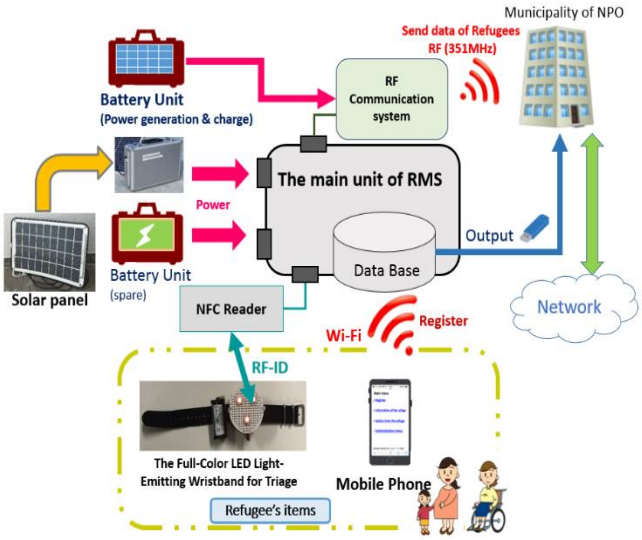


Figure 9: RMS for Phase 2

Table 2: Classification colors for VMT and handling method

Medical Questionnaire	Class (Color)
・ MQ1: Two or more items selected from fever, headache, abdominal pain (diarrhea), and nausea. ・ MQ1: A total of four or more items selected ・ MQ4: "Treatment required within 3 days" selected	1 (orange)
・ MQ2: "Inoperable without assistance" selected for two or more items	2 (pink)
・ MQ1: 1~3 items selected from the 7 items ・ MQ2: "Some actions require assistances" selected for two or more items (Accepting up to one caregiver) ・ MQ3: Pregnant woman (9 months ~) or a family with an infant ・ MQ4: "No treatment required within 3 days" selected ・ The person who should move to a private room according to judgment by the administrator based on the contents of the description column	3 (purple)
・ MQ3: Pregnant woman (~8 months) ・ Person who can stay in a large room according to decision by the administrator or medical staff based on the content of description	4 (blue)

5.5 e-questionnaire table from the RMS

Figure 8 shows the registration screen of the electronic questionnaire. By answering this electronic questionnaire, the RMS automatically performs the VMT. Table 2 shows triage classification criteria for the answers of the electronic questionnaire.

As a specific criterion for the triage from e-medical questionnaire, the e-medical questionnaire form has four question items: "MQ 1: health information", "MQ 2: presence / absence of assistance in daily behavior", "MQ 3: prepartum / postpartum women", and "MQ 4: existing medical treatment (such as a chronic illness) ". We will explain each check item in detail. In MQ 1, the respondent is asked to select any symptom that applies to him/her from the seven items of fever, headache, abdominal pain (diarrhea), nausea, dizziness, cough (sputum), and runny nose. MQ 2 is a question about whether the respondent requires assistance in any of the three items of walking, meals, and excretion. The answer is selected from three options: "no problem", "some actions require assistances", and "inoperable without assistance". MQ 3 is an item that asks whether or not the respondent is pregnant or has any infant, and if applicable, whether the pregnancy period has exceeded nine months. MQ 4 is an item that asks whether a medical treatment such as dialysis and medication is necessary, and whether the treatment is necessary within 3 days. Also, in consideration of detailed descriptions and answers that do not correspond to any items, a text box for free description is provided. The RMS automatically determines the color of the division into the triage based on the criteria of Table 2 from the answer result of this e-examination table.

It is thought that this will solve Problem ④ " The QoL of the victims declines in refuge life " mentioned in Chapter 2.

5.6 RMS and triage wristbands Prototype System of VMT

An outline of the VMT prototype proposed in this paper is shown in Fig.9. The VMT is a system that adds the proposed VMT operation functions and the LED wristband to the RMS of Phase 1. The information input screen of a person requiring consideration and the questionnaire for confirming the health condition can be accessed from a WWW browser installed on an information terminal such as a smartphone. In addition, the administrator distributes VMT wristbands to all evacuees. In order to identify persons who are color-coded, we devised VMT wristbands so that it indicates the color code of each person by LED emission and helps to smoothly guide the person to an appropriate refuge spaces. We adopted IEEE802.15.4 standard wireless communication for communication between LED wristband and RMS. The reason for adopting this standard is that it can be connected to more than 40,000 nodes theoretically in addition to lower power consumption than the Wi-Fi standard.

