<u>**Regular Paper**</u>

# Development of a Safety Confirmation Collection System in a Time of Disasters Using Q-ANPI Service Linked with Web Interface

Mitsuki Sano*, Keiichi Abe*

* Kanagawa Institute of Technology, Atsugi City, Kanagawa, Japan
abelab.sano.0914@gmail.com, abe@he.kanagawa-it.ac.jp

***Abstract*** -In the future, when a large-scale wide-area disaster as Nankai Trough Earthquake occurs in Japan, there is a possibility of the loss of electric power and communication infrastructure. In such a case, a Q-ANPI service for collecting information on the safety of disaster victims using the Quasi-Zenith Satellite MICHIBIKI, which can cover the entire country, would be very anticipated to be useful. The Q-ANPI system allows the use of smartphones for registering safety information on the refuge management PC. However, this requires a special application for Q-ANPI installed on the smartphones in advance. Therefore, s smartphone without this application cannot be used if the communication infrastructure for smartphones is cut off due to a large-scale disaster, etc. For this reason, the Q-ANPI service cannot fully exhibit its advantages despite the use of the information and communication technology.

In order to solve this problem, this research describes a technology that allows users to input safety information from a general web browser without using a dedicated app. We also propose a method to operate the system with lower power consumption than the conventional Q-ANPI service system.

***Keywords***: QZSS-MICHIBIKI, Victims information, Q-ANPI service, Refuge Management System.

## 1 INTRODUCTION

In the future, when a wide-area disaster such as the Great East Japan Earthquake occurs, there is a possibility of the loss of electric power and communication infrastructure. In fact, when the Great East Japan Earthquake occurred, ICT (Information and Communication Technology) could not be fully utilized, making it impossible to promptly disseminate information on disaster victims, etc. [1]-[6]. To solve these problems, we have developed a Refuge Management System (hereinafter referred to as RMS) [7]. This RMS [7] utilizes ICT to collect information on disaster victims in each shelter and to manage the long-term health of each victim, and can transmit the collected victim information via simple radio communication, such as amateur radio, as well as other means. The information collected by this RMS can also be stored in a USB flash memory and be taken out manually. RMS can manage on a shelter-by-shelter basis.

However, assuming a scenario in which a wide-area disaster such as a major NANKAI Trough earthquake occurs in Japan in the future, it is necessary to manage disaster victims in a wide-area rather than on a shelter-by-shelter basis. As a solution to this problem, we have previously proposed a wide-area disaster victim management system [8] in which RMSs are installed in each evacuation center, and all evacuation centers and disaster victims can be managed centrally by linking these RMSs in cloud.

However, there are two issues with this approach. The first point is that the RMS requires an environment that can be connected to the Internet even in the event of a communications infrastructure cutoff. Second, a wide-area disaster victim management system developed independently will require considerable sales efforts to be accepted by local governments, making it difficult to spread the system. As a technology to solve these problems, there is a safety information service, Q-ANPI, using the Quasi-Zenith Satellite MICHIBIKI [9] promoted by the Secretariat of the Strategic Secretariat for Space Policy and Management, Cabinet Office, Government of Japan. MICHIBIKI covers the entire communication area of Japan, and the Q-ANPI service is promoted by the Cabinet Office, so it is easy to be accepted by local governments, etc.

Therefore, we considered this technology to be a solution to the problem. Therefore, this study focused on the Q-ANPI service. Currently, Q-ANPI provides two input interfaces for registering the safety information of disaster victims on a refuge management PC installed in the refuge. One is to download a smartphone application to a smartphone used by a disaster victim, and register the victim's safety information on the refuge management PC. The second method is to register the information directly on the PC using a keyboard. In the case of registration using a dedicated smartphone application, when the communication infrastructure is cut off due to a large-scale disaster, those who have installed the dedicated application on their own smartphones in advance can register their safety information from their smartphones. However, those who had not installed the application beforehand would not be able to download the dedicated application during the communication infrastructure breakdown, and would not be able to register their safety information from their smartphones. For this reason, safety information may also be registered directly from the refuge management PC (Personal Computer) using a keyboard. In the midst of a large-scale disaster, if a large number of people register directly on the refuge management PC, a great deal of congestion will probably occur. Therefore, we believe that the current Q-ANPI system will not be able to take full advantage of the convenience of inputting safety information from smartphones in the event of a large-scale disaster when the communication infrastructure is cut off. In addition, when electricity and communication infrastructure are cut off due to a large-scale disaster, it is also necessary to operate the refuge management PC with low power consumption when collecting safety information on the refuge management PC.

This paper describes a technology proposed to solve this problem. It also describes the development of the prototype system proposed in this paper and the evaluation of the effectiveness of the system from various perspectives, including an actual simulated evacuation drill using the prototype system and the results of a demonstration questionnaire evaluation.

In Chapter 2, we provide an overview of the Q-ANPI service. Chapter 3 describes the position of this study with respect to related studies, and Chapter 4 gives an overview of the proposed system and the system flow. Chapter 5 evaluates the proposed system, and Chapter 6 presents the conclusion.

## 2 Q-ANPI SERVICE

Session 2 will introduce existing Q-ANPI services.

