Evacuation drills with real-time earthquake information system on campus over the past five years

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SUMMARY
Real-time earthquake information has been sent experimentally since 2004 in Japan. The system provides an alert and various security controls to facilitate a person's safety a few seconds before an earthquake occurrence. Evacuation drills using the system have been conducted at the Aichi Institute of Technology since 2005. The risk mitigation of such a real-time earthquake information system for a campus is addressed through a questionnaire survey of the student body. According to the results, many students think the system is useful for their safety. The system has the potential for use as a part of education about disaster mitigation. However, the "Willingness To Pay" for the system has declined among students. It has become no more than an evacuation drill with no new sense of urgency.

Keywords: Real-time earthquake information, evacuation drill

1. INTRODUCTION

Real-time earthquake information has been in place since 2004 in Japan. The system provides an alert and various security controls to enable personal safety a few seconds before an earthquake occurrence. Discussion for the improvement of the earthquake early information system (after this, EEW) has begun. Zollo et al. (2010) have proposed a methodology for on-site early warning applications. They have discussed the relation between alert level and some indexes about ground motion measurements. Matsumura (2011) has reviewed the history, actual state, practical problems and limits of EEW. He has proposed that EEW can be treated not only as the alert system before a ground motion but also as a ground motion detection control system. It means that the EEW is one of the triggers for various emergency systems. Those previous studies aim to discuss EEW advanced technology. Moreover, due consideration is needed not only regarding technical development but also the accumulation of experience from the user's viewpoint.
We have inspected the real-time earthquake information system since 2006 on our campus. The present study aims to check the change in student opinions about the system and disaster mitigation from 2006 to 2010. In addition, the change of opinion after the 3.11 Tohoku earthquake-tsunami in Japan is discussed by the questionnaire survey of freshman students.

2. SUMMARY OF REAL-TIME EARTHQUAKE INFORMATION ON OUR CAMPUS

The Yakusa campus of the Aichi Institute of Technology is located to the east of Nagoya City, and to the north of Toyota City. The environment of the campus is in a hilly, forest area. The campus is 658,644 square meters in area, and the total floor space of this campus building is 113,218 square meters. Since the foundation of the school in 1959, approximately fifty thousand students have graduated from the Engineering, Management and Information Sciences Departments and the Graduate school. At present, the number of students, office staff and faculty is about 6,000 people. There has been concern about the old school buildings and the laboratory equipment which had been

built in the 1960's. The establishment of a new system would be a good opportunity to improve campus safety and to educate about disaster. Since it is far from the sea, there is no risk of a Tsunami.
We established the Earthquake Prevention Consortium in 2004. The consortium comprised a construction company, a computer software company, a consulting company and the Aichi Institute of Technology. One of the project targets of the consortium was how to use and manage a real-time information system. We tried to define the system according to the ground characteristics of each place. Through discussion in our consortium, it was decided to test the system on our campus.
The Disaster Prevention Center (Deprec) at the Aichi Institute of Technology as the base facility of a real-time earthquake information system was built in 2005 with 2 key points in mind. The first was how to sound the warning around the campus. At the time, the real-time earthquake information system was used experimentally. There was an agreement with the Japan Meteorological Agency to use the information among the campus members only. We should prepare for the drills carefully to prevent a panic. We set up speakers which were not able to adequately sound the alarm outside of the campus. However, our campus area is large. The test of the sound volume was done carefully. The second point was how to handle the system for evacuation. The first few seconds of the initial stage are very important for effective use of a real-time earthquake information system. We made an emergency manual for this system, and held an explanatory meeting with the office staff and all students.
The system has been operating since July 2007. The Japan Meteorological Agency calls this system "Earthquake Early Warning" (EEW). It is called "Kinkyu Jishin Sokuho" in Japanese.
Since 2007, we held an explanatory meeting for the freshman every year. Figure 1 shows the 2012 version of the leaflet. One side shows the campus map which indicates the evacuation route and outline of our system. When the predicted intensity is "Less Than 5" on the Japanese seismic scale is reached, the siren will sound. Then, after 3 seconds, there is a warning announcement: "Attention! Earthquake Coming!". The other side is an explanatory note about the real-time earthquake information system. The principles and limits of the system are described with illustrations. In addition, the prediction intensity is shown on the supposition that the Tokai-Tonankai Great Earthquake has occurred.