Figure 10 shows an overview of the LED wristband system developed this time. We used a commercially available microcomputer AT mega328P for the wristband Micro Control Unit (MCU). Also, the development of the AT mega328P microcontroller was done in Arduino-like C language. We also used IEEE802.15.4 standard XBee for the wireless communication module of this system. We communicated by defining the Xbee on the RMS side as the coordinator and the Xbee on the full color LED wristband side as the device.

Figure 11 shows the communication procedure between the RMS and VMT wristbands. We designed the RMS to transmit a request command to VMT wristbands so that the emission color of the LED can be changed as needed. We defined the command length of this system as 10-byte character data. The 10-byte character data includes 7 bytes as the device number, 1 byte as the color code, and the remaining 2 bytes as the delimiter (combination of CR and LF). The device number is the unique ID of VMT wristbands and is treated as hexadecimal characters. The color code is O, P, M, or B in order from class 1 to class 4 for VMT in Table 2, and the system lights the LED in the color corresponding to the input code.

Figure 12 shows a wireless communication system between the RMS main unit and a VMT wristband. Wireless communication between devices is performed by the RMS main unit acting as the coordinator and a VMT wristband acting as the end device. Also, if data on a VMT wristband is difficult to reach, the refuge manager can use a router device for relaying. This enables the system to communicate with all victims.

6 QUESTIONNAIRE EVALUATION OF VIMS

At Kanagawa Institute of Technology Academy Festival and open campus, we conducted a questionnaire evaluation of the prototype system for the RMS which is the solution method of Phase 1, and the VMT which is the solution method of Phase 2. We conducted this questionnaire after introducing the outline of this research and the demonstration of the prototype. Chapter 6 describes the contents and results of the questionnaire evaluation regarding them.

6.1 Questionnaire Evaluation on Phase 1 Prototype

Questions in the Phase 1 prototype (RMS) correspond to questions Q1.1 to Q1.3 shown in Table 3. The questionnaire target was 38 individuals who visited the RMS exhibits. In this questionnaire, Question 1.1 (Q1.1) and Question 1.2 (Q1.2) are four choices. Also, we asked the respondents to describe and answer Question 1.3 (Q1.3) arbitrarily. For the results for Q1.1 and Q1.2, the number of answers to the question is treated as a score, and the result of them is shown as a column graph with each average score (the full score is 4.00 points) in Fig. 13.