### 2.1 Overview of Q-ANPI Service

Q-ANPI [9] is a safety confirmation service for disaster victims using the Quasi-Zenith Satellite "MICHIBIKI", which is promoted by the National Space Policy Secretariat, Cabinet Office, Government of Japan. Figure 1 shows an overview of Q-ANPI. The Q-ANPI service consists of a Q-ANPI refuge management PC for collecting information on disaster victims and a Q-ANPI terminal for communicating with the Quasi-Zenith Satellite "MICHIBIKI", as shown in Figure 1. The communication between the Q-ANPI terminal and the Quasi-Zenith Satellite "MICHIBIKI" is in the 2 GHz band, the communication between the Q-ANPI terminal and the refuge management PC is in the 920 MHz band, and the communication between the refuge management PC and smartphones is via Wi-Fi. The victims in the refuge can register their safety confirmation information in the refuge management PC from their smartphones or other devices using a dedicated application.

There are two ways to register, one is to send it via wireless communication, and the other is to display a QR code and read it into the refuge management PC using a web camera. After that, the safety information collected by the refuge management PC is sent to the QZSS server via the Q-ANPI communication terminal and the Quasi-Zenith Satellite "MICHIBIKI". The QZSS server is the control station server where various items of information such as the refuge information, victims information, det k ailed refuge information, and rescue support information are stored. In addition to smartphones, disaster victims can also register their safety information directly on the refuge management PC. In Q-ANPI, telephone number is used as the ID number for confirming the safety of a disaster victim, and relatives of the victim can confirm the safety of the victim by entering the victim's telephone number on the QZSS server's safety confirmation Web site. In addition, the system allows related ministries, agencies, and local governments in charge of disaster prevention to access the QZSS server via the Internet to monitor the evacuation status of each evacuation site. There is no charge for using the Q-ANPI system and no communication fees.

### 2.2 Registration of Safety Information of Disaster Victim

Figure 2 shows the procedure for registering the safety information of individual disaster victims. There are two methods for registering the safety information of individual disaster victims.

The first method is to enter the information directly into the refuge management PC. Fig. 3(a) shows the registration screen of the refuge management PC. The registered information includes telephone number, name, date of birth, gender, admission/exit status, whether or not to disclose, address, presence or absence of injuries, need for nursing care, presence or absence of disabilities, and presence or absence of pregnant women.

The second method of registration is through a smartphone application. Fig. 3(b) shows the smartphone application registration screen. This registration application is available on iOS and Android smartphones. The personal safety information entered in the smartphone application can be transferred to the Q-ANPI information collection management PC by two methods. One is to display a QR code on the smartphone application and hold it over the camera of the Q-ANPI information collection management PC to transfer the safety information to the Q-ANPI information collection management PC. The other method is to transmit the safety information via Wi-Fi. The contents registered on the dedicated application are the same as those registered on the Q-ANPI information management PC.

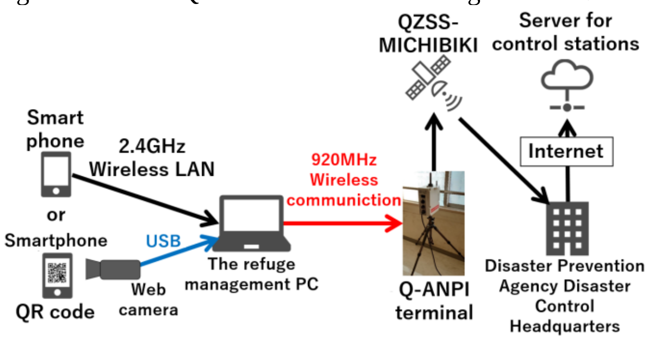


Figure 1: Overview of Q-ANPI service.

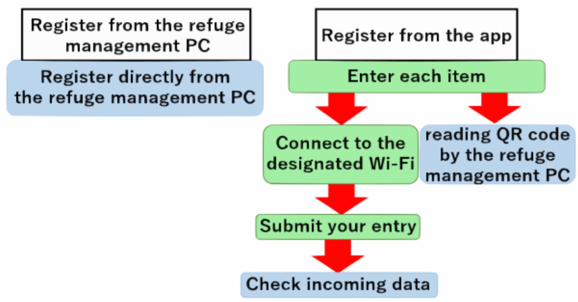


Figure 2: Victim safety information registration method.


(a)Safety confirmation screen of Q-ANPI information collection management PC (b) Smartphone application safety registration screen

Figure 3: Victim safety information registration screen.


Figure 4: Safety information confirmation screen on the disaster prevention organization server.

## 2.3 Safety Confirmation at Quasi-Zenith Satellite Control Station Server

Figure 4 shows a page of the safety confirmation site of the QZSS server on the Internet. If the safety confirmation of the victim has been registered in advance, the safety status of the victim can be confirmed by entering the victim's phone number and pressing the search button on the QZSS server's safety confirmation site shown in Fig. 4.

## 2.4 Types of Information Handled by Q-ANPI Service

Table 1 shows the types of information handled by the Q-ANPI service. The types of data handled by Q-ANPI can be broadly classified into (1) through (4) as shown in Table 1. (1) Refuge information is information on the location and closure/opening of the refuge. (2) Personal safety information is information on the safety of individual disaster victims, such as personal numbers (telephone numbers) and whether safety information should be disclosed or not. (3) Detailed refuge information includes the number of injured people, shortage of supplies, etc. (4) Rescue support information is information addressed to

Table 1: Types of information handled by the Q-ANPI service.

| Types of Information | Overview | Transmitted Data |
|---|---|---|
| ①Refuge Information (Collected Information) Refuge ⇒ Satellite | Provide refuge conditions and number of victims collected at refuge. Number of content : 84bit | Location of refuge, Refuge closed/opened, Number of victims(up to 131,071) |
| ②Victims Information (Collected Information) Refuge ⇒ Satellite | Provide victims information collected at refuge. Number of content : 84bit | Personal ID(phone number), Victims information disclosure, availability of victim's information, supplemental information, |
| ③Detailed Refuge Information (Collected Information) Refuge ⇒ Satellite | Provide detailed refuge Information collected at refuge. Number of content : 22characters/348bit | It can handle textual information and free-format binary information. |
| ④Rescue Support Information (Simultaneous transmission /Individual transmission) Satellite ⇒ Refuge | Collect Rescue support information addressed to refuge from user agencies and provide the information to refuge. Number of content : 59characters/944bit | Rescue support information (Simultaneous transmission, Individual transmission) |

refuges regarding rescue support. (1), (2), and (3) are information transmitted from refuges, while (4) is information addressed to refuges. Of these four types of information handled by the Q-ANPI service, only the information (2) is used in this study, i.e., the information on the safety of individual disaster victims. The information volume of the personal safety information for disaster victims is 84 bits.