3. OUTLINE OF QUESTIONNAIRE SURVEY

3.1. Questionnaire survey at the evacuation drill

To check the effect of the system, we conducted an annual evacuation drill since 2006. The students followed safety guidelines according to the warning. After the warning finished, they assembled on the soccer ground. There was no panic, and the evacuation was done smoothly.
We conducted 2 questionnaire surveys of student opinions.
The first survey was done for students who joined the drill in 2006. We handed out a questionnaire on the soccer ground, and collected survey response there. 3,179 students gathered on the soccer ground. The number of responses was 2,591.
The second survey in 2010 used the internet website developed for student life. The site has been used for lecture scheduling, to obtain information format and lecture feedback questionnaires. Some 3,106 students gathered on the soccer ground. There were 639 responses.
Although the method of distribution at those surveys is different, we ask the same questions. The change in student opinions is a novel way to consider real-time earthquake information systems of the future.

3.2. Questionnaire survey at freshman orientation

We have held an explanatory meeting for the freshman every year since 2007. In addition, the questionnaire survey has been conducted to obtain their opinions. In this paper, we show two results from those surveys.

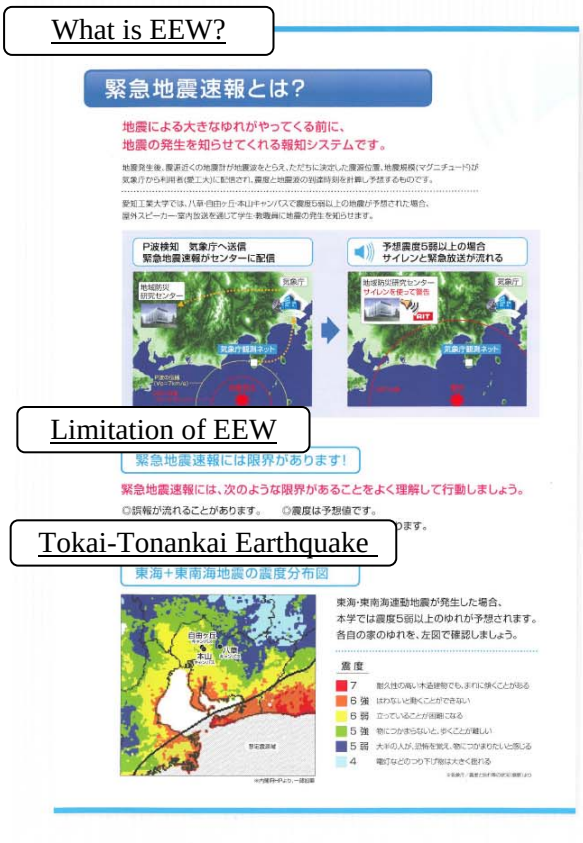
Flowchart when the EEW Alert starts up

Campus Map

What should you do for your safety before the seismic motion?

What should you do after an earthquake?

What is EEW?



Limitation of EEW

Tokai-Tonankai Earthquake

Figure 1. 2012 version of the leaflet (Above “Front”, Below “Back”)

First, we asked them about EEW reliability in April 2011. “The earthquake early warning system can provide the warning a few seconds before the seismic motion occurred at Sendai City in 2011.3.11. Owing to the technical limitation and the trouble, the right information after 3.11 has been provided one in three times. How would you deal with the system?”
Second, we asked about the WTP (Willingness To Pay) for our campus system. To discuss the change of their opinion before and after the 3.11, we used the results in 2007 and 2011, inquiring “If the great earthquake comes (Japanese seismic intensity “of less than 5 Lower or 7”), you might be able to survive, thanks to this information system. How much will you pay for the system annually? Please check one of the following 5 boxes: (0, 500, 100, 1500 and 3000 Japanese yen) about the quid pro quos set forth in the questionnaire.
The number of survey responses was 1385 in 2007, and 1155 in 2011.