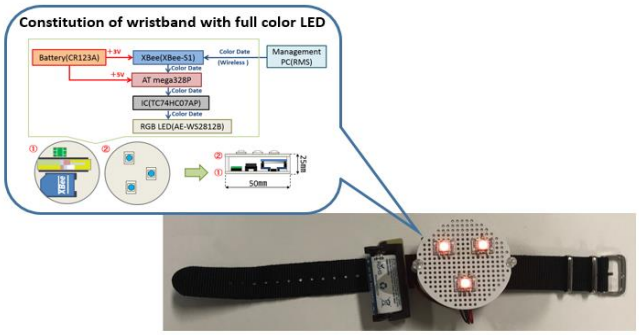


Figure 10: A full-color LED light-emitting wristband system

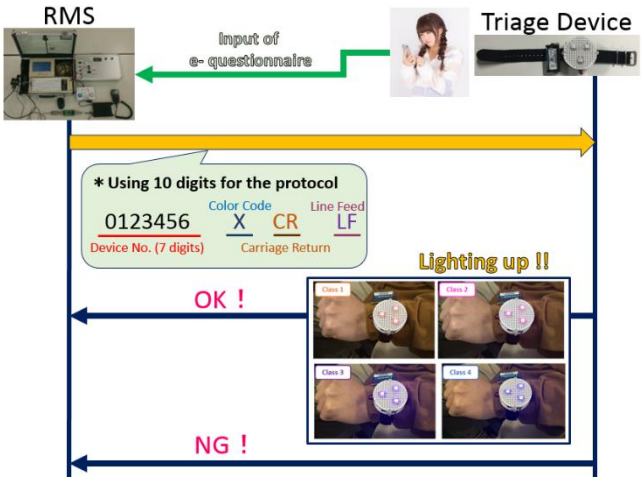


Figure 11: Communication procedure between RMS and VMT wristbands

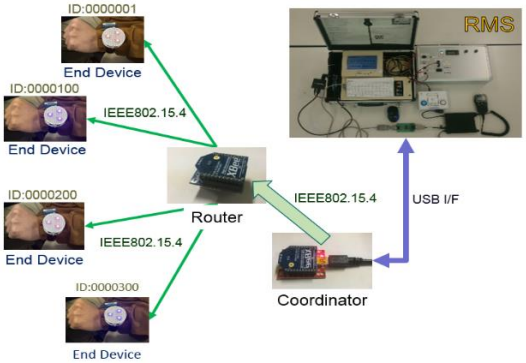


Figure 12: Wireless communication system between

Table 3: Questionnaire questions on VIMS prototypes

	Contents
Q1.1	Did you understand the outline of RMS? 4 : Good 3 : Neither 2 : Poor 1 : Very poor
Q1.2	Do you feel like using this system when a large-scale disaster occurs? 4 : Good 3 : Neither 2 : Poor 1 : Very poor
Q1.3	Please tell us about opinions and requests about RMS. (descriptive expression)
Q2.1	Was it easy to input evacuation information and fill in *e-medical questionnaire form* on the RMS? 5 : Very good 4 : Good 3 : Neither 2 : Poor 1 : Very poor
Q2.2	Do you think that VMT is necessary after listening to the explanation of the electronic triage for persons requiring special care? 5 : Very good 4 : Good 3 : Neither 2 : Poor 1 : Very poor
Q2.3	Do you think the quantity of items in the VMT evacuation information and e-medical questionnaire form is appropriate? ・ Too much ・ Much ・ Appropriate ・ Less ・ Too less
Q2.4	What other kinds of people do you think need consideration other than the consideration items listed in "Decision Criteria" in Table 1 (of this paper)?

In Q1.1 "Do you understand the outline of RMS?" 29 answered "Very good" and 8 answered "Good". It was found that 97% of the visitors understood the system. Also, the average score for this question was 3.74 points.

In addition, for Q1.2, "Do you feel like using this system when a large-scale disaster occurs?", 21 visitors responded "Very good", and 9 responded "Good". On the other hand, it was thought that about 20% of the visitors could not decide to use this system because there were 7 non-responders. The average score for Q1.2 was also 3.64 points, and it was found that more people felt dissatisfaction than Q1.1. We asked the reason for one visitor who answered "Poor" in this question. As a result, he said "Because RMS and battery unit are a bit heavy."

Furthermore, the following answers were obtained in response to the question Q1.3 "Please let me know if you have any feelings, opinions or requests about the refugee management system".

- Pet information should also be included in the RMS.
- It is better to reflect facial pictures on the RMS.
- The system should also be available at a time other than when a disaster occurs.

6.2 Questionnaire Evaluation on Phase 2 Prototype

Questions in the Phase 2 prototype (VMT) correspond to questions Q2.1 to Q2.4 shown in Table 3. The questionnaire target was 20 individuals who visited the RMS exhibits. The answering method was to distribute the questionnaires asking questions Q2.1 to Q2.4 and to have the visitors fill in the questionnaire after the demonstration, as in the method described in the previous section. Questions 2.1 (Q2.1) to 2.3 (Q2.3) are five choices. Also, we asked the respondents to describe and answer Question 2.4 (Q2.4) arbitrarily. For the results, the number of answers to the question is treated as a score, and the result of them is shown as a column graph with each average score (the full score is 5.00 points) in Fig. 14(Q2.1&Q2.2) and shown as a pie chart Fig. 15(Q2.3).

As for the medical questionnaire about Q2.1, 10 visitors responded "Very good", 6 visitors responded "Good", 2 visitors responded "Neither", and 2 visitors responded "Poor" about Q2.1 "Was it easy to input evacuation information and fill in e-medical questionnaire form on the RMS?". Also, the average score for Q2.1 was 4.20 points.

Next, about Q2.2 "Do you think that VMT is necessary after listening to the explanation of the electronic triage for persons requiring special care?", 14 visitors responded "Very good", 6 visitors responded "Good". There was no one who answered "Neither", "Poor" and "Very poor". Also, the average score for Q2.2 was 4.70 points.