# 3 RELATED WORK

A previous study of disaster victim information dissemination in response to a wide-area disaster is the RMS development [7]. This RMS utilizes ICT to collect information on disaster victims in each refuge and to manage the long-term health of each victim and can transmit the collected disaster victim information. The RMS can transmit information by simple radio communication and amateur radio, in addition to storing disaster victim information on USB flash memory devices and allowing users to manually take it outside. This RMS can be managed on a shelter-by-shelter basis.

However, assuming a wide-area disaster such as the Nankai Trough earthquake that is expected in the future, it is necessary to manage victims in a wide-area rather than in refuge. As a solution to this problem, we have previously proposed a wide-area disaster victim management system[8] in which RMSs are installed in each refuge, and all refuges and disaster victims can be managed centrally by linking these RMSs with a cloud server.

However, there are two problems with this approach. First, it requires an environment that can be connected to the Internet even when the communication infrastructure is cut off. Second, a wide-area disaster victim management system developed independently by a private sector will require considerable sales efforts to be accepted by local governments, making it difficult to spread the system.

Q-ANPI, a safety information service using the Quasi-Zenith Satellite MICHIBIKI [9] promoted by the Secretariat of the Strategic Secretariat for Space Policy, Cabinet Office, Government of Japan, exists as a technology to solve these problems. The Quasi-Zenith Satellite MICHIBIKI can communicate throughout Japan even in the event of a large-scale disaster, and the Q-ANPI service is promoted by the Cabinet Office, making it easy to be accepted by local governments. In particular, since the control station servers used in Q-ANPI are owned by the national government, they are more easily accepted by local governments than those developed by a private sector. This technology can therefore be used to solve the two issues mentioned above. Therefore, this study focuses on the Q-ANPI service.

As described in section 2.2, the current Q-ANPI provides two input interfaces for collecting information on disaster victims. One is to download a dedicated smartphone application and register the safety information of disaster victims through the application, and the other is to input and register the safety information directly from the Q-ANPI refuge management PC using a keyboard. In the case of the registration method using a dedicated smartphone application, assuming a scenario in which the communication infrastructure is cut off for a long period of time due to a large-scale disaster, those who have installed the dedicated application in advance can register their safety information, but those who have not installed it will not be able to download the dedicated application during the communication infrastructure cut-off period. For this reason, the current system additionally allows people to register their safety information directly from the refuge management PC using a keyboard. Since it is assumed that one such PC will be placed in each refuge, a great deal of congestion will probably occur if there are a large number of people registering directly on the refuge management PC. Therefore, the authors believe that the current system (Q-ANPI) cannot fully utilize the advantages of using a smartphone.

On the other hand, the previous study on the Q-ANPI service proposed a system [10] that can collect safety information of disaster victims more widely than the conventional Q-ANPI service by combining Q-ANPI and ad hoc communication of smartphones. The proposed system is very useful when disaster victims do not know how to access Wi-Fi access points in the refuge, when they cannot connect to the refuge management PC, or when collecting safety information on victims outside of refuges. However, this related technology [10] also has a problem in that it cannot be used unless a dedicated application is downloaded in advance. In addition, the refuge management PC used in Q-ANPI uses an ordinary notebook PC, which consumes more than 12W of electricity. Therefore, the authors believe that in the event of a large-scale disaster, a system that can operate the refuge management PC with low power consumption is needed when not only the communication infrastructure but also the electric power infrastructure is cut off.

To solve these problems, the authors propose a method for inputting the safety information of disaster victims using a Web browser already installed on smartphones. In addition, we propose a method that can be operated for a longer period of time than a laptop PC by using a power-saving embedded system instead of a laptop PC to collect information on the safety of disaster victims.

# 4 PROPOSED TECHNOLOGY

In this study, we considered that Q-ANPI using the Quasi-Zenith Satellite MICHIBIKI is suitable as a solution to the issues of loss of communication infrastructure in the event of a large-scale disaster and ease of acceptance by local governments and other entities. However, as described in Chapter 3, when the communication infrastructure is cut off due to a large-scale disaster, it is expected that Q-ANPI cannot fully exhibit its merits because the dedicated application for registering safety information from smartphones cannot be downloaded. In addition, since the refuge management PC installed in the refuge use an ordinary laptop PC, they consume a lot of power, and considering the case where the power infrastructure is cut off due to a large-scale disaster, it is essential to operate the refuge management PC with even lower power consumption.

To solve this problem, this study proposes a method to input the safety information of disaster victims using a Web browser already installed on smartphones. In addition, this study considers that the power infrastructure will be cut off at the same time during a large-scale disaster. Therefore, we propose a highly practical safety information collection system that is robust even in the event of power infrastructure failure by linking the Q-ANPI service with a web server system built on an embedded microcontroller board that can operate with low power consumption, without building a web server and DB (Data Base) on the refuge management PC.