4. RESULTS

4.1. Results at the evacuation drill

Figure 2 shows the ratio of knowledge about EEW. In 2010, almost all students were familiar with the name _“the earthquake early warning system.”

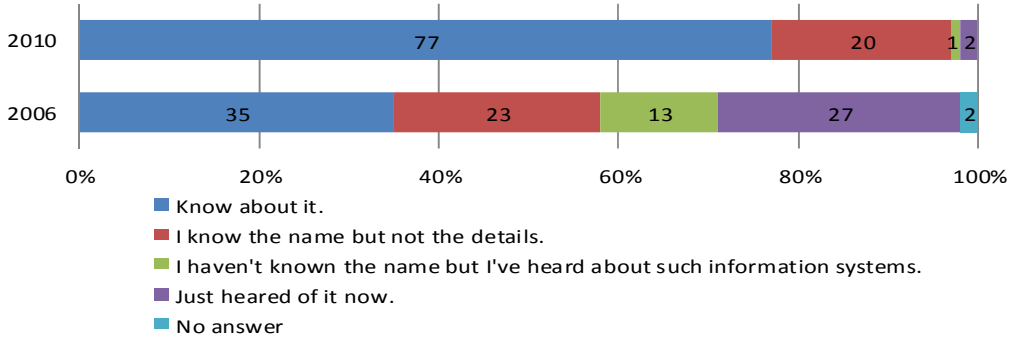


Figure 2 Ratio of knowledge about EEW

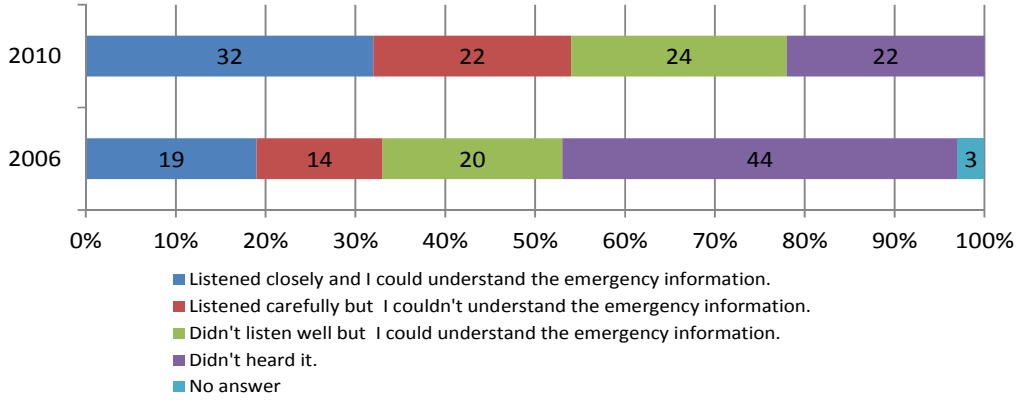


Figure 3 Ratio of usability of the siren and announcement

Figure 3 shows the result of usability of the siren and announcement. In 2006, many students could not hear the siren and announcement. We have since reinforced our speaker system. In 2010, many students could understand the information. However, 22% students answered they could not hear the information. It is difficult to provide information to a large sprawling campus with many buildings.
Figure 4 shows the reaction to the siren and announcement. In 2006, many students did something to protect themselves. In 2010, 35% of students did nothing.
Figure 5 shows the answers about the total usability of the system. The ratio of positive answers

increased. Almost all students answered that the system was “Useful” or “Fairly useful.”