On the other hand, about 50% of the respondents answered "appropriate" to Q2.3 "Do you think the quantity of items of the VMT evacuation information and e-medical questionnaire form is appropriate?" The remaining 50% answered "too much" or "much".

As for Q2.4 "What other kinds of people do you think need consideration other than the consideration items listed in "Decision Criteria" in Table 1 (of this paper, section 5.1)", there was an opinion that "children unattended by their parents also need consideration".

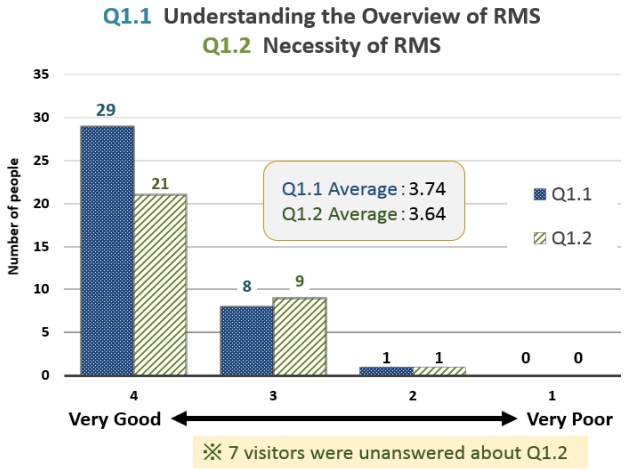


Figure 13: Results of Questionnaire (Q1.1 & Q1.2)

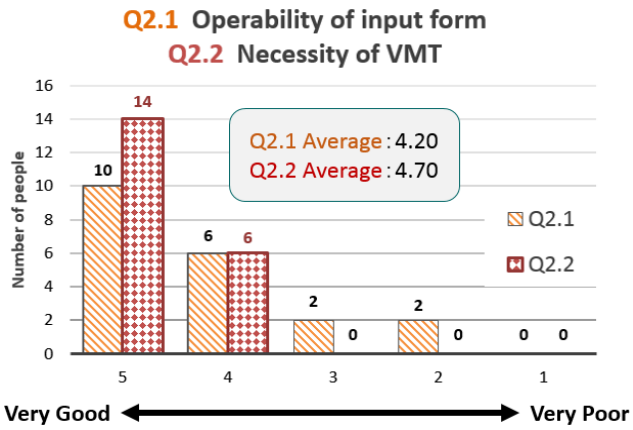


Figure 14: Results of Questionnaire (Q2.1 & Q2.2)

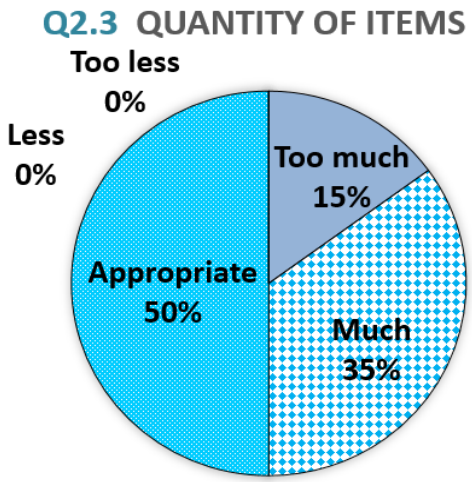


Figure 15: Results of Questionnaire (Q2.3)