## 4.1 Proposed System

Figure 5 shows the system proposed in this study, which adds a web interface to the conventional Q-ANPI system so that disaster victims can input safety information from a web browser of their smartphones. This allows users to enter safety information without using a dedicated app. In addition, in order to achieve long-term operation even when the power infrastructure is cut off in the event of a large-scale disaster, the Web interface developed by this research uses a Raspberry PI 3B+ (hereinafter referred to as RPI), which is a small and low-power-consumption microcontroller. We created a system in which a web server and DB (Database) were built on this RPI. Fig. 6 shows the appearance of the prototype developed in this study. The RPI is used as an intermediary between smartphones owned by disaster victims and the refuge management PC. When a smartphone owned by a disaster victim connects to the web interface from its web browser, a page for inputting the victim's safety information is displayed, as shown in Fig. 7. When the safety information is entered on this page, it is automatically registered in the DB in the web interface. This collects the safety information of multiple victims in a refuge. The system then sends the information to the refuge management PC in a batch. When the person in charge of the refuge management presses the data transmission button on the application for the refuge management PC, the data are transmitted to the server of the control station via the Quasi-Zenith Satellite “MICHIBIKI”. The system enables relatives of disaster victims to confirm the safety of the victims by accessing the server of the control station via the Internet.

## 4.2 How to Display the Safety Information Input Page from a Smartphone

As with Q-ANPI, the system in this study is built on a LAN (Local Area Network) with commercially available Wi-Fi wireless routers. In addition to receiving safety information from smartphones and the Web interface, the refuge management PC serves as a gateway to the Q-ANPI terminal (920 MHz). For the connection to the web interface from a smartphone, the SSID of the Wi-Fi wireless router (in this case, "QANPI_179") is made open to allow connection to the network without a password. A printout of the URL of the safety information input page converted into a QR code is prepared in advance. By holding the QR code over the camera of a smartphone, anyone can easily display the safety information input page on the Web interface. This enables smooth registration of the safety information of disaster victims.

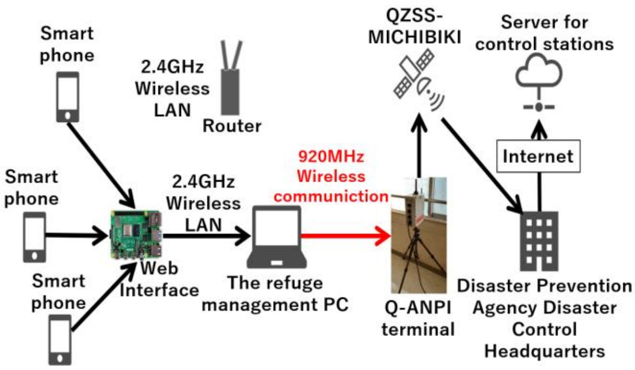


Figure 5: Overview of our proposed system.

Figure 6: Prototype of Web Interface.

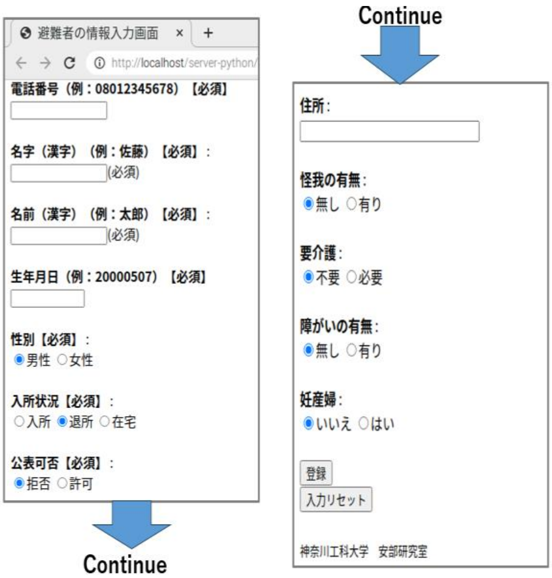


Figure 7: Safety information input page screen for disaster victims.

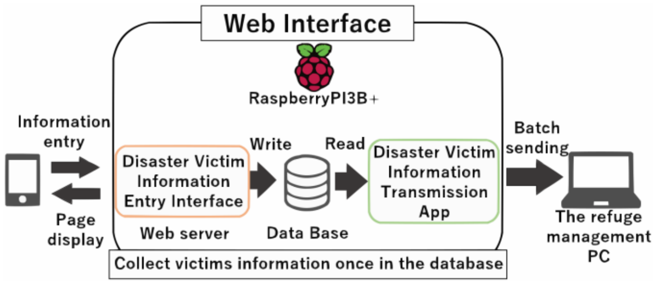


Figure 8: Overview of Web Interface.

## 4.3 Prototype System of Web Interface

Figure 8 shows an overview of the prototype of the web interface proposed in this paper. The web server was built on RPI using nginx, and MariaDB was used for the DB. The reason for using nginx for the web server is to achieve high processing speeds that allow multiple inputs of victim information at the same time. The application for the victim safety information input interface shown in Fig. 7 was developed in PHP and HTML languages. The "disaster victim information transmission application," which transmits the safety information of disaster victims registered in the DB server to the refuge management PC, was developed in python 3.7, and is an application that transmits all safety information registered in the DB. Since the application for the refuge management PC automatically discards duplicate information, we decided to use a simple application that sends all DB data at once. Fig. 6 shows the appearance of the prototype of the Web interface developed this time. This is a prototype with a web server and DB (Data Base) built on RPI. The Web interface is operated remotely from a terminal to eliminate the need for a display.