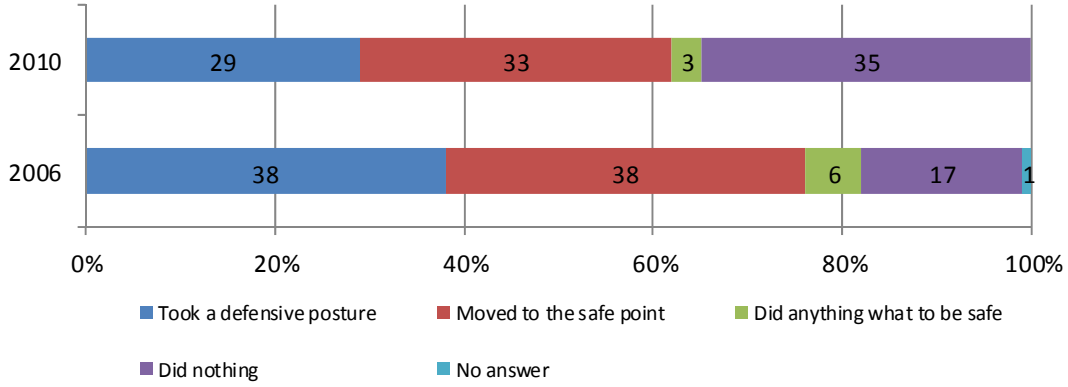


Figure 4 Ratio of reaction to siren and announcement

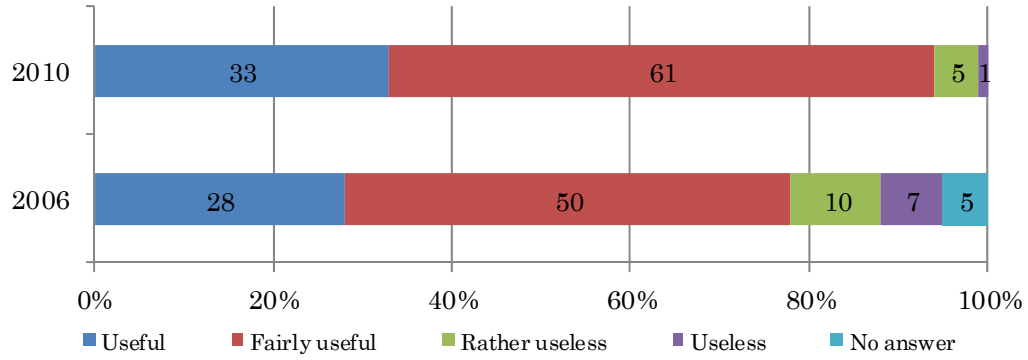


Figure 5 Ratio of EEW total usability

4.2. Results at freshman orientation

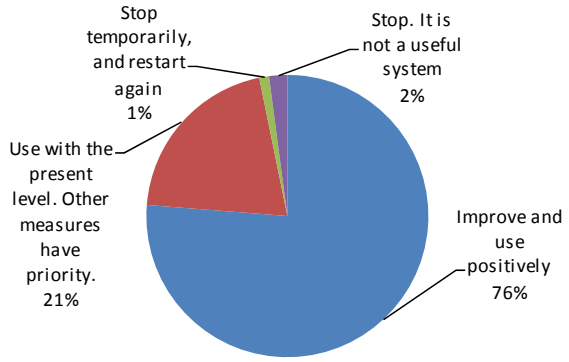


Figure 6 Opinion about EEWs after 3.11.

Figure 6 shows opinions about EEW after 3.11. Many students answered that the system should be improved and used positively. 21% of the responses were “Use with the present level. Other measures have priority.” Although many problems occurred after 3.11, almost all students think the EEW system should be used.

Figure 7 shows the WTP for a case of seismic intensity of “7”. Many students answered they can pay 3000 yen. However, compared to 2007, the WTP had decreased by 2011.

Figure 8 shows the WTP for a case of seismic intensity of “Less Than 5”. Many students answered they can’t pay.
In addition, the seismic intensity influences the result of WTP. In this survey, we show the seismic intensity only. However, the type of earthquake is an important factor in the EEW alert ability. The absolute value of WTP should be discussed carefully for judging EEW usability.