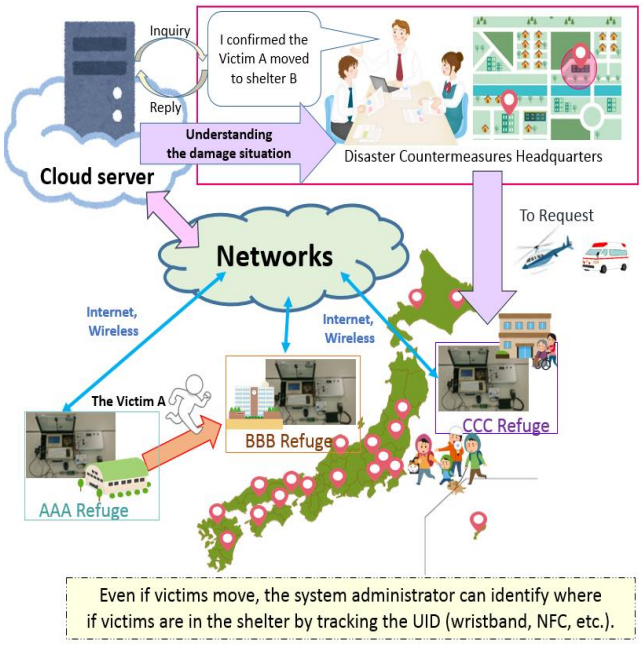


Figure 16: Attendance management method of victims in refuges nationwide

6.3 Conclusion of Questionnaire Evaluation

As a result of conducting the questionnaire about the prototype system of Phase 1 and Phase 2, it is thought that many people highly appreciated the significance of the proposed VIMS system. Also, the average score was high in both Phase 1 and Phase 2. Above all, in the questionnaire on VMT in Phase 2, it was found that 100% of people understood the necessity of this research.

On the other hand, as there were also suggestions regarding this system, we also felt that it is necessary to study and improve it in the future.

7 CONCLUSION

This paper described the realization of the Victims Information Management System (VIMS), which centrally manages the disaster situation and the relief needs (including the need for relief for persons requiring special care) in refuge areas around the country. Since this VIMS is a large-scale system, we are conducting research in four phases, and promoting development toward the final goal of realizing the VIMS. Therefore, in this paper, we described in detail Phases 1 and 2 completed as prototype development.

In Chapter 4, we proposed an RMS corresponding to Phase 1 (“The existing disaster victim support systems cannot operate when there is a power and communication infrastructure disruption immediately after the disaster occurs”), and a method for collecting and sending the relief needs in conjunction with a solar charging unit. We also proposed a system to manage entry and exit in refuges using UID management owned by the victims.

We proposed VMT for Phase 2 (“The existing systems cannot adequately collect the needs for persons requiring special care”) in Chapter 5. Specifically, we have proposed a system that mechanically determines the health status of victims from electronic questionnaires, and selects and guides the victims to evacuation spaces according to the patients' status.

In addition, a questionnaire survey on the prototype development of Phase 1 and Phase 2 of the VIMS research and development confirmed the effectiveness of this proposed system because many people answered that this proposed system is necessary.

Therefore, it is thought that Problems ① to ④ of the existing victim support systems mentioned in Chapter 2 can be solved by the contents of Phase 1 and Phase 2. The solution to Problem ③ was not described in detail in this paper, but as shown in Fig. 16, we consider that this can be solved by installing the proposed RMS at refuges around the country as well as connecting the RMS via a network and centrally managing it with a cloud server. By using the UID of the victims and the evacuation entry and exit management information, system administrators can track victims and check their presence.

In the future, we plan to study a system to acquire biological information of the victims in the refuge corresponding to Phase 3 and manage their health. In addition, we are developing an application that visualizes disaster information and disaster relief needs in a unified manner by mapping on a map the disaster victim information obtained from the RMS in various locations corresponding to Phase 4.

REFERENCES

[1] Ministry of Internal Affairs and Communications of Japan : “Survey result report on evacuation support of people who need assistance during disasters ” , (Mar.2009). <http://www.shakyo.or.jp/research/2014_pdf/20140530_jisedai.pdf >

[2] Cabinet Office Government of Japan : “Survey result report on promotion of comprehensive measures on evacuation” <http://www.bousai.go.jp/kaigirep/houkokusho/hinan_taisaku/houkoku.html>, (Sept.2016).

[3] Article 8, Paragraph 2 of the Disaster Countermeasures Basic Law of Japan, <http://www.japaneselawtranslation.go.jp/law/detail_main?re=01&vm=04&id=3092>

[4] Information and Communication Technical Committee in Japan : “"Security guideline for ICT tool (cloud service) useful for large-scale disaster response” , First Edition,

[5] K.Akasaka, K.Abe et al., “ Development and evaluation of Refuge Management System using ICT at the time of Large scare disaster (In Japanese) ” , Information Processing Society of Japan, CDS, Vol.7, No.3, pp.15‐25, (Sept.2017).

[6] K.Akasaka, K.Abe et al., “ Proposal on Refuge Management System for Large Scale Disaster for Persons requiring special care by using triage ” , IEEE BigComp2019 proceedings, pp.525-531, (Feb. 2019)(ISBN:978-1-5386-7789-6).