### 4.4 Power Operation Method of Our Proposed System

Assuming that power and communication infrastructures are cut off in a large-scale disaster, power supply is important in a real refuge. To operate the proposed system, it is considered necessary to use one solar panel and two or more battery units. One battery unit is used for the refuge management PC, web interface, wireless router, Q-ANPI terminal, etc. The other battery unit is charged with electricity generated by the solar panel, and the batteries should be exchanged alternately.
Table 2 shows the results of power consumption measurements for each device used in the proposed prototype system. Power consumption was measured using a digital power meter. Among the devices used in this prototype, the Q-ANPI terminal consumes the largest amount of power, 15W. The second highest is the refuge management PC with a maximum of 12W, the third is the RPI, and the fourth is the wireless router. The RPI alone used with a Web interface consumes approximately 3W, a dramatically low level of power consumption. The Q-ANPI terminal and the refuge management PC consume a lot of power. Therefore, when not transmitting data using the QZSS MICHIBIKI, the Q-ANPI terminal can be turned off, the refuge management PC can be put to sleep, and long-term. Operation can be achieved with a single battery charge by having only the proposed Web interface powered on.

Figure 9 shows the operation of the Q-ANPI service using the proposed system. When collecting safety information, only the Web interface is put into operation, the Q-ANPI terminal is turned off, and the refuge management PC is put into sleep mode. In this way, the overall power consumption can be reduced to a total of approximately 3.5W during the collection of safety information. For example, using a commercially available 240Wh portable battery power supply, the system can be operated for approximately 60 hours on a single charge.

## 5 EVALUATION

We evaluated the effectiveness of the prototype of the system proposed in this study from three perspectives: a demonstration evaluation based on a simulated evacuation drill, a questionnaire evaluation based on a demonstration, and a measurement evaluation of the prototype's power consumption. In the evaluation through a simulated evacuation drill, we conducted a questionnaire to determine whether the proposed system is practically usable, and compared it with the conventional Q-ANPI system to determine how easy it is to input safety information. In addition, a questionnaire survey was conducted by exhibiting a prototype demo to investigate the ease of use of the proposed system and find points to be improved. We also evaluated the power consumption of the prototype system using the Web interface proposed in this study.

Table 2: Power consumption of each device.

| Device | Model | Power consumption |
|---|---|---|
| Q-ANPI terminal | | 15W at active |
| The refuge management PC (Windows10) | Versa Pro VX-5(NEC) | Max 12 W at active |
| | | Max 0.42 at sleep |
| Wireless router | WMR-433W2-BK (BUFFALO) | 2.5 W at active |
| Web interface(RPI) | Raspberry PI3B+ | 3W at active |

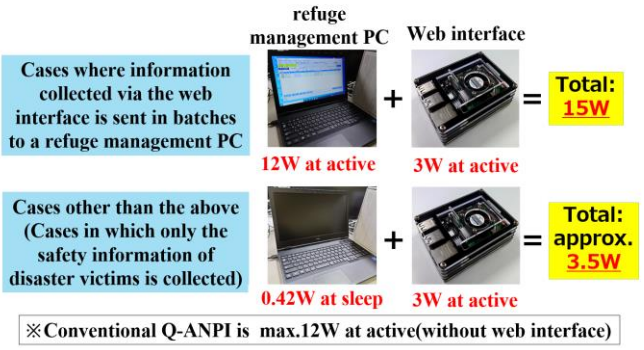


Figure 9: Power consumption in Q-ANPI operation method using proposal method.

### 5.1 Evaluation through Simulated Evacuation Drill

A prototype of the proposed system was utilized and evaluated through a simulated evacuation drill. The simulated evacuation drill was conducted on August 5, 2022, on the premises of the Kanagawa Institute of Technology. Figure 10 shows the evacuation route of the simulated drill. Table 3 shows the schedule of the actual evacuation drill and the actual action time required. Before the simulated evacuation drill, one Q-ANPI terminal, one refuge management PC, one web interface system, one solar panel, and one battery with 240Wh capacity were placed in the former gymnasium of the university, which served as the evacuation site. It was assumed that a major earthquake occurred at 14:00. All participants in the evacuation drill initially hid under desks, and after the earthquake subsided, they descended the stairs from the classroom (E602) on the 6th floor of Building C2 to the first floor, and then followed the evacuation route shown in Fig. 10 to the entrance of the university's soccer field. After taking roll call at the evacuation assembly, all the evacuees were moved to the old gymnasium, which was the evacuation site, where three evacuation supervisors set up a proposed system and opened the evacuation desk (Fig. 11). Table 3 records the time from immediately after the earthquake until the equipment was removed. The time required from the occurrence of a major earthquake to the gathering at the evacuation site was 9 minutes, which indicates that the evacuation was completed fairly quickly. The time required to open the evacuation site was about 8 minutes. Table 4 shows a comparison of the input time of safety information of disaster victims between the conventional Q-ANPI and the proposed system. The proposed system required only about 3 minutes, while the conventional Q-ANPI system required about 11 minutes.

The proposed system took only about a quarter of the time of the conventional system. Factors that caused the conventional Q-ANPI system to take such a long time include the time required to download the dedicated application and the time required to establish a Wi-Fi connection. The proposed system uses a QR code for easy access to the safety information input page, which is a major factor. But, even with the conventional Q-ANPI system, if the dedicated application is already installed on the smartphone, the input time taken would be similar to that of the proposed system.

Therefore, in the case that the cell phone communication infrastructure is cut off and the dedicated application is not installed on the smartphone in advance, the proposed system is superior in terms for on-site use in actual disasters.