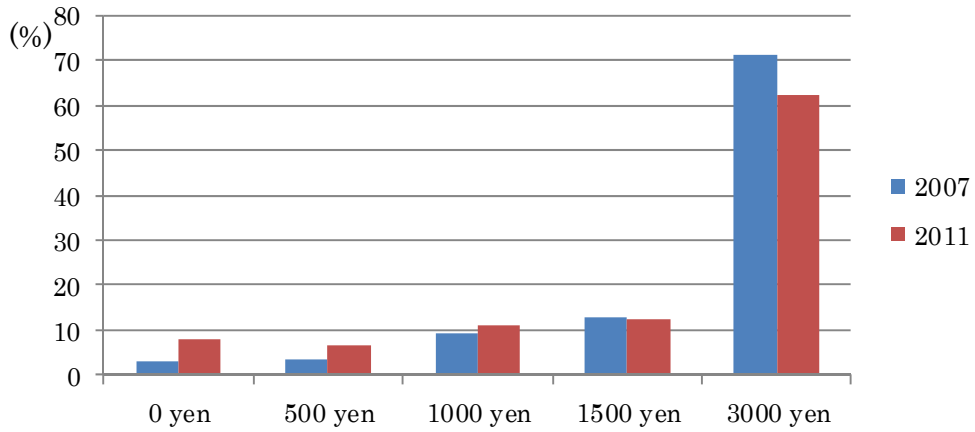


Figure 7 WTP in case of seismic intensity of “7”

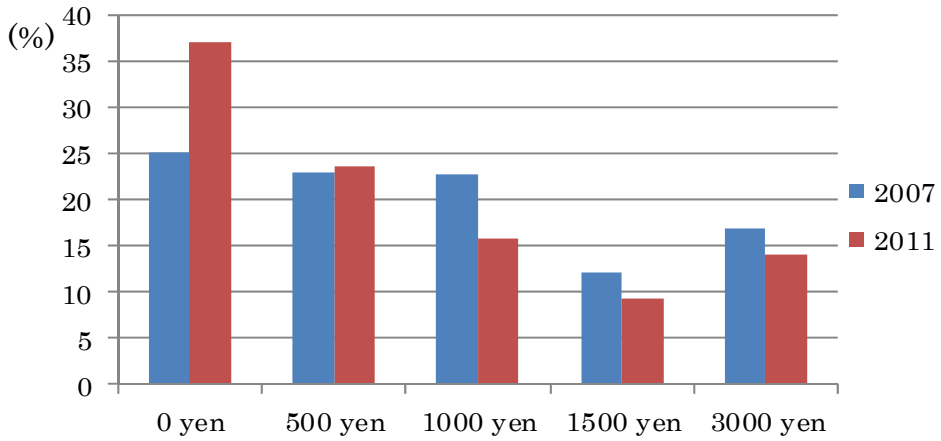


Figure 8 WTP in case of seismic intensity of “Less than 5”

5. DISCUSSION AND CONCLUSIONS

Results of a survey questionnaire may differ with the methods used. Nevertheless, trends in student responses can be identified.

(1) Knowledge of the real-time earthquake information system is growing. Many students think the system is useful for their safety. However, WTP has declined after 3.11. We suppose that, although the students may think the present system is not satisfactory, they hope that it will be improved. From another viewpoint, the students may think the information should be provided free. EEW is a standard function of mobile phones in Japan. NHK (Japan Broadcasting Corporation) has provided EEW for TV and radio broadcasting. EEW is no longer a special tool for students.

(2) No panic has occurred. Students have accepted the system calmly. Over the past 5 years, the drill has become merely routine. At the first evacuation drill, the real-time earthquake information system was altogether new. However, real-time earthquake information has also become routine knowledge over 5 years. A new risk has occurred due to lack of interest. To solve this problem, our evacuation drill should be done not only for campus safety but also for education against disaster as future engineers. The evacuation should be improved every year according to our ability, and stepped up to

become a part of the education program, including safety management, disaster prevention and risk management.
(3) Some students say they couldn't clearly hear the warnings. It is difficult to send such warnings over a large campus with separate laboratories and classrooms. Investment is needed not only for EEW but also in other countermeasures for disaster mitigation and education.
In future, we hope to develop a total disaster mitigation program based on our experience with the real-time earthquake information. The framework is called "the disaster mitigation campus." Our campus has an open space and buildings which have the potential for relief bases in a serious disaster. Combining emergency relief activities with the educational opportunities will yield vastly improved effectiveness on campus.

ACKNOWLEDGEMENT
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