[7] Microsoft of Japan : “About the earthquake disaster recovery support system” , <http://www.microsoft.com/ja-p/citizenship/disasterrelief/ default.aspx>

[8] A.Hamamura, N.Egusa et al., : “ AkariMap : Evacuation Support System for Everyday Use in Offline Environment (in Japanese) ” , IPSJ DICOMO 2014,pp.2070-pp.2078, (Jul.2014).

[9] Nishinomiya City Urban Improvement Corporation : “ Outline of evacuees support system ” , <http://www.nishi.or.jp/homepage/n4c/hss/>

[10] N.Kosaka et al., “Applicability Assessment of An Emergency Management Support System “KADAN”” , IEEE BigComp2019 proceedings, pp.532-537, (ISBN: 978-1-5386-7789-6), (Feb. 2019).

[11] Bank of Japan Settlement Agency Settlement Trends, <https://www.boj.or.jp/statistics/set/kess/release/2017/kess1703.pdf>, (March 2017).

[12] M.Ohara , et al., : “Residents in the evacuation center at the occurrence of a disaster Efforts of people who need assistance triage ” , Japan Disaster Reconstruction Association Journal, Volume No. 10 Vol.6-No.1, pp. 19-24, (Jun. 2014).

[13] Cabinet Office Government of Japan : “Guidelines for securing and managing welfare evacuation shelters”, (April 2016). <http://www.bousai.go.jp/taisaku/hinanjo/pdf/1604hinanjo_hukushi_guideline.pdf>

[14] H.Kojima, K.Nagahashi, K.Okada, “Proposal of the Disaster-Relief Training System Using the Electronic Triage Tag”, Advanced Information Networking and Applications (AINA) 2011 IEEE International Conference on, pp. 256-263, DOI: 10.1109/AINA.2011.104 (2011).

[15] T.Massey, “The Design of a Decentralized Electronic Triage System”, <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1839501/>, (2006).

[16] T.Imarura, T.Higashino *et al.*, : “ Evaluation of Electronic Triage Tag to observe injured person’s condition in Real Time *(In Japanese)* ” , SIG Technical Reports, 2010-MBL-53 -No.5, pp.1‐8, (Mar. 2010).

[17] N.Kiyama, T.Higashino *et al.*, : “ An Advanced Electronic Triage System for Rescue Operations in Disaster *(In Japanese)* ” , Information Processing Society of Japan, Vol.51-No.9, pp.1916–1926, (Sep. 2010).

(Received November 22, 2019)
(Revised February 5, 2020)

Kosuke Akasaka received the B. E. degree from Kanagawa Institute of Technology in 2018. He is currently engaged in research on ICT disaster support management systems at Department of Electrical and Electronic Engineering, Graduate School of Engineering, Kanagawa Institute of Technology.

Takayo Namba received Ph.D. from Nagano College of Nursing in 2009. She was a professor of the faculty of nursing, Kanagawa Institute of Technology from Apr.2017 to Mar.2019. She has been a researcher of the faculty Health Science since Apr.2019. Her research interests about Elderly Abuse and Co-dependency, Educational program and Visiting nurses. She is a member of the Japan Academy of Nursing Science and the Japan Society for Health and Welfare etc.

Masao Isshiki Ph.D Prof. Professor of Kanagawa Institute of Technology since 2011. Director of Smart House Research Center since 2012. JSCA HEMS-Task Force chairman since 2011 and also working for many chairmen of METI, MIC and MLIT. Project professor of Keio University

since 2009 to 2015 responsible for W3C/keio site manager. Fellow of ECHONET Con-sortium. Masao holds a Ph.D. degree in heat transfer engineering from the Tokyo University of Agriculture and Technology, and a master's degree in mechanical engineering from the University of Tokyo Institute of Technology. He currently lives in Tokyo, Japan.

Keiichi Abe received Ph. D. in informatics from Shizuoka University in 2012. He has been an associate professor of the Faculty of Creative Engineering, Kanagawa Institute of Technology since 2016.His research interests include smart system using IOT technology, Interactive system using Robot and CG, and Victims Information Management System at Large Scale Disaster, HEMS. He is a member of Information Processing Society of Japan, the institute of Electronics, Information and Communication Engineers of Japan and a member of IEEE.