## 5.2 Questionnaire Evaluation after Simulated Evacuation

In the demonstration evaluation through the simulated evacuation drill, a questionnaire survey was conducted after the simulated evacuation drill, since personal safety information was collected by two systems, i.e., the conventional Q-ANPI and the proposed system. The actual number of participants in the simulated evacuation drill was 9, and 6 males (67% response rate) responded to the questionnaire. Fig. 12 shows the results of the questionnaire. To Question 1, "In the event of a large-scale disaster, would you like to actually use the proposed system used this time, which uses a browser for data input, in an evacuation center?", three respondents answered "Yes, I would like to use it," and three respondents answered "Yes, I would like to use it somewhat.” This resulted in a high average score of 3.5 on the 4-point scale in which the highest score of 4 was given to "would like to use" and the lowest score of 1 was given to "would not like to use". Next, to Question 2, "Which system was easier to use, the conventional system or the proposed system?”, 83% of the respondents answered that the proposed system was easier to use. Next, in response to Question 3, "In Question 2, what was easy to use about the conventional system?”, the answer was "Because there is no need to search in a browser.” In Question 4, "In Question 2, what was easy to use in the proposed system?”, five respondents answered "The fact that it can be used without downloading a dedicated application." To Question 5, "Is there any other information on disaster victims that you think is necessary besides the existing information (phone number, name, date of birth, gender, admission status, availability, address, injuries, assistance needed, disabilities, pregnant women)?”, one respondent answered, "Information such as pre-existing medical conditions, family doctor, and medications used on a regular basis would be helpful.” Next, to Question 6, "What do you think needs to be improved in the future regarding the proposed system?”, as shown in Fig. 12, the most common response to this question was "Type of evacuee information" (five responses), followed by "Ease of text input" (two responses).

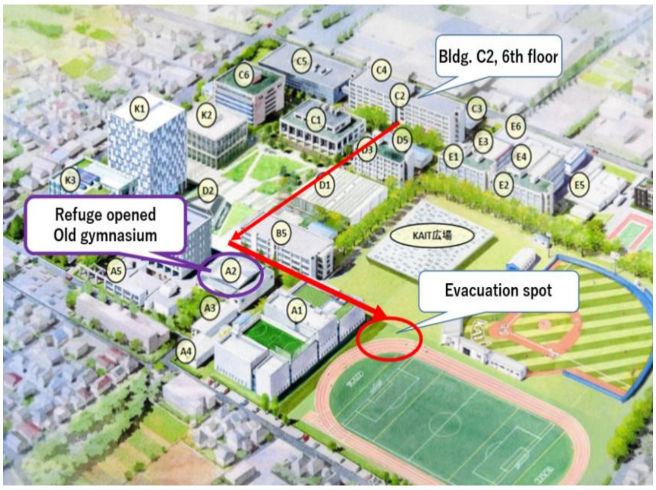


Figure 10: Evacuation route for simulated evacuation drill.

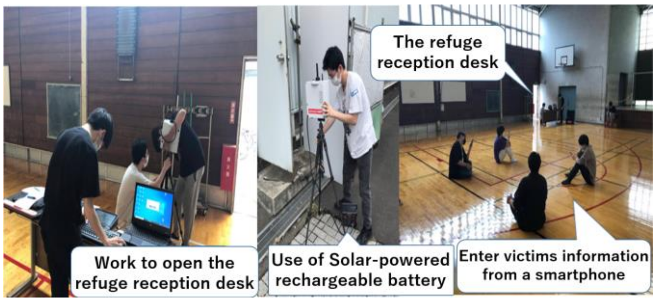


Figure 11: Overview simulated evacuation drill.

Table 3: Schedule for the Demonstration Experiment.

| Scheduled time | Action | Actual times required | Remarks |
|---|---|---|---|
| 14:00 | Earthquake-Hide under the desk | 14:00 | |
| 14:15 | Evacuation to a refuge | 14:06 | Evacuation by stairs from the 6th floor of Building C2 |
| 14:20 | Gather at evacuation site | 14:09 | |
| 14:25 | Move to the refuge (old gymnasium) | 14:09 | |
| 14:40 | Establishment of the refuge | | |
| | Completion of evacuation center opening | 14:17 | |
| 14:55 | Enter victim information (Install dedicated app) | Start 14:17<br>Finish 14:28<br>(11minutes) | Mistakes in downloading the dedicated app and connecting to Wi-Fi required time to complete the input. |
| | Enter victim information by the proposed system | Start 14:34<br>Finish 14:37<br>(3minutes) | Fastest input time |
| 15:00 | Fill out the questionnaire | Start 14:35<br>Finish 14:37 | |
| 15:15 | The withdrawal | 14:41 | |

Table 4:Comparison of proposed and existing systems in terms of victim information input time

| | time of inputting disaster victim information | Cause |
|---|---|---|
| Proposed system | About 3 minutes | URL of the disaster victim information input page is converted to a QR code |
| Q-ANPI system | About 11 minutes | Mistakes in downloading the dedicated app and connecting to Wi-Fi |

## 5.3 Questionnaire Evaluation through Demonstration Exhibition of Prototypes

Next, we explained the proposed system to visitors to our open campus and asked them to directly see the actual prototype system and answer a questionnaire. A total of 12 people responded to the questionnaire: seven males (six in their teens and one in his 40s) and five females (two in their teens, one in her 20s, one in her 30s, and one in her 50s). The questionnaire results from this demonstration are shown in Fig. 13. The "score" shown in Fig. 13 is a numerical value that represents the average of the responses of the survey participants. First, as shown in Fig. 13, to Question 1, "Did you understand the overview of the proposed system that you used this time?", the score was 3.33, which is high compared to the highest score of 4: 4 respondents answered "well (4)" and 8 respondents answered "somewhat well (3)".

Next, to Question 2, "In the event of a large-scale disaster, would you like to use the proposed system used this time in an actual evacuation center?", the score was 3.75, which is quite high, with 9 respondents selecting "Yes (4)" and 3 selecting "Yes, somewhat (3)". To Question 3, "How was the operability of the Q-ANPI system and the proposed system?", Fig. 13 shows that the score of the proposed system was 4.25 on the 5-point scale, about 0.50 higher than the conventional system whose score was 3.75.

Next, to Question 4, "What are the points to be improved in the proposed system? (Multiple answers allowed)", many respondents answered "Ease of input" (6), indicating that the proposed system needs to be improved in this respect. Other personal safety information and points to be improved that the respondents thought were necessary for the proposed system were "family information" and "heavy and congested Internet connection".

## 5.4 Measurement and Evaluation of Prototype Power Consumption

Considering the use of a commercially available 240Wh battery, it is estimated that the RPI alone can operate for about 3.36 days. A more power-saving operation could be achieved by using the RPI as a stand-alone device without the LCD display screen, with the terminal software for the RPI installed on the refuge management PC so that the RPI's "disaster victim information transmission application" could be run remotely.

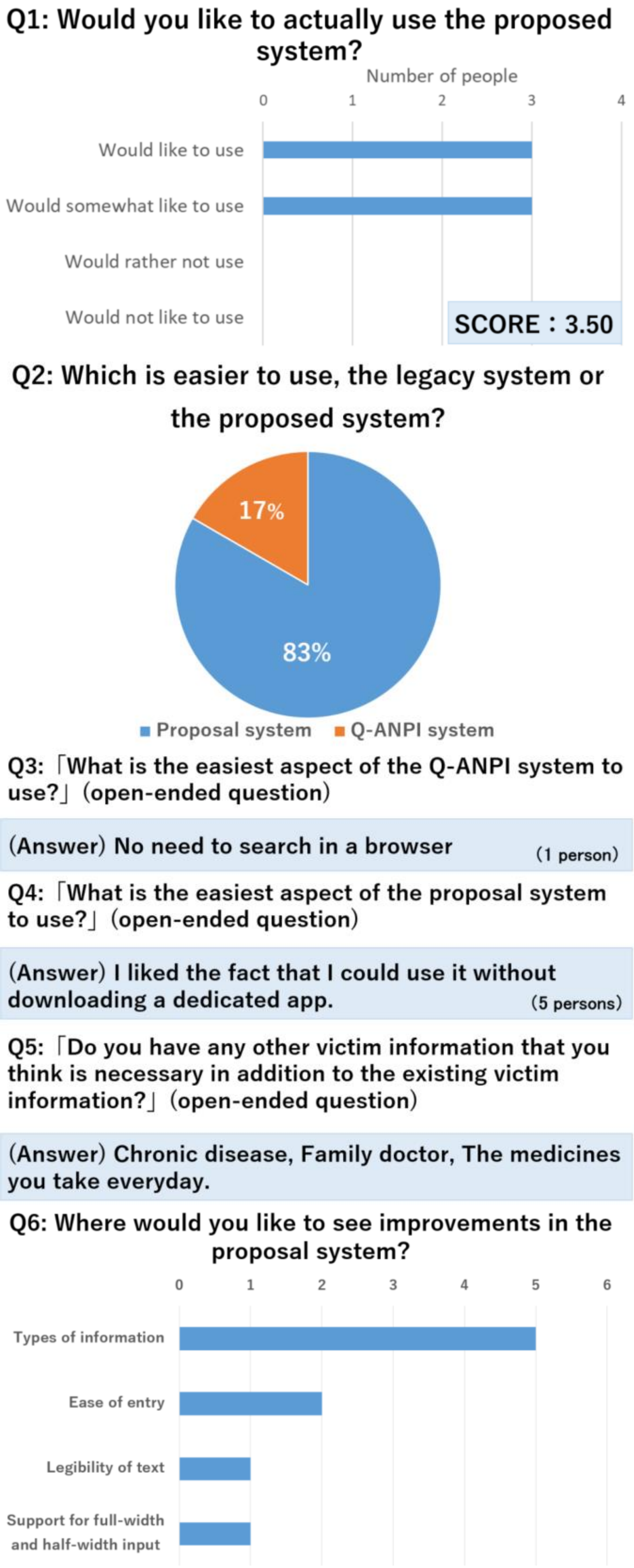


Figure 12: Questionnaire results for simulated evacuation drill.

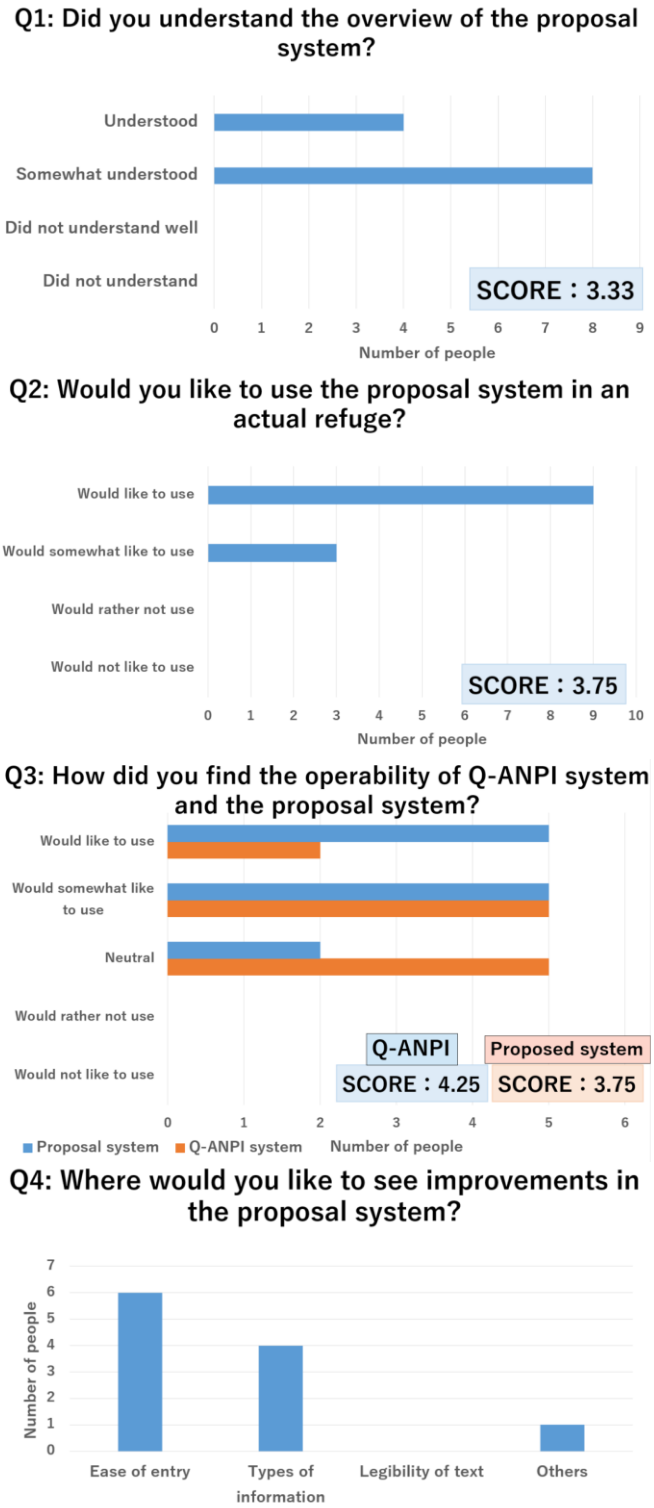


Figure 13: Questionnaire results for the prototype.

It is also considered a good idea to turn on the power of the Q-ANPI terminal and the refuge center management PC only when communicating via the Quasi-Zenith Satellite “MICHIBIKI”, and turn them off and in sleep mode for the rest of the time.

Assuming such an operation scenario, only the RPI unit (3W) and the wireless router (2.5W) would be used in constant operation, so the 240Wh battery would last approximately 1.8 days. If the two battery units are operated alternately, long-term operation is possible even when the power infrastructure is cut off.

# 6 CONCLUSION

This paper addressed the issue of Q-ANPI, a service for collecting safety confirmation information on disaster victims using the Quasi-Zenith Satellite "MICHIBIKI", in the case that the cell phone communication infrastructure is cut off and the dedicated application is not installed on the smartphone in advance, and the safety information from the smartphone owned by the disaster victim cannot be registered on the refuge management PC. The paper discussed how to solve this problem. The paper also discussed energy-efficient operation of PCs used to manage evacuation centers in the event of a power infrastructure cutoff. To solve this problem, we proposed a web interface that enables the input of safety information of disaster victims by utilizing a web browser already installed on smartphones. This Web interface collects the safety information of multiple disaster victims, sends it to the refuge management PC at any given time, and the PC transmits it to the control station server via the Quasi-Zenith Satellite MICHIBIKI. This allows safety information to be entered using a web browser already installed on smartphones without downloading any dedicated applications, making it a general-purpose interface. To reduce the operational power consumption of Q-ANPI, the Q-ANPI terminal is turned off when collecting safety information, the refuge management PC is put in sleep mode, and only the Web interface is operated to collect safety information on disaster victims. It was found that if the Q-ANPI terminal and the refuge management PC are activated only when transmitting data to the server at the control station, the power consumption of the entire system can be minimized to about 4W.

In a questionnaire survey conducted after the simulation training, many respondents answered that they would prefer to use the proposed system rather than the conventional Q-ANPI system, and many of them answered that the proposed system was “easier to use.” However, some respondents pointed out the following points for improvement of the proposed system: "Ease of text input" and "Types of victim information.” In addition, we would like to increase the number of participants in simulated evacuation drills. The prototype of the proposed web interface was developed using RPI of low power consumption.

In the future, if the proposed system and Q-ANPI's previous research [10] are all successfully linked, it will be possible to develop a highly realistic system that can smoothly collect safety information on disaster victims at actual disaster sites where people are in turmoil.

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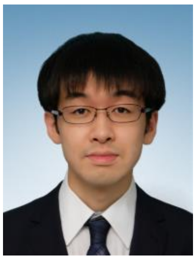

**Mitsuki Sano** received the B. E. degree from Kanagawa Institute of Technology in 2023.
He is currently engaged in re-search on ICT disaster support management systems at Department of Electrical and Electronic Engineering, Graduate School of Engineering, Kanagawa Institute of Technology.

**Keiichi Abe** received a Ph. D. in informatics from Shizuoka University in 2012. He has been a professor of the Faculty of Creative Engineering, Kanagawa Institute of Technology. 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 IPSJ, IEICE, ACM and IEEE.